

Karuk Tribe Climate Vulnerability Assessment
Assessing Vulnerabilities From the Increased
Frequency of High Severity Fire

Karuk Tribe Department of Natural Resources
2016

***Coordinated and Compiled by Dr. Kari Marie Norgaard with key
input from Kirsten Vinyeta, Leaf Hillman, Bill Tripp and Dr.
Frank Lake***

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Yootva to All!

May the Karuk and all Tribal People achieve the full sovereignty over their knowledge, lands and spiritual practices.

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Executive Summary

Ongoing and future ecological outcomes of climate change in the Mid Klamath region of California include changes in precipitation patterns, increasing droughts, increasing frequency and severity of wildfires, and more significant disease and pest outbreaks (Butz et al. 2015, Garfin et al. 2014, Mote et al. 2014). Among the most pressing of the local dimensions of climate change taking place within Karuk ancestral territory is the increased risk of high severity fire (Lenihan et al. 2008). For the last thousand years, forested areas have become adapted to frequent occurrence of relatively low intensity fire from human and natural ignitions (Perry et al. 2011). These fire adapted forests burned in smaller overall areas in mosaic patterns that contained patches of high intensity fire (Mohr et al. 2000, Skinner et al. 2006, Perry et al. 2011).

The Klamath Basin has experienced a progressive increase in high severity fire in recent years as a result of both climate change and past and present federal land management practices that have led to increased fuel loads (Odion et al. 2004, Miller et al. 2009 and 2012, Taylor and Skinner 2003). Taken together, climate change and past management activities have created landscape conditions that have the potential to transition much of Karuk ancestral territory to an early seral condition that has a tendency to repeatedly burn at high severity (Odion et al. 2010, Cocking et al. 2012). Such circumstances would mean the potential loss of many culturally significant species, in turn causing a domino effect through the entire ecosystem.

While fire is a central component of Karuk management and culture, increased fire severity and frequency poses particular and unique risks to specific Karuk tribal foods and cultural use species on the one hand, and to broader Tribal programmatic goals and activities on the other. As Karuk people we are fortunate to retain relationships with hundreds of species we consider our relations (Lake et al. 2010). These foods, medicines and fibers are embedded within cultural, social, spiritual, economic and political systems, and daily life (Lake 2013, Norgaard 2014). Impacts to culturally significant species in the face of climate change have thus more direct impacts on Karuk people than for communities who no longer retain such intimate connections with other beings and places in the natural world. Yet part of the increased vulnerabilities Karuk people face as the climate changes are a direct result of the strength of these connections. For example, the loss of acorn groves that have been family gathering sites for generations is much more than an economic impact.

We, the Karuk Tribe are working to prevent these circumstances. We are evaluating the potential impacts of climate change in our region and preparing responses to mitigate possible losses (Karuk Tribe 2012, Norgaard 2014a and b). Changing patterns of fire behavior affect specific Karuk tribal traditional foods and cultural use species, create infrastructure vulnerabilities to Karuk tribal programs and pose broader implications for the Tribe's long term management authority and political status (Norgaard 2014 a and b). Not only is climate change the result of human activity, humans are integral components of the Klamath ecosystem. Humans have shaped the ecology, fire behavior and species composition of Karuk ancestral territory through tribal traditional management, and since 1910, through the activities of the US Forest Service. Understanding climate-induced vulnerabilities for particular species therefore requires an interdisciplinary approach that

incorporates biological and fire science with sociological understanding of human factors. Discussions of habitat zones and species profiles reflect this intersectional dimension to vulnerability.

Vulnerabilities faced by the Karuk Tribe in the context of high severity wildfire do not occur in a vacuum. These vulnerabilities must be understood in the context of existing susceptibilities, as well as the past, present and future management actions of Tribal and non-Tribal land managers. Not only does high severity wildfire hold the potential to negatively affect some species more than others for biological reasons, species with already compromised ecological niches that may have more difficulty in adapting will be at greater risk in the event of large scale, high severity fires. Furthermore, past management actions such as logging, road building and fire suppression interact with fire events to influence the level of eco-cultural vulnerability, as do management actions taking during a fire and those that may follow in the long term. As such, our analysis also considers how past management actions, management actions taken during a high intensity wildfire event, and those that may come in the future may create vulnerabilities for a given species.

Another major dimension of vulnerability related to jurisdictional recognition and its results for tribal management authority and sovereignty. Responding to the impacts of increased high severity fire both during and after the fires requires coordination across jurisdictions with multiple federal and state governmental entities that may or may not understand their consultation responsibilities, carry them out appropriately, have conducted their own climate planning, or included the Karuk Tribe in their climate planning efforts. The resources and actions (or lack thereof) of federal agencies, from the U.S. Forest Service to CalTrans, can impact Karuk tribal vulnerabilities as much as climate change itself. Responding to high severity fire in the context of unrecognized jurisdiction is enormously time consuming for Karuk tribal staff. Unrecognized jurisdiction impacts tribal program capacity and management authority, leading to further unequal burdens for tribes.

Not only is climate change the result of human activity, humans are integral components of the Klamath ecosystem. Humans have shaped the ecology, fire behavior and species composition of Karuk ancestral territory through tribal traditional management, and since 1910, through the activities of the US Forest Service (Crawford et al. 2015). Climate change vividly reveals the flaws of Western economic and environmental principles and practices at the global scale. Western capitalist economies have prioritized profit over well-being, and individualism over community. Many proposed climate change solutions protect the status quo by prioritizing profit and individual responsibility, yet there is also an increasing realization that solutions must be found elsewhere, in alternative, community-based models that prioritize long-term social and environmental wellbeing (Whyte 2013, Dunlap and Brulle 2015). Recognizing tribal knowledge, leadership and management at this juncture allows forward movement at multiple levels.

Fortunately, in the face of the changing climate, many ecologists, fire scientists and policy makers, Native and non-Native alike have turned to indigenous knowledge and management practices with renewed interest and optimism in the hope that they may provide a much needed path towards both adaptation and reducing emissions (Williams and Hardison 2013, Martinez 2011, Raygorodetsky 2011, Vinyeta and Lynn 2013, Whyte 2013, Wildcat 2009). In the context of climate change, Karuk tribal knowledge and management principles regarding the use of fire can be utilized to reduce the likelihood of

high severity fires and thereby protect public as well as tribal trust resources (Norgaard 2014). In particular, there is increasing recognition of the importance of indigenous burning as an ecosystem component and restoration technique. Fire is especially important for restoring grasslands for elk, managing for food sources including tan and black oak acorns, maintaining quality basketry materials, producing smoke that can shade the river for fish, and more. Karuk fire regimes generate pyrodiversity on the landscape by extending the season of burn and shortening fire return intervals. The multitude of foods, materials and other products that come from Karuk environments are in turn evidence of the profound diversity of fire regimes that are required to maintain relationships with hundreds of animal, plant, and mushroom species (Lake 2007 and 2013, Anderson and Lake 2013). As Karuk Director of Natural Resources Leaf Hillman puts it, “Fire is a cultural resource.”

Tribes have been key leaders in responding to climate change through both so-called mitigation —efforts to stop further climate change— and adaptation — developing responsive measures for coping with the unfolding ecological and atmospheric changes. Tribes can often be found leading the way in climate change policy, strategy and resistance by participating in the political process, engaging in sustainable land stewardship, and being at the forefront of many climate change activism efforts. This Climate Vulnerability Assessment is a first step towards climate adaptation planning. The vulnerability assessment we have developed here is unique in that it holds the potential to inform both adaptation and mitigation efforts, given that wildfires themselves generate emissions (McMeeking et al. 2006, Langmann et al. 2009), and a reduction in high severity fires could result in a reduction in forest emissions. While a detailed Climate Adaptation Plan is needed in follow up to this Climate Vulnerability Assessment, the conclusion nonetheless includes a number of preliminary recommendations.

Introduction

Anticipating future impacts from climate change is a challenging task. Climate change is one of the most dramatic and widespread impacts the modern world has faced and attempting to come to terms with the data and implications can be daunting. Fortunately we are not facing it alone. Tribal and non-tribal peoples around the world are engaged in efforts to halt fossil fuel production, move to renewable energy and transportation systems, document the current impacts from climate change, and plan for the future. This report is one piece of that effort. The [Karuk Department of Natural Resources Strategic Plan](#) notes that

"Since time immemorial, the Karuk have lived in the Klamath-Siskiyou Mountains in the mid- Klamath River region of northern California. With an Aboriginal Territory that includes an estimated 1.38 million acres, the ancestral people of the Karuk resided in more than one hundred villages along the Klamath and Salmon Rivers and tributaries. Thriving with a subsistence economy supported by rich natural endowments and a strong culture-based commitment to land stewardship, Karuk environmental management has shaped the region's ecological conditions for millennia. Through carefully observing natural processes, the Karuk have developed traditional management regimes based on a landscape-level ecosystem approach. Self-described as "fix the world people", the Karuk continue ceremonies that restore balance and renew the world."

