TRAILS AS CONSERVATION: ROAD-TO-TRAIL CONVERSION IN THE RESTORATION OF REDWOOD NATIONAL PARK'S LOWER PRAIRIE CREEK WATERSHED

By

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-For Buddy-

Abstract:

A history of intensive, clear-cut logging adjacent to the historic boundary of Redwood National & State Parks (RNSP) in California's North Coast has created a post-industrial landscape within much of the present-day park. Overstocked with an unnatural composition of timber species, severely degraded habitat, and crisscrossed with a network of abandoned logging roads sets the scene for the site of the Lower Prairie Creek (LPC) Restoration Project. Remediation along this network of logging roads, in conjunction with forest thinning efforts, has begun a long-term effort to set this landscape on a trajectory towards a future stable-state condition. However, within the project site, there is currently limited opportunity for engagement through trails, and even less opportunity to understand how the story of this place, including its restoration, has shape the land.

Research Objective: *How can road-to-trail conversion and a proposed trail network in the Lower Prairie Creek Restoration Project Area at RNSP establish a precedent for documenting previous anthropogenic changes to an ecosystem while raising awareness and/or recording the benefits of ongoing restoration?*

A review of both design and redwood ecology literature, coupled with field observations, mapping and trail network development has led to an iterative design process for exploring how trail and restoration design can advance conservation in sensitive landscapes

Table of Contents

Introduction:

We consider redwood forests to be the quintessential natural landscape in America. A forest primeval, a place untouched by humans. But by every definition they are still an anthropogenic landscape in their modern form, the product of undeniable human intervention. In reality, they are not only a place within a human-dominated matrix, their creation as a designated wild landscape is intrinsically artificial. The natural and cultural processes that have produced the places that we see and continue to drive dynamic environmental change are visibly manifested in landscapes (Nassauer 2012). This visible representation can provide an opportunity to merge cultures through common experience within environmental systems. This holds true across all landscapes, even ancient redwood forests. Because of this characteristic, ecological design needs to go beyond strictly mimicking nature, and provide resilient landscapes that are the visible embodiment of societal values (Nassauer 2012). Viewing "the landscape" in this way can push us beyond the traditional interpretation of the word and the entrenched thought relating to its original, blunt meaning – defined as a portion of land or territory, both natural and human-made, encompassing what the human eye could see. Landscape as a composition of man-made spaces on the land is much more than it appears at face value (Jackson 1984). Could the landscape we value include those where we have deliberately chosen not to intervene? What does it mean when we value a landscape in its "natural state"? Can there truly be a landscape without human influence – particularly the places we have sought to preserve for their ecological or scenic value?

The history of Redwood National and State Parks (RNSP) is a synthesis of these natural and cultural values and can serve as a prime example for how we should view and use the landscapes we consider untouched wildlands. This is particularly pertinent because the post-industrial character of RNSP goes unnoticed by most visitors.

This represents the consolidation of thousands of acres of old growth redwood stands into key ecological and aesthetic destinations essentially serving as tourist attractions. What remains as RNSP today is merely a remnant shadow of the few giants spared once the lumberman set down their axe on a clear-cut landscape.

So now, a half-century since logging stopped and legislation formally protected the land, how do we view this place? Both physically and philosophically. As restoration attempts to put these overstocked, regenerated forests on a trajectory towards old-growth, stable state conditions, how can we allow visitors to engage in this landscape? For the majority of unacquainted sightseers who come to this park, how do we teach them to read the history of this place? How do we tell this story?

These questions pose an eco-revelatory design (ERD) challenge; to reconcile this landscape, there is a need for a design strategy that attempts to enhance the ecosystem function while engaging visitors by revealing ecological and cultural phenomena, processes and relationships that are affecting it (Arisoy 2018).

Redwood forests are refuge. They play a foundational role in everything from colossal carbon sequestration – acre for acre more standing biomass than any other forest ecosystem – to an indelible physical manifestation of our collective cultural identity (Van Pelt et al. 2016). They hold a wealth of Traditional Ecological Knowledge (TEK) as well as character significant to indigenous identity. From the words of writers like John Steinbeck to Woody Guthrie, redwoods are recognized as an inseparable element of national cultural significance. The social conflict that resulted in the formation of RNSP was just as much a cultural fight as it was a battle over the use of our public natural resources. Today, we are left with a landscape formed in the wake of this strife. This, coupled with increasing annual visitation rates across the entire National Park system that could further threaten the resources of RNSP, presents an opportunity for thoughtful landscape design, particularly the design of trails, to merge the cultural and natural values that previously led to this strife (O. of C. & S. S. National Park Service 2017).

The topic of this literature review and case study research is to evaluate and synthesize current thought in the fields of landscape architecture, landscape ecology, ecological restoration, and public engagement as they pertain to public lands and trail design.

This review will serve as a foundational guide to the role that trails play in uniting cultural and natural landscapes, protecting sensitive resources, and providing visitor engagement in our National Parks. Specifically, the context for reviewing the literature in these fields is to apply their findings to the Lower Prairie Creek Watershed Restoration Project at Redwood National & State Parks in far-northern California.

The organization of the following literature review will be reflective of these topics. It will be broken into three primary sections: **Natural Resources, Cultural Resources,** and **Trails & Design**. **Natural Resources** will cover a range of ecological aspects, including but not limited to: Redwood Ecology, Restoration Ecology, Landscape Ecology and papers highlighting how Climate Change will impact these systems. **Cultural Resources** will cover the historic context and primary sources relating to the study site, themes of ecological design and environmental ethics, and the history of landscape architecture in the national parks; again, this is an overview of this section. The **Trails & Design** component will synthesize literature pertaining primarily to design within protected natural areas and what limited work there is on trails more generally. Following these sections is a comprehensive analysis titled: *Lower Prairie Creek: Restoring Ecological Integrity and Sharing the History of the Landscape through Trail Design.* This section outlines a proposed network throughout the project site and the following patterns, themes and generalizations summarize how trails might be used as a vital tool in conservation, at the intersection with restoration at a landscape scale.

The literature review & case study of the Lower Prairie Creek Restoration Project at Redwood National and State Parks is meant to reveal relevant themes and approaches but is by no means exhaustive of every aspect within the respective disciplines. There are a large number of studies relating broadly to restoration ecology, landscape ecology, cultural landscapes, and design, but this review will focus on those studies that relate most directly to this project. While these individual components are well researched, their intersection with trail design represents a knowledge gap in the literature that this review seeks to highlight.

Figure 1 The mark of logging on the landscape (National Park Service, 2018d)

NATURAL RESOURCES:

Ecological Restoration -

A primary component of this project, and the motivation for the creation of a trails system within the Lower Prairie Creek Watershed of RNSP, is the ensuing restoration project that is underway to address the challenges of a logged-over landscape. This restoration project is addressing a portion of federal land within the National and State Park network near-to 10,000 acres in total extant. The 8,000 acre core that the main phase of restoration represents is comprised of a primary and secondary regeneration with significant abiotic functional disruption, such as woody debris and fill clogging creeks and overstocked stands with a species composition that favors more valuable timber species, such as Douglas Fir (*Pseudotsuga menziesii*) and Sitka Spruce (*Picea sitchensis*), a consequence of aerial seeding by the timber companies following the clear-cut. As a result of these characteristics, it is advantageous to review literature within the discipline of Ecological Restoration, specifically manuscript relating to Forest and Watershed Restoration. These will be the two primary topics of this component of the Literature Review.

History and Theory of Ecological Restoration and the Engagement of People in the Process

Ecological Restoration is an ever-evolving field that is driven and shaped by public engagement and interest in the land. The rigid, straightforward approaches to utilitarian landscape uses have shifted as we better understand ecological function and our anthropogenic impact on these systems. Significant thinkers, from Gifford Pinchot to John Muir, and Aldo Leopold to Rachel Carson have steered our collective approach toward a more ecologically in-tune view of the landscape (Nash 2014). Pinchot's 'conservation' approach, that shaped the Forest Service practices to this day, were juxtaposed to Muir's 'preservationist' understandings, more reflective of the Park Service mission, yet both were fresh interpretations of how we use the land and rely upon the natural systems that it supports. Leopold's awareness, forged in his early research and writings, ultimately summarized in his *Land Ethic* (Leopold 1949), aptly characterized this change in viewpoint.

> "One of the penalties of an ecological education is that one lives alone in a world of wounds. Much of the damage inflicted on land is quite invisible to laymen. An ecologist must either harden his shell and make believe that the consequences of science are none of his business, or he must be the doctor who sees the marks of death in a community that believes itself well and does not want to be told otherwise" (Leopold 1949)

Rachel Carson's *Silent Spring* bluntly forced people to acknowledge the direct harm that the industrialized world has on the health of the planet – something we are still seemingly failing to acknowledge in the modern climate change era (Carson 1962).

This new view, and the environmental movement it helped to spark, has fostered an appreciation and interest in the health of the land. The history and the evolution of theory of restoring ecosystems was born alongside this temporal change. Ecological restoration, a more practice-related application grounded in a recognition of the role of humans in managing ecological function, far predates the recent advent of restoration ecology, a more academic, science and theory based field.

In evaluating and understanding the role that humans have played in regulating ecosystems, there is substantial standing that these two "systems" have never operated independently since the dawn of the Holocene. This rings especially true in the landscapes of the American West.

Many of what we consider to be wild landscapes today were shaped through conscious and deliberate actions by native people in reciprocal ways of interacting with the world around them. An understanding of ethnobotany and Traditional Ecological Knowledge (TEK) in restoring landscapes cannot be understated (Anderson 2001; Anderson and Barbour 2003). What we have considered to be pristine wilderness is a direct reflection of a system of complex and profound ecological changes spurred on by indigenous actions (Anderson 2001). This shift in understanding has recharacterized first nation peoples as gardeners, horticulturalist, and plant dispersers fundamentally reorganizing the biological structure of natural communities (Anderson 2001).

Many indigenous people were intensely in-tune with their environment, to the point where they had an active hand in regulating disturbances and managing the landscape (Anderson and Barbour 2003; Kimmerer 2011). For example, the indigenous use of prescribed fire, such as those the Ahwahnechee used to manage Yosemite Valley, encouraged early successional plant communities more favorable to the grazers they hunted and plants they collected while simultaneously regulating the fire regime of the landscape (Anderson and Barbour 2003; Uprety et al. 2012). The role that TEK and Native Americans played as agents of ecological disturbance, and the disturbance regimes they determined, was what defined the landscape Europeans found when they arrived in the Americas (Anderson and Barbour 2003). Today, land managers everywhere in the United States from community forests to national parks are attempting to simulate the native management practices to reach their sustainable goals (Anderson and Barbour 2003).

This represents a gradient between "humanized" and "pristine" landscapes; a somewhat subjective use of adjectives that highlights an essential question that must be asked for the purposes of landscape protection and management (Vale 2002).

> "For any particular area of America (and anywhere else, for that matter), did (and do) the fundamental characteristics of vegetation, wildlife, landform, soil, hydrology, and climate result from natural, nonhuman processes, and would these characteristics exist whether or not humans were (and are) present?
> (Vale 2002)

These native management practices and TEK signify a wealth of knowledge and an unparalleled resource in understanding the history of a site and its past ecological conditions. Unraveling that history and using it to inform restoration decisions can be done in several ways.

1. Oral interviews and participant observations with indigenous peoples
2. Reviews of Ethnographic Literature
3. Analysis of Museum Artifacts
4. Ecological Field Experiments
5. Analysis of Plant and Animal Remains in Archeological Context

(Anderson 2001)

Conclusions drawn from these methods are cross-verified to determine the historic interactions between people, animals, and the ecosystem (Anderson 2001). These collectively contribute to a tremendous depth of knowledge for restoration practitioners to pull from. The temporal scale of TEK is unmatched and should be foundational to any proposed restoration project.

When applied to ecological restoration, TEK represents an unparalleled intersection of nature and culture. This reciprocal restoration is a positive feedback relationship, mutually reinforcing restoration of the land and culture, repairing ecosystem services that contribute to cultural revitalization (Kimmerer 2011). Focusing on restoring subsistence-use activities, cultural keystone species, traditional indigenous diets, and indigenous land management practices to benefit nonhuman relatives in the form of biodiversity simultaneously revitalizes TEK, language and culture (Kimmerer 2011). Furthermore, there is a great opportunity for exercising spiritual responsibility and the establishment of place-based, sustainable economies through this reciprocal approach to restoration (Kimmerer 2011). The opportunity for utilizing reciprocal restoration with the Yurok people in the Lower Prairie Creek watershed and throughout RNSP is evident.

A thorough evaluation of this reciprocal relationship reveals several ambiguities with how we perceive landscapes. There is a confusion that real world landscapes exist somewhere between human world and natural world, when in reality there is a gradient of overlap between the two; most landscapes considered "pristine" are defined by the conditions created through human engagement with the natural system (Vale 2002).

The concept of restoring this TEK and stewardship to the management practices of landscapes aimed at repairing ecological function far predates the term "restoration ecology," coined by John Aber and William Jordan III of University of Wisconsin (UW) - Madison (Jordon III and Lubick 2011). As Jordon and Lubick point out, this historical line is blurred when viewed through the lens of indigenous human engagement with nature around the globe (Jordon III and Lubick 2011). Intentional human changes to the nonhuman environment can be attributed to cultural and religious traditions over the last 120,000 years; these are the basis for the elements that make up the field of restoration ecology today (Jordon III and Lubick 2011). In this context, some of the earliest modern restoration practices where conducted by federal agencies and programs, such as the Civilian Conservation Corps (CCC); work by Professor John T. Curtis, his graduate students, and CCC workers in 1936 documented and restored tallgrass prairie species in the UW – Madison Arboretum (Curtis 1971) (Jordon III and Lubick 2011). These became the first, formal iterations of the official, recognized field.

Practices developed at the Curtis Prairie of the UW Arboretum, and by other UW – Madison faculty such as Aldo Leopold, laid the foundation for the expansion of the field into the broader areas of conservation and land management. Projects, such as the Fermi National Laboratory Tallgrass Prairie, engaged non-governmental organizations (NGO) in restoration; in 1974 The Nature Conservancy (TNC) applied these concepts to the 260 hectare government site (Fermilab 1971). Recognizing natural processes, such as the indigenous use of fire in maintaining ecosystems, has increased to a more mainstream awareness.

Nonetheless, there is still a significant gap between how policies and restoration efforts are implemented and what the science says; this difference between knowledge and action can be addressed by increasing the general understanding of ecological processes of the system being restored (Brancalion and van Melis 2017). Listening to academic researchers, facilitating discussion between them and those applying the methods at NGOs – like The Nature Conservancy (TNC), policy makers, and other practitioners should be reinforced through a network with flexibility (Brancalion and van Melis 2017). This goes both ways, the practical limitations of those who are tasked with carrying out research-based restoration actions are inevitably limited by the resources available to them. “Recognizing that scientific research is just one ‘piece of the puzzle,’ that knowledge is co-created by all project members into action” is an important step in any restoration project and the evolution of the field (Brancalion and van Melis 2017). This can be done by establishing a mutual trust that manages the successes and failures of a project as learning experiences (Brancalion and van Melis 2017).

Restoration projects rarely start with a blank slate, landscapes have continuously changed and evolved over the centuries, or in some cases millennia, of human influence (Bell 1995). An important recognition is that the latest changes to the land have just come at a faster rate, resulting in a composition of biotic and abiotic conditions that are less reflective of the constraints that previously defined the landscape (Bell 1995). This is even more true as historic climatic trends have been altered by human activity. Utilizing the historic conditions of an ecosystem as a restoration goal, or even reference point, is dubious when considering global climate change (Crow 2012).

To evaluate and define an aesthetic and ecological condition going forward, determining these preceding influences and conditions are essential to assessing the goodness-of-fit of a proposed restoration design (Bell 1995). In fact, many view the implementation of restoration objectives as fundamentally a value-based, not scientific, activity (M. A. Davis and Slobodkin 2004). This can lead to conflicting opinions surrounding public engagement and the interpretation of a site. Whether stakeholders are “knowledgeable, helpful, disinterested, or antagonistic" towards a project is often a function of outreach and education (Monroe 2004). Involving citizens in the act of natural resource management, through these communication strategies, can be essential to the success of a project (Monroe 2004). This outreach can pose challenges, but establishing a two-way dialogue between communities and those directly involved in the project is critical (Monroe 2004). This is including ongoing interpretation of the work that is being done. As Davis and Slobodkin propose in their definition:

> "Ecological Restoration is the process of restoring one or more valued processes or attributes of a landscape" (M. A. Davis and Slobodkin 2004)

Therefore, we are forced to confront the valued processes through the lens of the stakeholder. What are the priorities of the community in-which the proposed project will occur? What will their response be to the proposed objectives and goals? And how can this be enhanced or mitigated through interpretation and communication? One may also ask: what are the 'hidden' processes that hold value, and are worth restoring, that may not be immediately evident (such as groundwater-recharge, riparian buffering, regulating nutrient cycling, etc.). The ultimate goal is setting a landscape on a positive trajectory where ecological function increases overtime in a sustainable pattern. In forest restoration, as the ensuing *Forest Restoration* section will address, this is focused on setting a successional trajectory towards a steady-state community.

It should be recognized that the development of this field has been filled with its own moral challenges too.

> "As its history makes clear, eco-centric restoration is an elusive idea that entails troubling contradictions and ambiguities, challenging not only the land manager but also the environmental philosopher" (Jordon III and Lubick 2011)

As Almassi highlights, this has come with both praise and criticism; ethicists have debated whether it is an admirable endeavor or the “impossible, arbitrary, domination or delusional” type of thinking that created many environmental problems in the first place (Almassi, 2017). He points to critics’ characterization of the field (and general debates surrounding the ethics of ecological restoration) as “scholastic quibbling” and contrasts it with measurable/calculable outcomes of improved ecological function. Almassi’s argument that ecological restoration differs from conservation biology and land development morally in that its direction and meaning are only found in “environmental degradation or destruction” is challenged by his own counter-argument, He notes “the power and appeal of restoration is that it enables a constructive response to harm or wrongdoing,” of which there is no shortage, “with tangible, measurable ecological and human benefits (Almassi 2017). We must face the truth that we are inexplicably intertwined with the environmental quality of the land, on a global scale. Restoration ecology represents a real outlet for addressing, regulating or mitigating the harm that is inflicted – or, to iterate, as Leopold stated at the birth of this ethical debate, ecologists can serve as the “doctor who sees the marks of death in a community.” The assertation that ecological restoration is morally unfounded since its existence relies upon the destruction of the nature it seeks to repair is a disconnected and unrealistic view. As Almassi suggests, restoration is needed to repair past damages: “Ideally we never do ourselves, each other, or nature wrong; but we have, we do, and we will, and so we need environmental-ethical guidance applicable to life *after* injustice and wrongdoing” (Almassi 2017). On top of this reality, many restoration projects can serve to be both culturally and ecologically reparative, while ethically clarifying (Almassi 2017). The history of ecological restoration and human responses suggest that it can actively nurture a positive relationship with nature. Its goals and objectives highlight the harms that we have done, but also provide us with reconciliation and restitution. This optimistic view holds the power to motivate beyond an initial project into the physical embodiment of the sentiment surrounding global environmental change and the nature-restoration movement.

Forest Restoration

Forest restoration, as a subset of restoration ecology, is grounded in the understanding of forest ecosystem ecology. Contemporary forest restoration is focused on improving ecosystem function (Stanturf, Palik, & Dumroese, 2014). The objectives and strategies for obtaining these goals are done primarily through rehabilitation, reconstruction, reclamation, and replacement. Forest restoration, as mentioned more generally in the history of restoration ecology, is aimed at creating an environment in which the forest is set on a successional trajectory to an established, desirable, or defined historic condition. Many of the actions that have led to the current condition of the forest have compounding effects, for example, the removal of logging roads throughout RNSP is aimed at reducing erosion, landslides, and ultimately sediment deposition in sensitive watersheds with anadromous spawning habitat. Specifically in redwood stands, attempting to restore ancient forests to their old-growth condition is hindered by an overwhelming time-scale. Creating the most advantageous conditions to speed up this succession and set the forest on a trajectory toward a steady-state environment becomes the primary objective. These four above-mentioned strategies are the principal ways these challenges are addressed and each is described below.

In forest ecosystems, rehabilitation is the restoring of desired species composition, structure, or processes to the existing, degraded ecosystem (J. A. Stanturf, Palik, and Dumroese 2014). Forests may be degraded for a myriad of reasons, and the processes of augmenting or removing the existing species is one method to restore these ecosystem processes to an historically accurate composition and role (J. A. Stanturf, Palik, and Dumroese 2014). There are many methods used by land managers to implement rehabilitation of forests. This ranges from mechanical forest thinning to restoring the historic fire regime; these methods influence everything from canopy structure and age to landscape hydroperiod and the volume of biomass locked in forest deadwood (J. A. Stanturf, Palik, and Dumroese 2014). These methods are pertinent to the restoration of RNSP in developing a more resilient, heterogeneous forest across the landscape. Reconstruction, on the other hand, is beginning with a landscape that is currently under another land-use, such as agricultural. This is done by reestablishing native plant communities to address soil health, hydrology, nutrient cycling, and other processes that do not exist on the land following its other resource uses (J. A. Stanturf, Palik, and Dumroese 2014). A comprehensive understanding and evaluation of the site history and historic uses is foundational (Grese 2017). Reclamation pertains to a more intensive degradation of the land, which is typically devoid of vegetation. This can be the result of resource extraction and other industrial impacts to the landscape (J. A. Stanturf, Palik, and Dumroese 2014). Lastly, replacement is the strategy of adapting restoration practices to changing environments. Challenges, such as global climate change, force land managers to replace locally-adapted genotypes with new species, genotypes, or technological integration, thus creating novel ecosystems (J. A. Stanturf, Palik, and Dumroese 2014; Hobbs et al. 2006). Restoration here is not simply an attempt to recreate a historic condition, but rather about looking toward the future resiliency of the system. This concept overlaps the practices of assisted migration, resulting from the need to adapt to environmental changes occurring at a rate beyond plant migration capabilities (Williams and Dumroese 2013). Assisted range expansion is, in part, reliant upon seed-transfer and other similar practices beyond historic ranges, depending on species and site specifics (Williams and Dumroese 2016).

Macroscale properties have been proposed to monitor forest restoration practices in temperate regions (Keddy and Drummond 1996). While the research by Keddy and Drummond in their 1996 paper, *Ecological Properties for the Evaluation, Management, and Restoration of Temperate Deciduous Forest Ecosystems*, pertains specifically to deciduous forests, these core principles still apply to the temperate forests of coastal northern California and other similar ecoregions. The properties they propose to monitor for forest restoration are as follows:

1. Tree size
2. Canopy composition
3. Quality and quantity of course woody debris
4. Number of spring ephemeral species in the herbaceous layer
5. Number of typical corticolous bryophyte species
6. Density of wildlife trees
7. Fungi
8. Avian community
9. Number of large carnivores
10. Forest area

(Keddy and Drummond 1996)

These principles allow for the prioritizing of conservation sites following the initial recognition, ranking and protection of key forest areas. Additionally, monitoring these forest properties can aid in the assessing of changes in the forest and evaluate the direction of restoration efforts and need for additional alterations (Keddy and Drummond 1996). Lastly, these properties enable land managers to evaluate the effective harvesting methods and determine those that cause the intended alteration to ecosystem structure and function (Keddy and Drummond 1996). Site-specific characteristics, such as soil, slope aspect, moisture availability, herbivory, disease, and individual plant or community traits are essential considerations that need to be evaluated in any forest restoration initiative (Grese 2017).

The dynamic nature of ecosystem processes is easily altered by the demographic responses to a myriad of stressors, such as invasive species introduction, herbivory, and external nutrient inputs (Dávalos, Nuzzo, and Blossey 2014). There are prevalent but unpredictable interactions between these stressors that require an in-depth analysis of concurrent environmental forces (Dávalos, Nuzzo, and Blossey 2014). Balancing the available knowledge about the system under restoration with the limited resources available can pose a challenge to any restoration project, and can force practitioners to prioritize their energies and goals. It is important to note that recreational uses, such as trail erosion from mountain biking, trampling, and harms resulting from vandalism can influence forest restoration efforts, which is particularly pertinent to the RNSP Lower Prairie Creek Project and proposed trail network (Grese 2017) (Youngblood 2018).

Broadly speaking, restoration methods are reflective of the tools available to a land manager (J. A. Stanturf, Palik, and Dumroese 2014). For example, adding vegetation can be an effective restoration technique, but it is also a response to the available plant materials. Adjusting composition, structure, and ultimately ecological function is an artifact of resource, therefore, restoring the role of natural disturbances such as fire and flooding can be integral to long-term forest sustainability (J. A. Stanturf, Palik, and Dumroese 2014). These practices, while relating to stand-level design, are scalable to the landscape; restoration is not undertaken in a social vacuum, and depends upon the systems of governance that regulate the relationships between stakeholders (J. A. Stanturf, Palik, and Dumroese 2014). These key agents highlight the fact that social considerations precede biophysical factors in defining the degree of restoration that is possible (J. A. Stanturf, Palik, and Dumroese 2014).

As a result of these socioeconomic considerations, serious questions need to be addressed in any forest restoration project. Asking whether restoration activates are actually beneficial to the landscape and its ecological integrity is vital to lasting positive impact (R. Brown et al. 2007). Decisions to enact large-scale restoration projects can be motivated by decision-makers, ultimately to feeble ends. For example, Federal Agencies have, at times, had reactionary, questionable restoration projects enacted at national scales, such as responses to wildfires in the American West in the 1990s (R. Brown et al. 2007). Therefore, it is important to ensure that restoration projects are founded upon scientifically credible principles and criteria, and have strong citizen engagement, particularly when it comes to federal public lands (R. Brown et al. 2007). The core restoration principles, as they relate to forest restoration are as follows:

1. Ecological Forest Restoration
2. Ecological Economic Principle
3. Communities
4. Work Force Principle

(R. Brown et al. 2007).

These principles are aimed at restoring natural processes and resiliency, develop economic incentives aimed at protecting or restoring the ecological integrity of the landscape, and utilizing a highly skilled, well-compensated community workforce to carry out the restoration project (R. Brown et al. 2007; National Park Service 2018d).

Figure 2 Forest Thinning in RNSP (Wheeler, 2018; National Park Service, 2018d)

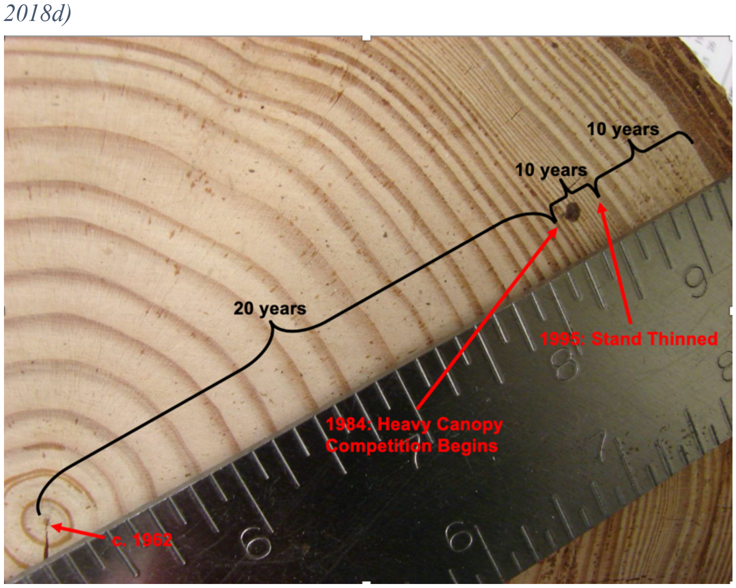


Figure 3 Redwood Vigor Before & After Thinning (Wheeler, 2018; National Park Service, 2018d)

Lastly, and more specific to the Lower Prairie Creek (LPC) restoration project at RNSP, is the concept of variable-density thinning. This process, developed by researchers at the park and throughout the Pacific-northwest who faced the challenge of dense thickets of timber-valued species left behind by the industry's aerial seeding efforts, is RNSP's primary approach to forest restoration.

While much of the landscapes' modern conservation history has been focused on removing the saw from the land, thinning has taken the controversial step of returning cutting to these already logged-over areas, in an effort to more closely mimic natural forest regeneration.

In this process, the forest is broken down into plots, where trees are randomly selected to be removed. This isn't only the selection of the weakest or least impressive on the landscape – here foresters are seeking a randomized range of sizes (by diameter at breast height - dbh) that creates a more complex forest canopy and understory [See Fig. 2, 3] (Keyes, Perry, and Plummer 2010; Leonard, Berrill, and Dagley 2016). These efforts are aimed at stand structure, species composition, vigor and fuel loading.

In Redwood National Park the goals of this restoration are:

Primary:

- Restore more appropriate balance in overstory species composition.
- Promote vigorous tree growth (accelerate canopy development, increase stem diameters).
- Increase understory diversity (increase vertical and horizontal structure to increase biodiversity).

Secondary:

- Reduce old-growth forest edge
- Increase connectivity of disjunct old-growth forests.

These efforts are also focused on removing those species that would not have naturally occurred in certain areas of the park, primarily *P. menziesii* and *P. sitchensis.* A particularly interesting aspect of this type of forest restoration, is the thought that it could pay for itself. By allowing loggers to take what they thin from the forests to the sawmill, the overall cost of this project can be greatly reduced. It is worth noting that this has led to some hotly debated gray-areas in resource usage on National Parks lands.

Watershed Restoration

There is overlap in the principles, challenges, and barriers of watershed restoration and the aforementioned forest restoration. Particularly with projects like the Lower Prairie Creek Restoration, there is concurrent forest and watershed repair underway. Although it is not always the primary focus of forest restoration projects, improving forest quality simultaneously improves watershed health (Calder 2007). These efforts can regulate flooding, increase dry season flows through improved infiltration rates exceeding evapotranspiration rates and increase groundwater recharge, reduce erosion, and improve water quality (Calder 2007).