Today, the task of *fixing the world* involves dealing with new threats to both riverine and "upslope" forest or broader landscape habitats and species in the face of climate change, as shifting and increasingly variable precipitation patterns impact stream flows, snowpack, river temperatures and fire regimes (Butz et al. 2015, Melillo et al. 2014, Karl et al. 2009, Spies et al. 2010, Lata et al. 2010, Fettig et al. 2013, Wimberly and Liu 2014, Mote et al. 2014). Climate change is still often thought of as an issue affecting future people in some far away place. Within Karuk ancestral territory on the mid Klamath, the effects of climate change are immediate and occurring now (Butz and Safford 2010 and 2011, Vander Schaaf et al. 2004, Olson et al. 2012, Damschen et al. 2010, Harrison et al. 2010).

Ongoing and future ecological outcomes of climate change in the Mid Klamath region of California include changes in precipitation patterns, increased droughts, increased frequency and severity of wildfires, and disease and pest outbreaks (Butz et al.

2015, Garfin et al. 2014, Mote et al. 2014). Temperature measurements from Orleans, California, where the Karuk Department of Natural Resources is located, indicate that between 1931 and 2014 average annual temperatures increased by 2° F (1.1° C) (Butz et al. 2015). Klamath River temperature has also increased in the last fifty years (Bartholow 2005). Precipitation for Karuk Homeland territory is expected to be more variable, with a trend in increasing elevation for the snow/rain elevation. Maritime influences, on shore storms are predicted to moderate, the influences of more interior warming and drying for the western Klamath region (Butz and Safford 2010 and 2011, Vander Schaaf et al. 2004, Coops and Waring 2001).

These local impacts are consistent with regional, national and international trends as well as climate models (Bennett et al. 2014, Butz et al. 2015, Coops and Waring 2001, Dalton and Mote 2013, Gafin et al. 2014). Statewide, California is the hottest and driest since modern record keeping has taken place (Mann and Gleick 2015). The [2014 National Climate Assessment reports for the Southwest Region](#), which includes California, relates in their key findings that snowpack and streamflow amounts are projected to decline in parts of the Southwest, and increased warming, drought, and insect outbreaks, all caused by or linked to climate change have increased wildfires (see further discussion of these trends and their impacts in Chapter One).

Among the most pressing of the local dimensions of climate change taking place within Karuk ancestral territory is the increased risk of high severity fire (Lenihan et al. 2008), Mote and co-authors write:

The largest effects of future climatic variability or change on Northwest forests are likely to arise from changes in fire frequency and severity. Changes in other disturbances, such as wind, insects, and disease, are also possible under climatic change, although the potential character of these disturbances under climatic change is poorly understood. General warming is likely to encourage northward expansion of southern insects, while longer growing seasons are highly likely to allow more insect generations in a season. Forests that are moisture stressed are often more susceptible to attack by insects such as bark beetles and spruce budworm, although the timing and magnitude of effects varies greatly (e.g., Thomson et al., 1984; Swetnam and Lynch, 1993). Interactions between multiple disturbances (e.g., between insects and fire) will be especially important under projected climatic change (2003, p. 71).

The [US Forest Service Fire Effects Information Systems glossary](#) defines fire severity as "the degree of environmental change caused by fire" (USFS ND). In this assessment, we use "high severity fire" to refer to fires that lead to severe soil and vegetation burns, including but not limited to fire that replaces entire stands and affects high percentages of the upper canopy layer. Locally in the Klamath Mountain region fire severity patterns have been described and evaluated with related but different metrics (see Odion et al. 2004, Miller et al. 2009 and 2012, Halofsky et al. 2011). The Klamath Basin has experienced a progressive increase in high severity fire in recent years as a result of both climate change and past and present federal land management practices that have led to increased fuel loads (Odion et al. 2004, Miller et al. 2009 and 2012, Taylor and Skinner 2003). While fire is a central component of Karuk management and culture, increased fire severity and frequency poses particular and unique risks to specific Karuk tribal foods and cultural use species on the one hand, and to broader Tribal programmatic goals and activities on the other (Lake 2007 and 2013, Norgaard 2014, see Welch 2012 and Lake and Long 2014 for a broader discussion of fire effects to cultural resources and tribal values).

"While fire is a central component of Karuk management and culture, increased fire severity and frequency poses particular and unique risks to specific Karuk tribal foods and cultural use species on the one hand, and to broader Tribal programmatic goals and activities on the other."

In addition to increases in fire severity, there are changing patterns of fire size, and changes in the frequency of these very large hot fires. Changes in fire size also result from a combination of climate change and local management actions. For the last thousand years, forested areas have become adapted to frequent occurrence of relatively low intensity fire from human and natural ignitions (Perry et al. 2011). These fire adapted forests burned in smaller overall areas in mosaic patterns that contained patches of high intensity fire (Mohr et al. 2000, Skinner et al. 2006, Perry et al. 2011). Today, a combination of a century of fire exclusion, the presence of even-age highly fire prone tree 'plantations,' post logging brush fields, and changing patterns of temperature and precipitation have led to a series of very large, hot fires within Karuk ancestral territory and homelands (Odion et al. 2004, see

Chapter Two). Again, the frequency of these much larger, high severity fires is increasing (Miller et al. 2012). Taken together, climate change and past management activities have created landscape conditions that could be completely devastating with future fires.

These conditions have the potential to transition much of Karuk ancestral territory to an early seral condition that has a tendency to repeatedly burn at high severity (Odion et al. 2010, Cocking et al. 2012). Such circumstances would mean the potential loss of many culturally significant species, in turn causing a domino effect through the entire ecosystem. Historical natural and human (tribal) ignitions formed landscape patterns of higher severity patches on southern aspect, higher slope near the ridges, with lower severity, or mixed severity in other locations of the landscape (see Taylor and Skinner 1998 and 2003). Fire exclusion and suppression practices, combined with forest management activities (e.g. harvesting older forest, establishing plantations), have increase the density of trees, shrubs, and fuel loading (Odion et al. 2004). Climate change, in particular changes in precipitation (ie. drought) coupled with increasing temperatures, has increased the susceptibility of forest to higher severity fires. Former frequent mixed-severity fires maintained a biophysically mediated landscape of different vegetation conditions or seral stages. As these higher density vegetation and fuel loaded areas burn, generally the mature tree component is shifted to more early seral grass, forb, fern and shrub dominated vegetation (Shatford et al. 2007). Increases in potential receptivity of vegetation to ignition (e.g. increasing days of the fire season), now facilitates the prior-burned areas to burn again at higher severity, thus facilitating an altered state to more non-tree vegetation communities (Odion et al. 2010).

We, the Karuk Tribe are working to prevent these circumstances. We are evaluating the potential impacts of climate change in our region and preparing responses to mitigate possible losses (Norgaard 2014a and b, Karuk Tribe 2012). This Climate Vulnerability Assessment is a first step towards climate adaptation planning. Changing patterns of fire behavior affect specific Karuk tribal traditional foods and cultural use species, create infrastructure vulnerabilities to Karuk tribal programs and pose broader implications for the Tribe's long term management authority and political status (Norgaard 2014 a and b). We consider the importance of vulnerabilities at each scale in Chapters Three, Four and Five.

Climate Change and Tribal Climate Justice

[The Intergovernmental Panel on Climate Change](#) defines vulnerability as “the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or

susceptibility to harm and lack of capacity to cope and adapt” (2014, p. 1775). An abundance of environmental and climate justice literature emphasizes that poor people and people of color will continue to be more impacted than the population at large as the climate changes (Cuomo 2011, Lynn et al. 2011, Shonkoff et al. 2011).

While communities around the world are challenged to come to terms with unique combinations of ecological, economic and political threats, tribes face amongst the most immediate and significant impacts (Bennett et al. 2014, Cameron 2012, Donatuto and O’Neil 2010, Hanna 2007, Maldonado et al. 2013, Marino 2012, Stumpff 2009, Tsosie 2013, Whyte 2013, Williams and Hardison 2013, Wood 2014, Huffman 2014).