The primary motivator for improving watershed quality and function in projects like those at RNSP are to improve the health of anadromous fisheries by focusing on improving habitat for spawning salmon. This is typical of projects in the Pacific Northwest, but it essential that planning accounts for future scenarios under climate change. These changes are integrated by factors of local and regional climate, land cover, hydrology, and species population dynamics (Battin et al. 2007). Changes to precipitation patterns will likely cause spatial shifts in salmon abundance, therefore focusing watershed restoration on habitat improvement and protection can help to mitigate the effects that reduce resilience and adaptability of salmon populations under a changing climate (Battin et al. 2007).

As with forest restoration, there are limitations to any watershed restoration project. Millions of federal and private dollars are allocated annually to stream habitat improvement in the Pacific Northwest aimed at increasing fish populations (Roni et al. 2004). To effectively use these resources, its essential that the principles of watershed processes are fully understood, the existing high-quality habitat areas are protected, and decision-makers rely upon up-to-date scientific information pertaining to restoration practices (Roni et al. 2004).

As habitat connectivity is restored, ongoing management efforts should focus on hydrologic, geologic (sediment delivery and routing), and riparian processes (Roni et al. 2004). This includes road decommissioning and maintenance, livestock exclusion, and other riparian zone enhancements (Roni et al. 2004). In-stream complexity can be enhanced through the addition of wood, boulders, nutrients and sediment removal (Roni et al. 2004). Again, this is relevant to the removal of logging roads throughout RNSP to improve watershed health and in the establishment of a trails network. Clogged channels left by logging companies have virtually blocked a majority of streams and tributaries to Prairie Creek, a key focus of the overarching restoration. Following the application of these methods and objectives, on-going monitoring should occur regularly to better understand the biophysical function of the watershed and inform any future restoration efforts (Roni et al. 2004).

Landscape Ecology & Restoration

The field of landscape ecology is born from a broader ecosystem understanding of ecological function. It aims to comprehend the effects of spatial configuration of mosaics on a wide variety of ecological phenomena, both biotic and abiotic (Wiens et al. 1993). Understanding how these phenomena are carried out across landscapes represents an invaluable asset in effective resource management and is foundational to the field of conservation (Wiens et al. 1993).

The primary and secondary regenerated forest throughout most of RNSP represents a low-quality forest matrix connecting two old growth patches (Prairie Creek & Redwood Creek). For this reason, it is relevant to review literature relating to landscape ecology, and how restoration and increased connectivity of these patches through the regenerated forest matrix will increase ecosystem function.

> "Landscape ecology, with its emphasis on pattern and process at large spatial scales, when combined with ecological restoration creates the potential for a 'big picture' approach to supporting restoration activities and to aiding the related decision-making that occurs. Landscape ecology provides a useful contextual framework for considering the many dimensions of restoration – historic, social, cultural, political, aesthetic, moral, and ecological – that are implicit in the above questions. Landscape ecology also adds an important spatial component to the practice of restoration." (Crow 2012)

Landscape ecology evaluates the ecological consequences of environmental heterogeneity or patchiness in spatially explicit terms (Wiens et al. 1993). This can be evaluated through a number of metrics or measurable features across landscape mosaics. These include:

- Size distribution
    - Frequency distribution of sizes of patches of a given type
- Boundary form
    - Boundary thickness, continuity, linearity (e.g. fractal dimension), length
- Perimeter: area ratio
    - Relates patch area to boundary length; reflects patch shape
- Patch orientation
    - Position relative to a directional process of interest (e.g. water flow, passage of migrants)
- Context
    - Immediate mosaic-matrix in which a patch of a given type occurs
- Contrast
    - Magnitude of difference in measures across a given boundary between patches
- Connectivity
    - Degree to which patches of a given type are joined by corridors into a lattice of nodes and links Richness Number of different patch types in a given area
- Evenness
    - Equivalence in numbers (or areas) of different patch types in a mosaic (the inverse of the degree of dominance by one or a few patch types)

- Dispersion
    - Distribution pattern of patch types over an area
- Predictability
    - Spatial autocorrelation; the degree to which knowledge about features at a given location reduces uncertainty about variable values at other locations

(Wiens et al. 1993)

These metrics, and an understanding of mechanistic ecological function in the context of landscape ecology can be used to solve challenges in reserve design (Simberloff 1988), habitat fragmentation (Saunders, Hobbs, and Margules 1991), and biodiversity maintenance (Wilson and Peter 1988), shaping the future of conservation ecology (Wiens et al. 1993).

A question to be asked here is: how does this pertain to the urban context of the landscape in question; does culture need to be taken into consideration (Wu 2010)? In recognizing that humans currently appropriate approximately 24% of the planets terrestrial net primary productivity (NPP), and virtually every landscape's ecosystem has been influenced or "domesticated" by humans there is a profound need to evaluate the human role in shaping ecosystems at a landscape level (Kareiva et al. 2007; Haberl et al. 2007; Wu 2010).

While not a conventional example of a human-dominated landscape, the historic impacts to ecological function, forest NPP, and the present-day initiative to restore these characteristics across the landscape highlight the cultural context in which this must be evaluated. These components, analyzed in the Cultural Resources section of this review, highlight the intertwined quality of nature and culture on ecological phenomena across the landscape of RNSP. To effectively restore the ecosystem, these qualities need to be evaluated at a landscape level.

Redwood Ecology

Redwoods themselves are ineffable. They are of an ancient genus that dates back to the Cretaceous Period, when dinosaurs dominated the animal kingdom (Sawyer et al. 2000). Their role as a natural feature in our cultural landscape is tantamount to that of Mount Everest and the Blue Whale (Noss 2000). The threat of the lumberman's axe pushed this ecosystem to the brink of disappearance from the face of the earth (something that will be visited in-depth in the Cultural Resources portion of this Literature Review). While today the species itself may be protected in iconic state parks, preserves, and even a National Park bearing its name, these forests are far from being secured resources. There is mounting evidence that redwood forests cannot perpetuate themselves in small, isolated stands across human-altered landscapes – which is what the majority of their historic range looks like today (Noss 2000). Redwoods are so massive that the loss of connectivity amongst ancient groves can impact the greater forest. There is indication that when fragmented stands are isolated they lose their ability to maintain diversity and even propagate new, giant trees (Noss 2000). The loss of the largest individuals in a grove, with the most complex crown structure, causes water stress, since the moisture captured from the fog by those individuals is immediately lost (Noss 2000). The forests that these giants support are comprised of far more than just big trees; a "bewildering," intricate community of life depends on their existence (Noss 2000). "Fungi, lichens, liverworts, vascular plants, earthworms, millipedes, mollusks, insects and salamanders" occur just in the canopy environments of the largest Coast Redwoods – not to mention the life that exists in the forest strata below the 'tallest-trees-on-earth' (Noss 2000).

Figure 4 Redwood range, current & historic extent (Spence 2011)

Even though the species itself may not be in *immediate* threat of extinction (it is currently a listed endangered species), the ecosystem it supports, as we know it, is under attack (Farjon and Schmid 2013; Noss 2000) . Since European arrival to North America, the extent in area of Redwood forests has declined by 95 percent (U.S. Fish and Wildlife Service 1997). For these reasons, it is imperative that we address the recovery of logged-over forests, such as those targeted in the Lower Prairie Creek Restoration site at RNSP, through forest restoration.

Fire Ecology & Other Disturbance Regimes

In general, California's redwood forests have long been associated with a moderately frequent to frequent fire regime (Norman 2007). There is widespread knowledge of indigenous use of fire across California, but the frequency of its intentional usage in Redwood Forests is uncertain (Striplen 2014) (Varner and Jules 2016). The occurrence of fire generally is more often associated with the southern extent of the species range (Norman 2007). In Northern California, the frequency is thought to be much less because lightning strikes are infrequent and the cooler, moist climate is less conducive to the spreading of large-scale fire (Norman 2007). Analysis of samples by Brown and Swetnam have given some insight dendrochronologically to the historical fire regime of the area near Redwood National Park (P. M. Brown and Swetnam 1994). Their methods outlined a suggested approach to evaluating specific redwood forests using tree cores and assessing fire-scars.

The redwood itself is a remarkably fire-adapted species; it's thick, fibrous bark is resistant to ignition and its seed germination requires the bare mineral soil conditions provided following fire (Noss 2000). Records of surface fires in 1894 and 1974 within the old-growth stands of Redwood National Park show marked growth increase following this disturbance (Noss 2000). Studies have also shown that following fire, basal resprouts are abundant; even trees under 20 cm dbh that were top-killed by fire resprouted vigorously (Noss 2000). Impacts on stand structure following surface fires have been proven inconsequential, however they have been shown to reduce competition, depending on slope, aspect and intensity of the disturbance (Abbott 1987; Noss 2000). The wide range of fire-return intervals suggests this disturbance has a variable influence on the structure and composition of redwood forests, varying throughout their range (Noss 2000).

> "Natural fire frequencies vary substantially among redwood forests in different areas, ranging from 6 to 600 years. Generally, fire-return intervals are longest near the coast and shortest inland. Fire frequency also varies naturally within a landscape, depending on exposure and moisture conditions. Fire therefore has a variable influence on redwood stands, ranging from very strong to virtually nonexistent" (Noss 2000)

> "Holocene sediments containing redwood pollen also frequently contain charcoal, an indication of fire, and human artifacts. This evidence, together with the oral history of the Yuroks and other native peoples of the redwood region, suggests that these people burned many of the redwood forests fairly regularly. How strong was the influence of Indian burning compared to lightning set fires? What does this influence

suggest for management of redwood parks today? We still lack definitive answers to such questions" (Noss 2000)

Establishing a universal understanding of redwood forests relationship to fire remains enigmatic (Varner and Jules 2016). This represents a major gap in our understanding of how best to conserve, manage and protect redwood forests (Varner and Jules 2016). Since frequent, low intensity fires do not leave significant scars, past research using dendrochronology may have under-represented the frequency of these burns – particularly the low intensity fires that may have been practiced by native peoples. Perhaps looking to the indigenous cultural relationship with fire and their TEK specific to a localized forest or redwood stand can shed light on how best to utilize fire as a tool for restoration.

In addition to fire, wind and flooding also represent a frequent disturbance regime throughout the coast redwoods range. In far-northern California, along the Pacific coastline, windstorms are a particularly regular phenomenon (Noss 2000). This not only induces tree-falls, emphasized by the species unparalleled height, but can impact forest and canopy structure due to the development of "reiteration-falls" (Noss 2000). This is when large sections of the canopy in a mature tree are lost, impacting everything from the tear-out on the remaining trunk and broken branches that resprout giving rise to new trunks, to the volume of course woody debris on the forest floor (Noss 2000). As these tear-outs occur, the wounds provide entry points for wood-decaying fungi, creating hollows within the ancient trunks which are then colonized by terrestrial vascular plants, including woody shrubs (Noss 2000). This repeated pattern over time can lead to the widening of an individual trees canopy, resulting in multi-trunked trees.

Flooding disturbances, on the other hand, impact the lower-lying alluvial flats where many of the largest coast redwoods are found. Flooding also leads to resprouting, and can cause large trees to be uprooted and buried in sediment and the river changes course (Noss 2000).

Figure 5 Black Bear Damage on a Juvenile Redwood (Jack Pritchard 2018)

Lastly, animal damage is another frequent disturbance in redwood forests. While not able to kill mature trees due to their chemical protection through tannins and volatile essential oils, insects infest redwood trees and can impact the rate of growth &/or reproduction throughout a stand by targeting specific physiological characteristic, such as cones (Roy 1966). Mammals too damage young redwoods. Black bears frequently strip the bark from small trees to access the sugar-rich sap flow following winter hibernation, while black-tailed deer browse redwood sprouts (Roy 1966; Noss 2000). Bears cause the greatest damage, targeting young trees from 25-50 cm dbh (Giusti 1990). This is a frequent disturbance throughout the Lower Prairie Creek Restoration site and one that will undoubtedly impact the restoration of the second growth forest here [See Fig. 5].

Conservation & Management of Redwood Forest: Biodiversity, Carbon Sequestration and the Ecological Legacy of Logging

Conservation leaders have highlighted three key challenges in the conservation and management of redwood forests throughout their historic range: preservation of biodiversity, the need to work at a landscape scale, and the gradient of socio-economic communities across the historic range.

Broadly speaking, redwood forests today are *not* the quintessential example of a diversity-rich ecosystem; they are stripped to a fraction of their historic extent, representing a millennia-long effort to restoring biodiversity throughout their range (Cooperrider, Day, and Jacoby 1995; Fox 1996). A consensus in the conservation community has emerged mirroring a landscape ecology approach to ecosystem management (Ricketts et al. 1999). Working at a broad geographic scale to preserve the biodiversity of redwood forests, and the ecoregion of the Pacific Northwest, shows many localized variations in both social and natural systems across the specie's range. In the same way that the description of disturbance regimes varies across the northern and southern extent of *Sequoia sempervirens*, so too does the biotic and abiotic conditions that dictate the composition of species and ecosystem function. The socioeconomic variation of the communities throughout this range also varies dramatically (Noss 2000). This is reflected in local attitudes concerning the redwood and environmental conservation at large. This also represents a primary hurdle to conservation of the redwood and one that will be analyzed as it comes to light in the Cultural Resources section of this literature review.

This challenge of fragmentation across the redwood (and other keystone species) range has led ecologists to argue for bioreserves (Cooperrider, Day, and Jacoby 1995). This, in large part, is what the collaboration between national, state, and tribal agencies at RNSP represents.

Goals and Objectives of the Bioreserve Strategy:

1. To represent in a system of protected areas, all native ecosystem types and seral stages across their natural range of variation
2. To maintain viable populations of all native species in natural patterns of abundance and distribution
3. To maintain ecological and evolutionary processes, such as disturbance regimes, hydrological processes, nutrient cycles and biotic interactions
4. To manage landscapes and communities to be responsive to short-term and long-term environmental change and to maintain the evolutionary potential of the biota (Noss and Cooperrider 1994)

(Cooperrider, Day, and Jacoby 1995)

Recognizing the ecological harms and degradation that has occurred throughout the redwoods range is an essential first step to setting these forests on a trajectory to a desired condition.

Particularly pertinent to RNSP is the history of logging on the landscape. Intensive resource extraction and road building in the park not only reduced biomass but also harmed terrestrial habitats through:

1. Loss of old-growth habitat
2. Fragmentation of remaining mature stands
3. Displacement of species dependent upon mature trees or dead wood
4. Alteration of tree stand composition
5. Long-term loss of soil fertility
6. Removal of riparian vegetation
7. Soil erosion and disturbance
8. Streambank erosion
9. Altered streamflow regimes
10. Loss of stream shade
11. Increased sediment loads in streams

(Cooperrider, Day, and Jacoby 1995)

This legacy of logging as an anthropogenic disturbance on the landscape has left its indelible mark, even on portions of RNSP that were considered preserved. A 2001 study of the park, including a portion of the area in which the current Lower Prairie Creek restoration is taking place, showed that, due to edge effect, the extent of functional, old-growth habitat is a fraction of what it's thought to be (Russell and Jones 2002).

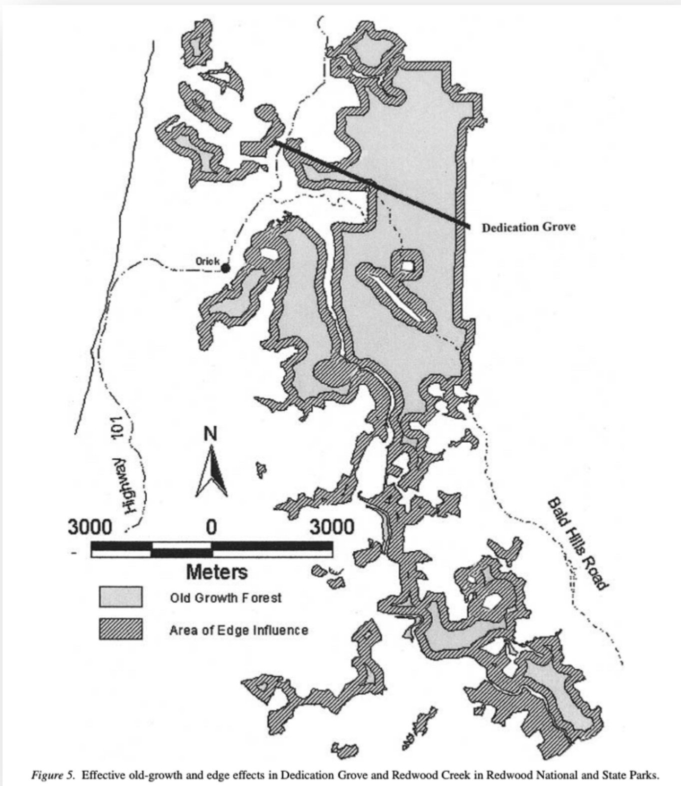


Figure 6 Effective old-growth and edge effects RNSP (Russell & Jones, 2002)

Areas that are primary gathering places for visitors, like the Dedication Grove and Trillium Falls do not function as old-growth habitat as a result of edge effect [See Fig. 6] (Russell and Jones 2002). In fact, their research showed that within their study area, 53% of the old-growth preserved was influenced by edge conditions, "leaving 47% as effective old-growth" (Russell and Jones 2002). Perhaps this shows a confliction/challenge between the aesthetic quality of a site and its ecological quality. Universal measures of the botanic community, such as Floristic Quality Assessment Index (FQA), could serve as a viable metric for this evaluation across old-growth and second-growth redwood forests (Freyman, Masters, and Packard 2016).

One area that research is just beginning to uncover is the ecosystems that exist 300’ up in the canopy of the redwood. Perhaps this could be used as a measure for biodiversity and restoration aims, since certain species only exist in the tops of old-growth individuals? How can visitors to the park interact or engage with these spaces? Are these stories that can be told?

Furthermore, this ecological legacy of logging leading to a disconnected, spread-out nature of the modern day park emphasizes the need for a landscape ecologists approach to repairing the scars on the land. Considering connectivity, evenness, and other measurable characteristics spatially distributed across the landscape mosaic spanning Del Norte & Humboldt Counties is essential in evaluating the effectiveness of any restoration efforts.

A major challenge hindering this connectivity is the aforementioned over-stocked stands that exist in the areas where the most intense, clear-cut logging occurred. Aerial seeding has led to a composition of species that does not represent historic conditions. Moreover, the marks of logging are evident, if you can recognize them. Scars remain in the form of an extensive road-network and benches, log-decks, abandoned equipment, slash and coarse woody debris. All of these characteristics represent qualities foreign to the old-growth groves. The truth is, in its current form, environmental policy and legislation may evoke the image of preserving our nation’s redwood forests, but the land tells another story. If stakeholders seek to ever return the logged-over sections of RNSP to a functional ecosystem on a landscape or regional scale, and secure the earth last remaining strongholds of redwood forest, they must address these aspects of human disturbance.

Natural Resources Challenges & Summary:

The key natural resources challenges to the management of redwood forest, as this review has shown, relate to ecosystem function at a landscape level following logging and other human disturbances on the land. Specifically, restoration ecologist must target the occurrence of edge effect and connectivity in the remaining old-growth stands. Road removal and comprehensive watershed restoration, across a complex network of drainages, that minimizes future erosion and mitigates the sediment that has been deposited in critical spawning habitat over the last half-century is vital to the restoration of ecosystem function at this landscape scale. These are already a stated goal of the LPC Restoration project. In doing so, thinning of over-stocked stands and interrupted or misunderstood disturbance regimes must be restored on the landscape, providing the opportunity for biotic-complexities across the forest strata to return. This process should be directly informed by the TEK of the Yurok people, and grounded in what current scientific understanding is available. That being said, there is also a great role for visitors, volunteers, and citizen scientists to play in the management of these forests following the initial variable-density forest thinning. The invaluable resource that these groups represent will mirror that of the reciprocal restoration and relationships found in TEK. The design and implementation of a comprehensive trail network throughout the LPC site will provide both recreation and the opportunity for direct engagement and monitoring by the public. This will ensure the preservation of biodiversity at a landscape scale, while simultaneously telling the story of the socio-economic communities found across the redwood's historic range – communities that shaped the course of the redwood-human relationship. This information can inform future management efforts and address the key ecological challenges to the management of redwood forests.

CULTURAL RESOURCES:

Landscape Architecture, Ecological Design & History: Where ecology, place, and conservation overlap

Landscape architecture, ecological design, and history overlap at the intersection of science, design, and engagement. An overview of the history of landscape architecture in the National Parks, ecological design, and the site history informing the development of a trail design theory frames an environmental ethic guiding effective landscape management. These elements have been explored individually, gradually and in-depth over the last century and a half, but placing them at the juncture of restoration ecology and trail design theory represents an area of study ripe for future exploration and research.

The History of Landscape Architecture in the National Parks

While seemingly centered on the design of urban or human-dominated landscapes, the history of landscape architecture if profoundly intertwined with the history of the National Parks and the wild landscapes of the American West. An overview of American landscape architecture history reveals key themes of naturalism and design that became integrated into the origin of and early planning by the National Park Service

Arguably the greatest, and earliest example is the work of Frederick Law Olmsted in the formation of America's parks. The acclaimed designer of New York's Central Park and noted "Father of Landscape Architecture" was instrumental in the creation of nationally owned, federally managed public landscapes (Carr 1998). One of the clearest and most commonly pointed-to examples is the creation and early management of what is now Yosemite National Park. Far prior to a unified National Park system, California's Yosemite Grant was the first federally owned place set aside specifically for the preservation of its scenic landscape beauty (Carr 1998).

While a somewhat uncontested or even obvious argument in modern conservation and landscape architecture, at the time this concept was wholly new. In cities, Olmsted pushed the field of design into an appreciation of natural stylings, creating "scenic" beauty. But what he saw in the mountains of California was a landscape so unique that only preservation seemed appropriate in managing its resources and protecting its potential benefits:

> "it is a scientific fact that the occasional contemplation of natural scenes of an impressive character … is favorable to the health and vigor of men and especially to the health and vigor of their intellect beyond any other conditions which can be offered them."
>
> "without means are taken by government to withhold them from the grasp of individuals, all places favorable in scenery to the recreation of the mind and body will be closed against the great body of the people"
>
> (Noss 2000; Olmsted 1865)

As Ethan Carr points out in his influential work on the subject, *Wilderness by Design*: *Landscape Architecture and the National Parks* "it's harder for us today, perhaps to understand the commonalities between Central Park and Yosemite Valley." Going on to say that, "issues of urban park systems seem distant from those of wilderness preservation. In the 19th century, however, both parks expressed the cultural value placed on scenic landscape beauty.” (Carr 1998). To understand this perspective, we must trace the early history of the field of landscape architecture to this point of holistic landscape conservation, and understand more completely the origin of concepts we consider inherent today.

The idea of a “landscape park,” evolved from a shift in the fledgling field of western landscape architecture. The design of formal estate gardens for English nobility transitioned into ideas and contributions of ‘landscape gardening,’ led by the works of Lancelot “Capability” Brown (1716-1783) and Humphrey Repton (1752-1818), who promoted the concept of aesthetic appreciation for the English countryside (Carr 1998).

While seemingly distant from the conversation of landscape conservation and California’s redwoods, the design contributions of Brown and Repton greatly influenced the work of American landscape architects, such as Calvert Vaux and Olmsted in their work on Central Park, which laid the groundwork for modern conservation. The massive terraces and elaborate knot gardens of English Estates that extended “architectonic spaces,” connecting the architecture to the surrounding landscape, were accompanied by ancient hunting parks. Villas were often intentionally placed within or directly adjacent to these wooded areas to reserve the hunting rights of a landowner (Carr 1998). This concept quickly developed into an appreciation for wild landscape itself, not just those decisions made for utilitarian needs or the dominance of human intervention over nature.

> “Mid-18th century an increased interest in the design and management of parkland eclipsed more conservative enthusiasm for architectonic gardens, and many terrace gardens were simply removed. The landscape park that replaced

> those gardens, however, differed from the medieval hunting park that had preceded it. The landscape park exalted a modern appreciation of picturesque views and aesthetics, not a medieval preoccupation with hunting rights and rituals."
> (Carr 1998)

This fascination for the picturesque landscape and aesthetic appeal for wild form was introduced to the United States by Olmsted and Andrew Jackson Downing, evolving from the English romantic movement (Murphy 2016). Beyond just the notion of English "Landscape Gardening," what became landscape conservation grew from fundamental concerns to make a place beautiful, enhancing "emotional impact of sensual experience" (Murphy 2016). This, as is well understood today, is inseparable from the preservation of its ecological condition, function or wellbeing.

From here we see the origins of both the American contribution to the field of landscape architecture *and* the creation of "America's Best Idea," the National Parks. Olmsted's work in urban landscapes, and his signature style of creating seemingly-natural places, positioned him to advance the concurrent movement calling for the preservation of landscapes in the American West, which was rapidly being settled and developed. However, these ideas extended beyond a strict appreciation for the aesthetic and into the realm of natural sciences. Notions such as "plant thick and thin quick" highlighted his understanding of the need for active management of the public landscape, grounded in ecology (even before the field of ecology was formally established) (Olmsted 2015).

> "This testimony establishes the supreme folly of the supposed public opinion that had been alleged as the reason of the course of management – pursued with reference to the plantations of the park; vindicates the proverbial injunction to planters, '**Plant thick**

> **and thin quick**,' and enforces the conviction that prolonged delay of thinning must lead to a condition of well-started plantations that can be judiciously dealt with only by a complete clearance and re-planting of the ground"
>
> (Olmsted 2015)

Olmsted judiciously applied this knowledge and his experience in designing Central Park to the creation of a management plan for the newly established Yosemite Grant in California's Sierra Nevada Mountains. He called the future National Park "far the noblest public park, or pleasure ground in the world," noting it's importance to the advancement of natural, scenic preservation in landscape architecture (Beveridge 2009). Knowing that merely naming a landscape as 'protected' was only the first step in its conservation, but that it also required comprehensive management put Olmsted well before his time.

This idea of protecting a landscape in its existing state was wholly new. Olmsted argued in his report on the areas within the bounds of the Yosemite Grant, and similar reservations to those of the Valley and the Mariposa Grove of Giant Sequoias, are public institutions; these resources are an unparalleled store for fostering popular education in scenic conservation and aesthetic appreciation (Beveridge 2009). This was in active defiance to the homesteading, claim-holding attitudes of the mid-nineteenth century, and challenged settlers, such as James Hutchings (and his notorious Yosemite Valley mill), claim to Federal Lands (Beveridge 2009). Olmsted even advocated for the preservation of places like Yosemite for qualities that are just now being appreciated, such as the psychological benefits of scenic nature and managed access for the public to shared landscapes (Olmsted 1865; Beveridge 2009).

Figure 7 Olmsted Point - A rare view of Yosemite's Half Dome from the East (Pritchard 2016)

The Yosemite Report, and its contribution to the Parks' modern ecosystem management, cannot be understated. It established a perspective of viewing a landscape, in its natural or unaltered state (admittedly with general disregard to the role indigenous people have played in managing ecosystems), as the place through which the human moved, connecting key views, sightlines, and other opportunity for the appreciation of scenic beauty in new ways. While easy to make an argument for in pristine or dramatic landscapes like Yosemite, when this concept is applied to a variety of natural, or even cultural settings it challenges traditional conceptions of landscape design. The power of scenery in landscape design connects the visitor to a place and grounds them in reference to aesthetics and design, without making major design decisions in altering the landscape itself.

Simultaneous to this discussion of conservation and the creation of the Yosemite Report, landscape architects were discussing how the field might engage users and visitors in the nature of the land surrounding them. Prompting questions of how people utilize natural spaces. William Gilpin's 1792 essay on picturesque travel described the "high delight" produced "by the scenes of nature," establishing the concept of the *Picturesque Landscape* (Carr 1998). Understanding this motivation of preserving scenic beauty is important, but has become eclipsed by contemporary understanding of humans' role in natural systems, particularly in places like national parks.

The culmination of many of these ideas can be summarized by J.B. Jackson's concept of the Vernacular Landscape. Jackson challenged designers to consider *what* the term landscape is, in a vernacular, or cultural evolution and environmental influence, sense. In many ways, the National Parks are a vernacular landscape; beyond the inseparable bond of indigenous culture with place, the creation of a park, bounding land and determining conservation as its highest-and-best-use, defines it in a vernacular sense. The landscape reflects the physical, biological, and cultural character of the everyday occupations and activities of humans that shaped the land (Jackson 1984). This perspective is particularly salient to the landscape of RNSP. Redwood, a place that is often considered or idealized as ancient, inherently beyond the timescale of humans, has a deep vernacular definition – the history of Yurok peoples, early western settlers, mining, logging and conservation in the midst of the timber wars has undeniably shaped its current condition [see Land Use History below].

Furthermore, this introduction to the concept of both culture and aesthetics to the discussion of trails and trail design is important. Often glossed over by practitioners in other fields, landscape architects recognized the need for aesthetic beauty to be recognized and valued. This places nature on a level playing field with the highly designed, geometric formal gardens and landscapes of Europe, marking the birth of American landscape architecture.

The converse of this, is that it gave American citizens, the ultimate stakeholders of the National Parks System, an image of the far off landscapes they hold claim to. While the history of the National Parks and the creation of the National Park Service is relevant to the discussion of landscape architecture and advancements in the field outside of the parks, to go too in-depth would distract from the central discussion of trails, restoration and landscape architecture in the National Park system.