[The 2014 National Climate Assessment](#)

[Indigenous Peoples chapter](#) explains that climate change impacts on tribes are likely to be especially severe given that they are “compounded by a number of persistent social and economic problems,” and that indigenous adaptive responses “occur against a backdrop of centuries-old cultures already stressed by historical events and contemporary conditions” (Bennett et al. 2014, p. 298). The authors identify a number of vulnerabilities that may affect (and are in some cases already affecting) indigenous communities in the face of climate change, including loss of traditional knowledge as a result of rapidly changing ecological conditions, increased food insecurity due to reduced availability of traditional foods, changing water availability, and loss of historic homelands in which indigenous lives,

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traditions and subsistence activities have been carried out for millennia (Bennett et al. 2014).

As Karuk people we are fortunate to retain relationships with hundreds of species we consider our relations (Lake et al. 2010). These foods, medicines and fibers are embedded within cultural, social, spiritual, economic and political systems, and daily life (Lake 2013, Norgaard 2014). Impacts to culturally significant species in the face of climate change have thus more direct impacts on Karuk people than for communities who no longer retain such intimate connections with other beings and places in the natural world. Part of the increased vulnerabilities Karuk people face as the climate changes are a direct result of the strength of these connections. For example, the loss of acorn groves that have been family gathering sites for generations is much more than an economic impact.

Karuk culture is directly reliant and dependent on mixed fire severity regimes (see Lake 2007, Norgaard 2014 c.) Burning at a specific season, frequency, and intensity for a variety of severities linked with various vegetation community fire effects perpetuate cultural ecosystem services and resources. Many basketry materials require specific prescriptions or applied fire to promote morphological plant characteristics (Anderson 1999), or forest related food resources and habitat quality (Anderson and Lake 2013, Lake and Long 2014). Fire was and is a tool to manipulate landscape- to patch-scale fire effects necessary for Karuk cultural sustenance and well-being (Lake 2013).

A second dimension of Karuk vulnerability to high severity fire in light of climate change results from the actions taken (and not taken) by federal land managers before, during and after high severity fires (Welch 2012, Timmons et al. 2012, Norgaard 2014). A major dimension of vulnerability related to jurisdictional recognition and its results for tribal management authority and sovereignty (Williams and Hardison 2013, Tsosie 2007 and 2012). The federal government's primary trust responsibility to Indian Tribes was reaffirmed in 2014 by [Secretarial Order 333-5: Federal Trust Responsibility to Federally Recognized Indian Tribes and Individual Indian Beneficiaries](#) (Sec. Order 3335- Jewell 2014). Furthermore, as the Department of Interior acknowledged in [Secretarial Order 3289](#), this responsibility includes the duty to protect lands from the impacts of climate change (USDI 2009). Despite the many policies regarding tribal consultation and tribal trust responsibility, lack of implementation of these policies in practice leaves Karuk

tribal jurisdiction mostly unrecognized. Responding to the impacts of increased high severity fire both during and after the fires themselves requires coordination across jurisdictions with multiple federal and state governmental entities that may or may not understand their consultation responsibilities, carry them out appropriately, have conducted their own climate planning, or included the Karuk Tribe in their climate planning efforts. The resources and actions (or lack thereof) of federal agencies, from the U.S. Forest Service to CalTrans, can impact Karuk tribal vulnerabilities as much as climate change itself. An increased frequency of high severity wildfire has the potential to

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negatively impact infrastructure provided by other entities such as roads, electricity and water systems, which in turn may affect species of concern, program capacity and management authority (Chief et al. 2014, Cozzetto et al. 2013).

Responding to high severity fire in the context of this unrecognized jurisdiction is enormously time consuming for Karuk tribal staff. Unrecognized jurisdiction impacts tribal program capacity and management authority, leading to further unequal burdens for tribes. This Vulnerability Assessment engages the vulnerabilities faced by the Karuk Tribe in practice through an examination of both direct impacts from the increased severity of wildfire, and the impacts we as a Tribe face in light of the actions of federal agencies.

Climate Change Compels Action

The seriousness of climate change for humans and all species compels immediate action. Action is needed both to reduce the emissions of greenhouse gases, and to cope with the present and continuing ecological and atmospheric changes affecting the Karuk Tribe. In

December of 2015 the leaders of nearly 200 nations around the world committed to keep global temperatures from exceeding 1.5 degrees C above modern levels. The “Paris Agreement” is, however, non-binding. It is imperative upon all people to keep pressure on responsible parties to take appropriate steps to reach this goal. Responding to the changing climate requires many different forms of action at many scales. Each nation, community, family and individual is uniquely positioned to respond in different ways. The most useful and appropriate actions to take will also vary across time.

Tribes have been key leaders in responding to climate change through both so-called mitigation —efforts to stop further climate change— and adaptation — developing responsive measures for coping with the unfolding ecological and atmospheric changes.

Tribes can often be found leading the way in climate change policy, strategy and resistance by participating in the political process, engaging in sustainable land stewardship, and being at the forefront of many climate change activism efforts (Williams and Hardison 2013, Whyte 2013). Despite not being major greenhouse gas emitters, many tribes have embarked upon ambitious projects to reduce their emissions including use of renewable energy and transportation sources. One important step many tribes are taking to prepare their communities for ongoing climate change impacts is carrying out a climate vulnerability assessment—such as this one— to find out the ways in which their communities are vulnerable to the climate impact projected for their region.¹ These vulnerability assessments are typically followed up by the development of tribal climate change adaptation plans that aim to maximize tribal resistance and resilience in the face of projected impacts. The vulnerability assessment we have developed here is unique in that it holds the potential to inform both adaptation and

"Tribes have been key leaders in responding to climate change through both so-called mitigation —efforts to stop further climate change— and adaptation — developing responsive measures for coping with the unfolding ecological and atmospheric changes."

¹ See e.g. Pacific NorthWest Tribal Climate Change Network website, <http://tribalclimate.uoregon.edu/links/>

mitigation efforts, given that wildfires themselves generate emissions (McMeeking et al. 2006, Langmann et al. 2009), and a reduction in high severity fires could result in a reduction in forest emissions (Defossé et al. 2011, Hurteau and North 2009, Volkova et al. 2014).

Need for Tribal Knowledge and Leadership

This document assesses vulnerabilities faced by the Karuk Tribe in light of increasing fire severity. It is important to note, however, that while much focus has been placed on the vulnerability of indigenous communities, the traditional knowledge, and deep interpersonal and interspecies network ties that often form part of indigenous communities are sources of significant resilience.

Historically, tribes have adapted to numerous large-scale changes, be they environmental or social (Turner and Clifton 2009; Whyte 2013). If tribes are more vulnerable today it is not because of an inherent weakness, but because of the way colonialism and Western land management policies and practices have limited—if not outlawed—the ability of indigenous communities to exercise their resilient lifeways (See section on "Perspectives on Climate Change Vulnerability and Resilience" in [Vinyeta et al. 2015](#) (p. 19) for more discussion).

Climate change vividly reveals the flaws of Western economic and environmental principles and practices. Western capitalist economies have prioritized profit over well-being, and individualism over community. Many proposed climate change solutions protect the status quo by prioritizing profit and individual responsibility, yet there is also an increasing realization that solutions must be found elsewhere, in alternative, community-based models that prioritize long-term social and environmental wellbeing (Whyte 2013, Dunlap and Brulle 2015). Recognizing tribal knowledge, leadership and management at this juncture allows forward movement at multiple levels. Fortunately, in the face of the

"If tribes are more vulnerable today it is not because of an inherent weakness, but because of the way colonialism and Western land management policies and practices have limited—if not outlawed—the ability of indigenous communities to exercise their resilient lifeways."

changing climate, many ecologists, fire scientists and policy makers, Native and non-Native alike have turned to indigenous knowledge and management practices with renewed interest and optimism in the hope that they may provide a much needed path towards both adaptation and reducing emissions (Williams and Hardison 2013, Martinez 2011,

"In the face of the ecological threat of climate change there has been a heightened understanding of the value of indigenous traditional ecological knowledge regarding the use of fire by Western science practitioners, academic institutions and Federal and State land management agencies."

Raygorodetsky 2011, Vinyeta and Lynn 2013, Whyte 2013, Wildcat 2009).