Nonetheless, a quick overview of how this thread of design perspectives can be traced from Olmsted's work in Yosemite to the modern era of park management is helpful in understanding the restoration of RNSP and the creation of trails. The early, targeted goal of "conserving the scenery" profoundly shaped how we interact with our national parks today (Carr 1998). As Carr highlights, symbolic projects and New Deal era policies created aspects of the National Parks that are considered central institutions today. Design features such as the

Blue Ridge Parkway, Glacier National Park's Going-to-the-Sun Road, Grand Canyon Village, Yosemite Village, and Mount Rainier's "Master Planning" were driven by the thoughts and goals of landscape architects (Carr 1998). This also established automotive transit, and a reciprocal relationship based on 'motor fees' as a source of revenue incentivizing the type of personalized sight-seeing that the car brought, as the primary way to access and navigate within the parks (Carr 1998). Many of these early park projects were carried out by the Civilian Conservation Corps (CCC) and Works Progress Administration (WPA), setting a standard in both work quality and design styles that are still seen and used in parks today (Carr 1998).

Many popular trails in the National Parks today, from Zion's Angels Landing-West Rim Trail and it's infamous 'Walter's Wiggles' switchbacks to the Bright Angel Trail built by the Havasupai Peoples prior to being kicked off of their ancestral land to make way for the new Grand Canyon National Park, are reflective of similar design styles and trail building techniques (i.e. the use of natural materials, trail building standards, and subtle but deliberate gestures towards key sightlines) (National Park Service 2018a; Paige 1985).

Much of this continuity, and the general rustic theme of the parks design style can be attributed to Thomas Chalmers Vint. What we consider to be park aesthetics today stems from the design theory and landscape engineering techniques developed from the early 20 century through the New Deal era. Vint's work on Mission 66, a targeted revamp of park infrastructure to expand visitor services in the 10 years leading up to the NPS 50th anniversary in 1966, was a catalyst for solidifying these stylings across the entire park network (McClelland 1998). From

Going-to-the-Sun Road to the Blue Ridge Parkway, these projects and this era of design in the building of our national Parks fundamentally shaped how we interact with these landscapes (McClelland 1998).

A key perspective that Vint focused on, and one that echoed Olmsted's vision nearly a century earlier, was knowing that the increase in visitors to the park was not necessarily negative, that it would help spread a passion for the conservation of these landscapes, but to do so, deliberate design that accommodated the masses would be necessary (McClelland 1998).

During this period, there was a shift in what constituted a park, and there continues to be an evolution in how we understand landscape conservation. For example, the subtle orientation and perspectives provided by trails laid by the CCC have defined the human space within these wild or "natural" landscapes. For better or worse, this outlining infrastructure also defines how we perceive the nature within our parks. Early parks, such as Yellowstone, Mount Rainer, and Sequoia had profound influence on the landscape design, setting a design precedent within our parks (McClelland 1998).

The creation of parks such as Mesa Verde, established in 1906 as the first National Park set aside for its cultural resources in the form of Adobe Pueblo cliff dwellings, or as President Roosevelt described it, the first park to "preserve the works of man," was a significant step in the park system's history (National Park Service 2015). This action advanced the National Park's conception of what the preservation of scenery entailed. Blurring this line between natural and cultural landscapes has been a central, albeit not always acknowledged, undertone to the National Parks. As the NPS advanced through the 20th century, they evolved into an agency that not only protected pristine natural resources and culturally significant landscapes, but ventured into spaces of conservation that sought to repair damaged land.

This evolution is seen in Great Smoky Mountains National Park, whose piecemeal creation from 1925 to 1936 incorporated post-industrial landscapes, such as those previously logged, farmed or privately settled, posing a challenge to what constituted nature in the eyes of NPS landscape architects; regardlessly becoming the most visited National Park today (N. R. S. and S. National Park Service 2019). These places have stories to be told, ones that overlap the natural and cultural elements of place – advancing into a comprehensive understanding that focuses on the human role in the ecology of place.

Figure 8 Clearcut logging in the Blue Ridge Mountains 1936 (National Archives in the Public Domain 1936)

A pivotal moment in this thinking was in 1952 and again in 1969 when the Cuyahoga River was so polluted that it caught fire.

This was another pivotal moment in NPS history. The event brought direct attention to how we've abused landscapes, on a regional level, for the advancement of industrial or consumptive needs. The Cuyahoga Valley National Park was established in 1974 (as a Recreation Area; 2000 as a full National Park), Born from the grassroots efforts of social and environmental movements in the 20th century, expanding to encompass both areas of traditional recreational uses *and* those degraded, such as the Krejci Dump (National Park Service 2018b). While applying (new environmental) policy and litigation that held the corporations responsible for major pollution accountable, the park service turned to the TEK of this land, recognizing the profound relevance of indigenous relationship to land when applied to restoration.

> "Our concept of land is that it is not a thing to be possessed, but rather something sacred and alive. We have a saying, 'We do not own the land, we are of the land, we belong to it.' We call the Earth, Kukna, our mother. All life comes from the Earth, she nourishes us, carries all life and gives us a place to put our feet." - Hìtakonanu'laxk, Lenapé Nation (Hìtakonanulaxk 1994)

This awareness and connection to TEK in design and restoration should be central to informing the design decisions within National Parks. Many trails are built upon elements of indigenous trail networks, including those in the Lower Prairie Creek watershed at RNSP.

Conservationists came to recognize that the preservation of far off landscapes, National Parks emblematic of the NPS like Yellowstone and Yosemite, could not be separated from the conservation of nature in or adjacent to our cities. The Cuyahoga River catching fire was a catalyst that created a lasting trajectory towards the restoration of the landscape and the establishment of a full National Park into law by the US congress. A land that was not pristine, but in fact, was in many ways toxic. Today, people camp, fish, and recreate in these places. They use trails ranging from rail to trail conversion, to the conventional hiking trail one might imagine in a National Park.

How we view this history of landscape architecture in the National Parks situates us in the social and environmentally historic context in which the discussion of trails and restoration is placed. We must consider how people are interacting with these landscapes. There is no place, no matter how seemingly wild or untouched where a deliberate decision has not shaped a user's experience, engagement or interaction with the landscape. From the design and layout of elaborate overlooks and roads to the emblematic structures, and trails people have come to adore. These are elements of the land that did not happen by chance, and characteristics that define place, impact ecological communities and dictate the functionality of the landscape. This positions the role of landscape architect, as design decision-maker, as a primary steward of our National Parks.

Ecological Design & Environmental Ethics: Our Relationship to Nature in Restoration and Engagement

A wide overview of both our role in nature, our relationship to nature, and our shared perception of wilderness is salient to this discussion. This overview is centered upon the field of ecological design, and how these attitudes have shaped both ecology and landscape architecture in our understanding of the collective relationships with nature.

Broadly speaking, the field of ecological design has come into existence in the last half century, but in recognizing the history of ecological restoration and traditional ecological knowledge, it is something that has always shaped human thought [See Ecological Restoration section above].

Principals of ecological design overlap several fields, from green architecture to sustainable agriculture, landscape architecture to environmental engineering. The term "Ecological Design" was defined by Sim Van der Ryn and Stuart Cowan as "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes" (Van der Ryn and Cowan 1996).

While formally defining it in an applicable, academic sense is new in the last thirty years, the concepts of engaging with ecological functions and balancing the needs of humans with the health and function of the environment has been a central tenant to the field of landscape architecture since its inception. The ideas of Olmsted, Andrew Jackson Downing and others in the mid 19th century evolved into what we understand today. This progressed through the contributions of landscape architects like Jens Jenson, O.C. Simonds and Frank Waugh who laid the ground work for utilizing native species and early concepts of ecological restoration while designing landscapes in ways that encouraged social interactions within natural settings (Grese 2004). Leading landscape architects from this period influenced an awareness of the integral requirements of a successful design or management plan to fall at the intersection of aesthetics *and* scientific understanding.

> "In order to a comprehension of the principles of healthy forest growth, let us consider some of the processes of nature, and learn from them her requirements"
>
> – H.W.S. Cleveland 1882

Writings from landscape architects such as H.W.S. Cleveland's 1882 *The Culture and Management of our Native Forests*, Charles Eliot's 1897 *Landscape Forestry in Metropolitan Reservations*, and early American horticulturalists' such as Liberty Hyde Bailey and colleagues suggested aspects of what we'd now call ecological design (Grese 2004).

Many of these concepts were echoed in Victor Shelford's *The Naturalist's Guide to the Americas,* including essays like Stanley White's *The Value of Natural Preserves to the Landscape Architect* establishing key ideas in the progression of the field (Shelford 1926). This period from the late 1800s through the early 20th century shaped concepts considered foundational to modern thought and the landscape architectural approach to the management of nature, beyond the initial work of Olmsted and before the more recent efforts in ecological design.

This history of ecological design and conservation played directly into the story of redwood forest conservation. Olmsted's son, Frederick Law Olmsted Jr. was instrumental in the creation of California's parks, surveying the landscape and garnering public support for the protection of the ancient forests as Save the Redwoods League Councilor. In his final report on to the league in 1929 he wrote:

Figure 9 Frederick Law Olmsted Jr. Conservation leader, parks pioneer, and Save the Redwoods League Councilor and collaborator.
(Save the Redwoods League 2020)

"The magnitude and importance, socially and economically, in California, of the values arising directly and indirectly from the enjoyment of scenery and from related pleasures of non-urban outdoor life … are incalculably great."

– Frederick Law Olmsted Jr., 1929

Today, we consider an understanding of the local and regional ecosystem as an obvious element in any site design. However, this notion has been deliberately developed and shaped by the design decisions and grounding of landscape architecture and ecological restoration in scientific thinking. The need for developing a well-designed trails network in concert with the restoration of RNSP is apparent; ecological restoration is the intersection of design and activism, where theory meets action and concerns for our environment are addressed by optimism overtaking despair (E. Higgs 2003).

> "Ecological Restoration is about making damaged ecosystems whole again by arresting invasive and weedy species, reintroducing missing plants and animals to create an intact web of life, understanding the changing historical conditions that led to present conditions, creating or rebuilding soils, eliminating hazardous substances, ripping up roads, and returning natural processes such as fire and flooding to places that thrive on these regular pulses" (E. Higgs 2003)

> "The question Olmsted posed in 1865 remains unresolved: how to admit all the visitors who wish to come without their destroying the very thing they value? The moment people come to a place, even as reverent observers, they alter what they came to experience. Preventing the destructive effects of human visitation requires management of water and soil, plants and animals, and people (and this is now routine at national parks and forests). Yet the *idea* of management is anathema to some. This is because they see wilderness as something separate from humanity – as untouched by human labor and culture, on the one hand, and as a place where one's behavior is free and unconstrained, on the other. Both ideas are problematic; both result, ultimately, in the destruction of what they value" (Spirn 1995)

But the field of ecological restoration has also resulted in profound cultural shifts; changes in attitudes that give hope and direction in a world of otherwise overwhelming environmental degradation.

This shift has led to a division in the world of ecological restoration, conflicting approaches to achieve an ends, one that splits along lines of technology driven, large scale projects of innovative grandeur – ones that think of our role in destroying an ecosystem as the source of the same skills necessary to restore it (E. Higgs 2003). This is juxtapose to a landscape architect's perspective. The role of design in restoration cannot be overstated. Design adjoins Ecological Integrity and Historic Fidelity, recognizing the profoundly important role that the community plays in lasting ecological change (E. Higgs 2003).

> "in the end, it would be a failure if we did not recognize that the reality of nature and society are greater than our capacity to understand and manipulate them. In advocating design I am proposing Wild Design, the kind that operates in sympathy with the vitality of life" (E. Higgs 2003)

This intersection is what Higgs has called Focal Restoration, converging on community engagement and the local culture (E. Higgs 2003). Particularly within national parks, forests and wilderness, practitioners need to ask if they are restoring an idea or a place; while aiming to preserve sensitive habitat, the cognitive approach to conserving the culture of a place is necessary to be successful in considering *what* is being restored. A landscape, whether it be a national park or local parcel, is inherently outlined by the boundaries that humans define. Its qualities and characteristics stem from this demarcation. If we define it as wholly natural, i.e. without humans, we are describing the human relationship to the space as outside of or apart from it. With a landscape scale restoration project like the Lower Prairie Creek project at RNSP, trails might provide a space to ensure this type of community connection and focal restoration to occur.

Restoration is something that has been discussed for decades in the environmental literature, perhaps without direct acknowledgement. Aldo Leopold's concept of developing a Land Ethic reflects these attitudes.

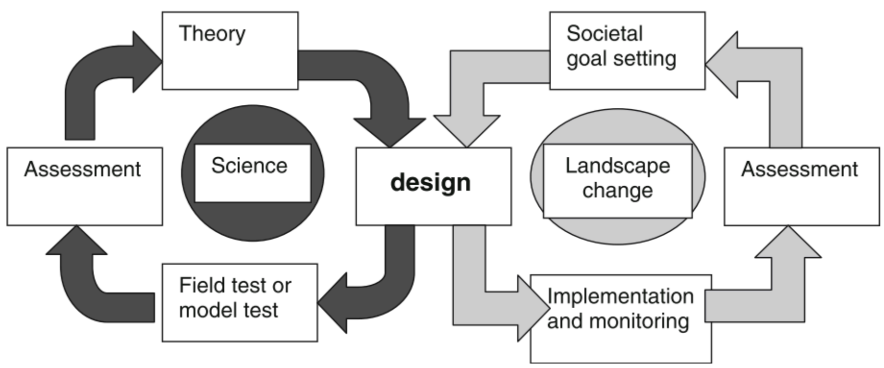
> "A land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such." (Leopold 1949)

In restoring a landscape, designing in harmony with an ecological community, we must also center the design on the human community to create a lasting sense of place. The seminal works of designers and ecologists such as Ian McHarg's *Design with Nature*, Randy Hester's *Design for Ecological Democracy*, and Kevin Lynch's *The Image of the City* all reiterate this connection between human space, community and nature, walking the line of theory and application (Hester Jr., 2010; Lynch, 1960; McHarg, 1969). For example, McHarg argues that in the urban setting, there is a disconnect between visions of the American dream and community: in displacing nature while expanding our built environment, we failed to realize "that a subdivision is not a community," nor that "the sum of subdivisions that make a suburb is not a community," and that "the sum of suburbs that compose the metropolitan fringe of the city does not constitute community nor does a metropolitan region" (McHarg, 1969). While admittedly discussing this problem in the context of urban and metropolitan regions, his pointed argument that we need a deliberate integration of nature into community, and community into nature is still relevant to the national park.

This poses the question, in a rural or wild setting like Redwood National Park, who is the community? Is it the local towns of Orick and Klamath, CA? the Tribal Community of Yurok? The nearest sizable cities of Eureka and Crescent City, CA? The logger who once cleared the land? or is it the national park visitor, who often comes from across the country or even across the globe to see the ‘world’s tallest trees’? The trail is where these stakeholders interface with the landscape, and subtle design decisions, in conjunction with the management of the land, influence both the protection of sensitive resources and foster a sense of ownership and stewardship over these shared collective resources. This is where design decisions influence ecology. This can be directed as a force for positive enhancement of both ecosystem and experience, ultimately shaping land health in measurable ways.

As Nassauer and Opdam argue, design is the common ground for scientists and practitioners to make deliberate decisions about landscape change (Nassauer and Opdam 2008):

Fig. 2 Design as a link between science and landscape change



Incorporating this type of scientific assessment in to the decision making of land management, the role of designers is elevated. Ecological Design recognizes that our place as humans is within a nature, as a part of it, not separate from it. This type of thinking has highlighted the need to rethink a central tenant of our collective relationship to nature – the idea of naturalness.

> “We cannot solve problems by using the same kind of thinking we used when we created them”

– Albert Einstein

"To keep every cog and wheel is the first precaution of intelligent tinkering"

– Aldo Leopold

Restored landscapes are being addressed under shifting environmental foundations. Anthropogenic changes to natural systems are creating an unprecedented future. Factors ranging from habitat fragmentation and the loss of top predators, the spread of invasive species, altered disturbance regimes, air and water pollution and global climatic change challenge the conventional concept of Naturalness (Stephenson, Millar, and Cole 2010). This represents a clear challenge in the future of Ecological Design. Key concepts of 'naturalness,' such as historical fidelity, are becoming undesirable and even unobtainable in a no-analog future (Stephenson, Millar, and Cole 2010).

So how can we adjust our way of thinking to accommodate these changes? Perhaps the philosophies of the designers that recognize the need for ecology in place, in ways that are dynamic and accommodate environmental change, can serve as a guideline.

David Cole and Laurie Yung (2010) point to a changing context of park and wilderness stewardship: "naturalness is the central guiding concept in park and wilderness law and policy, the basis for deciding where, when and how to intervene in biological and physical processes." They further note that while this remains "a useful way to articulate why we have parks and wilderness areas, the concept no longer provides a sufficient foundation for making difficult decisions about how we go about the business of preservation."

A lot of these concepts of conflicting or convoluted conservation aims in the context of dynamic change parallel the summary of our relationship to nature, and the environmental ethics of placing the human outside of it. As William Cronon suggested in his 1995 paper, *The Trouble With Wilderness*, there exists a central paradox in our relationship to nature:

> "Wilderness embodies a dualistic vision in which the human is entirely outside the natural. If we allow ourselves to believe that nature, to be true, must also be wild, then our very presence in nature represents its fall. The place where we are is the place where nature is not." (Cronon 1995)

As Gregory Aplet and David Cole (2010) write in response to this paradox, therefore, there must also be a trouble with the concept of 'naturalness.' There is a problem in the long-stated aim of restoring or protecting the naturalness of a landscape, because that very concept suggests the "freedom from intentional human control." Changes to the meaning of the word naturalness, our evolving understanding of ecological science, and the emergence of wilderness values challenges our notions of naturalness (Aplet and Cole 2010). We are now faced with placing a landscape, and its subsequent management, on a scale of <u>ecological condition</u>, ranging from novel to pristine, and <u>freedom from control</u>, from controlled to self-willed (Aplet and Cole 2010). In a similar way to how Cronon suggested that the concept of Wilderness is not what it seems, the somewhat ubiquitous notions of landscape condition push us to think beyond naturalness.

> "As conservation imperatives have expanded beyond the setting aside of parks and wilderness areas to working within them to protect their values, new concepts are needed to guide management – concepts that can be drawn on to articulate a desirable and attainable future for park and wilderness ecosystems that accounts for human impacts, global change, and evolving public values" (Aplet and Cole 2010)

Might trails represent a place for this articulation to occur? The ability to directly engage people with the dynamic changes to a landscape uniquely situates trail at the intersection of management and preservation of cultural values and history.

One useful framework in thinking about trails as a potential solution, through exposure and engagement, for this problem in our thinking about conservation and naturalness is the concept of Wild Design (E. S. Higgs and Hobbs 2010). Wild Design is proposed as principles to guide interventions in protected areas. This is where the intersection of design and science can be applied to achieve tangible intervention.

Wild Design principles:

Clarity – clear goals and values to ensure the transparency of values

Fidelity – entails careful historical research to understand past conditions and to assess these past conditions against present functions, structures, and patters faithful to the ecosystem

Resilience – ensure that autogenic functioning is restored and that the ecosystem has appropriate resources to cope with external perturbations

Restraint –less intervention is better than more

Respect – interventions are always proxies for assumptions about what is appropriate to a particular ecosystem

Responsibility – responsibility includes wide knowledge of techniques and projects, operating according to high ethical standards and striving to allow ecosystems to flourish

Engagement – strong reciprocal ties are needed between people and ecosystems to ensure successful durable interventions

(E. S. Higgs and Hobbs 2010)

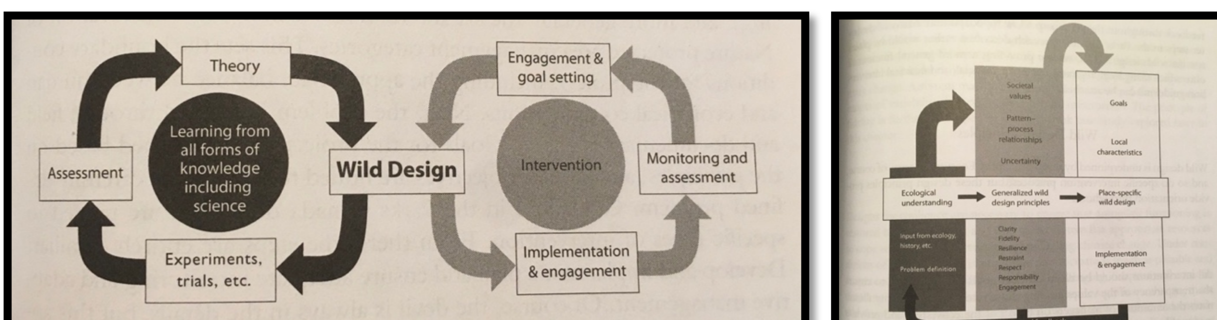


Figure 10 Wild Design as the intersection between knowledge acquisition and ecological intervention (E. S. Higgs and Hobbs 2010)

Lastly, Wild Design can serve as an Ethical Intervention – decisions to intervene in natural systems should never be made lightly, and must follow the seven criteria above to guide any actions taken. While all ecosystems, sites and designs differ, all interventions are designs; acknowledging the interplay of human intervention and ecological processes, patterns and structures is central to the concept of Wild Design (E. S. Higgs and Hobbs 2010).

How do these apply to trail design? We can look to trails as the location for this wild design to occur – in developing a trail design theory, we should evaluate how the location for engagement, responsibility, respect, restraint, resilience, fidelity, and clarity come together on the landscape and through the trail network.

However, we must be cognizant of the potential for these decisions and restoration efforts to result in the "museumification" of nature (Gobster 2007). As Paul Gobster (2007) points out, this phenomenon can result in the revision of landscape and its land use history, how it presents nature through restoration, design and implementation as well as the potential impact on nature experiences. In designing a trail network and developing an overarching trail design theory, landscape architects should consider how the trail is integrated with the management of the land, telling the story through its restoration without eliminating a balance between the goals of achieving authenticity in ecological restorations and the authenticity of nature experiences.

To summarize this thinking, we must look to the long history of landscape architecture in the national parks as well as the broader thought on ecological design and environmental ethics that have shaped the field of restoration ecology. Landscape architects, as designers of the land, are placed in a unique situation that pits their decision-making at the intersection of science and landscape change. In carrying out this responsibility, they must simultaneously avoid the follies that lead to paradoxical thinking or even ineffectual interventions. Using tools and concepts such as Wild Design, Focal Restoration and an understanding of the challenges surrounding the idea of naturalness; while thoughtfully considering "how to admit all the visitors who wish to come without their destroying the very thing they value" is imperative. Simultaneously, landscape architects must support the role of community in restoration, through the necessary engagement of local stakeholders in the management of the land. Trails are uniquely situated to provide a viable platform for these pieces to come together. Not only do trails provide an opportunity for direct access to protected landscapes, managing the challenges that increased visitation has on sensitive resources, but they can direct people to place, through experience and considerate documentation of the land use history.

Land Use History of Redwood National Park & the Lower Prairie Creek Watershed.

The formation of Redwood National Park is a tumultuous history. Elements of this story have been foreshadowed throughout this case study and the review of literature pertaining to the development of trails in conjunction with the restoration of Lower Prairie Creek. This directly shaped the use of the land, its abuse, and its ultimate rehabilitation in the late 20th and 21st centuries. This history is best summarized by Dr. Mark D. Spence's description of the park's land-use mosaic:

> "Redwood National and State Parks (RNSP) stands for many of the same iconic wilderness virtues associated with older western parks like Yosemite, Yellowstone, Sequoia and Kings Canyon, and Glacier. Like the waterfalls at Yosemite, or the bison and grizzlies at Yellowstone, RNSP's ancient redwoods present a spectacle of primordial America along with a promise that such a place will remain undiminished for future generations. Yet unlike these and other "crown jewel" parks, the landscapes now within Redwood's boundaries were profoundly and actively shaped by a host of twentieth-century land-use regimes that involved farming, ranching, fishing, road building, recreation, and—most significantly—industrial logging." (Spence 2011)

This history is also framed by a complex narrative that places the redwood, the 'world's tallest tree,' as a cultural icon, but a visit to the park challenges this individualized connotation. Unlike its Sierra sister park Sequoia, home to the *largest* tree on earth, the coast redwood and the park that bears its name does not display any one tree as the main attraction the way Sequoia idolizes General Sherman. In fact, the tallest individual tree's (named Hyperion) exact location is only known to a few researchers and park employees. This makes the experience of RNSP much more about the landscape scale, forest ecosystem than about a solitary resource or single feature. This is further complicated when we reflect upon the park's complex, piecemeal history, and come to learn just how little of the current protected area reflects the forests' historic grandeur.

Early History & Indigenous People

The early history of the Park was tribal. The Yurok peoples have inhabited this landscape for thousands of years.

> “Native American associations with RNSP are the most varied and deeply informed of all historical attachments to the current park area, from the many lessons derived through generations of residence, resource use, trade and travel in the pre-contact era, to the skills acquired by adaptation and participation in new economies—including commercial fishing, agricultural work, tourist guiding, timber harvesting and processing, and conservation.” (Spence 2011)

This, in conjunction with recent NPS efforts to consult tribal leaders in the management of these native landscapes, has led to modern decision-making efforts on a government-to-government basis, informing management, interpretation and restoration of the park (Spence 2011).

Figure 11 Sweat House (National Park Service, 2018; Wheeler, 2018)

The Yurok, Tolowa, and Chilula (whose names were ascribed by non-native peoples) maintained communities throughout much of the current park, up into the modern era - including records of an ‘operational sweathouse’ at the mouth of Redwood Creek into the 1920s [See Fig. 11–12] (Barlow 1980).

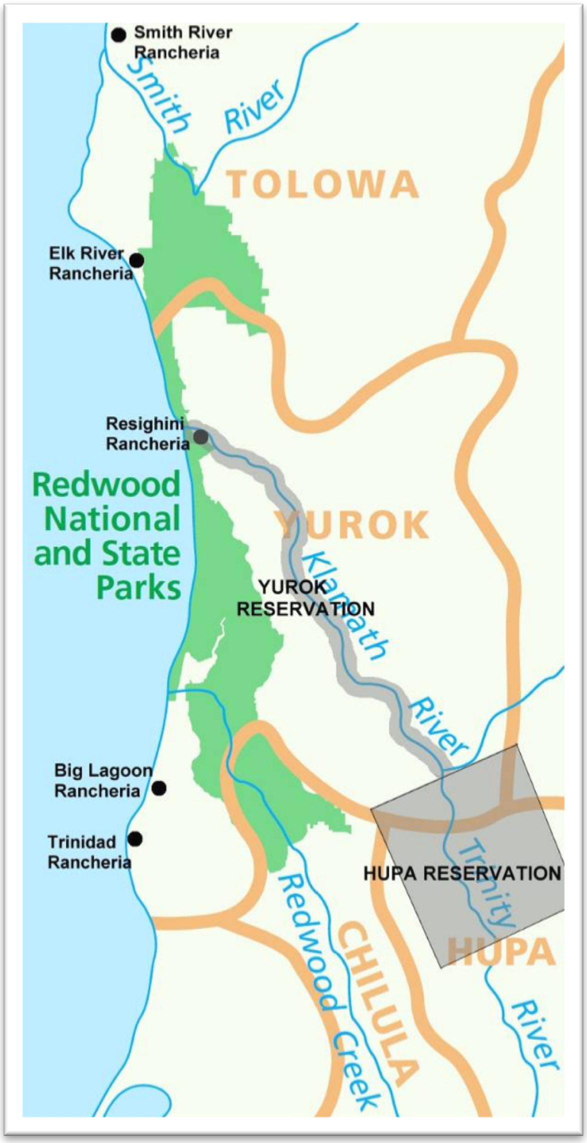


Figure 12 Native Landscapes of RNSP (Spence 2011)

Living memory of this still survives in many records of the descendants and families that live in Orick. Yurok Villages such as See-gon!o on the south side of Freshwater Lagoon, Aw-tmek-quar on the north side of Redwood Creek, and the village of Oreq-w (whose name is loaned to modern day 'Orick' - centered on the Cal Pac Mill site) are prime examples of this cultural history (Barlow 1980).

Within the LPC restoration site, Espeu, ['Eshpeu' or 'Espew' in Yurok] (centered upon Espa lagoon near Gold Bluffs) stands as a key cultural node for the modern interpretation of this native landscape (Barlow 1980; Bearss 1969). This indigenous presence is evident today, with the Klamath valley containing the present-day Yurok Reservation. The North Coast remains a primary stronghold of indigenous culture. However, as in the case throughout all of North America, native people were persecuted and forced off their ancestral land to make way for white settlers who exploited and abused the resources that these native cultures relied upon.

Early Spanish, Russian and American explorers pursued coastal expeditions, traveling off the shore of Humboldt and the North Coast. However, early land expeditions, like those led by

Jedidiah Smith and fur traders from the Hudson Bay Company were some of the first westerners to set foot upon and explore this landscape intimately (Bearss 1969).

Historic Routes used throughout this early period cross the landscape of the LPC restoration site. One primary route, the Trinidad-to-Klamath Trail, overlaps sections of the proposed trail network (a'golok or Zone 1_Trail A), a trail that followed an historic native route and became an official U.S. Postal Service Route [See Fig. 13 & Appendix I]. Today, historic landmarks (such as notable trees or prominent landscape features) delineating this trail are all but lost due to the intensive logging and resource extraction of the mid-20th century. However, thanks to historic cartographic records and descriptors, what remains of the ridgeline that this route followed can be traced:

> "The Trinidad-Klamath Trail paralleled the beach from Stone Lagoon to Lower Gold Bluff. It then forked. While one branch continued up the beach fronting the bluffs, the main trail ascended the ridge north of Major Creek and led eastward to Boyes' Prairie on Prairie Creek, then swinging to be west, it rejoined the other trail at Upper Gold Bluff. The trail then paralleled the Pacific as far as the mouth of the Klamath." (Bearss 1969)

However, even on this well-known route, conflict between settlers and the Yurok was frequent as this biased account from a settlers perspective recalls:

> "As on many early western trails, a man traveling between the Klamath and Trinidad had to be on his guard. Pat McGrath, in the winter of 1875, left Baker City, Idaho Territory, en route to Eureka. About midway between the Klamath and Gold Bluffs, Pat was stopped by nine Indians, who asked for money. After relieving Pat and his traveling companion of their money, they tied them up and stripped them of their packs and clothing. While the Indians were directing their attention toward Pat, his friend kicked loose his bonds and fled. Pat now cried that "Soldiers were coming," and the redmen dropped everything and raced to their canoe, which was hidden in a slough.

After freeing himself, Pat made his way to Mrs. Johnston's. To show him how lucky he was, Mrs. Johnston took Pat to the beach and pointed to a freshly dug grave. Here rested a white man, whose body had been found several days before in the surf. He had met his death at the hands of Indians. Several Indians had been heard to boast that they would take the lives of five whites in revenge for an injury done one of their people accused of stealing a horse in Arcata. One of the men presumed marked for death was Henry Orman, the manager of the Gold Bluff diggings." (Bearss 1969)

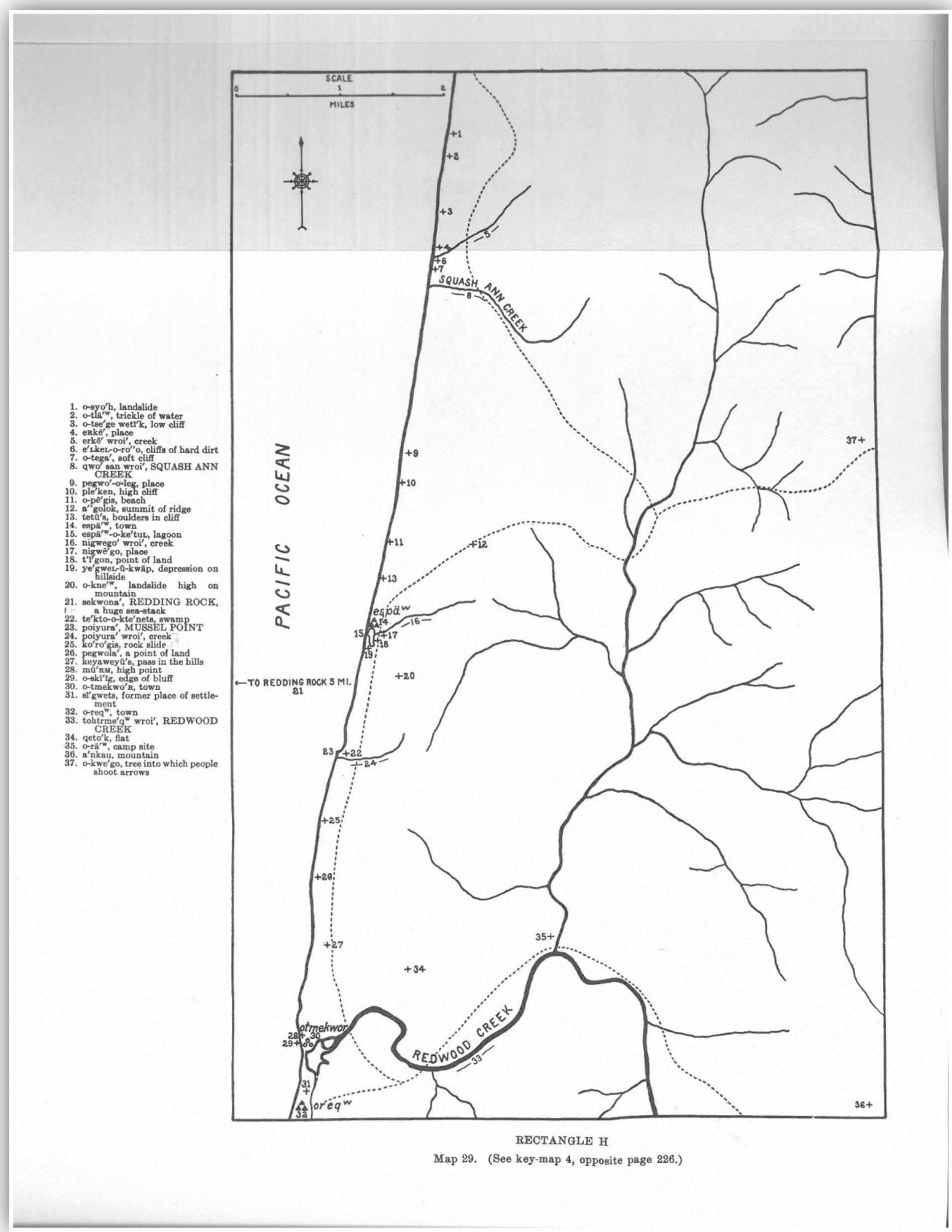


Figure 13 Yurok Map of Prairie Creek; Trinidad-Klamath Trail - Mail Routes, Ark., Calif., Ill., Iowa, Kan., Ky., Mo., Neb., Nev., N. Mex., Tenn., Tex., and Utah, 1858-1862," Library P.O.D., pp. 238-239, NA, NNR/68-724. "Denny was to leave Trinidad on Tuesdays at 6 a.m. and to reach Crescent City by 3 p.m. the following day. On July 1, 1863, the route was shortened by 18 miles to extend from Trinidad to Crescent City. Denny was again the low bidder, securing the route for $1,500" (Bearss 1969)

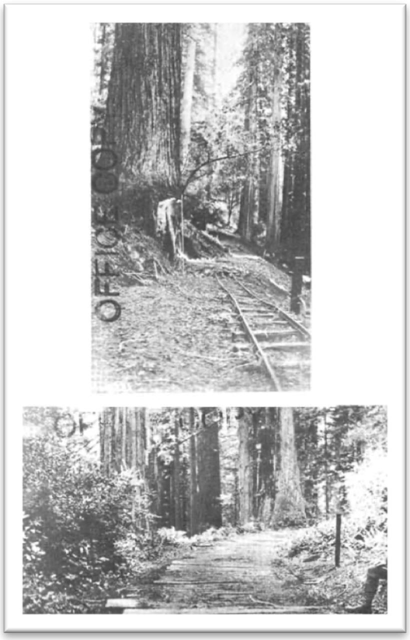


Figure 15 Crescent City-Trinidad Road, Prairie Creek Redwood State Park 1925 (Bearss, 1969)

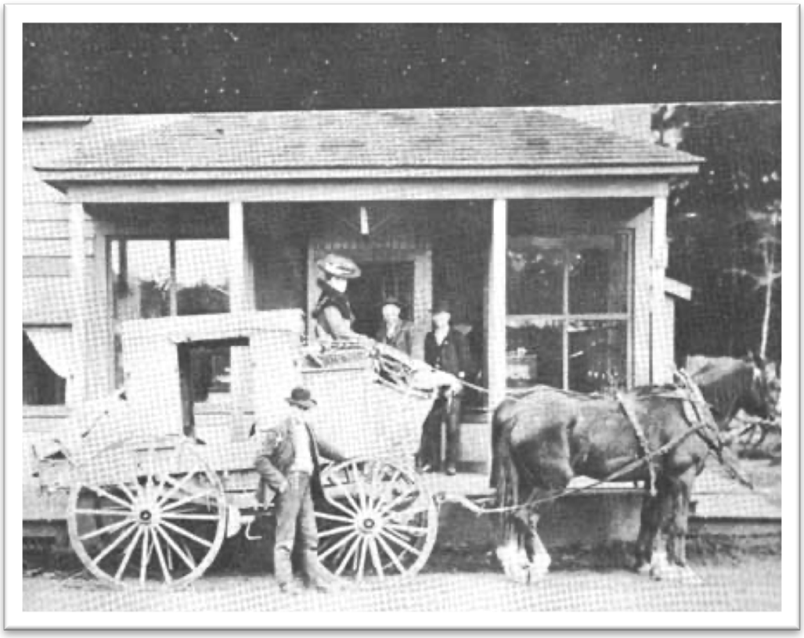


Figure 15 Stagecoach – Smith River stage 1900 (Bearss 1969)

Figure 14 Construction of the Redwood Highway along the Cliffs South of Cushing Creek, Del Norte County, CA 1922 (Bearss 1969)

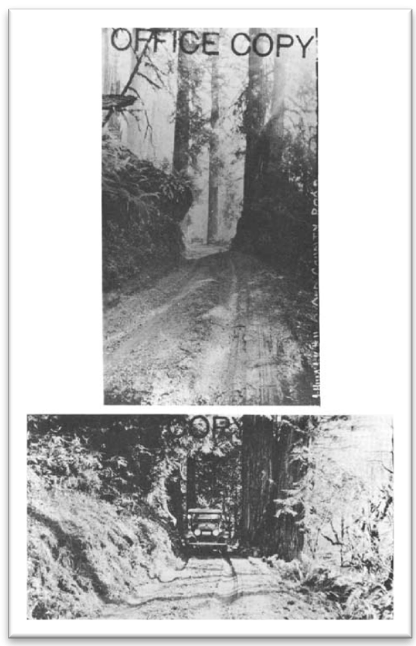


Figure 16 Crescent City-Trinidad Road 1925 (Bearss 1969)

As settlement advanced, and modern roads were established, the network of early trails faded [See Fig. 15–18]. Once mechanized logging at the hands of private industry began to dissect the landscape, these routes were altogether lost. The character of this history is

Figure 17 Redwood Highway 1910 (Wheeler 2018; National Park Service 2018d)

emblematic of the park born from it; a turbulent history that's more 'wild-west,' and grassroots conservation than the typical lock-it-up scenery that often accompanies federal protections.

The story of this place, traced through the generations that engaged with this landscape is emblematic of an enigmatically ever-evolving yet deeply ancient and unchanged forest. This has created a patchwork landscape, in some ways nearly unrecognizable and in others the symbol of untouched, unsullied nature.

Logging, Mining & The Patchwork Park

The initial iteration of the National Park was swept up in the opposition to resource extraction and the prominence of environmental legislation of the 1960s and 70s. This extraction began early, driving settlement along the remote, rugged coastline in search of the land's abundant resources. While logging holds prominence in the Redwood narrative, the settler's first story of this place was the same reason that drove many west – the search for gold. In 1848, the same year that gold was found at Sutter's Mill in the foothills of the Sierra Nevada Mountains sparking the California Gold Rush, gold was found along the Trinity River – the primary tributary to the Klamath of RNSP.

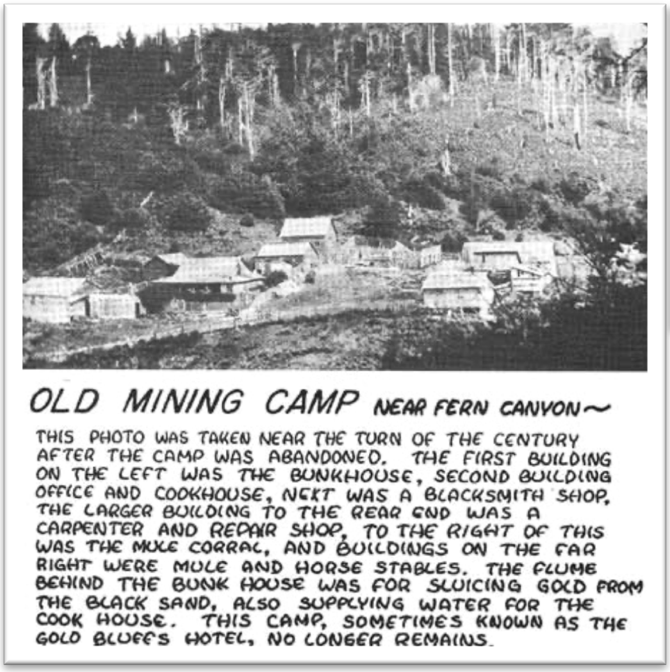


Figure 19 Fern Canyon Mining Camp (Bearss, 1969).

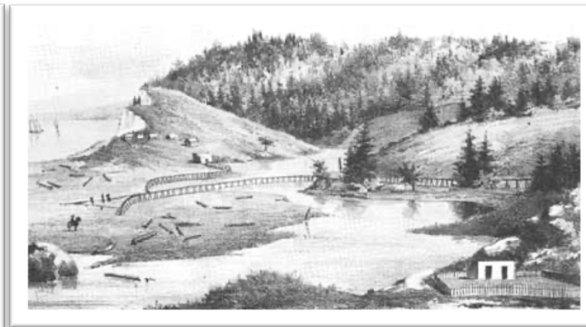


Figure 18 Old Mining Flume - Gold Bluffs Beach (Bearss, 1969).

Figure 20 Union Gold Bluffs Mine Lithograph (National Park Service 2018d)

While there was no gold found in Orick, deposits from the historic mouth of the Klamath River left sediment with fine gold deposits along the area known as Gold Bluffs. This led to extensive mining (Wheeler 2018).

Mines were established not only within the boundary of the modern day National Park, but within the LPC project site itself. One such mine was the Union Gold Bluffs Mine at Major Creek, where there is still evidence of foundational footings found at this site today (Miners Loop or Zone 5_Trail C). Other mines were located at Espa Lagoon and the mouth of Fern Canyon, a popular modern tourist destination (Wheeler 2018; Bearss 1969). The establishment of permanent settlements at gold mining camps, such as those at Gold Bluffs, created conflict between the aboriginal population and the whites that settled in search of gold (Bearss 1969).

By the 1880s and 1890s the production of mines along gold bluffs slumped, leading to their ultimate closure in the 1920s (Bearss 1969). This halt in mining led to the transition towards the obvious moneymaker – the Redwood.

The North Coast's abundant timber resources were immediately evident. The early explorers noted trees of remarkable stature, yet the immense size also served as a physical barrier to cutting them down. Not to mention the fact that they grew largest far from any sizable city. Individual trees were cut down and served the needs of the area's first settlers. By the time mills were establish, there was still little evidence of humans on the land. This changed dramatically as logging techniques advanced.

During this period, families like the Davison's (for whom park landmarks such as Davison Rd, etc., are named) settled in the valleys and spruce swamps, establishing ranches and homesteads (Wheeler 2018). Interest quickly shifted from gold to the abundant natural resources of the region – particularly, the unparalleled timber of the Coast Redwood. An abuse of the Homestead Act known as the Scottish Syndicate of the Redwoods, led to the consolidation of land and power by the timber industry. At the turn of the 20th century, fraudsters Charles King, David Evans, and Joseph Russ conspired to purchase the homesteading rights of sailors who came to port in the city of Eureka. This 'Scottish Syndicate' in the Redwoods illegally transferred tens of thousands of acres of Old Growth redwood timber from public to private, monopolized hands (Sheperd 2014). This created a stronghold of natural resources under the control of the early timber barons.

This early commercial logging was driven by oxen and then by rail. The advent of the 'steam donkey' and rudimentary chainsaws expanded logging exponentially. However, it wasn't until the 20th century that large scale, industrial logging clear-cut the forests, irreparably altering the watersheds of RNSP.

Figure 21 Logging of the Redwoods (National Park Service 2018d)

Figure 24 Ox Team, Bull Puncher, and Skid Road at Fort Dick, 1895 (Bearss, 1969).

Figure 25 Steam Spool Donkey 1895 (Bearss, 1969).

Figure 23 Horse Team Pulling a "Car" on a Pole Road. Small logs served as rails for the log cars. (Bearss, 1969).

Figure 22 Log Dump (Bearss, 1969).

Figure 26 Logging Rail Car 1910 (Bearss, 1969).

Concurrently, as logging progressed throughout the remote, mostly-disconnected North Coast, the allure of the mighty Redwood began to spread. This prompted the creation of early park units along California State Route 101, which would go on to serve as the basis for much of the regions modern landscape conservation. The co-management of these parks was apparent early on; areas such as Prairie Creek Redwoods State Park 1925 (where much of the ongoing LPC restoration is centered &/or adjacent to) and Jedediah Smith State Park 1939 were created at the height of the New Deal era (Anthrop 1970; Bearss 1969).

Federal programs, such as the aforementioned CCC were instrumental in the creation of park infrastructure – to this day, the corps-built Prairie Creek Visitor Center remains a main visitor center for both the NPS and California State Parks (Anthrop 1970). The CCC also

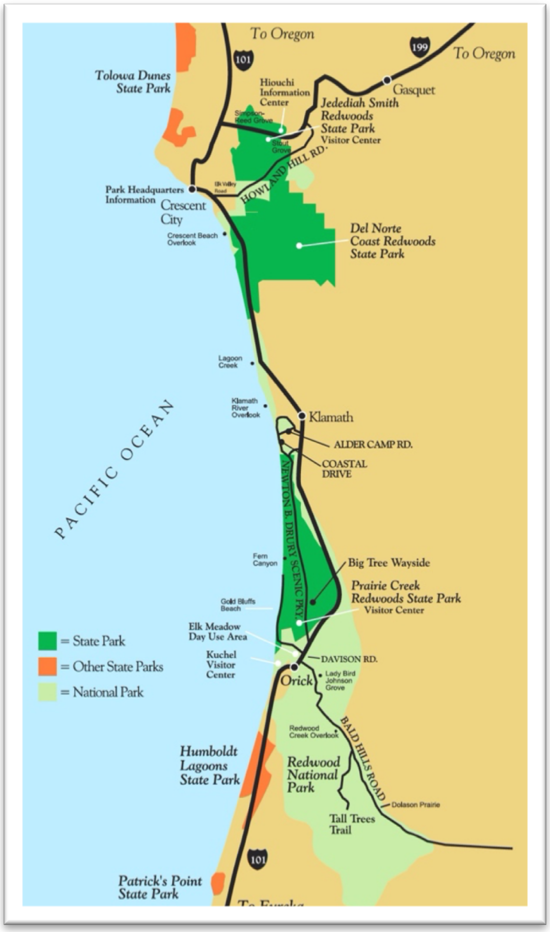


Figure 28 Modern Extent of RNSP (Spence 2011)

Figure 27 Prairie Creek CCC (National Park Service, 2018; Wheeler, 2018)

influenced the early trails of RNSP. These landscapes, diametrically defined by conservation and industry, represent an early understanding of the threat that logging, mining, and other resource extraction posed to the Redwoods.

Early efforts to create a federal park for redwoods were stifled by timber industry interests. These included assessments championed by the first US Forest Service Chief and noted conservationist, Gifford Pinchot, and President Theodore Roosevelt (Bearss 1969). Failing to safeguard the redwood forest in its most impressive form, these led to minimal protections, such as Muir Woods National Monument and other small reserves throughout the dryer

Figure 29 Dorthea Lange's 'Stump Ranch,' which made famous the threat that logging posed to the Redwood in Orick, CA, motivating early conservation efforts around Redwood and Prairie Creek watersheds (Lange 1939)

stretches of the species range; where the tree did not grow to the same stature as those along the North Coast. This allowed for the continued exploitation of the redwood unchecked.

The greatest resistance to over-exploitation of the redwoods came from conservation organizations such as Save-the-Redwoods League, which remains the leading organization in redwood and giant sequoia conservation to this day (Save the Redwoods League 2020; Bearss 1969).

Nonetheless, the economic allure of the redwood was too enticing. Particularly, the war effort of both World War I & II increased this inevitable threat, stripping much of the North Coast's timber.

> *"During World War I the lumber industry thrived and millions of feet of redwood were felled."* (Bearss 1969)

Figure 30 ARCO Clear Cutting, Billboard & "Redwood Industry Recreation Area" (Wheeler 2018; National Park Service 2018d)

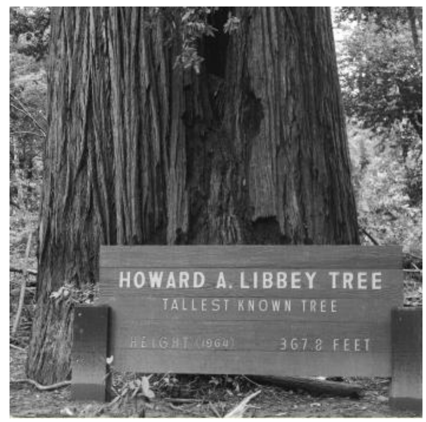
This directly shaped the landscape of the Lower Prairie Creek Watershed. Areas immediately adjacent to the ocean, near Gold Bluffs and Fern Canyon, were cleared of Sitka Spruce for airplane construction of WWI and during the inter-war period (Wheeler 2018). This continued, increasing during the post-war (WWII) housing boom, as the demand for timber exploded. The tree's rot resistant nature and high quality, straight lumber represented a coveted timber resource that was a huge boon for builders and homeowners alike (Wheeler 2018; Anthrop 1970).

Post-war logging in this remote section of the North Coast led to industry opposition of conservation initiatives, prompting the peddling of deliberately false information about the management of forest resources; such as that of the ARCO (Arcata Redwood Company) promoting recreation on private, corporate owned land that had been clear-cut and reseeded, making up substantial portions of the National Park today [See Fig. 32]. The companies did not want to relinquish their control or ownership of the land (Anthrop 1970; Wheeler 2018). And only did so once it was abundantly clear that the initial NPS approach to protecting this precipitously disappearing resource was grossly inadequate. Without immediate action, the redwood forest would be lost.

With the support from national leadership and congress in the 1960s, writing-on-the-wall for the logging industry led to the rushed extraction of timber within the current extent of the National Park. During this period from the 1950s – 1970s, logging continued to extract over 1 billion board feet annually, eventually reducing the harvest to 500 million board feet annually by the 1990s – still a dramatic level of extraction in the face of conservation initiatives rushing to save what remained of the old growth forests (Save the Redwoods League 2020). Even as conservation was elevated to a national status under federal protections, logging continued to be the primary industry throughout the region. When the creation of Redwood National Park was first signed into law by President Johnson on October 2, 1968, it consisted of a thin line of redwoods winding along the immediate floodplain of redwood creek. Deemed “the worm,” this minimal protection of the redwood forest was evidently inadequate. A thin “Redwood Curtin” developed along route 101, providing the illusion of thriving forests. However, within a decade, it became clear that continued logging on private land uphill of the park was driving erosion and flash-flooding along streambeds and imposing significant alterations to the microclimate that allowed the protected redwoods to grow to their notable stature. Dieback was being observed in the canopies of the tallest trees. This served as a catalyst for many of the landscape-scale conservation efforts seen today. This prompted the NPS and conservation groups like Save-the-Redwoods League to recognize that to save the tree we must conserve the forest, even across those privately owned lands that were actively being logged (Anthrop 1970; Spence 2011; Wheeler 2018).

Sections of the park, such as the Tall Trees Grove, and a team of researchers from the National Geographic Society, garnered international attention for the fledgling park, motivating tourism and travel to see the “World’s Tallest Trees” (Wheeler 2018). Even though the claim that this grove held the tallest individual tree was later disputed, it brought to light the fact that the conditions allowing for these colossal giants to thrive were being stripped. As a result of this upslope logging, the land had fundamentally changed. To protect the future of the ecosystem and change the fate of the Redwood, the Save-the-Redwoods League purchased over 100,000 acres to expand the parks boundaries – of which only a fifth of the land was old-growth (Schrepfer 1983; Save the Redwoods League 2020). The administration of the state and federal parks were combined in 1994 to address the unique and dynamic concerns of managing this patchwork landscape.

This culminated in an era termed "The Timber Wars." A period of conflict that brought to national light the battle over old growth forests in the pacific northwest from the redwood coast to the temperate rainforests of British Columbia. Potential extinction of indicator species such as the Northern Spotted Owl (*Strix occidentalis caurina*) brought this issue to a national spotlight. In 1980 the United Nations recognized the redwood forests of RNSP a World Heritage Site and Biosphere Reserve, further stoking the fire between public and private interests across this landscape in



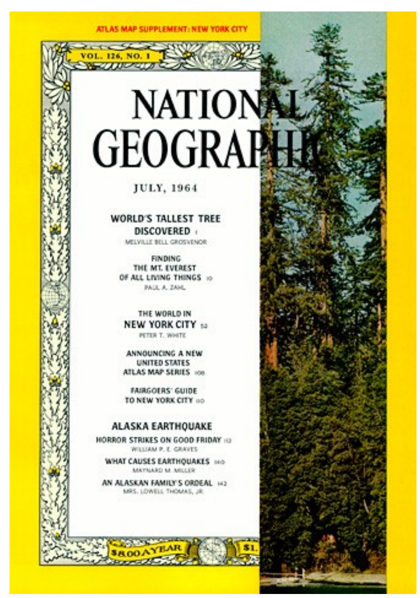


Figure 31 National Geographic Society, July 1964

a divisive period (Wheeler 2018). The fierce opposition to the federal government and their say over the logging industry is still very present in the town of Orick, and throughout the extent of the park, today. It will take generations for this to ease, if ever. While today this story is primarily told in a lopsided perspective favoring the conservationists, the loggers mark on the landscape and creation of ecological damage did provide the conditions for the lessons being learned through innovative landscape-scale restoration that is being seen across RNSP today. This directly pitted our consumptive habits against our protectives desires. Redwood serves as a testing ground for how collaborative conservation can raise awareness of how unchecked human behavior leads to landscape scars.

This makes logging an essential element of the story being told. While it seems obvious to us today that clear-cutting of these majestic forests irreparably harms the ecosystem, we cannot condemn the behavior of past humans, judging them through the lens of our present-day perspective. We can only learn from their mistakes, righting their wrongs to ensure that this history does not repeat itself. Restoration ecology in Redwood National Park represents a beacon of hope in conservation; an inherently selfless pursuit to restore the lands that our predecessors harmed to a condition that even our great grandchildren may not live to see. This type of landscape restoration creates a trajectory unlike any other, both temporally and spatially, to an ends we may not know, and across these times/spaces we must make sure the story is told and both the efforts and passion is renewed through the network of multi-use trails that document this experience.

<u>Restoration is an essential part of this Redwood National Park's history:</u>

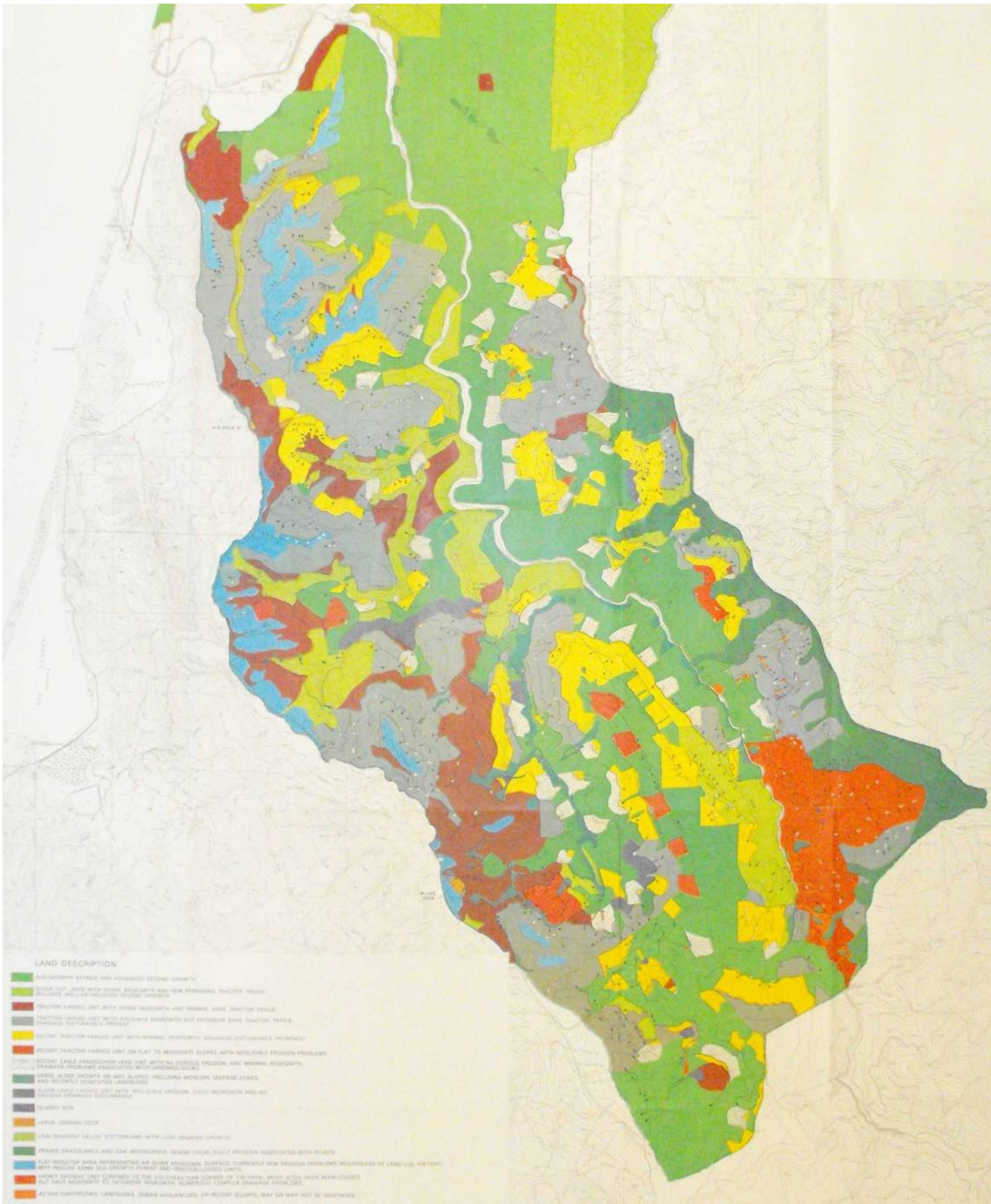


Figure 32 As shown by the above map delineating environmental conditions of the redwood creek basin,, restoration of the forest was included in this map from May 1980. In addition to "old growth," " prairie grasslands", and "older cut units with dense regrowth," It shows highly disturbed and areas vulnerable to erosion. This patchwork history is reflective of the gridded "cuts" made by the timber industry throughout the 20th century. These areas have become the primary targets for restoration and this information has served as a vital informant of the landscape history. (Spence 2011)

Key challenges to landscape architecture, ecological design, history & the future of landscape architecture in the management of National Parks:

The key challenges facing the management of cultural resources in Redwood National Park and the LPC restoration site relate to the threats of over visitation, accessibility and establishing forms of resource protection that allows for the engagement and interpretation of both historic and natural resources. Many of the solutions to these challenges can be found in the culmination of collective thought in the field of landscape architecture, ecological design, environmental ethics and restoration ecology. These fields, and their extensive overlap show that there are significant opportunities and range of approaches to addressing these challenges. Understanding the factors that transitioned the American national park system from its initial iteration protecting the scenic beauty of nature in its pristine form, to the safeguarding of cultural resources, and even repair damaged landscapes while advancing community engagement is central to this thinking. Trails can serve as the space for this to play out, and nowhere is this more evident that at Redwoods National Park.