In particular there is increasing recognition of the importance of indigenous burning as an ecosystem component and restoration technique (Arno 1985, Lewis 1982, Mason et al. 2012, Kimmerer and Lake 2001). Many Western scientists and practitioners note that Native management practices allow for multi-species management, landscape patchiness, and the abundance of important species (see e.g. McGregor 2008, Smith and Sharp 2012, Whyte 2013, Williams and Hardison 2013, Eriksen and Hankins 2014). In the face of the ecological threat of climate change there has been a heightened

understanding of the value of indigenous traditional ecological knowledge regarding the use of fire by Western science practitioners, academic institutions and Federal and State land management agencies (see e.g. Agrawal 2002, NRCS/Native Practices Work Group 2010, Ross et al. 2010, Whyte 2013, Huffman 2014). Indeed, tribal management techniques are often the most effective mechanism to achieve many aspects of public land management desired by all agencies. Especially in the face of climate change, enabling tribes' abilities to use traditional management techniques may be the best way for agencies to achieve their own goals on issues as diverse as protection of the wildland/urban interface, providing habitats for fish, wildlife, and plants, combating incursion by invasive species, and supporting local economies. This is so not only because tribes have proven techniques for maintaining ecological conditions in the face of intensive fuel loading and past wildfire suppression; tribes frequently also have less bureaucratic structures than

other agencies. Tribes have existing authorities for many management actions under shared jurisdiction within existing Federal trust responsibilities that ought to be more fully implemented (Lake and Long 2014; Norgaard 2014b).

Approach

This assessment takes a multidimensional approach to evaluating the vulnerabilities that important traditional foods and cultural use species, Karuk tribal programs and tribal management authority may face in light of the increased frequency of high severity wildfire. This approach is illustrated by the notion that fire is medicine, that fire is a component of traditional ecological knowledge and that humans are ecosystem components (see Wells 2014).

Fire is Medicine

This document works from the starting point that fire is necessary for the landscape to thrive. Karuk use of fire has been central to the evolution of the flora and fauna of the mid-Klamath ecosystem (Anderson 2005, Lake 2007 and 2013, Lake et al. 2010, Skinner et al. 2006). Fire is especially important for restoring grasslands for elk, managing for food sources including tan and black oak acorns, maintaining quality basketry materials, producing smoke that can shade the river for fish, and more. Karuk fire regimes generate pyrodiversity on the landscape by extending the season of burn and shortening fire return intervals. The multitude of foods, materials and other products that come from Karuk environments are in turn evidence of the profound diversity of fire regimes that are required to maintain relationships with hundreds of animal, plant, and mushroom species (Lake 2007 and 2013, Anderson and Lake 2013). As Karuk Director of Natural Resources Leaf Hillman puts it, “Fire is a cultural resource.”

Fire and Traditional Ecological Knowledge

Despite its central importance for both ecosystem and community well-being, Karuk traditional knowledge regarding the use of fire is at risk of decline due to factors ranging from the dynamics of forced assimilation and lack of acknowledgement by non-Native land management agencies, to insufficient tribal management capacity and even the extent of

ecological changes in ecosystems themselves (see Huffman 2013 and 2014). Maintaining Karuk traditional knowledge requires the practice of cultural management. Traditional knowledge is a living system that is enacted and carried on thorough active ongoing management. Land management is a central expression and affirmation of Karuk culture, identity, spirituality and mental and physical health (Lake et al. 2010).

Humans as Ecosystem Components

Not only is climate change the result of human activity, humans are integral components of the Klamath ecosystem. Humans have shaped the ecology, fire behavior and species composition of Karuk ancestral territory through tribal traditional management, and since 1910, through the activities of the US Forest Service (Crawford et al. 2015). Increasing fire severity is due to a combination of the changes in temperature and precipitation described above and the fact that fire suppression in the Klamath Mountains has decreased fire return intervals, resulting in increased fuel loads and fire severities for many forested riparian zones (Lake 2007, Skinner 1995, Skinner 2003, Skinner et al. 2006). That humans are ecosystem components matters for other reasons as well. When wildfires occur they are the subject of additional management actions, usually some form of fire suppression. And long after fires have ceased to burn, management actions such as re-seeding, sediment control, road building and salvage logging may occur. Understanding climate-induced vulnerabilities for particular species therefore requires an interdisciplinary approach that incorporates biological and fire science with sociological understanding of human factors. Discussions of habitat zones and species profiles reflect this intersectional dimension to vulnerability. For each species of focus we address how cultural burning benefits the species (see example of Spring Chinook Salmon in Table 1).

Table I.1 Effects of Karuk Cultural Burning on Spring Chinook Salmon Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Smoke from fire may reduce sun light air and lower air and water temperatures, benefitting salmon 	<ul style="list-style-type: none"> Gravel and wood debris has entered aquatic systems following fire and enriched salmon habitat Water flows may increase as a result of properly burned landscape 	<ul style="list-style-type: none"> Mosaics of burning patches reduce vegetation evapotranspiration, and contribute sediment and debris for instream habitat; Reduce larger extensive high severity fires.
Sources: Toz Soto, see Robock 1991	Sources: Toz Soto, Frank K. Lake	Sources: Frank K. Lake

Secondly, we address how species may be impacted during a high severity fire event, during the immediate aftermath (roughly 24 months) and long term. (See Table 2).

Table I.2 Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Smoke from fire may block light from the water's surface and reduce water temperatures, benefitting salmon. Smoke inversions reduce vegetation evapo-transpiration (water use) increasing temporary water yield. 	<ul style="list-style-type: none"> Burned canopies over riparian corridors can increase sun exposure and stream temperatures. Moderate light increases improve aquatic productivity when coupled with higher water yields Severe post-fire erosion can reduce spawning habitat 	<ul style="list-style-type: none"> High severity patches contribute sediment and woody material replenishing downstream habitat. Fires that reduce excessive tree density reduce evapotranspiration and can increase pulses of water in sub-drainages High severity fire converts large tracks of forest to brush that tends to burn at high severity over and over, creating a perpetual early seral condition with chronic sediment inputs
Sources: Toz Soto, Frank K. Lake, see Robock 1991	Sources: Dwire and Kauffman 2003 Frank K. Lake, Shu-ren 2003	Sources: Dwire and Kauffman 2003, Frank K. Lake, Shu-ren 2003

Third, the vulnerabilities faced by the Karuk Tribe in the context of high severity wildfire do not occur in a vacuum. These vulnerabilities must be understood in the context of existing susceptibilities, as well as the past, present and future management actions of Tribal and non-Tribal land managers. Not only does high severity wildfire hold the potential to negatively affect some species more than others for biological reasons, species with already compromised ecological niches that may have more difficulty in adapting will be at greater risk in the event of large scale, high severity fires (see [USFS FEIS](#) for species profiles). Furthermore, past management actions such as logging, road building or fire suppression interact with fire events to influence the level of eco-cultural vulnerability, as do management actions taking during a fire and those that may follow in the long term. As such, our analysis also considers how past management actions, management actions taken during a high intensity wildfire event, and those that may come in the future may create vulnerabilities for a given species (see example in Table 3).

Table I.3 Effects of Federal Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none">• Suppression limits beneficial debris and water that would normally enter streams and rivers after fire	<ul style="list-style-type: none">• Fire retardant chemicals may affect the survivability of Chinook salmon, particularly in earlier life stages	<ul style="list-style-type: none">• Salvage logging takes trees that could have otherwise ended in the stream and benefitted salmon habitat
Sources: Toz Soto, Bisson et al. 2003, Noss et al. 2006	Sources: Dietrich et al. 2013, Noss et al. 2006	Sources: Toz Soto, Noss et al. 2006, Karr et al. 2004

The above tables illustrate our intersectional approach with respect to vulnerabilities of specific species. Vulnerabilities to program capacity and tribal management authority follow the same format.

Overview

Chapter One of this assessment provides general context on the Karuk Tribe, including location, size, political status and infrastructural context. This chapter then describes general challenges of climate change within Karuk ancestral territory and homelands (beyond wildfire) and their health, economic and social consequences. Chapter Two gives a more detailed discussion of the complexity of fire as both medicine and traditional practice on the one hand, and a potentially dangerous force in light of changing patterns of fire behavior due to climate change on the other. This chapter engages centrally with the notion that humans are ecosystem components and that climate change is not happening in isolation of other failing non-Native management actions affecting Karuk foods, programs and management authority. Chapter Three examines how increasing high severity fire creates vulnerabilities for traditional foods and culturally important species. The discussion centers on six different habitat zones, each followed by a series of profiles on how high severity fire creates vulnerabilities for specific species within that habitat type.