Writers from Olmsted to McHarg, and Leopold to Spirn have dramatically shaped how we view these spaces in their modern form. In realizing this, we can build off of their work and follow the future trajectory of the field of landscape architecture to better understand the future of our national parks – we can utilize these lessons to tell the narrative of place while simultaneously protecting its sensitive resources. Landscape architects can leverage this to understand the profound opportunity and continued role that trails play in conservation of our shared public landscapes. Again, not only do trails provide an opportunity for direct access to protected landscapes, but they can guide people to place, through experience and considerate documentation of the land use history.

TRAILS & DESIGN

Trail design concepts and theory

Trails provide an opportunity to enhance a variety of perspectives on the landscape. They not only direct one through a space, but can connect people to the land by fostering experiences that instill concepts of stewardship and a sense of ownership. In many ways, trails represent a direct opportunity for imparting the type of attitude and approach to conservation that Aldo Leopold called for in his seminal work on creating a *Land Ethic*. By placing visitors or individuals *within* the landscape, grounded in developing their own perspective towards a land ethic, they might recognize their relationship to it, and responsibility for a place's Land Health (Leopold 1949).

While there are innumerable resources on the construction, maintenance, stewardship and even policy of trails and trail networks, there are limited resources that assess the role that trails play in the conservation, access and design of public landscapes. There are even fewer that assess how these factors are played out, or contribute to, the restoration of disturbed or degraded landscapes. Again, this represents a potential gap in knowledge that this research seeks to address.

One such resource, foundational to contemporary conceptions of trail design theory, is the work *With People in Mind: Design and Management of Everyday Nature* by Rachel Kaplan, Stephen Kaplan and Robert Ryan (Kaplan, Kaplan, and Ryan 1998). In this work, the authors develop three primary themes:

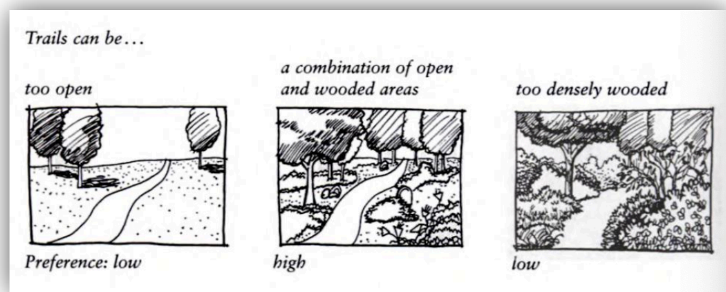
1. Trails through natural areas bring individuals into intimate contact with nature, allowing both observation and exploration

2. Trails invite one to proceed, thus enhancing a sense of security. In a setting that lacks trails it may be less clear that venturing forth is appropriate
3. Even people who feel guilty taking the time to enjoy nature may enjoy trails through natural settings while walking or biking to work

(Kaplan, Kaplan, and Ryan 1998)

These themes were developed from "a variety of studies [that] have documented people's desire for opportunities to get away from all the unnatural things of city life, to enjoy natural beauty," and that, in utilizing well-designed trail networks, "the various activities that involve locomotion though natural areas provide popular means to fulfill such desires" (Kaplan, Kaplan, and Ryan 1998). From these themes, the authors developed five key patterns for Trail Design:

- T1 Trails, narrow and curving
  - The promise of discovering what lies just beyond the bend in the road greatly increases preference
- T2 Views, large and small
  - What can be seen from the trail makes all the difference



- T3 The trail surface
  - Trail surfaces are important, both visually and functionally
- T4 The trail's path
  - Helping people stay oriented is an important function of a trail
  - Landmarks are important (i.e. key bridges, crossing or nodes)
- T5 Points of interest
  - Stopping points along the way can provide opportunities for resting and observing

Concepts such as T2 Views, large and small directly apply to the development of a trail network throughout the restoration site of Lower Prairie Creek Watershed at RNSP. The juxtaposition of existing old-growth destinations throughout the park and these underutilized and overstocked portions of the landscape set for restoration are a display of this outlined range of preferences, from too open to too densely wooded. By implementing the variable density thinning plans that the Park Service has outlined for the project, the restored areas will be set on a trajectory that ultimately resemble a more desirable "combination of open and wooded areas," that is seen in existing old growth trails throughout the park.

This applies to a concept in landscape architecture theory more broadly – Prospect-Refuge Theory . This foundational design concept applies to trail design. The notion that humans evolved as an "edge" species in a savanna environment over many thousands of generations, establishes a preference for the forest edge condition within the open grassland-woodland environment of the savannah, seeking a sheltered prospect form which humans could view the open landscape in search of food and shelter (Appleton 1996; Wilson 1984). This theory states that there is a preference for similar spatial arrangements, where both the prospect of opportunity and the refuge or safety of shelter are sought, including those along trail networks.

Another pattern that Kaplan, Kaplan and Ryan (1998) highlight that is particularly pertinent to the development of a trail network throughout the Lower Prairie Creek Watershed is *T4 The Trail's Path*. Developing an interconnected system of trails is more interesting to the visitor, but it also requires resources that help with orientation, and the development of key landmarks along its course. The authors use the example of a waterfall as a key destination landmark; the project site at Redwood could incorporate both cultural and natural features as notable landmarks that distinguish location. Furthermore, signage can guide orientation and tap into the existing surrounding trails system, however too much signage can detract from or change the user's experience. Perhaps, in recognizing this, there is an opportunity to create a network that guides users, orienting location while simultaneously prompting further questions that may not have immediate answers.

Another manuscript outlining a potential theory for the design of trails is the work of Frank Waugh, who likened the creation of a trail to the arc of a story. Waugh's early work greatly shaped how we consider landscapes in the public domain – particularly the concepts of mixed use and recreation on and within the National Forest System and the abovementioned contributions to early ecological restoration (Waugh 1918a). This, coupled with the thinking of his contemporaries such as Aldo Leopold, pushed the agency to encompass areas of wilderness and recreation within National Forests. This is relevant to the concept of trails on National Park Service lands because it shaped Waugh's thinking about how one experiences a landscape.

In his work with the Forest Service, he developed guidelines for trail network and "landscape engineering." As he described in a section titled "Trail Location with Reference to the Development of Scenery," Waugh outline what he viewed as essential concepts in the creation of trail networks.

> "The principal points of interest (such as outside views, vistas up or down a stream, waterfalls, particularly good trees, etc.) are sought out first of all. The route is then laid

in such a manner as to connect these points, having due regard to grade and to other practical considerations” (Waugh 1918b)

While he discussed these principles in the context of the U.S. Forest Service’s National Forest System, the concepts apply generally not only to other federal public lands, like the National Parks, but trail design and public landscapes at large. He described the creation of a trail as the telling of a story, wherein trail views are the creation of a “paragraphic point.”

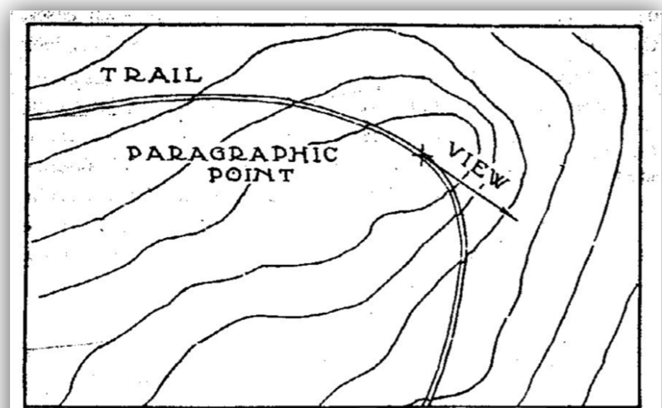


FIG. 4.—The development of trail views at paragraphic points.

Figure 33 The Paragraphic Point of a Trail (Waugh 1918b)

In this way, trails can be thought of as a means for telling the story of site, and introducing users to the features of a landscape. For the project at RNSP, this story includes the elements of a landscape restoration project, and the history of extraction that led to it. If done well, it might also tell the larger story of the human relationship to this landscape and the patterns that have influenced the sense of place that exists, both prior to and following the need for ecological restoration.

Waugh’s outline of trail design theory in *Landscape Engineering in the National Forests* can be summarized in his 6 primary themes and/or objectives for establishing a successful trail or network of trails.

Waugh's Trail Design Theory:

1. For the purposes of landscape engineering each trail or road should be divided into sections or paragraphs
2. Each of these paragraphs should represent one object of interest or one important view, these objects and views having been selected in advance of the trail study
3. As far as possible the views in any series of connected paragraphs should deal with one subject, theme or motive. When the time comes for changing to another motive the former one should be wholly dropped and undivided attention given to the new theme until it in turn is exhausted. Mixing themes is the worst possible design.
4. Each view or landscape picture should usually appear at the end of the paragraph, which should be at the point where the trail makes its principal change of direction. If a change of grade is to be made, too, should come this paragraphic point.
5. These best points of view should be emphasized by appropriate means, such as cutting out trees, widening the trail, placing seats or setting up finger boards
6. The successive views dealing with any one theme should be presented in a progressive climactic order. (Waugh 1918b)

Lastly, in summarizing the current collective thought on the development of a trail design theory, applicable to all landscapes, is the recognition that the shape of a trail, its materiality, and its course throughout the greater landscape can influence the users' experience. This influence shapes how interesting and individuals perceived experience is, and even the speed at which they move throughout the space. A resource put out by the State of Minnesota Department of Natural Resources titled *Trail Planning Design and Development Guidelines* highlights the characteristics and design decisions that make up or enhance the experience along a trail (MNDNR 2007).

These characteristics and patterns of influence on the user, as shown in the following diagrams range from trail shape, anchors and flow to the creation of crossing boundaries and development of larger trail networks that rely on the establishment of landscape anchors and spatial gateways.

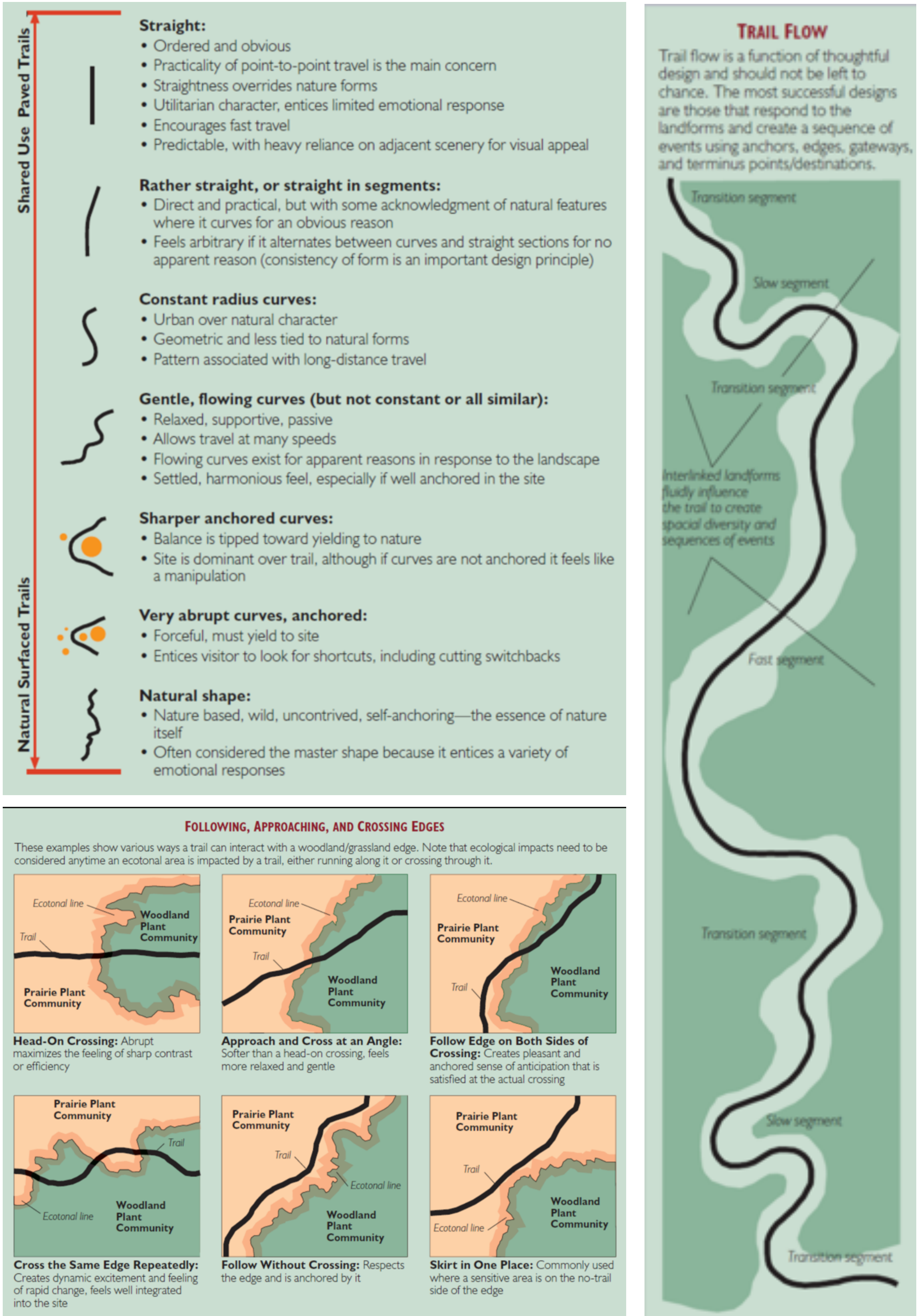
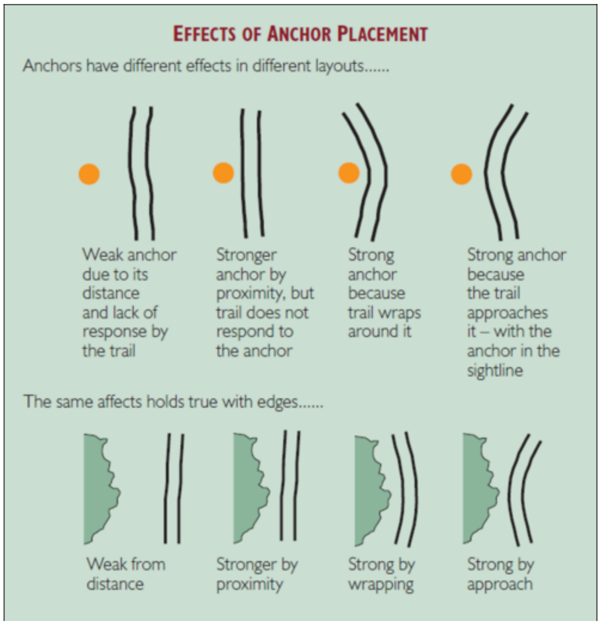


Figure 34 Trail Design Concepts (MNDNR 2007)



When developing a greater network, large scale factors come into play, such as considering how and where opportunities for "looping" may occur. When considering how this influences the ecosystem that the user is moving through, there is a need to acknowledge ecological buffers, connectivity, and opportunities for creating a sequence of events that maximizes the trail experience (MNDNR 2007).

Researches have highlighted the need for a scientific basis for the trail design and maintenance literature, one that utilizes a *Trail Sustainability Rating System* to assess and improve trail design (Marion and Wimpey 2017). Analyzing trail tread erosion and soil loss along trails should influence design and maintenance decisions; these environmental factors should be coupled with ecological decision by recognizing the threat that sediment deposition has on watershed qualities (Marion and Wimpey 2017).

Through the concepts that the Minnesota DNR resource outlines, the designer should consider how and where qualities such as intentionally limited sightlines, spur trails, observation areas or points of interest and connectivity are grounded in minimizing impact to existing or remnant natural areas (MNDNR 2007).

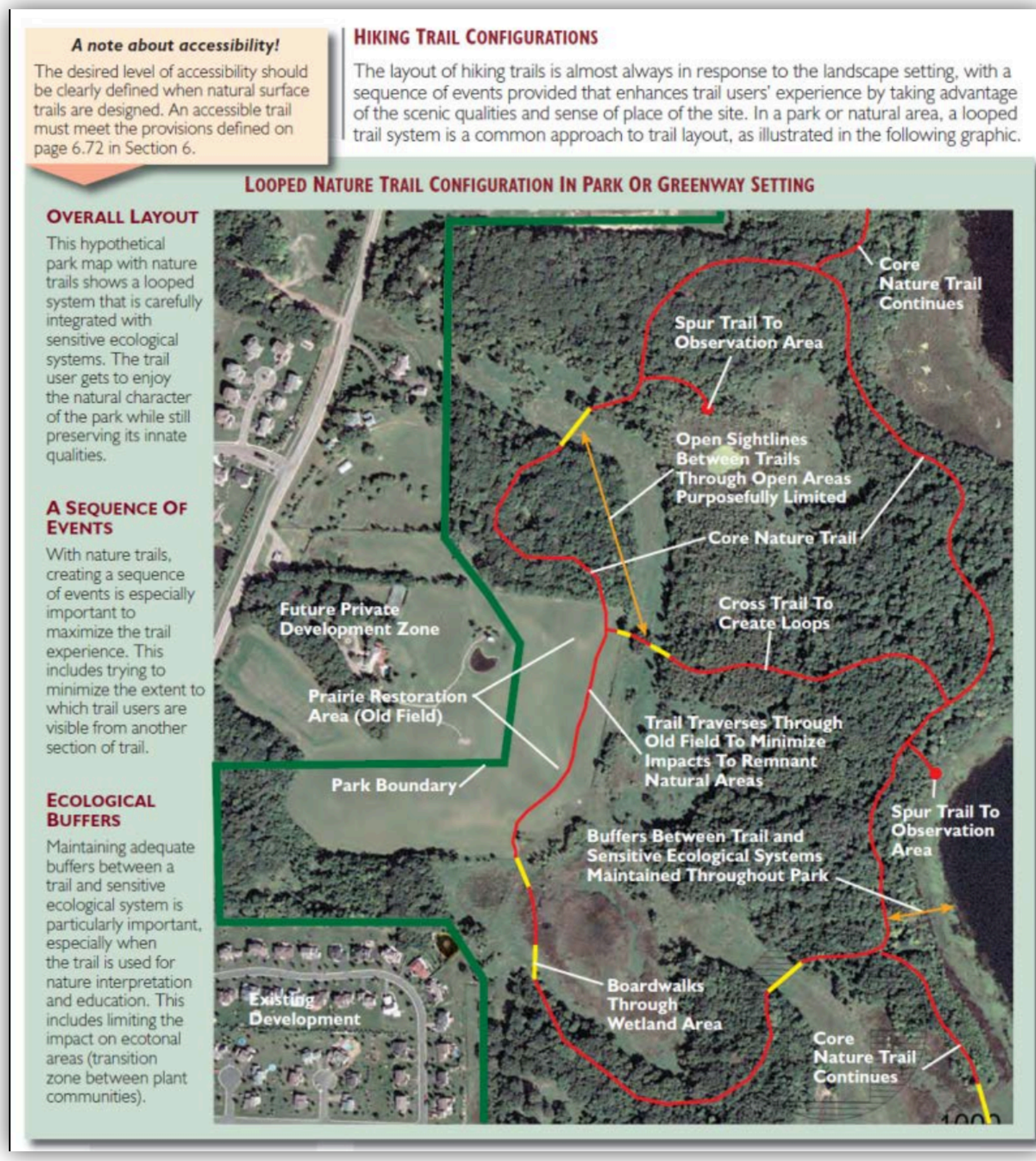


Figure 35 Trail network design concepts & their grounding in ecology of the surrounding matrix (MNDNR, 2007)

In evaluating these trail design patterns and themes, several questions emerge: how do these principles apply to remote parkland? Moreover, how do they relate to areas of degraded or disturbed parkland like in the case of redwood? Redwood's somewhat unique qualities as both sanctuary for pristine old growth and post-industrial ground zero for the timber wars places it in a unique light that challenges conventional conceptions of trail design and its place in our parks.

Furthermore, landscape architects must acknowledge that trails throughout urban green spaces may have fundamental differences from those of a rural (or even designated wilderness) federally managed landscape (such as RNSP). For example, while both spaces are highly-valued for their nature based recreational opportunities, the urban greenway attracts demographically diverse visitors, where elements of social interactions and neighborhood connectivity are highly valued by those urban trail users (Keith et al. 2018). These are challenges that the remote parkland should strive to address by reducing barriers to entry and enhancing the accessibility of federal public lands, however, these needs may not be directly met in the development of a new trail network in a far-off landscape. The traditional national park model, like in the case of Redwood, is inherently removed from the urban community. While the NPS has worked to reconcile this through community revitalization goals, there exists a dramatic geographic barrier to access that should not be overlooked (Weber and Sultana 2013; National Park Service 2018c). All design decisions should recognize this systemic problem and create spaces that are inviting to all.

Road-to-Trail Conversion

In the context of the restoration of Lower Prairie Creek, it is important to overview the process of road-to-trail conversion. There is a great opportunity for some of the crisscrossing network of abandoned logging roads, slated for removal and remediation, to be converted to trails infrastructure throughout this process. These existent roads are a great source of sediment deposition into prairie creek and its tributaries (impeding spawning habitat for the endangered coho and chinook salmon) and, due to their cut-and-fill profile, and grotesque forms of stream crossing (mostly fill-in in nature; some culverts or rudimentary/degraded corduroy), they are a major source of erosion, landslide and sediment deposition.

Figure 36 Early Park Service effort to address erosion following a landslide in Berry Glenn (National Park Service 2018d)

The Best Management Practices (BMP) for road rehabilitation in the context of road-to-trail conversion is salient to the design of a trails network throughout the project site. The definition of road-to-trail conversion, as defined by Brian Merrill and Ethan Casaday (2003) of the California State Parks' Roads, Trails and Maintenance Section of the North Coast Redwoods District is:

> "Conversion of a road to a trail by mechanically narrowing the road surface. Excavation of road embankment and landing fill and stabilization of excavated materials on the inboard edge of the cutbench. A narrow portion of the road cutbench is preserve to serve as the trailbed." (Merrill and Casaday 2003)

This term/concept is synonymous with road conversion and trail construction. They suggestion detailed considerations of: aesthetics, air quality, biological resources (plants, trees, fish, birds, amphibians, exotic plants, wetlands, and wildlife corridors), cultural resources, geology/soils, hydrology/water quality, hazards and hazardous materials, should all be considered in the greater context of land use and land use planning before conducting this process of remediation (Merrill and Casaday 2003).

In a landscape as scarred as Redwood National Park, little harm can come from road-to-trail conversion, as removing these road is already a top priority of restoration. To take this opportunity to consciously convert these into a network of recreation trails, varying in uses, is auspicious. The grade for many of these logging roads, while acknowledging their poor current condition, is favorable for a comfortable slope for user experience. Logging decks, where the management of cut timber was sorted (and will be utilized in the ongoing thinning efforts) should be considered under this umbrella – these landings can be integrated as opportunities for key nodes in the network.

What constitutes a trail?

Lastly, and broadly speaking, trails can be motivation for both recreation and resource conservation. This is a central tenet of the lose body of literature on trail design theory. Trails connect the user to significant historic or cultural places, such as Boston's Freedom Trail, telling the story of colonial America and the birth of a nation (Grenier et al. 1993). This analysis highlights the broad range of what constitutes a trail, and prompts questions of the possibility of unifying concepts. From the Freedom Trail to Oregon Trail, even within the context of historic landscapes, the range of embodiment is massive. Playing a vital role in ecotourism, landscape architecture, and even urban planning, these can be trails for pedestrians, bicycles, or other modes of locomotion, that ultimately connect history and interpretation of a site (Grenier et al. 1993). This can also include trails on a far greater scale and an arguably deeper context, such as the Lewis and Clark National Historic Trail or the Trail of Tears National Historic Trail – both of which cross large swaths of the country and are rooted in deep cultural significance (National Park Service 2020a, 2020c).

Another category of trails is the concept of a continuous thru-trail or (often categorized as) a National Scenic Trail (National Park Service 2020b). Some precedents that might serve as useful guides in trail design are the Appalachian Trail - AT (and the noted resources of Appalachian Mountain Club); Pacific Crest Trail – PCT; and the Continental Divide Trail - CDT; together these three National Scenic Trails make up the “Triple Crown” of thru-hiking. However, each trail has dramatically unique styles, characteristics and histories that define them. For example, the AT is known for its difficult up-and-down sections that are managed by local trail clubs, while the PCT is a continuous pack-grade trail primarily managed by federal agency trail crews.

These National Scenic Trails, and others, crisscross the backcountry and front country of many national parks and public landscapes. Looking for places to integrate within larger networks or historic corridors should be considered. One potential larger trail network that the RNSP LPC trails could tie into is the 1200 mile California Coastal Trail. Looking for this opportunity to engage beyond the local scale can extend how the trail is both used and perceived.

Nonetheless, the concept of a trail is somewhat vague and can vary greatly. The factors that vary, such as tread material (i.e. hard-pack gravel vs. asphalt vs. woodchip), layout, length and interpretation are all covered within the collective theory that is summarized by the manuscripts of Kaplan et al, Frank Waugh, and the Minnesota DNR resources above.

The development of a general trail design theory, particularly one that applies to a breath of landscapes and within a context of restoration is a gap in knowledge. The proposal of a trail network in the Lower Prairie Creek watershed of RNSP humbly aims to address this gap – admittedly not wholly answering the questions raised about trails and restoration but ultimately putting forth a theory with the hopes of prompting more.

LOWER PRAIRIE CREEK: Restoring Ecological Integrity and Sharing the History of the Landscape through Trail Design.

As the history and summary of pertinent literature shows, Redwood National Park is a unique and dynamic landscape. It does not fit a traditional model of a National Park, either in the way it is governed or the resources it protects, but at its core it represents the ideals of the National Parks System, for the "benefit and enjoyment of the people." In fact, the forward-looking vision of the parks' efforts goes beyond the traditional preservation mentality. The collaborative nature of a mixture of Federal and State Lands, supported by the National Parks Service (NPS), California Department of Parks & Recreation (CDPR), Redwood Parks Conservancy (RPC), and Save the Redwoods League (SRL), affords the park the opportunity to be far reaching and forward-thinking.

Figure 37 Tall Trees Grove 1976 Dave Van de Mark - Clearcut logging immediately adjacent to the primary grove of Redwood National Park (Spence, 2011)

The complex history of logging, conservation, indigenous rights and the need for protecting and restoring the landscape at a regional scale has led to one of the largest and most expensive expansions of a National Park in US history. Threats to protected Old

Growth stands downstream motivated interest in reforesting the clear-cut watershed upslope to reduce sediment deposition harming the trees shallow root systems [See Fig. 38]. In 1978, President Carter signed the *Redwood National Park Expansion Act*, legislation that expanded the park boundaries by 48,000 acres, of which 39,000 acres were logged over landscape (Spence 2011). This was a relatively new concept for the NPS, whose efforts preceding this were primarily focused on preserving and protecting pristine natural resources. Degraded, clear-cut Coast Redwood forests did not fit this mold. This provided a distinctive opportunity for the park and its stakeholders to become the testing grounds for innovative forest restoration practices.

This history echoes elements present in the formation of other National Parks, highlighting the importance of "future benefit" to the Parks Service's mission. The history of industrial landscapes, private ownership and settlements in Great Smoky Mountains National Park has a similar legacy to Redwood's logging past; the piecemeal nature of Acadia National Park and Sleeping Bear Dunes

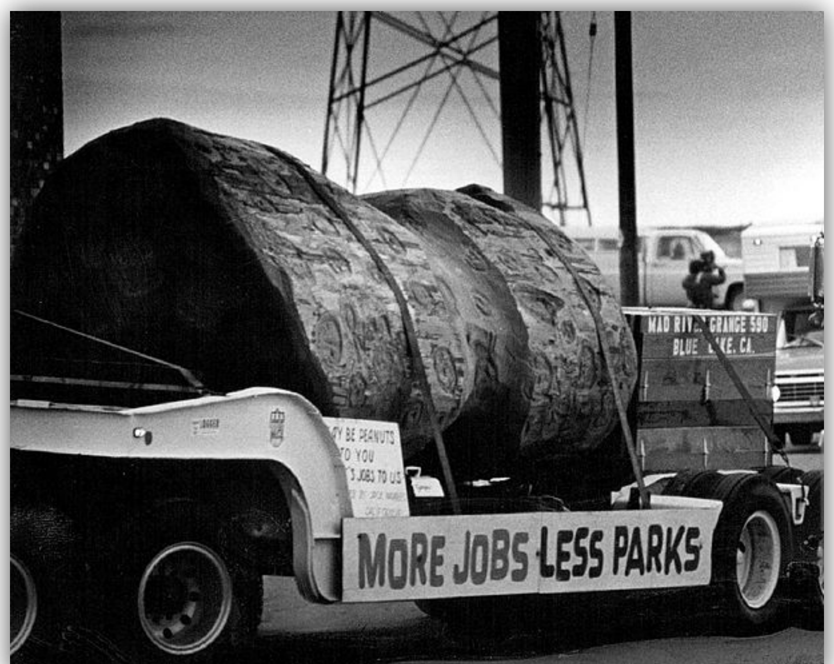


Figure 38 Redwoods Not Peanuts to Loggers "A convoy of 12 logging trucks pulled into Denver Saturday night from Washington, D.C. Lead truck, carrying giant redwood peanut, was part of protest of legislation that would limit harvesting of lumber in Redwood National Park in northern California. The protest convoy was formed earlier this month in effort to save loggers jobs from threat of proposed expansion of Redwood forest." (Larson 1977)

National Lakeshore from private to public lands is not unlike the transfer of property from timber companies to the public in Northern California. Regardless, Redwood is still unique amongst parks for the scale of this undertaking. Redwood National Park's creation was arguably the most controversial and opposed formation of a National Park in history and remains a point of contention on both the natural and social landscapes throughout the region today [See Fig. 39].

RNSP is also unusual in its chief aim to preserve a landscape as an example of, and a refuge for, an individual species and the ecosystem that supports it. The Coast Redwood (*Sequoia sempervirens*) is of an ancient order whose forests once dominated the northern hemisphere over 125 million years ago. Today, only a thin strip along the northern coastline of California persists, and of this its extant has been reduced by 95% since European settlement. Of the 5% of Coast Redwood old growth that still stands, 39% can be found within RNSP's boundaries (Noss 2000). Like it's inland relative the Sierra Redwood or Giant Sequoia (*Sequoiadendron giganteum*), which is protected by *Sequoia & Kings Canyon National Park*, as well as the Mariposa, Tuolumne & Merced Groves in *Yosemite National Park,* National Parks provide safe haven for these prehistoric holdouts. Both of these Parks created an example of how these giants can be protected in perpetuity, but it could be argued that *S. giganteum* did not face the same pressures as the Redwood forests on the coast since their timber value was substantially less, often splintering under their own weight when felled.

Today, the RNSP, which serves as a World Heritage Site and International Biosphere Reserve, still faces vulnerability from the scar that logging left. Over 400 miles of logging haul roads, spur roads, and skid roads crisscross the landscape. Creek crossings and ephemeral streams were plugged by "Humboldt bridges" that consisted of large woody-debris and slash from the clear-cutting process being jammed into creek beds allowing logging trucks access, with the occasional culvert to direct stormwater flow, while only further channeling sediment deposition. These roads - and even more importantly, these culvert-crossings - are actively being removed to improve both the quality of the watershed and the health of the forest for several threatened and endangered (T&E) species.

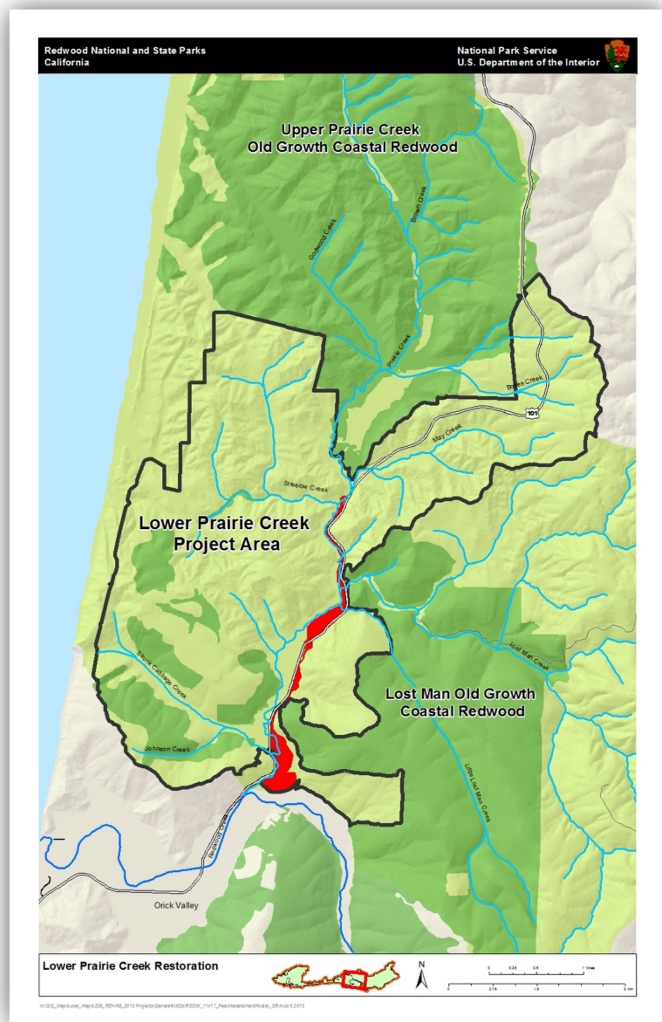


Figure 39 Lower Prairie Creek Project Area, Redwood LPC Database (National Park Service, 2018d)

With the help of SRL, (whose efforts have purchased and protected almost all of the remaining old growth redwood stands left in Northern California) the park has shifted its attention to restoring the land acquired through the 1978 expansion. The Lower Prairie Creek Restoration Project seeks to simultaneously thin second growth (to improve forest biodiversity and structural heterogeneity; aerial seeding by the timber companies has led to a species composition that favors *Pseudotsuga menziesii* and *Picea sitchensis* over Redwood) while removing the network of logging roads across the

9,200 acre site. Once restored, the Lower Prairie Creek Watershed will connect two separated old growth patches (*Prairie Creek Redwoods State Park* and *Redwood Creek Watershed*) to create the largest contiguous old growth redwood forest on earth. This presents an auspicious opportunity to develop a world-class network of trails that not only connects the old growth of *Prairie Creek Redwoods State Park* and *Redwood Creek Watershed* to the landscape that is actively being restored, but an opportunity to curate the history leading up to its rehabilitation. This trail system has the potential to interpret the anthropogenic changes to the landscape and highlight the importance of the ongoing restoration work, aimed at healing the scar left by the greed of the timber industry. Furthermore, the proposed trails system would connect and solidify the Trillium Falls Corridor, making the somewhat-fragmented park feel far more unified. A proposed future Visitors Center, on the site of the historic Arcata Redwood Company (ARCO) Mill Site A, will allow visitors to enter directly into the forest upon arrival, a scenario that is currently not possible with the physical location of the existing Thomas H. Kuchel Visitor Center.

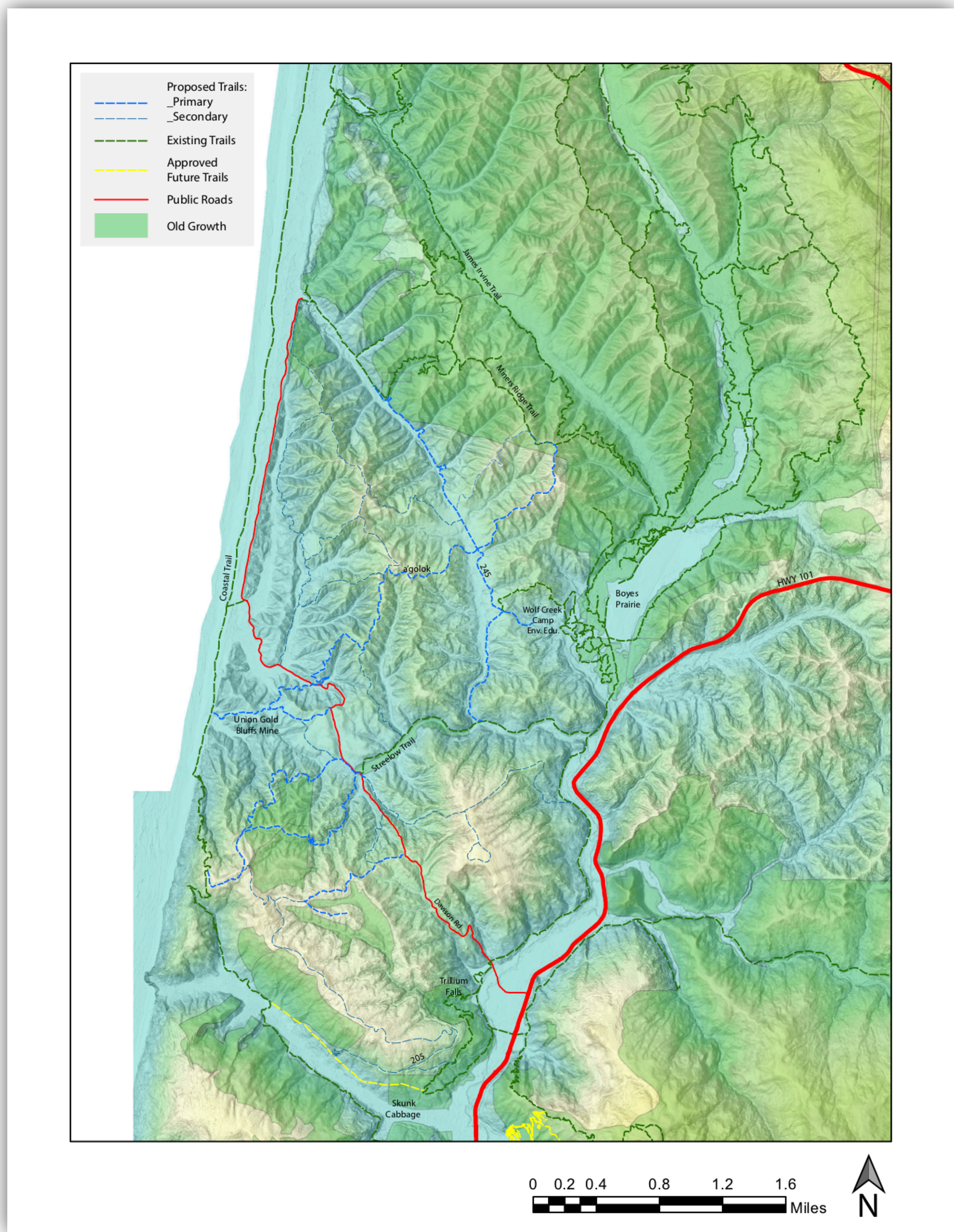
The heavy equipment required to remove logging roads is the same equipment that was used to build them. This machinery can be used to convert roads to trails expeditiously, and easily establish a range of trail accessibility for a variety of visitors. This project not only aims to propose routes throughout the Lower Prairie Creek Project Area, but provide a framework for documenting the history of the site. This will be done by identifying the location of key artifacts (either historical or natural features) and developing a template for the interpretation of these features. Converting historic logging roads into a vein of accessible trails throughout Lower Prairie Creek will introduce visitors to landscape scale forest restoration and the unique history of a dynamic park. Furthermore, this proposal can serve as an opportunity to reflect upon how both sensitive and degraded natural and cultural resources are managed, and how trails can foster conservation by providing access and education to a diversity of users.

Proposed Trail Network: Maps & Trails

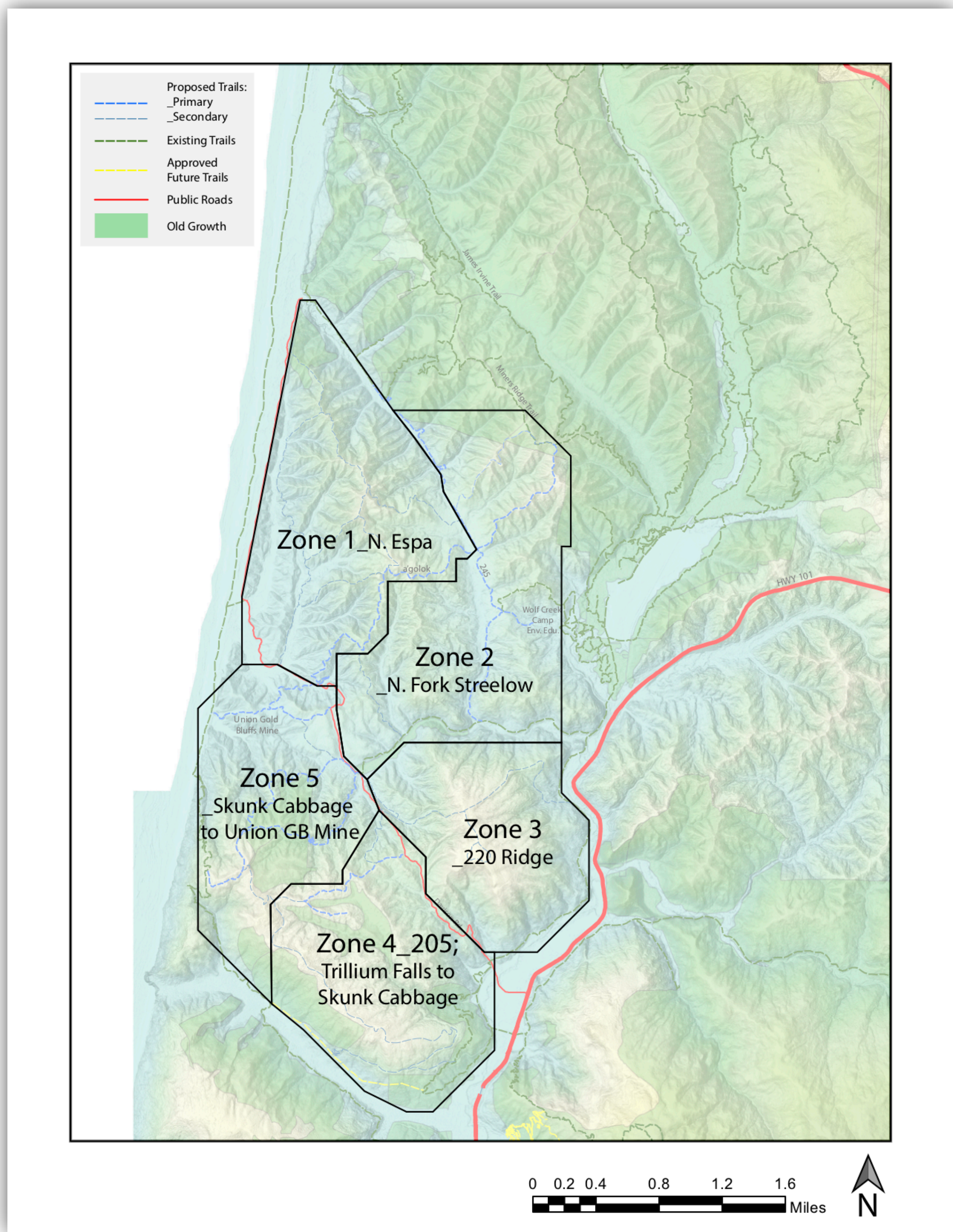
The following maps and descriptors represent the comprehensive extent of the network designed and key nodes, characteristics or landscape elements of each component. These routes were all walked, designed, and informed through &/or refined by data from historic photographs, field observations and site measurements (such as slope, aspect, length), GIS mapping analysis (using an Avenza Mapping Resource, EOSTools GPS, and a THETA 3D camera), and the insight from themes and patterns summarized in the literature review above. Many historic aerial photographs were invaluable in locating and following routes or identifying notable locations in the field (such as the logging road network itself or locating cuts made throughout various historic periods – something that is well documented in Park Service resources,) [See Appendix II]. This information, in turn, can also be used in the forest thinning and road removal process as a dataset delineating stream-crossings, and other physical landscape features of note (such as landslides or trees/groves of significance). These have been broken down into five primary zones, with similar features, elements or connectivity.

Figure 40 Clinometer used for measuring slope throughout these proposed routes during the trail design process (Pritchard 2018)

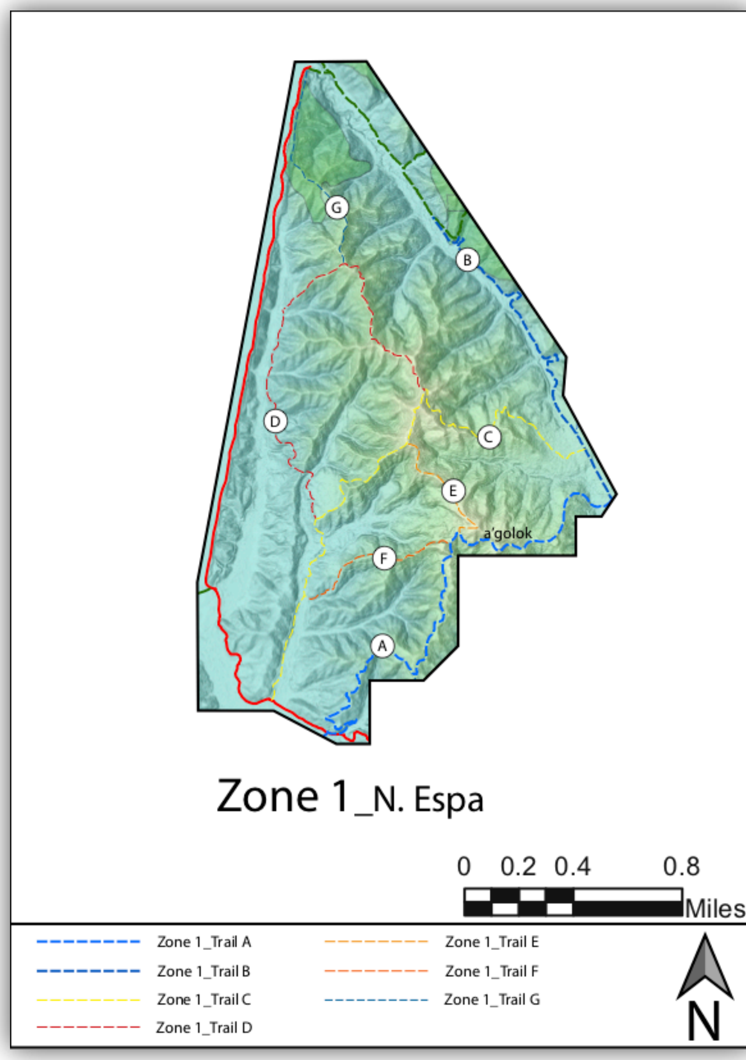
Proposed Trail Network Overview Map:



Lower Prairie Creek Restoration Trail Network Proposal:



Zone Maps & Descriptions:



Zone 1_North Espa:

Area Summary: This Zone is located in the Northwest corner of the project site, situated within the coastal hills north of Espa Lagoon, bound by Davison Rd to the South, Gold Bluffs & the Pacific Ocean to the West, Squashan (Also referred to in historical text as 'Squash ann') Creek/Miners Ridge to the North, and the current 450 Rd (a'golok)[i] Ridgeline to the East/Southeast [See Appendix I]. This coastal section has dense, fast growing vegetation, and prominent ridgelines that can be used to develop viewpoints and the greater viewshed throughout the network. There is record of indigenous uses in and around Espa Lagoon, and historical landscape uses from Mining, Logging, and a U.S. Postal Service Route. The 450/453 Rd is likely the ridgeline described in historical accounts of a trail connecting Gold Bluffs to Boyes Prairie (on the Trinidad to Mouth of the Klamath/Trinity Network). The floodplain of Squashann Creek was logged early on and is dominated by *Picea sitchensis,* used in the early construction of military airplanes.

Zone 1_Trail A [Primary]

Trail Name: a'golok (summit of ridge)

Location (*relative to existing logging roads &/or connection opportunities*): 450 - Davison Rd to 245 Rd

Length: [2.12 mi]

Max Slope: [20-25%] on North End of Trail

Orientation/Exposure: North to South

Major Hazards: N/A

Historic Logging Road Utilized: 453/450 Rd

# of Crossings (*culvert or otherwise*): [4+] Trail follows ridgeline, limiting major crossings; there are several at each end of the route, and evidence of ephemeral water flow as the trail climbs.

Major Points of Interest: a'golok, (the Summit of the Ridge); Large Old Growth Nurse Log in the Canyon from the section between Davison Rd and the point where the trail begins to rise as it switch-backs to the North; Potential Evidence of Mining Near the intersection with Zone1_Trail F (Strange LIDAR & ground truth evidence of historic slide suggests anthropogenic influence); Several Major Logging Landings; Wood Nymph (*Moneses uniflora*) found along this Ridge.

Description: The section from Davison Rd to the first intersection (Zone 2_Trail C) is [0.77 mi], continuing along the ridge, transitioning from the 450 to 453 rd to the North, intersecting with Zone1_Trail F [0.55], and Zone1_Trail E at an additional [0.05 mi], continuing [0.75 mi] to the junction with Zone1_Trail B/Zone2_Trail A the 245 Rd, following the North Fork of Streelow Creek, a Primary Tributary of the Lower Prairie Creek Watershed.

This route follows the general ridgeline of a historic Yurok and mining/trading route from Gold Bluffs to Boyes Prairie, along the greater Trinidad to the mouth of the Klamath/Trinity River trail. utilized by indigenous peoples, gold seekers, and the U.S. Postal Service (contracted to J.F. Denny for an annual rate of $1750).

The current condition of the road makes it an appropriate candidate trail for road-to-trail conversion. With the exception of the first hundred yards (approximate) North from Davison Rd, the entire length of the logging road-bench is still intact. It will likely be used as a primary haul route during the forest restoration thinning process. Following this use, it can be restored to a narrow corridor tracing the historic route across the project site, opening opportunities for visitor engagement and the interpretation of both cultural and natural histories.

Zone 1_Trail B [Primary]

Trail Name: Squashan Trail

Temp. Name)

Location: Miners Ridge Trail to 245 Rd

Length: [1.25 mi, to first intersection] [2.90 – 3.15 mi, to greater network; See Zone 2]

Max Slope: [5-10%]

Orientation/Exposure: East to West

Major Hazards: N/A

Historic Logging Road Utilized: 245 Rd

# of Crossings: 7

Major Points of Interest: Historic Sitka Spruce Logging – alleged evidence of original corduroy (was not able to locate); Wood Nymph (*Moneses uniflora*) found along this route

Description: The section from *Miners Ridge Trail* to the first intersection drops to the floodplain, and follows a road bench on the North side of the trail [1.25 mi]. The trail crisscrosses Squashan Creek and its tributaries, bordering along the Old Growth stands of Prairie Creek Redwoods State Park. This route follows historic haul roads that date back to the earliest days of logging within the Park; The intersection with Old Growth holds potential for a desirable route. This trail can also connect to existing Bike trails and get riders off of the road along Gold Bluffs, and an easier alternative back toward Drury Parkway and the Ossagon Trailhead. Overall, the road-bench is in good shape, although the portion to the south side of the creek has been removed in 1996 by State Parks; Crossings and overgrown routes will need to be reestablished to connect this route, there are significant crossings toward the Eastern end of the trail, nearing the saddle of the two watersheds.

Zone 1_Trail C [Secondary]

Trail Name: NW Streelow Trail

Location: NW Streelow Road to E. Camp Creek Rd

Length: [2.36 mi]

Max Slope: [10-15%]

Orientation/Exposure: North/Northeast to South

Major Hazards: N/A

Historic Logging Road Utilized: NW Streelow Rd

# of Crossings: 4

Major Points of Interest: Significant opportunity for North/South Coastal Views along the ridgeline; Lots of evidence of fauna movement in this area (Multiple Bears observed here throughout scoping); Environmental Camp could serve as a major node on network, addressing educational and recreational goals and objectives.

Description: The section from Davison Rd to the first intersection (Zone 1_Trail F) at E. Camp is [0.41 mi], continuing along the route, the trail raises gently for another [0.35 mi] until it forks (Zone 1_Trail D), climbing the ridgeline (A new section of trail, no extensive roads here, some evidence of skid roads) for [0.5mi] where it intersects with (Zone 1_Trail E), continuing for another [0.2 mi] until it crosses paths with (Zone 1_Trail D) once more (creating trail loop opportunities), and then descending again for [0.9 mi] where it meets with (Zone 1_Trail B).

Zone 1_Trail D [Secondary]

Trail Name: Espa Ridge Loop

Location: NW Streelow Road to E. Camp Creek Rd

Length: [1.87 mi]

Max Slope: [X%]

Orientation/Exposure: North to South Loop Trail

Major Hazards: Large Second Growth Redwood and Spruce have fallen across the road

Historic Logging Road Utilized: NW Streelow Rd

# of Crossings: 10 (Several Major Crossings, depending upon the final orientation of the trail)

Major Points of Interest: Opportunities to create connections for surrounding trails, and day use from E.Camp; Opportunities to create a more challenging route (Zone 1_Trail G) for bicycle use.

Description: This trail utilizes a mixture of existing logging roads and establishes new routes across both valley bottom and ridgeline; there is a dramatic decent, crossing, and climb following the trail clockwise (north from Zone1_Trail C), however following the current road bench, this road does not exceed 10% slope. There is opportunity here to continue along the ridge or follow the road west into the valley north of Espa Lagoon, and loop back up the ridge as shown in the map above.

Zone 1_Trail E [Secondary]

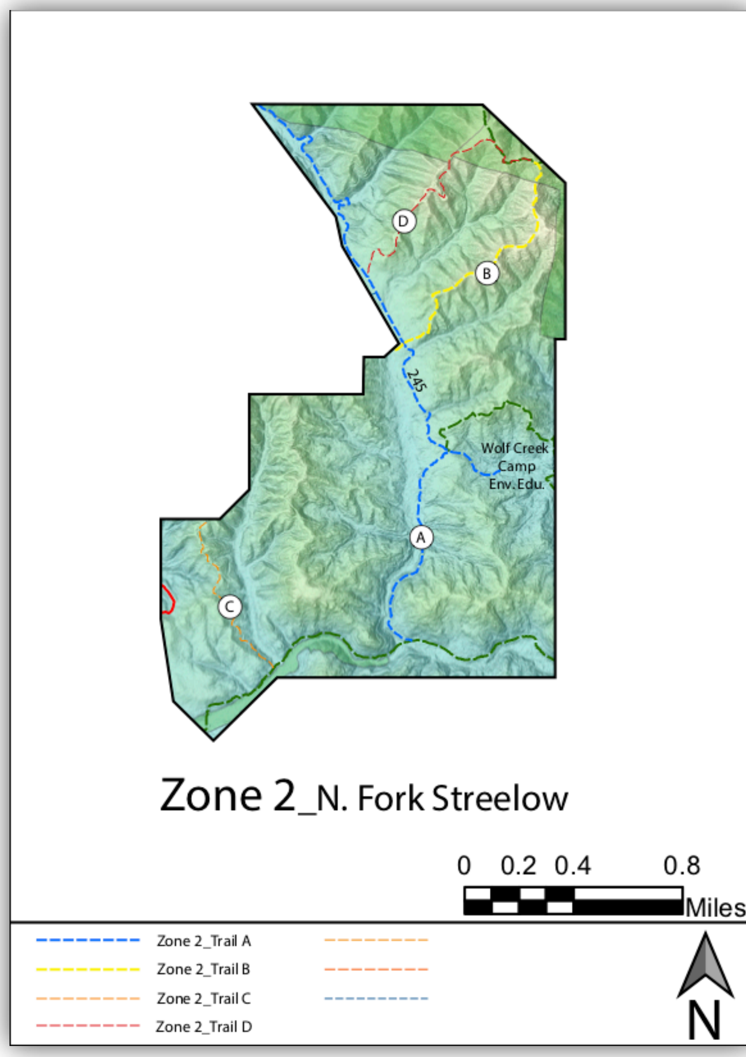
Trail Name: Ridge Connector Trail 1
Location: Connection; Zone1_Trail A to Zone1_Trail C
Length: [0.55 mi]
Max Slope: [X%]
Orientation/Exposure: Northwest to Southeast
Major Hazards: N/A
Historic Logging Road Utilized: NW Streelow Rd
# of Crossings: 2
Major Points of Interest: Connection opportunity
Description: This trail can serve to connect the surrounding secondary trails to the primary network.

Zone 1_Trail F [Secondary]

Trail Name: Ridge Connector Trail 2
Location: Connection; Zone1_Trail A to Zone1_Trail C
Length: [0.63 mi]
Max Slope: [X%]
Orientation/Exposure: Southwest to Northeast
Major Hazards: N/A
Historic Logging Road Utilized: NW Streelow Rd
# of Crossings: 1 (At junction with Zone 1_Trail C)
Major Points of Interest: Connection opportunity
Description: This trail can serve to connect the surrounding secondary trails to the primary network. Proposed route climbs from E.Camp to a'golok ridge trail.

Zone 1_Trail G [Secondary]

Trail Name: Mountain Bike Connection
Location: Connection; Gold Bluffs to Zone1_Trail D
Length: [0.85 mi]
Max Slope: [X%]
Orientation/Exposure: North to South/Southeast
Major Hazards: N/A
Historic Logging Road Utilized: N/A
# of Crossings: 1 (first 1/3rd of trail follows creek; exact line subject to change)
Major Points of Interest: Alternative difficult bicycle route
Description: This trail can serve to connect the surrounding secondary trails to the primary network. Proposed route climbs from E.Camp to a'golok ridge trail.



Zone 2_North Fork Streelow:

Area Summary: This Zone is located in the Northeastern corner of the Project site. The area contains the 245 road, which is a primary corridor through the valley of the North Fork of Streelow Creek; it currently serves as a main point of access to the interior logging roads from either Wolf Creek Camp/Environmental School &/or the existing Streelow Trail and beyond. The lower-lying areas of the valley contain massive remnant stumps from logging days, complete with distinct springboard holes that can provide interpretive opportunities in the future as this space is transitioned from post-logging to restoration and finally to public space. There are also several old growth trees scattered throughout this zone, left either for their poor timber quality (many are knotty and have significant fire scars) or for shelterwood (natural reforestation seed source).