Chapter Four examines how high severity fire creates vulnerabilities to tribal program capacity at three time scales: during high intensity fires, immediately following, and over the long term. Specific detail is provided for a number of programs within the Karuk Department of Natural Resources and for the Health Program. Chapter Five details vulnerabilities to tribal management authority in the face of high severity fires. This chapter examines the pre-fire jurisdictional context of the Karuk Tribe and the pre-fire management actions of federal agencies that influence tribal management authority.

Chapter Five then considers how interruptions to the practice of traditional knowledge, the crisis management orientation to fires, shifting jurisdictional terrain, and the focus and interest in the Klamath region by non-Native practitioners each shape vulnerabilities related to the increasing frequency of high severity fire. We examine these issues at three temporal scales (during fires, immediately afterwards and long term).

Climate change poses a threat not only to the Klamath ecosystem, but also to Karuk culture, which is intimately intertwined with the presence, use and management of cultural use species (Karuk Tribe 2010, Lake et al. 2010, Norgaard 2005). While a complete Climate Adaptation Plan is needed, the conclusion points to preliminary recommendations based on this assessment. Restoring fire processes and function is about restoring the human responsibility to other species. In the context of climate change, Karuk tribal knowledge and management principles regarding the use of fire can be utilized to reduce the likelihood of high severity fires and thereby protect public as well as tribal trust resources (Norgaard 2014).

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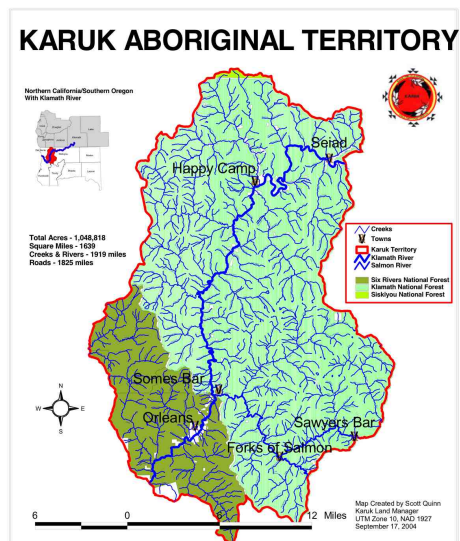
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Chapter One: Tribal Climate Change Impacts Overview

Since time immemorial, Karuk people have lived in the Klamath-Siskiyou Mountains in the mid- Klamath River region of northern California. With an Aboriginal Territory that includes an estimated 1.38 million acres, the ancestral people of the Karuk resided in more than one hundred villages along the Klamath and Salmon Rivers and tributaries (see Figure 1). Thriving with a subsistence economy supported by rich natural endowments and a strong culture-based commitment to land stewardship, Karuk environmental management has shaped the region's ecological conditions for millennia. Through carefully observing natural processes, the Karuk have developed traditional management regimes based on a landscape-level ecosystem approach. Self-described as "fix the world people", the Karuk continue ceremonies that restore balance and renew the world.

The Karuk Tribe is a federally recognized Indian Tribe (73 Fed. Reg. 18,535, 18, 544 (April 4, 2008)). The Tribe's Territory is the land base that was utilized in the process of receiving federal determination of tribal recognition. The Tribe continues to exercise jurisdiction over Tribal Lands. The Karuk Tribe governs reservation and trust lands, as well



as fee parcels within Karuk Aboriginal Territory. The Karuk Tribe is a self-governing Tribe employing roughly ~231 staff and with an annual operating budget of ~\$37 million the main tasks of which are to develop programs, policies and departments to administer services to Karuk people and to uphold responsibilities to care for the land. The governmental structure includes nearly twenty departments, programs, and services organized into three service districts. The geographic area is remote, with a single major highway connecting the 120 miles along the Klamath river between these districts. Administrative offices,

government operations, the Karuk Community Development Corporation (KCDC) and the Karuk People's Center are located in Happy Camp, the Department of Natural Resources is

located in Orleans and Somes Bar, and the Karuk Judicial System is located in Yreka. Health clinics, education and elders programs, housing authority offices, community computer centers, tribal court services, and human services/Indian Child Welfare programs are located in each of the three main population centers.

The Karuk Tribe interacts with other governments and agencies operating within Karuk ancestral territory. Electrical power (where available) is supplied by Pacific Gas and Electric and Pacific Power; Orleans and Happy Camp have municipal water systems; CalTrans and Siskiyou and Humboldt counties support highway maintenance. Agencies making decisions impacting Karuk Tribal Lands and resources include the Environmental Protection Agency (EPA), United States Fish and Wildlife Service (USFWS), United States Forest Service (USFS), California Department of Forestry and Fire Protection (CALFIRE), the State Water Board, and California Department of Fish and Wildlife (CDFW). In particular, nearly all Karuk ancestral territory is located within the National Forest System.

Due to the particular and immediate threat of increased fire intensity and severity in the Klamath region, this climate vulnerability assessment has a focus on the increased frequency of high severity fire. Other climate stressors including increased drought and temperatures, more variable weather, stronger storm systems, decreased snowpack, flooding, and increase in invasive species often intersect with the increasing frequency of high severity fire. These stressors --critically important in their own right -- are beyond the scope of this assessment but are discussed nominally here. This chapter will also outline general social, economic and health related vulnerabilities faced by the Karuk Tribe in light of the changing climate.

Changing Patterns of Temperature and Precipitation

California is currently in its fifth year of the hottest and driest statewide drought in recorded climate history (Diffenbaugh et al. 2015; Griffin and Anchukaitis 2014). In May 2016, California Governor Brown issued an executive order moving many temporary drought restrictions into permanent status. Figures from the National Academy of Sciences report indicated a projected average temperature increase of up to 3.5- 4.5 degrees F for the Klamath region in the next 50 years (as compared to the period of 1971-1999) (Garfin et al. 2014). Temperature changes measured to date are variable within the region -- at the

Orleans, CA weather station, average temperatures have already increased 2 degrees F in the period from 1931-2014 (Butz et al. 2015). Nighttime temperatures over the same period have increased by almost 4° F (2.2° C) (ibid). Warmer nighttime temperatures have a particularly significant effect on stream temperatures.

Precipitation patterns are also changing in the Klamath basin and across the Pacific Northwest. Between 2012 and 2014 California witnessed the most severe drought on record. Not only were precipitation records the lowest since first recorded in 1895, but tree ring records suggest this period may be the driest California has been in 1,200 years (Griffin and Anchukaitis 2014). Butz, Sawyer and Stafford (2015) note “Across the western United States, widespread changes in surface hydrology have been observed since the mid-1900s. These shifts include: decreased snowpack (particularly at low elevation sites; earlier snow melt and spring runoff (by 0.3 to 1.7 days per decade across Western US as a whole) decline in total runoff occurring in the spring (Moser et al. 2009) rising river temperatures (Kaushal et al. 2010) increased variability in streamflow (Pagano and Garen 2005).” The authors note the degree of *variability* in precipitation: “Year-to-year fluctuations in precipitation averaged over the Northwest have been slightly larger since 1970 compared with the previous 75 years, with some of the wettest and driest years occurring in the most recent 40 years” (xxii). Very significantly, precipitation and the amount of precipitation that falls as snow within the Klamath basin are also becoming more variable, e.g. the 5 year co-efficient of variation for annual precipitation is increasing at all weather stations in the Six Rivers National Forest (Butz et al. 2015).

While specific temperature, precipitation, fire and other aspects of the changing climate play out differently across regions of the United States and globe, trends occurring in Karuk ancestral territory are congruent with these larger patterns. In their recent report “Climate Change in the Northwest,” Dalton et al. (2013) note: “For the last 30 years, temperatures averaged over the Northwest have generally exceeded the 20th century average. During 1895–2011, the Northwest warmed by about 0.7 °C (1.3 °F)” and “During 1901–2009 the number of extreme high nighttime minimum temperatures increased in the Northwest” (xxii).

Changing patterns of temperature and precipitation, decreased snowpack, earlier snow melt and spring runoff, decline in total spring runoff, and increased variability in

streamflow have already been observed, and these trends are expected to increase (Butz et al. 2015). For example, future snowfall in the 6,000-10,000 foot elevation range is predicted to decrease by 22-93% across California by 2100. Both earlier dates of peak daily flows, and increases in the proportion of precipitation fall as rain translate into an increase in flood potential (Butz et al. 2015). In the Klamath Basin, notable trends include larger fires and longer fire seasons, denser smoke concentrations for longer periods of time, and fish and salamander die-off.