Zone 2_Trail A [Primary]

Trail Name: 245 Trail

Location: 245 Road; N. Fork Streelow Creek

Length: [1.65 – 1.9 mi] (accounting for spur to Wolf Creek Staff Housing)

Max Slope: [>5%]

Orientation/Exposure: North to South

Major Hazards: Dead Fall in section connecting Streelow Trail to Wolf Creek/Raven Ridge Junction

Historic Logging Road Utilized: 245

# of Crossings: 6

Major Points of Interest: Natural Beauty of N. Fork Canyon; Old Growth Trees (Shelterwood & Poor Timber Quality); Stump Graveyard (Massive Stumps line this route – Some of the Largest in the Project Area); Lots of fauna activity (Elk, Bear, Deer, etc…)

Description: This trail follows the line of the North Fork of Streelow Creek, a primary tributary and sub-basin of Lower Prairie Creek. At its southern terminus, the junction with the existing Streelow Trail, the trail rises gently as the canyon to the west gets deeper. The route diverges slightly from the creek, toward the intersection with spur trails that lead to Wolf Creek (residential spur & Ravens Ridge Trail). There is significant windfall/deadfall blocking a portion of the road bench before the trail turns inward. The trail then rejoins the creek, paralleling it for the remainder of the route until reaching the saddle where it enters the Squashann Creek Watershed (See Zone 1_Trail B). The entirety of the route is relatively level and uniform, with 6 culvert crossings (several of which are moderately large sub-tributaries with a significant amount of woody debris and sediment in them). There are no major failures along the 245 logging road as present.

Zone 2_Trail B [Primary]

Trail Name: Miners Ridge Connection

Location: 245-5-1 to 248 to Miners Ridge Trail

Length: [1 mi]

Max Slope: [25%]

Orientation/Exposure: Southwest to Northeast

Major Hazards: N/A

Historic Logging Road Utilized: 248; New Trail (connection to Miners Ridge

# of Crossings: 0 (crossing on 245 just before junction with this trail)

Major Points of Interest: State Park/National Park Boundary, Historic Signage (could provide an opportunity for interpretation).

Description: This trail follows the 245-5-1 Rd, climbing sharply out of the valley for a distance of a few hundred yards (approximate), and then leveling out once it reaches the ridgeline. The initial 25% slope will require an on-the-ground assessment of the micro-topography when being constructed to determine the optimum route, although elongated switchbacks following the logging road should suffice. This trail will serve as a primary conduit from the Lower Prairie Creek Restoration Project Area to the existing network of trails in RNSP to the north in Prairie Creek Redwoods State Park. As this trail enters State Park Property, the dominance of Old Growth is overwhelming, providing a profound experience for the hiker. This trail could connect as a loop with (Zone 2_Trail D; 247 Rd) or serve as an alternative. Both routes follow the ridgeline and have significant landings along their routes.

Zone 2_Trail C [Secondary]

Trail Name: Coho Trail

Location: Streelow Trail to 450 to 453

Length: [0.7 mi]

Max Slope: [X%]

Orientation/Exposure: North to South

Major Hazards: N/A

Historic Logging Road Utilized: 450

# of Crossings: 0 (follows ridgeline)

Major Points of Interest: There are large Old Growth Nurse logs along this route

Description: This trail would provide added connectivity between the primary routes of Streelow and a'golok/Zone 1_Trail A; it is a secondary route, proposed to increase the flow and distribution of visitors, providing a greater number of loop opportunities for individuals to determine a route of suitable length for their hike. The current logging road is in good shape and follows a gradual climb from Streelow Creek (trail) to the ridgeline, along a tributary basin of the watershed. There is an alternative connection route along the ridge directly to the East of the proposed trail, the 452 spur, which can serve as a secondary option if a mass action event occurs or another problem poses a hindrance on trail construction in the future.

Zone 2_Trail D [Secondary]

Trail Name: Miners Ridge Connection - Alternative (Temp. Name)

Location: 247 to Miners Ridge Trail

Length: [0.9 mi]

Max Slope: [15%]

Orientation/Exposure: Southwest to Northeast

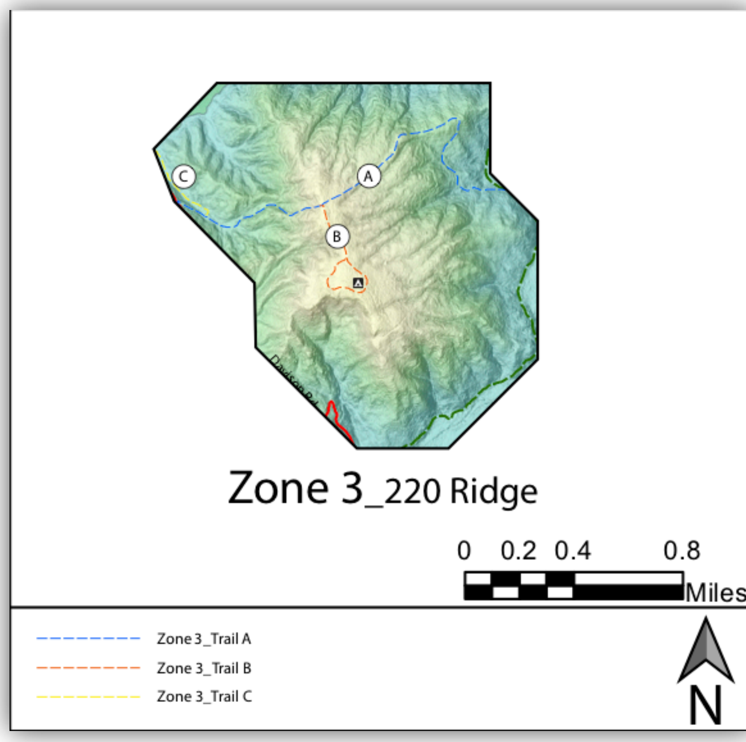
Major Hazards: N/A

Historic Logging Road Utilized: 247

# of Crossings: 0

Major Points of Interest: Major Landing Docks from Logging Operations

Description: This trail serves as an alternate or addition to Zone 2_Trail B. The route has a less dramatic initial climb, but is 0.3 mi West of the Zone3_Trail B trailhead. This could also create good loop opportunities between the two proposed routes. This road is in good shape, and if resources allow, should be a road to trail conversion. The connection to Miners Ridge will require a longer section of new trail than the connection from Zone 2 _Trail B, but follows the ridgeline and does not pose major construction or maintenance hurdles



Zone 3_220 Ridge:

Area Summary: This Zone is located to the West of the Project Area Bordering Davison Trail and Davison Rd. The Highpoint of the ridge could serve as a backcountry campground. It has a level area and is a more mature, second growth canopy. There are some remaining Old Growth Trees atop this ridge, but the slope to the West/Northwest is even aged, and was clear-cut. This area could serve as a good example for chronosequencing or interpretation of forest succession and the advantages of thinning and other restoration practices within the park [See Appendix II].

Zone 3_Trail A [Secondary]

Trail Name: Ursus Ridge
Location: Davison Spur A to Unnamed Rd to 230
Length: [1.5 mi]
Max Slope: [35%] (Following Skid Roads); [15-20%] following old road bench to the north of major landing
Orientation/Exposure: East to West
Major Hazards: Lots of Deadfall/Standing Dead; Young, even-aged forest on slopes; Large Old Growth Tree struck by lightning at top of ridge
Historic Logging Road Utilized: Davison Spur A; 220; 230
# of Crossings: 2 (trail follows south of drainage as it climbs)
Major Points of Interest: Views to the West, will develop as forest is thinned and matures
Description: This trail climbs from Davison A to the top of the ridgeline, following it as it descends (a newly proposed section of trail, no roads here), until it reaches the 230 road which connects to the existing Davison Trail, allowing movement to the trails of Prairie Creek Redwoods State Park.

Zone 3_Trail B [Secondary]

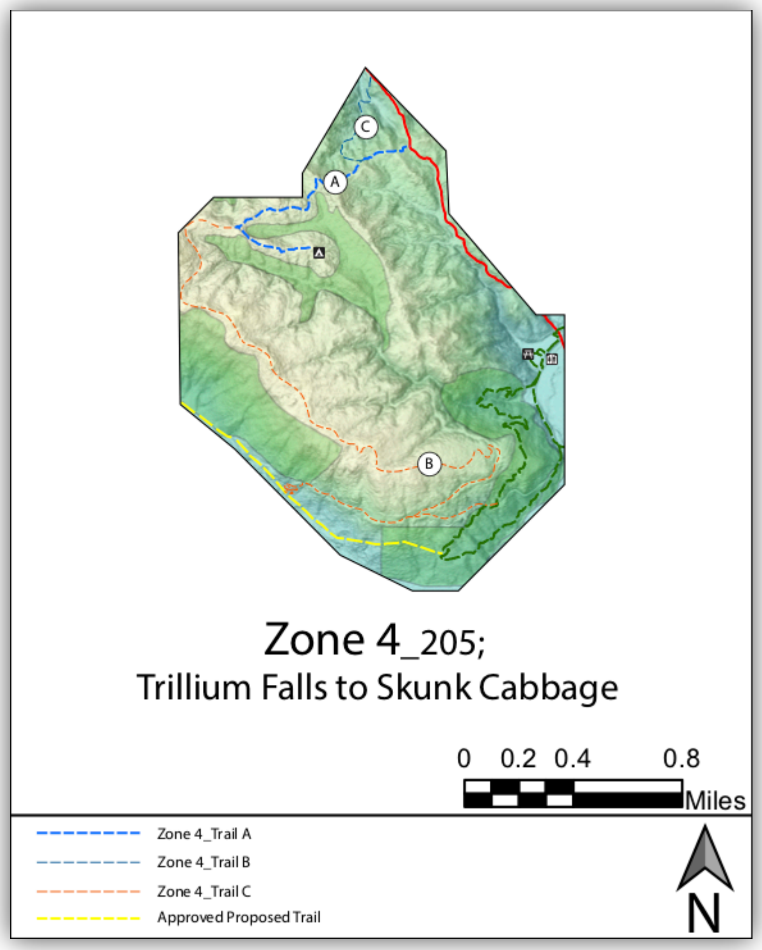
Trail Name: Lost Loop
Location: N/A
Length: [0.7 mi]
Max Slope: [>2.5%]
Orientation/Exposure: North/South with a loop
Major Hazards: Old Growth Tree Struck by lightning; Deadfall/Standing Dead and windy Ridge
Historic Logging Road Utilized: N/A (Early Logging, No defined roads, Near 220)
# of Crossings: N/A
Major Points of Interest: Flat Area with older Second Growth and open understory.

Description: This trail creates a spur off the Proposed Zone 3_Trail A, and would provide a great location for a back country site. Water would need to be packed in, but the site is flat and aesthetically pleasing. Views will develop over time as the forest matures.

Zone 3_Trail C [Secondary]

Trail Name: Anderson Valley Trail
Location: Davison Spur A
Length: [0.5 mi]
Max Slope: [>5%]
Orientation/Exposure: East to West
Major Hazards: Woody Debris in Creek
Historic Logging Road Utilized: Davison Spur A
# of Crossings: 2
Major Points of Interest: Old Boiler toward the Western trailhead; opportunity to connect people to trails and keep them off of Davison Rd.

Description: This trail parallels Davison Rd. and will provide an opportunity to connect people from Zone 1_Trail A to Streelow Trail and beyond, while keeping foot traffic off of Davison Rd itself. The trail is moderately level, following the flow of water down the Anderson Valley.



Zone 4_Trillium Falls to Skunk Cabbage:

Area Summary: This Zone is located in the central/southern area of the project site. This area serves as the primary node of connectivity into the interior of the young forest. Once the new National Park Visitor Center at ARCO Mill Site A is complete, many visitors will be able to connect to the Lower Prairie Creek (LPC) area via these trails, securing the Trillium Falls Corridor. This section of the NPS land is unique and primed for interpretation. The Trillium Falls/Mill B area is already popular amongst tourists for the scenic Old Growth and Roosevelt Elk presence; however, it is also a cultural rich location within the park. This Zone contains the last Old Growth cut within the park boundaries, acquired in the 1978 Park Expansion. There are still logging artifacts (Such as the Arch located adjacent to the Trillium Falls Lot, Signage, Cables, Spar Pole and more) found within this region, and can serve as a living reminder of the forests that were lost to the Axe for generations to come.

Zone 4_Trail A [Primary]

Trail Name: 205
Location: 205
Length: [1.2 mi]
Max Slope: [5%]
Orientation/Exposure: East to West
Major Hazards: N/A
Historic Logging Road Utilized: 205
# of Crossings: 0 (this section follows the Ridge)
Major Points of Interest: Old Growth; Youngest forest regeneration within the Park

Description: This trail follows the route of the 205 Rd, a main Haul Road used in the logging of Skunk Cabbage in the late 1960s and through the 1970s. This half of the 205 serves as a viable road to trail opportunity, with some existing room to establish parking off of Davison Rd, and level clearing for the establishment of a Backcountry Camp site encircled by Old Growth. This is opposed to the second half of the 205 Rd which contains 12 significant crossings, and steep side-sloped terrain (See Zone 4 Trail B). The juxtaposition of Old Growth and New Growth here is dramatic, and can serve as a visual education tool for people visiting the park.

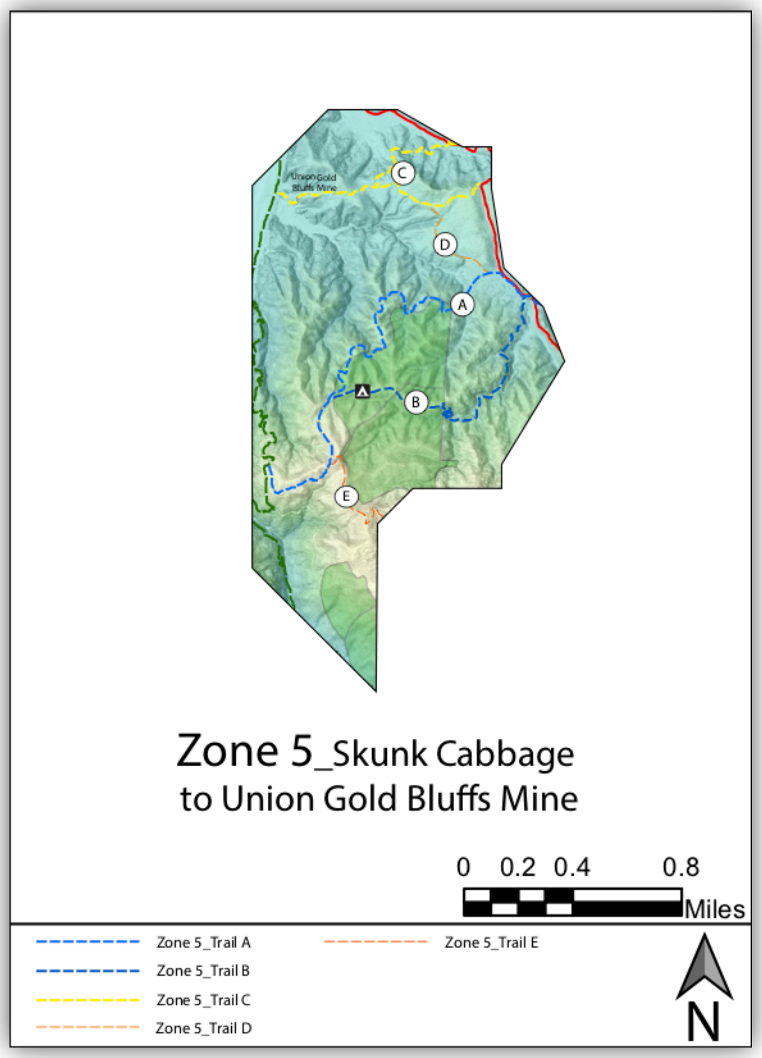
Zone 4_Trail B [Secondary]

Trail Name: The Last Stump Trail
Location: Ridgeline South of 205; 205 Spur
Length: [3.55 mi]
Max Slope: [10%]
Orientation/Exposure: East to West
Major Hazards: New Growth; Windfall/Deadfall; Mass Action event to the west of the junction with proposed Skunk Cabbage Trail (Along 205 Spur)
Historic Logging Road Utilized: 205
# of Crossings: 6
Major Points of Interest: Old Growth; Location of the Last Stump is situated along this route; History of Industrial Logging (See Zone Area Summary)

Description: This trail follows the ridgeline to the south of the current/historic 205 Rd. This road, as it is, as 12 significant crossings, which poses a great maintenance and construction challenge. By moving the trail upslope, the issue of establishing and maintaining bridges and crossings is reduced dramatically. The initial ascent from the East connects to the existing Trillium Falls Trail network, climbing [0.32 mi]; at which point the 205 Rd switchbacks, this is where the section that connects the proposed Skunk Cabbage Trail expansion diverges for [0.65 mi] – this is also where the "Last Stump" can be found, as well as the Van de Mark Images of the 205 [See Appendix III;IV]; the central section of this trail continues along the 205 for [2.40 mi], climbing the ridge at the next major turn in the road. The final junction and connection with Zone 5_Trail E and Zone 4_Trail A is spaced by [0.20 mi]. This Trail should be a Primary Route, the reason it is listed as a secondary trail is the issue of maintaining crossings along the 205 Rd. With stakeholder input, and additional adjustments to the trails configuration, this route will become a necessary part of the proposed network, unifying the Trillium Falls corridor from a hiker perspective.

Zone 4_Trail C [Secondary]

Trail Name: Davison Spur E
Location: Davison Spur E
Length: [.45 mi]
Max Slope: [25%]
Orientation/Exposure: North to South
Major Hazards: Large Woody Debris; Unmaintained Crossing
Historic Logging Road Utilized: Davison Spur E
# of Crossings: 6
Major Points of Interest: Connectivity to primary trails while keeping hikers off of Davison Rd; Bears Observed along this route
Description: As a road, this section is poorly maintained and poses issues in reestablishing viability along the route – however, there is potential for a trail to navigate around this and connect 205/(Zone 4_Trail A) to Streelow Trail and (Zone 1_Trail A), while keeping hikers off of Davison Rd by connecting to (Zone 3_Trail C - Davison Spur A_Anderson Valley Trail). There are defined crossing and Humboldt Bridges that are unmaintained, as well as sections with clear evidence of water movement, but no clear culvert crossing. Managing stormwater will be key along this route.



<u>Zone 5_Skunk Cabbage to Union Gold Bluffs Mine:</u>

<u>Area Summary:</u> This Zone is located in the Southwestern Corner of the Project area, and poses an opportunity to interpret both cultural and natural history. This area contains some of the earliest mining sites as well as a large patch of Old Growth Forest. Opportunities for Backcountry camping in ancient forest occur here. This section also contains remnants of the oldest logging operation within the park (Along Skunk Cabbage Creek), and sensitive natural resources that can be accessed by additional spur trails stemming from this network.

Zone 5_Trail A [Primary]

Trail Name: Spur B
Location: Davison Spur B
Length: [2.0 mi]
Max Slope: [15%]
Orientation/Exposure: Southwest to Northeast
Major Hazards: N/A
Historic Logging Road Utilized: Davison Spur B
# of Crossings: 9
Major Points of Interest: Old Growth; Connection to Coastal Trail; Abandoned Vehicles (Logging Truck and Car at northern end of trail)
Description: This trail follows the Davison Spur B Rd, and can provide the opportunity to connect the interior of the project area to the existing trails network. The route connects to trails along Davison Rd, climbing into the interior for [1.3 mi] where it joins with (Zone 5_Trail B), continuing for [0.30 mi] where it meets the junction with (Zone 5_Trail E), and then heads south for [0.36 mi] before reaching the Skunk Cabbage section of the Coastal Trail.

Zone 5_Trail B [Primary]

Trail Name: Forgotten Forest Trail
Location: Davison Spur D; New Trail
Length: [1.4 mi]
Max Slope: [15%]
Orientation/Exposure: West to Northeast
Major Hazards: Mass Action event halfway up Davison Spur D
Historic Logging Road Utilized: Davison Spur D
# of Crossings: 7
Major Points of Interest: New trail through Old Growth Forest; Old Growth Backcountry Camp
Description: This trail follows Davison Spur D, climbing along the northern headwaters of Streelow Creek for [0.70 mi]. Upon reaching the end of the road, the trail goes down to the creek, crossing over to the Old Growth and climbing back up to the ridgeline where it follows evenly until the junction with (Zone 5_Trail A). There is opportunity here for a new Backcountry camp in the marked, level area of this Old Growth ridgeline. There is also tremendous opportunity here to interpret *watershed restoration* as the area is restored.

Zone 5_Trail C [Primary]

Trail Name: Miners Loop (ADA/Interpretive Trail Potential)
Location: Davison Spur H
Length: [1.27 mi]
Max Slope: [>5%]
Orientation/Exposure: East to West
Major Hazards: N/A
Historic Logging Road Utilized: Davison Spur H
# of Crossings: 4
Major Points of Interest: Union Gold Bluffs Mine; Wood Nymph (*Moneses uniflora*) found along this route
Description: This trail follows the historic road along Major Creek from the Coastal Trail/Gold Bluffs Beach for [0.42 mi], at this junction, the trail connects to a loop with a level grade an potential for an ADA Accessible Trail; the [0.42 mi] section on the North end of this loop is in worse shape, but the southern section is nearly accessible

in its current state. There is also room for parking along Davison Rd here, where a vehicle gate currently stands. At a distance of [0.24 mi] from the potential parking area is the junction with (Zone 5_Trail D), which is designed to create connectivity opportunity and flow to the other primary trails proposed.

Zone 5_Trail D [Secondary]

Trail Name: Connector

Location: Unnamed road between Davison Spur H and Davison Spur B

Length: [0.40 mi]

Max Slope: [2.5%]

Orientation/Exposure: Northwest to Southeast

Major Hazards: N/A

Historic Logging Road Utilized: Unnamed

# of Crossings: 1

Major Points of Interest: Connection Opportunity

Description: This trail was discovered when exploring around Davison Spur H, in developing the route for (Zone 5_Trail C). The clear logging road bench is visible and easy to follow, with the exception of a few spots where fallen trees have blocked the route. The main appeal of this route is the opportunity to connect (Zone 5_Trail C) to (Zone 5_Trail A) and all of the auxiliary trails associated with those two. The crossing along this trail is ill-defined and may require rerouting in the future.

Zone 5_Trail E [Secondary]

Trail Name: Connector E

Location: 205 to Davison Spur B

Length: [0.47 mi]

Max Slope: X%

Orientation/Exposure: North to South

Major Hazards: N/A

Historic Logging Road Utilized: N/A

# of Crossings: 0, follows ridgeline

Major Points of Interest: Skirts Old Growth; Connects Primary Trails

Description: This trail diverges from the 205 Rd, to the North via a prominent ridgeline, where it connects to the Davison Spur B Rd. This will serve as a connectivity corridor between these two primary routes. The trail also skirts the old growth accessed by (Zone 5_Trail B), and can connect two Backcountry Camps.

Trail Network Summary: observations, design process and the themes that emerge:

The development of this trail network and identification of the key nodes and connectivity corridors are grounded in the ideas of trail design theory previously reviewed. Highlighting opportunities to connect this patchwork landscape in both a cultural and natural historic context is informed by on-the-ground observation and design, as hinted at in the descriptors of each route. This is a narrative best told through photographic examples of key locations or elements of the designed network.

Trail design decisions were further informed by additional research correlating to these field observations, stemming from a connection of natural and cultural landscape elements that emerged while conducting an analysis of the ecological stressors, physical conditions and the anthropogenic history of the landscape. This pattern, seen throughout the emergent themes, is interpreted by the following images (all of these photographs were taken during the author's field observations in 2018, unless otherwise noted).

The following is broken into four key sections: **Significant Cultural Landscape Elements**, **Significant Natural Landscape Elements**; **Natural & Cultural Intersections**; and lastly, **Trail & Restoration Precedents Elsewhere in RNSP**. These are the core features that defined the iterative design process, informing the generalizations of a trail design theory that was developed through the lessons learned in this case study of the RNSP LPC restoration.

Significant Cultural Landscape Elements

The cultural landscape, as shown through the summary of landscape and land use history of RNSP and the Lower Prairie Creek watershed, is tumultuous. The dynamic cultural shifts and dramatic changes in community attitudes toward the redwood forest and what became the national park's landscape can be seen throughout the designed trail network. These elements, ranging from abandoned logging equipment to the endless scars that rudimentary skid-roads left on the landscape are part of the forests cultural fabric. These scars teach the visitor to read the landscape's cultural history by bringing people in contact with significant elements that are marks of land health and history, prompting questions of these features origins in an otherwise seemingly wild place. It is profoundly important that these elements are not lost or forgotten, nor that this history is re-written or 'museumified' for the sake of conservation and ecosystem restoration.

Figure 41 Clockwise: Abandoned Tire along Zone 4_Trail A '205', Logging Skid Arch at Mill Site B/Trilliam Falls Zone 4; Logging Pulley of notable size

Figure 42 Clockwise: Overstocked forest regenerating on logging road; Clear logging road bench (note large stump to the left of image); Abandoned vehicles off Davidson Rd;, Abandoned vehicles; Early Logging/Pick-up Truck; Logging Cable frequently found throughout LPC Restoration Area

Significant Natural Landscape Elements

Natural landscape elements include those sensitive habitats and resources that this restoration seeks to protect and enhance. These include species found throughout RNSP as well as hyper-localized examples, such as individual grandmother trees (spared from timber extraction due to poor lumber prospects with knotty, disfigured or fire damaged trunks, as well as those saved as shelterwood for natural seed source in forest regeneration), ecotones and old growth patches.

These elements have the ability to expose or even teach visitors to appreciate the beauty and biodiversity of nature in RNSP, while recognizing the fragility that resource exploitation can place on these sensitive ecological resources. Trail routes, such as the "Last Stump" (Zone 4_Trail B) or "Ursus Trail" to Prairie Creek's Miners Ridge (Zone 3_Trail A), that juxtapose the dramatic disparity in forest structure of old growth and regenerated stands have been deliberately engaged throughout this design to prompt visitors to ask why there are these variations in the forest and what factors led to their occurrence.

In designing this network, it was immediately evident that due to the scale of the project site, the trails needed to engage the complexities of the landscape at large. This was achieved by making decisions or gestures that brought visitors to key nodes, features or elements of the broader landscape, rather than highlighting individual and perhaps ephemeral or even fleeting hyper-localized elements; guiding the user through a network that would still allow for individualized nature experiences while moving through a larger landscape.

Figure 43 Above: Large Black Bear Print (Ursus americanus); Below: Various native mammal scat - Mountain Lion (Puma concolor), Roosevelt Elk (Cervus canadensis roosevelti), American Black Bear (Ursus americanus)

Figure 44 - Top: Nurse Log with Western Hemlock (Tsuga heterophylla); Bottom: Sitka Spruce (Picea sitchensis) on Redwood Nurse Log

Figure 45 - Top: Banana Slug (Ariolimax spp.); Bottom: Rough-skinned Newt ((Taricha granulosa)

Figure 46 - Clockwise from Top Right: Wood Nymph (Moneses uniflora) – a rare, threatened or endangered in CA flower; Gnome Plant (Hemitomes congestum); Albino Red Huckleberry (Vaccinium parvifolium) – of an unknown or undocumented occurrence; Indian Paintbrush (Castilleja); a glimpse of the abundant Fungi of RNSP

Key natural features on the landscape, such as large 'grandmother' trees spared by the lumberman's axe serve as primary anchors throughout the network

Figure 47- Top Three: (Zone 3_Trail B) "Lost Loop" – early logging; fire scars and lightning damage on the remaining large trees; Bottom Two: Grandmother Trees along "205"

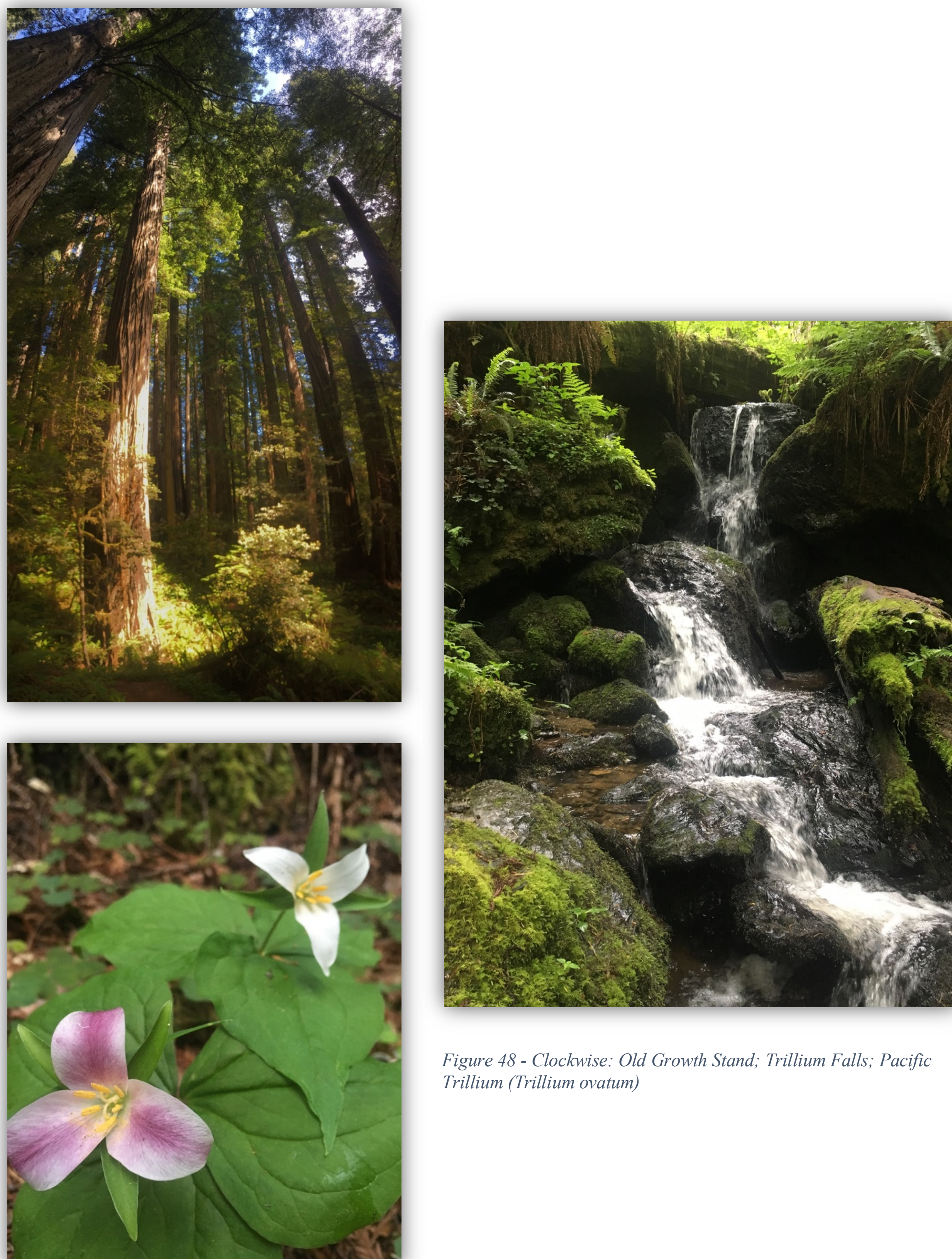


Figure 48 - Clockwise: Old Growth Stand; Trillium Falls; Pacific Trillium (Trillium ovatum)

Natural & Cultural Intersections

The intersection of natural and cultural landscape elements is where the crux of the overarching trail network design has occurred. This section highlights a few of the areas throughout the LPC network where the lines are blurred, where natural condition has been shaped by human intervention and vice-versa. Stands of Sitka Spruce along the coast that were actively logged early in the pre-park history, prior to and during WWI; cemeteries of 10'+ dbh stumps lining old logging routes stand tall with their notches demarking where the sawyers' springboards were once placed to fell these giants. These deliberately incorporated primary nodes and features force the visitor to confront the landscape's history of resource extraction. As restoration occurs, and dense stands are thinned, the modern mark of the chainsaw prompts questions of ecological restoration. This dynamic can provide an opportunity for citizen science, monitoring, interpretation and even passive pondering – prompting questions such as "what happened here?" or "why is this different?"

These opportunities for engagement and interpretation are the same ones that pose the questions of this landscapes history, and its future. Not only are these elements central to the concepts of design applied here, but they are tantamount to successful conservation.

Figure 49 - Substantial cutbank along logging road network, a frequent occurrence throughout the designed trails and primary target of restoration. These are scars caused by the cultural history, impacting the ecological future.

These massive stumps, now centered in the middle of the National Park, once stood as a front-line defense against the logger – denoting an historic park boundary. Note the notches where early loggers placed "springboards" to cut down the giant trees. Many of these stumps have circles of clonal root re-sprouts that encircle them.

Figure 50 - Early logging in this Sitka Spruce stand has resulted in a more mature second growth stand than the majority of the LPC project site. A seemingly 'natural' occurrence that is directly a result of the cultural history and human influence.

Figure 51 - A substantial landslide near Skunk Cabbage and "the Last Stump" trail, creating a significant gap in the densely regenerated canopy. This erosion and sediment deposition in the streams is a direct result of logging road building in the pre-park era

These overlapping occurrences become the key nodes that direct engagement. Areas and features that may seem to be strictly either natural or cultural become blurred when viewed through the lens of human influence over the landscape. Moments, such as trillium falls or fern canyon, become key nodes along the network – tying into existing routes and motivating people to draw connections. In walking these trails, it's also clear that the trees themselves, when viewed in the context of the forest, are the feature that motivates the hiker, biker or horseback-rider. The network design utilizes as many opportunities as possible to engage with what once was here – a single grandmother tree that somehow dodged the axe; large slash or un-salvaged timber abandoned in place serving as a solitary nurse log for the forest of the future; or the remote grove that humans have not engaged with in decades, if ever.

Trail & Restoration Precedents Elsewhere in RNSP

The following are examples of unique or notable characteristics of RNSP. Examples of Road-to-Trail conversion, resource management challenges as they relate to trails, and the unique, novel approaches to restoration that are ongoing. These are important reference points and characterize landscape qualities used in informing the design of the trail network throughout the LPC restoration site.

The Aph-Pah Interpretive Trail:

This relatively short interpretive trail shows how road-to-trail conversion can occur in RNSP. Located within the Prairie Creek Redwoods State Park portion of RNSP, this early logging road was rehabilitated, protecting watershed quality and improving ecosystem function while providing an engagement and education opportunity. While only a fraction of the proposed LPC trail network, this precedent can be used as a reference point for road-to-trail conversion in the future.

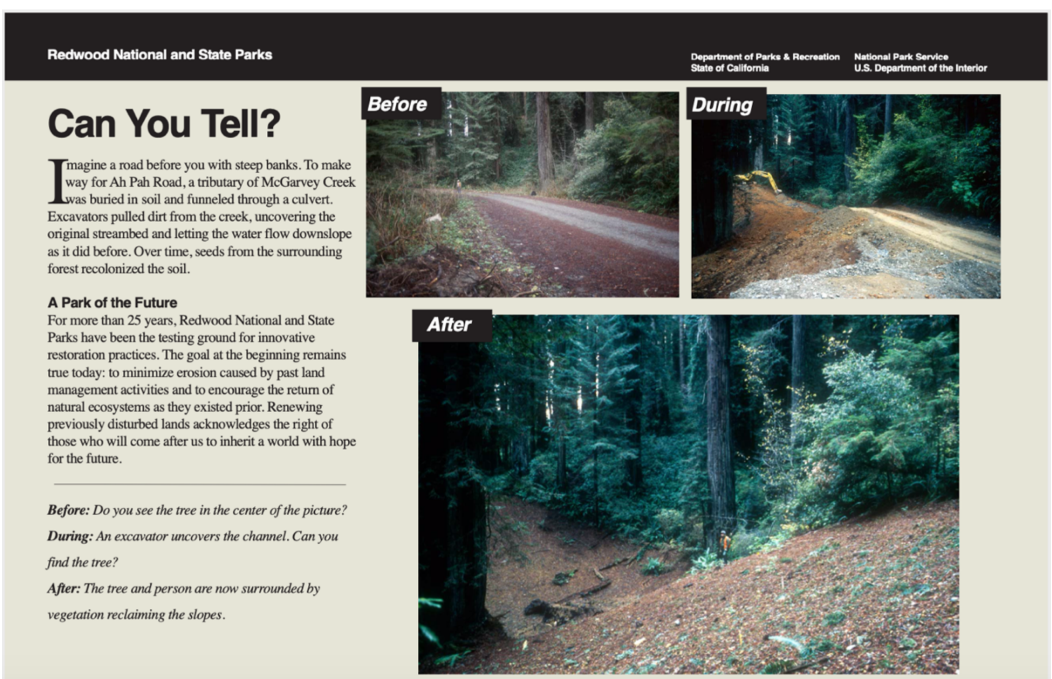


Figure 52 - Interpretive Signage along Ah-Pah Trail (National Park Service, 2018d)

Streelow Trail:

Streelow, integrated into the proposed LPC network, is a current trail in RNSP. This route can directly tie into the multi-use aspects of this trail system and the park at large, as it is already a popular biking and horseback riding trail. While not an interpretive trail in the same way that Ah-Pah is, Streelow too was a road-to-trail conversion. The numerous creek and drainage crossings along this route can be looked to as a precedent in creating the LPC trail network.

Figure 53 - Drainage Crossing (bridge) and trail section along the Streelow corridor

Current Logging in Redwood National Park:

Redwood NP is profoundly unique because it is one of the only parks with a forester on staff, and the only one where significant logging, for restoration, is actively occurring. This is contentious, putting the chainsaw back on the land, as it might further discourage those loggers who were kicked off and concerns those who fought to protect the land. Ironically, it is many of the original logging families (and their descendants) that opposed the creation of a park, now carrying out this forest thinning process.

Figure 54 - NPS Forester Jason Teraoka explains the ongoing forest thinning at RNSP

The Grove of Titans:

The risk that a lack of trails, in conjunction with over-visitation, might pose a threat to resource protection is evident elsewhere in RNSP. In Jedidiah Smith State Park, in the Northern end of RNSP, a previously undisclosed grove of the largest (by volume) individual trees has become an impromptu destination for visitors. Leaked GPS coordinates locating the grove have spurred a mass influx of visitors trampling the trees shallow root systems.

Research on this area has shown an unprecedented impact on ground flora, such as redwood sorrel (*Oxalis oregana*) and a diversity of native ferns that grow at the base of these giants. While the Redwood Parks Conservancy is actively raising funds to conduct an elevated boardwalk trail through this grove, the impact on this area should serve as a warning for other sensitive resources throughout the park, particularly as they are restored and evidence of rare flora and fauna return. Without clear trails, there may be unregulated or unguided interaction with these resources. This is opposed to the clear signage and interpretation that comes with well-established networks. Trails protect sensitive ecological resources while allowing for engagement and discovery.

Figure 55 - Signage, such as this one denoting accessibility from a trailhead elsewhere in the redwood parks, can help visitors know what to expect when venturing forward

Figure 56 - Damage at the Base of the Del Norte Titan; Signage discouraging off-trail exploration that poses harm to these trees

Trails & Restoration Generalizations: a contribution to trail design theory

In designing the proposed trail network throughout the Lower Prairie Creek Watershed of Redwood National Park, the themes of intrinsically intertwined natural and cultural elements of landscapes are manifest. We look to trails for recreation and engagement, but when coupled with ongoing restoration and viewed through the lens of resource management they become an invaluable tool for conservation. In summarizing this, three generalizations emerge. These are patterns that can and should be applied broadly to understand the role that trails can play in active management of sensitive ecological and cultural resources.

1. Trails allow visitors to become a "landscape detective"

There are novel ecosystems in the areas we consider wild. Parks like redwood, known for their embodiment of the forest primeval, is equal part post-industrial landscape. When providing opportunities for visitor engagement, trails should directly allow for the realization of this. They should not direct people only through the most pristine or notable areas of the park, but rather draw connections across the landscape in ways that allow for discovery of place. Furthermore, creating experiences necessary for visitors to know or come to understand the extractive behaviors that led to the landscapes current conditions, or the need for ongoing restoration, is concurrently opening their eyes to how we manage public landscapes. This may even challenge deeper contemplations of what the nature in our national parks looks like, the threats these places face, and what defines the boundaries between nature and culture. This could prevent the dangerous connotations that nature perpetrates itself, and that the resources of the national parks are separate from the outside influence of humans.

As landscape detective, these experiences become the initial inklings of what Leopold describes as an "ecological education." Perhaps leaving a cut bank (that doesn't greatly impede resource management), a row of old stumps, or logging equipment abandoned long ago could prompt this type of landscape detective experience – learning to read the landscape, both spatially and temporally. Providing the opportunity for these active nature experiences parallels Waugh's descriptor of a trail's 'paragraphic point;' that, in addition to the desired scenery, also guides people to landscape elements that leads to more questions, rooted in our relationship with wild nature.

Also, it is worth saying that these experiences are not necessarily through explicit signage, but rather through directing people to the places that prompt them to ask questions and explore further. Restoration and design come together along the trail. This is how we might foster future generations of ecologist, naturalists, landscape architects and stakeholders in our national parks and beyond.

2. Trails enhance experience and protect the resource

Trails shape the balance between visitor experience and a minimal environmental impact. Not only do trails allow for physically engagement, such as passive and active recreation, and clear protections from undue or unregulated pressures on a resource by guiding users throughout an ecosystem, but they can play an active role in the restoration process at large. By integrating trail planning into the restoration process, informed by TEK, they can serve as a vector for reciprocal restorations, and enhance the role of landscape architect as decision-maker and steward. Using well designed trails as a way to capitalize on citizen science, monitoring and public relations about resource management, they become integral to advancing the trajectory of a restoration project – informing future decision-makers about necessary management actions. As summarized in the literature, in a National Park the trail is where the stakeholder engages the resource. Understanding this can simultaneously address the conundrum that Spirn (1995) highlighted as the destruction of what we value. Weighing the social and educational benefits, trails allow visitors to engage with the sensitive spaces they might not otherwise be able to (they type of engagement that fosters theories 1 and 3), with minimal ecological harm relative to the unregulated alternatives.

3. Trails as Storyteller: trails transport people into an experience and chronicle the landscape narrative.

Trails allow us to ask the questions of *"how'd we get here?"* and *"where are we going?"* on a landscape scale. They transport people into an experience and chronicle the landscape narrative.

As this case study of the LPC Restoration in Redwood National Park clearly shows, they provide a necessary thread in telling the complex stories of place. They draw the user to locations and landscape elements that actively document change. Building off of both theories 1 and 2, which lead visitors to the places that prompt them to ask profound questions, the trail can provide those answers. Through interpretation and exposure, or as Waugh (1918) described as a "progressive climactic order," the trail becomes the storyteller of a landscape narrative.

Across landscapes, the manifestation of this may not be universally identical – many places like Redwood have deeply complex and tumultuous histories that one could spend a lifetime unpacking. But knowing that the trail guides the user to key elements of this story, as told by the land, is universal.

Trails as Conservation

These themes, patterns and the case study of Redwood National Park's Lower Prairie Creek Watershed Restoration project show how trails can be used as an essential resource in the toolkit of conservation. Again, trails provide a place for a recognition of land use history to occur. In settings like national parks – trails are ultimately what guides people's experience, and defines their perception of a parks sense of place. The elements we love in our national parks are born from subtle perspectives, exposures or framing that was a deliberate decision once made by a landscape architect or land manager; knowing how vital this has been in fostering a profound sense of ownership and stewardship over our shared federal public landscapes. When we view this through the lens of restoration, we begin to recognize the opportunity to foster conservation along the trail. By utilizing the qualities that exist at this intersection – education and exposure (as a landscape detective), resource protection, and storyteller of the landscape narrative – it is clear the role that trails can play in restoring degraded or abused landscapes, while documenting them through genuine nature experiences.

While the name and popular culture may be misleading, Redwood National Park is about the landscape – the forest not the tree. More so than other popular national parks key features like Yosemite's Half Dome or Yellowstone's Old Faithful, Redwood is about the ecosystem and the remarkable species of tree that supports it, not any one feature. Visiting this park gives people the chance to see this first hand.

Redwood is unique because it appears, at first glance, to be untouched and wholly natural. The reality the park faces is one of scars not unlike any post-industrial landscape, though the scars are not immediately evident to the visitor. With the use of trails as conservation, we have the opportunity to share the ecologist's perspective that Leopold (1949) described as:

> "the doctor who sees the marks of death in a community that believes itself well and does not want to be told otherwise."

To instill a lasting sense of ownership and responsibility for national parks like Redwood, we need more people to engage with the degraded parts of its landscape. As much as those few remaining, ever-popular pockets of pristine old growth inspire visitors, the damaged portions of the park, clear-cut decades ago, are the story of how the redwood forest was saved.

Without trails connecting people to these places, how are they supposed to know the damage that was done? How are they to learn, first-hand, the risk that unchecked exploitation poses to places like Redwood? Or how close we came to losing this collective cultural icon, altogether. This is what is protected when we view the trail as conservation.

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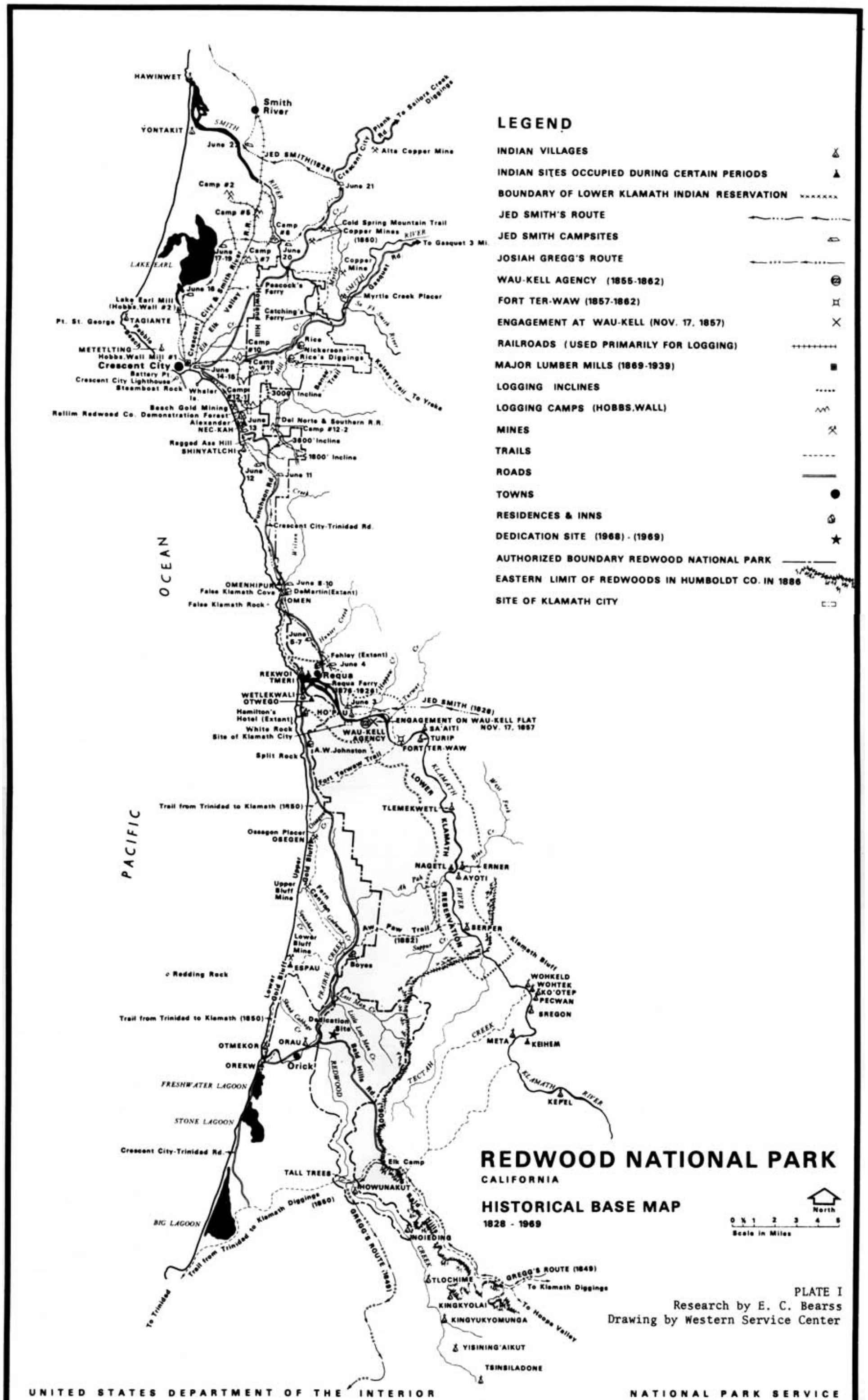
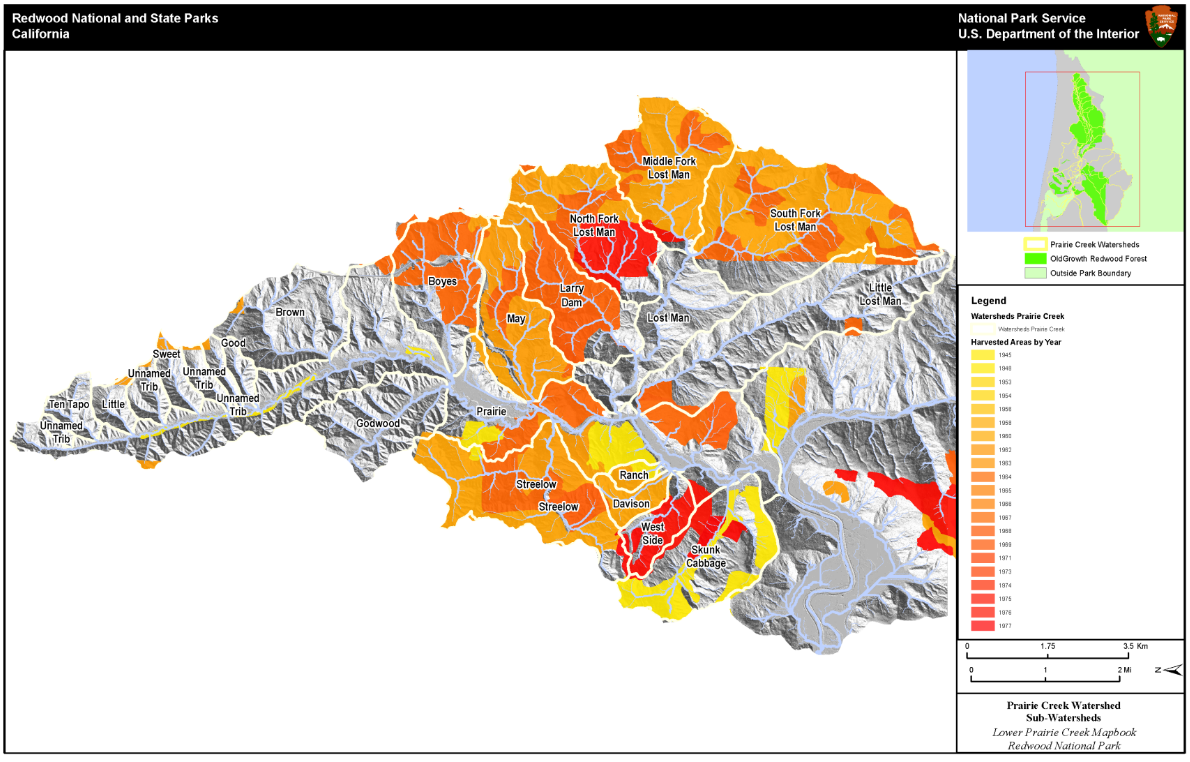
Appendix

Appendix I



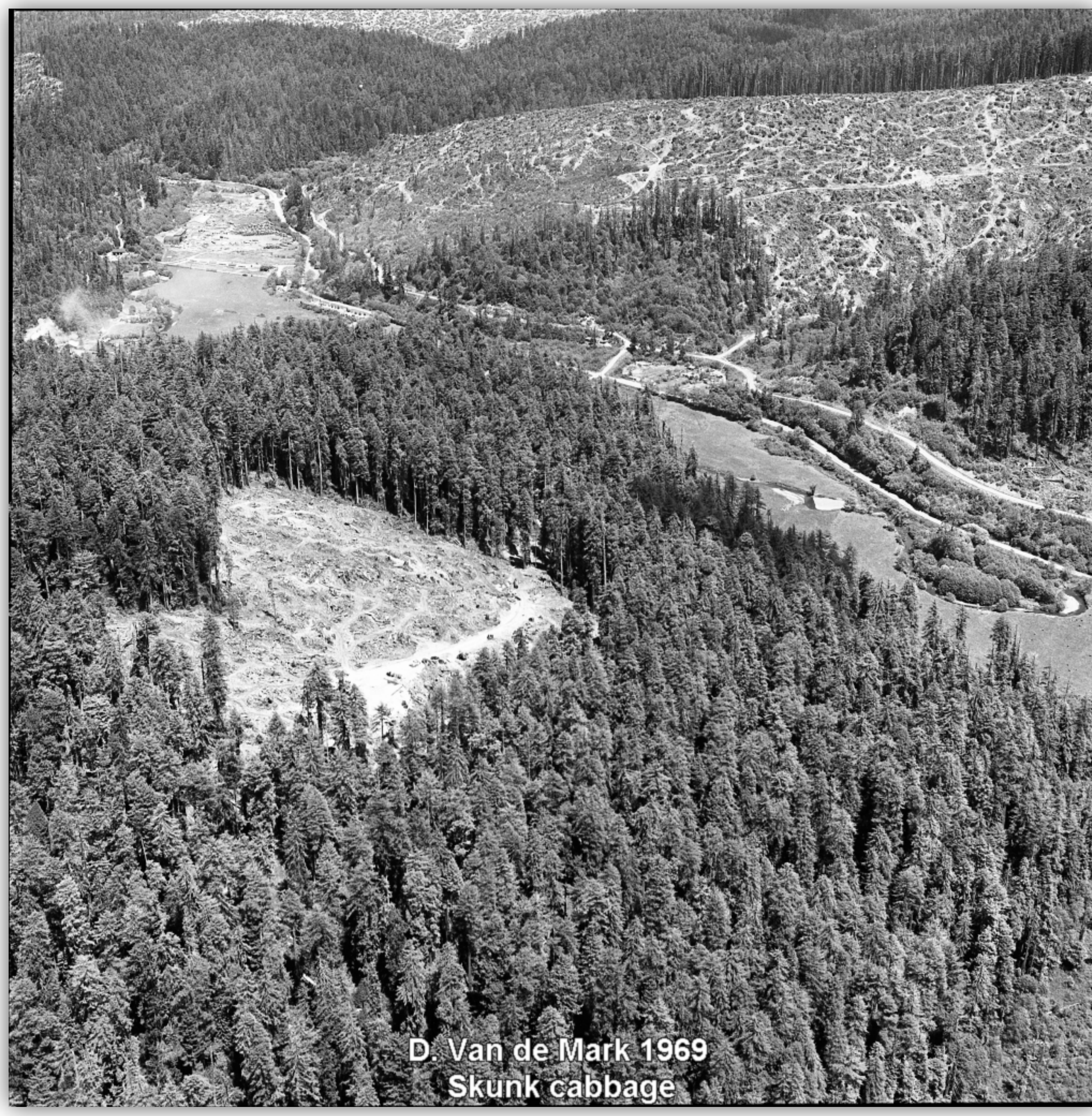
Appendix I: Redwood National Park Historic Base Map 1828-1869 (Bearss 1969)

Appendix II



Appendix II - Logging in the Prairie Creek Watershed Timeline (National Park Service, 2018d)

Appendix III

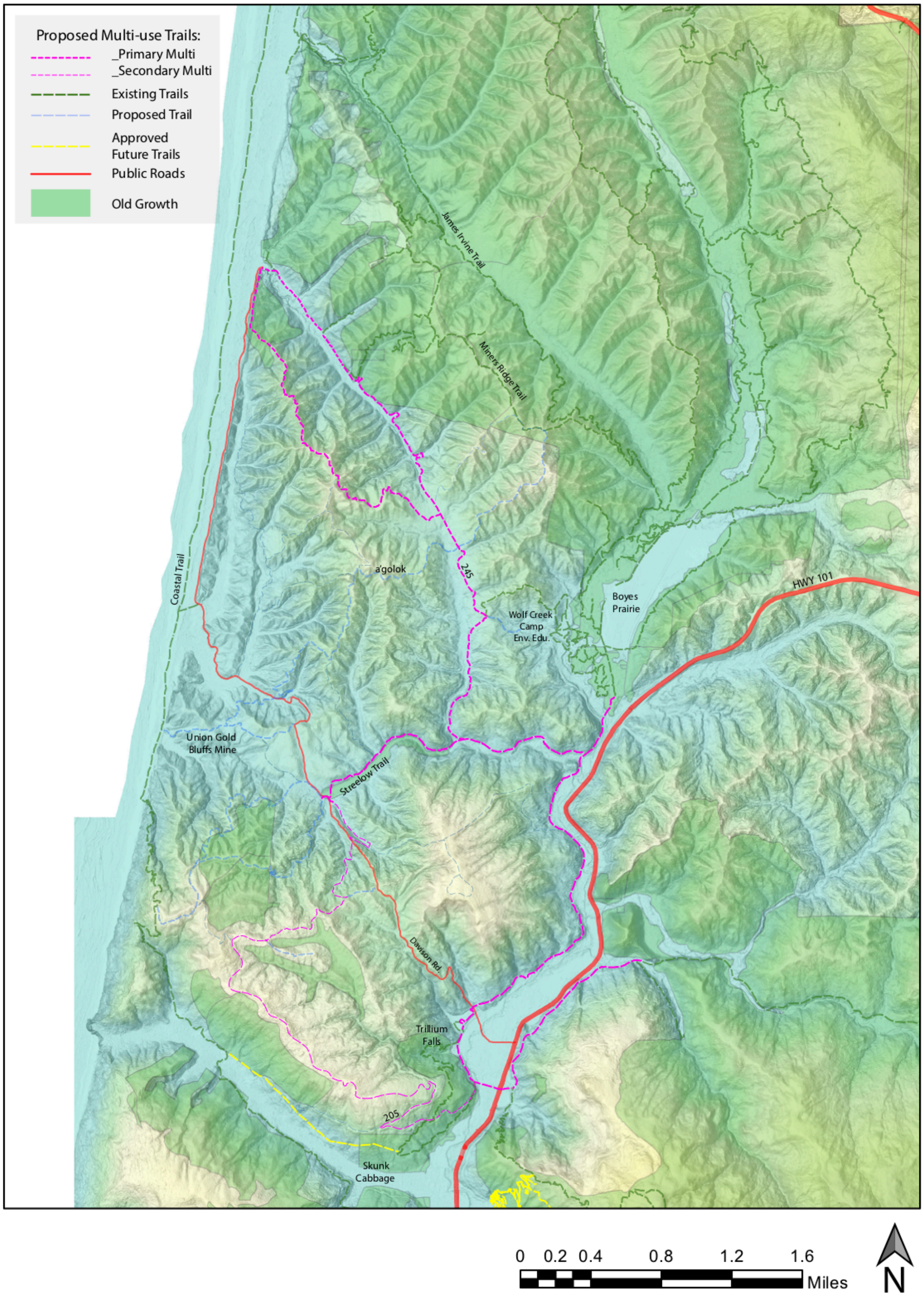


Appendix III - Skunk Cabbage Cut Image Used to determine skid roads and, in part, the location of "last stump" trail where logging in the park ended

Appendix IV

Appendix IV - Skunk Cabbage Cut Image Used to determine skid roads and, in part, the location of "last stump" trail where logging in the park ended

Appendix V



Appendix V - Proposed Multi-use Trails in the LPC network