Local projections for upcoming changes in temperature and precipitation generally follow region-wide forecasts. Dalton et al. (2013) review the projections from three major climate modeling efforts for the Pacific Northwest: “The Northwest is expected to experience an increase in temperature year-round with more warming in summer and little change in annual precipitation, with the majority of models projecting decreases for summer and increases during the other seasons.” Furthermore, among the future trends emphasized by Dalton et al. (2013) is that of increasing variability in precipitation:

The number of days with greater than 1 in (2.5 cm) of precipitation is projected to increase by 13% ($\pm 7\%$) and the 20-year and 50-year return period extreme precipitation events are projected to increase 10% (-4 to +22%) and 13% (-5 to +28%), respectively, by mid-century (xxiii).

Changing patterns of temperature and precipitation create major dimensions of climate change beyond the scope of this report. These conditions affect fire behavior—as discussed in Chapter Two— but are also significant problems in their own right. Each of these trends has profound implications for Karuk tribal traditional foods and cultural use species, tribal program infrastructure and Tribal management authority and political status. Drought, warmer temperatures and increased spread of disease interact to affect species of importance to Karuk people, albeit in different ways. For example, aquatic species like salmon, winter and summer steelhead, sturgeon and many others adapted to colder water are at risk from thermal stress and increased competition from non-native species as water temperatures rise (Rahel and Olden 2008). In 2014, California’s Salmon River, one of the last remaining strongholds of Spring run Chinook and Coho salmon, warmed to lethal temperatures. The survival of Coho salmon, (listed as endangered under the Endangered Species Act), as well as a dwindling population Spring Chinook salmon hangs in the

balance. These fish are critical to our food security, cultural survival and well-being. In August 2014, the Karuk Tribe issued an Emergency Declaration for severe drought conditions. Amphibians such as Pacific giant salamander (puuf puf) are particularly vulnerable to hotter, drier conditions resulting from climate change (Blaustein et al. 2010, Lawler et al. 2010). Tanoaks, critical for acorn production (Lenihan et al. 2003) are vulnerable not only to high severity fires as discussed in Chapter Three, but also susceptible to the invasive pathogen *Phytophthora ramorum*, which causes Sudden Oak Death (see below). These are just a few examples of the complex ways that changing patterns of temperature and precipitation affect hundreds of species of importance to Karuk people. Furthermore, these climate trends create vulnerabilities to Karuk program infrastructure and management authority. Detailed attention to these topics in a future expanded vulnerability assessment is urgently needed.

Species Invasions and Sudden Oak Death

Species invasions are another dimension of the changing climate that interacts with both the changing patterns of precipitation and temperature, and increasing frequency of high severity fires to generate impacts for Karuk people. Although humans have always moved organisms from one place to another as we travel, and participated in the shaping of so-called “natural ecosystems,” the rates of human travel, trade and hence new species introductions have expanded rapidly in past decades. Living organisms are moving around the globe at an unprecedented rate through direct importation and also as “hitch-hikers” on freighters, packaging and equipment. Some of these species take hold and spread rapidly in their new environment. When this occurs, native organisms and ecosystem relationships may be rapidly altered. Around the world, species invasions are increasing in light of climate change. In other cases, changing patterns of temperature and precipitation allow species that have long existed in one region to expand their reproductive cycle, as has occurred with beetle infestations in some western forests. Additionally, insects long known in a region may carry new sets of pathogens. Species invasions may become catalysts for high severity fires if the invasions in question are so significant that they fill a given habitat type with a more flammable species, or if they cause tree morbidity or mortality in forests, as has occurred in the four corners region of Utah, Colorado, Arizona and New Mexico

(Field et al. 2008). Mountain pine and spruce beetle outbreaks are expected to be an increasing problem within the Pacific Northwest as warming temperatures allow the insects to survive in high elevation forests where they were previously kept out by colder temperatures that impeded or limited insect survival (Dalton et al. 2013).

Invasive species that have drawn notable attention within Karuk ancestral territory includes Port Orford cedar root rot (*Phytophthora lateralis*), spotted and meadow knapweed, star thistle, Italian thistle and leafy spurge.² Invasive species have also been a concern to Karuk people in relation to herbicide spray, especially for basketweavers (Norgaard 2007). Of the invasive species in the region,

"Of the invasive species in the region, forest pathogens are of particular importance both directly for their impact on Karuk foods, fibers and medicines, and indirectly for their impact on fire behavior."

forest pathogens are of particular importance both directly for their impact on Karuk foods, fibers and medicines, and indirectly for their impact on fire behavior. Among the most concerning invasive pathogens is *Phytophthora ramorum*, which causes Sudden Oak Death (Ortiz 2008, Voggesser et al. 2013). This pathogen has destroyed millions of oak and other trees, and has caused twig and foliar diseases in additional plant species across California since the 1990s. The noted cultural practitioner Beverly Ortiz (2008a) writes "While the use of "acorn" for food has survived more than 200 years of severe cultural disruption, upheaval, dislocation, and suffering as a result of non-Indian intrusion, it now faces a new threat—Sudden Oak Death (*Phytophthora ramorum*)" (p.39).

Not only does this disease affect many species beyond the tanoaks for which it was named— a large percentage of these species are used by California Indians. Ortiz (2008) writes "Of the 23 native plant species and one genus that have been designated as regulated hosts for P. ramorum as of September 11, 2006, and the 18 other associated native plant species that may soon follow as regulated hosts, the author has identified

² See [US. Forest Service](#), [Mid Klamath Watershed Council](#) and [Salmon River Restoration Council](#) for more details.

contemporary cultural uses for all but 12” (419).³ Not only are these species of importance as food sources, Ortiz notes the spiritual significance of the relationships people hold with these plants:

The spread of *P. ramorum* into several coastal and near-coastal, California counties, threatens a vital, thousands-of-years-old relationship between people, cultural heritage, plants and their homelands. Cultural, social, community, emotional, spiritual and historical ties connect people to their homelands, and traditionalist California Indians feel an obligation to Creation, and the Creator, to continue to use plants within these homelands for food and other cultural purposes, while care taking the plants in culturally prescribed ways (Ortiz 2008, p. 425).

Species of importance to Karuk people that can carry or be directly impacted by the pathogen include tanoak, black oak, California bay laurel, madrone, hazelnut, evergreen huckleberry, manzanita, and salmonberry.

Ecological Significance of mid-Klamath Region

The Klamath region is highly biologically diverse and has been a refugia to which species migrated during past climatic changes (Olson et al. 2012). While the region is at great risk of increased frequency of high severity fires, it is also an area of the state with relatively high biological, geological and topographic diversity, and less urban development. These factors may once again make this region a climate refugia in the coming decades. Both the region’s ecological diversity and the qualities that provided relative protection during past climatic changes are ecologically advantageous, but these also cause complexities— they draw interest from non-Native scientists and land managers across the larger region who may or may not be aware of the Karuk Tribe’s presence, much less the ways that Karuk traditional ecological knowledge is integral to the region’s ecology, the Tribe’s ongoing management intentions, or their social and cultural importance (Norgaard 2014a, 2014b). For example, in an article considering the importance of the Klamath-Siskiyou region as a biological refugia in light of climate change, Olson et al. (2012) write:

³ A detailed resource of plants used by California Indians that are susceptible to Sudden Oak Death is available at www.suddenoakdeath.org

“Reducing non-climate stressors and securing protection for large, complex landscapes are important long-term actions to alleviate climate change impacts on biodiversity. Equally important is the immediate protection of a network of climate change microrefugia, particularly old growth and intact forests on north-facing slopes and in canyon bottoms, lower- and middle-elevations, wetter coastal mountains, and along elevational gradients. Such areas provide local opportunities for vulnerable species to persist within the ecoregion” (p. 65).

These goals certainly could align with Karuk values and management principles, but Olson et al. (2012) do not mention Karuk tribal presence in the area, nor indicate an awareness of the extent to which tribal management principles might aid in the restoration of the landscapes of concern. With the right knowledge and under the right circumstances, outside scientists could develop mutually beneficial, collaborative relationships with the Tribe. Yet, what often occurs is that outside scientists undermine tribal authority by lacking awareness of tribal presence, history, knowledge, cultural practices, and the federal trust responsibility.

"With the right knowledge and under the right circumstances, outside scientists could develop mutually beneficial, collaborative relationships with the Tribe."

Social Impacts of The Changing Climate

The climatic and ecological changes outlined in the first part of this chapter have profound implications for Karuk people. Climate vulnerability assessments tend to address the potential social implications of climate change related to human health, social networks and relations, economic opportunity and, to a lesser extent, political relations and jurisdiction (NAS 2008). People and communities that are already socially marginalized, such as people living in or near poverty, indigenous people, and other people of color, may lack the resources and socio-political networks to advocate for themselves, endure, and/or recover from climate change impacts, making them more vulnerable (Lynn et al. 2011). Increasingly, academic and policy-related literatures are assessing the ways that indigenous peoples and communities in North America are (or may be) vulnerable when dealing with ongoing climate change impacts (Bennett et al. 2014, Cameron 2012, Lynn et

al. 2013, Maldonado et al. 2014, Parrotta and Agnoletti 2012, Vinyeta et al. 2015, Voggesser et al. 2013, Whyte 2013, Wildcat 2013, Williams and Hardison 2013). Existing work analyzing the impacts of climate change for indigenous communities for the State of California is limited (e.g. a 2012 report by Cooley et al. entitled [*Social Vulnerability to Climate Change in California*](#) had one mention of tribes). Knowing full well the risks that climate change poses, tribal governments and organizations, and indigenous scholars and activists are leading the way in assessing tribal vulnerability, outlining sources of indigenous resilience in the face of climate change, and developing climate adaptation plans (ANTHC 2011, CIER 2007, CSKT 2013, Grossman and Parker 2012, Jamestown S'Klallam 2013, Maynard 1998, Swinomish 2010, Whyte 2013 & 2014, Wildcat 2009). This vulnerability assessment represents yet another example. We briefly survey general trends and issues below to provide a sense of the diversity of social impacts climate change may bring forth in tribal and other communities.

Health

Human and environmental health are intimately connected. Western land management strategies and projects have already compromised the health and abundance of species of cultural importance to tribes, resulting in both cultural loss and loss of health (Hoover 2013, LaDuke 1999). In the Pacific Northwest, hydroelectric dams have severely affected tribes' ability to gather salmon, which is a cultural and dietary staple. We the Karuk Tribe have been at the forefront of identifying relationships between traditional foods and diet related diseases in light of environmental degradation in both riverine and forest environments (Reed and Norgaard 2010, Norgaard, Reed and Van Horn 2011), and in relation to toxic algae (Jacoby and Kann 2007). Norgaard (2005) documents how declines in important and highly nutritious traditional food species such as salmon have led to spikes in rates of diabetes and other chronic diseases. Traditional foods such as salmon are vitally important for physical and mental health. As riverine temperatures continue to increase, salmon and other cool water dependent species are increasingly at risk. Already dangerously high levels of toxic blue-green algae are also expected to rise with increasing water temperatures. The changing climate poses a number of other physical human health risks including increases in the rates of diseases transmitted by food, water and insects,

rising pollen production (leading to higher rates of asthma and allergies), and increases in both heat related deaths and deaths related to extreme weather events (NAS 2008). The stresses associated with the impacts of climate change also pose risks for mental health. For indigenous communities that are often geographically, socio-politically and economically isolated, as well as culturally, spiritually and economically dependent on the lands and waters in their region, the health impacts of climate change can quickly become amplified.

Physical health or even sheer survival may also be compromised for indigenous peoples carrying out hunting and gathering activities in changing landscapes. Concerns

"The cultural impacts of climate change are just the latest in a long thread of what Jacob (2013) calls "soul wounds" imparted upon indigenous communities as a result of colonialism and a capitalist economy."

have been raised among Alaska Natives who may be facing elevated risks of life-threatening accidents as a result of thinning ice conditions in traditional hunting areas (Ford and Smit 2004, McBeath and Shepro 2007). While Karuk territory differs ecologically from that of Alaska Natives, climate change-induced landscape changes may be of concern if they affect the safety and health of tribal members while engaging in subsistence and traditional activities.

Climate change poses threats not only to physical health, but also to mental health,

particularly for people and communities with strong cultural, economic and/or spiritual ties to the land (Cunsolo Willox et al. 2013, McNamara and Westoby 2011). Indigenous people in the U.S. already contend with the daunting task of processing centuries of historical trauma resulting from colonialism, a fact that has led to high rates of substance abuse, suicide, and violence within indigenous communities (Maracle 1996, Mokuau 2002, Ross 1998, Smith 2005, Strickland et al. 2006, Weaver 2009). The cultural impacts of climate change are just the latest in a long thread of what Jacob (2013) calls "soul wounds" imparted upon indigenous communities as a result of colonialism and a capitalist economy. Luckily, many tribes and tribal organizations are turning to traditional healing practices to restore mental health and spiritual well-being to their communities (Jacob 2013, Mokuau

2002, Nebelkopf and Penagos 2005). As climate change progresses, it will be important for tribes to develop or continue to provide culturally-appropriate programs and strong, supportive social networks that can help tribal members deal with the stresses and mental health impacts associated with the economic, cultural, and spiritual stresses that may be brought on by climate change impacts.

Food security

Lack of traditional food impacts the Karuk Tribe not only due to decreased nutritional content of specific foods, but results in an overall absence of food, leaving Karuk people with basic issues of food security. Intimately linked to health concerns is the issue of food security. Once amongst the most plentiful food systems in the world, Karuk ancestral territory now falls under the classification of a food desert. This distinction is both based on the fact that Karuk people are denied access to many of their former (first) foods due to federal policy and environmental damage, and the fact that the nearest supermarket is a two-hour drive from most parts of Karuk ancestral territory. Before the impacts of dams, mining and over fishing, the Karuk people subsisted off salmon year round. With the destruction of the salmon population it is no longer possible for Karuk people to subsist on their traditional foods, yet people continue to rely on salmon and other fish for subsistence purposes. The 2005 Karuk Health and Fish Consumption Survey found that 59 percent of respondents live in households that fish for steelhead for food, 38 percent live in households that fish for spring chinook for food, and 50 percent live in households that fish for fall chinook for food. Forty percent of respondents answered that there are fish that their families once gathered that are no longer harvested and 58 percent of respondents indicated that they eat less salmon now than as a teen both frequently due to insufficient numbers of fish in the river to harvest. Additionally, 86 percent of respondents stated that regulations and low population numbers restrict them from gathering enough eel to fulfill their needs. Access to food and traditional food sources such as salmon are recognized as a basic human right by multiple

"Once amongst the most plentiful food systems in the world, Karuk ancestral territory now falls under the classification of a food desert."

international human rights treaties. The United Nations also recognizes the right to food security and food sovereignty.

Climate change poses further threats to food security by potentially shifting the ranges and abundance of plant and animal species that comprise a significant part of traditional indigenous diets (Lynn et al. 2013, Wesche and Chan 2010). This has both cultural and health repercussions for indigenous communities such as the Karuk Tribe. Climate change may exacerbate existing food security concerns in tribal communities by changing the habitats in which traditional food species live and grow, making them less abundant or unable to exist in their former range. Many tribes have embarked on food sovereignty movements in an effort to secure access to, and cultural relationships with, the food species that are vital to tribal health and well-being. The Karuk Tribe's food security program –a collaboration the Tribe is carrying out with U.C. Berkeley - is among these examples. As climate change advances, such programs and movements will be of utmost importance in promoting tribal resilience.

Economic

In the absence of salmon and other foods from the land, people purchase foods in grocery stores or rely on government commodities. Past environmental devastation of the resource base is also directly linked to the disproportionate unemployment and low socio-economic status of many Karuk people today, with the result that poverty and hunger rates for the Karuk Tribe are amongst the highest in the state and nation. The isolation of the ancestral territory, due in part to rugged terrain and narrow, winding roads, predestined the people of the area to be dependent on the extraction of local natural resources as capital for means of exchange in the market system. The logging and mining industries became important to the local economy providing seasonal jobs for people in the area. The boom-and-bust nature of these industries contributed to the cycle of poverty while disrupting healthy ecosystems and the services that they provided.

The Karuk tribal economy continues to center around formal and informal economic endeavors related to natural resources. As the future the abundance and range of key plant and animal species is affected by climate change, subsistence hunting, fishing and gathering activities that provide a significant percentage of food for some Native families will

continue to be compromised, forcing these families to spend more money on conventional groceries. This is particularly troubling given that indigenous communities are among the most economically impoverished in the United States (Leichenko 2003, Sarche and Spicer 2008). Poverty can affect one's ability to overcome or bounce back from severe weather and other climate change impacts as the lack of financial resources may prevent one from evacuating in time, receive proper healthcare, have a monetary safety net, or prepare for future changes. That said, tribal communities often have tight social networks, traditions and knowledge that foster resilience in the face of climate change and mitigate the vulnerabilities that may arise as a result of financial scarcity. Additionally, some tribes are diversifying their economic endeavors to make them more resilient in the event of climate change impacts on certain resources. Across the United States, tribes are also investing in renewable energy projects that not only mitigate climate change and serve as an alternative to fossil fuel, but also prop up the tribal economy into the future.

"Tribal communities often have tight social networks, traditions and knowledge that foster resilience in the face of climate change and mitigate the vulnerabilities that may arise as a result of financial scarcity."

It is important to note that in a traditional cultural paradigm void of Western influence, most tribal monetary systems were tied directly to the health and abundance provided by coupled human-natural systems. Indigenous communities typically could not generate site-specific excess needed for trade or use for specialty items such as ceremonial regalia without first fulfilling the human responsibility. In contrast, the contemporary economy and monetary system is linked to extraction, environmental degradation, and profit accumulation. As tribes move into a climate change era, there is an opportunity (albeit challenging) to plan for tribal economic futures that restore former responsibilities and values and prioritize social and ecological health as a key element of economic sustainability.

Political

This assessment engages relationships between the increasing rate of high severity fires and Karuk management authority, yet this is but one dimension of the possible political impacts Karuk people face in relation to the changing climate. Climate change creates

"Climate change creates enormous political tensions at various scales as communities and nations struggle with a wide range of economic and social challenges, such as forced migration, sea level rise and natural disasters."

enormous political tensions at various scales as communities and nations struggle with a wide range of economic and social challenges, such as forced migration, sea level rise and natural disasters. Other political challenges emerge due to the fact that laws and policies have been created in relation to a particular set of ecological conditions that are now changing. Political impacts for Native people resulting from climate change include impacts to tribal hunting, fishing, and gathering rights as species move, the loss of physical land due to sea level rise, and loss of land from increasing storm surge in the face of reduced ice and coastal erosion.

In addition, tribes face loss of political standing through shifting jurisdiction in light of the changing climate. Language from [UNDRIP](#) as related to tribal rights in the face of climate change including the United States" (6). Article 31 section 1 of the [UNDRIP](#) states:

Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs, sports and traditional games and visual and performing arts. They also have the right to maintain, control, protect and develop their intellectual property over such cultural heritage, traditional knowledge, and traditional cultural expressions.

The above-mentioned dimensions of climate change not detailed in this report certainly deserve fuller attention in a follow up, comprehensive vulnerability assessment. It is the Karuk Tribe's objective to follow-up this fire-focused assessment with one that

comprehensively assesses the diverse and multi-faceted ways in which climate change may affect Karuk people, lands, and waters.

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Chapter Two

Fire Exclusion and Changing Patterns of Fire Behavior

This document evaluates the vulnerabilities faced by the Karuk tribe in light of the increasing frequency of high severity fire within Karuk ancestral territory. Yet unlike widespread conceptions of fire as ‘bad,’ fire is an essential component of Karuk cultural practice and ecosystem health. Fire is medicine. Fire is referenced in our creation stories and is part of our world renewal ceremonies. As Karuk Director of Natural Resources and spiritual leader Leaf Hillman puts it, “We are closely related to fire. Fire takes care of us and we take care of fire.” Fire takes care of people in part by enhancing the availability and quality of food resources. Ecologist Kat Anderson (2005) describes the ecological benefits of indigenous burning:

When Indian women or men set hillsides on fire, they not only spurred the growth of young sprouts from shrubs and trees but also opened up areas to increased sunlight, heightened the structural complexity of forest, woodland, and shrubland habitats, stimulated the seed germination rates of seral and serotinous species, recycled nutrients for the whole community, altered insect populations, and promoted increased biodiversity. Periodic burning encouraged native annuals, grasses, and herbaceous perennials to grow under shrubs and trees, creating a healthy understory that enhanced the permeability of the soil surface, checked surface erosion, increased rates of nutrient cycling, enhanced soil fertility, and provided food and habitat for animal species, thus increasing biodiversity and the possibility of mutualistic community interactions. . . (p. 238).

Fires may be understood to be beneficial or hazardous to the extent that they support desired ecosystem conditions and cultural values. Karuk people have used fire to enhance foods, fibers and medicines and to benefit other species since time immemorial. Across California the use of fire by Native people generated profound food productivity and biodiversity. The policy of suppressing fire was intended to allow as many conifers as possible to reach maturity for commercial timber (Show & Kotok 1923). Regardless of the contrasting values of commercial timber harvest or subsistence cultural uses, the mid-Klamath ecosystem is fire adapted (Cocking et al. 2012, Skinner et al. 2006, Taylor and Skinner 2003). Together with alterations of the global climate system from fossil fuel emissions, the alteration of local fire regimes over the past century has led to the increase

in the size and frequency of high severity fires within Karuk ancestral territory (Dalton et al 2013). It is this new pattern of fires that pose vulnerabilities for Karuk species of importance, tribal programs, and management authority as discussed in this assessment.

During fires, cultural resource advisors work alongside fire fighters to keep suppression activities from damaging cultural resources. But fire itself is a cultural resource vital more so than ever in the context of climate change. The actions of agencies prior to, during and after fires threaten this resource by creating conditions under which fire cannot or is not being used as a pro-active management tool. These barriers to the use of fire range from explicit and implicit regulations, to discourses of fire as bad through Smokey Bear campaigns, and the added challenge of using fire in the

"The continued ability of Karuk people to use fire on the land is essential to a host of inter-related social processes including physical and mental health and political sovereignty."

face of artificially high fuel loads from past fire suppression and other forms of non-indigenous management. The continued ability of Karuk people to use fire on the land is essential to a host of inter-related social processes including physical and mental health and political sovereignty. Karuk Cultural Biologist Ron Reed explains this relationship:

Without fire the landscape changes dramatically. And in that process the traditional foods that we need for a sustainable lifestyle become unavailable after a certain point. So what that does to the tribal community, the reason we are going back to that landscape is no longer there. So the spiritual connection to the landscape is altered significantly. When there is no food, when there is no food for regalia species, that we depend upon for food and fiber, when they aren't around because there is no food for them, then there is no reason to go there. When we don't go back to places that we are used to, accustomed to, part of our lifestyle is curtailed dramatically. So you have health consequences. Your mental aspect of life is severed from the spiritual relationship with the earth, with the Great Creator. So we're not getting the nutrition that we need, we're not getting the exercise that we need, and we're not replenishing the spiritual balance that creates harmony and diversity throughout the landscape.

This chapter provides background information, history and context on the importance of fire in order to contextualize the vulnerabilities emerging from increasing frequency of high severity fire resulting from climate change that forms the basis of this assessment. The

chapter first outlines the ecological and cultural importance of fire, then provides a brief summary of fire suppression over the last century, and finally engages changing patterns of fire behavior in light of climate change. We emphasize the notion that humans are ecosystem components at both the local and global scale. Ultimately, restoring our fire practices and regimes is about restoring the human responsibility to other species.

Fires vary dramatically, as do perspectives on and understandings of fire. In particular, fires vary by intensity, severity, frequency and size. Fire ecology is complex -- detailed engagement with this topic is beyond the scope of this report. Key qualities emphasized here include fire intensity and fire severity. The US Forest Service Fire Effects Information Systems glossary defines fire intensity as "a general term relating to the heat energy released in a fire." Many fires burn with a mosaic of intensities – burning very hot in certain patches and cooler in others. Traditional Karuk burning is mostly low intensity fire, but high intensity fire has specific ecological benefits as well. In contrast, fire severity indicates "the degree of environmental change caused by fire" (USFS ND). Severity is normally evaluated in terms of the degree of mortality of dominant overstory vegetation (e.g. trees) -- ranging from low severity in the case of non-lethal surface fires, to high severity stand-replacing crown fires (see also Agee 1993, Keeley 2009). In this assessment, we use "high severity fire" to refer to fire that leads to severe soil damage and consumption of most live vegetation, including but not limited to fire that replaces entire stands and affects high percentages of the upper canopy layer.

The mid-Klamath region has long experienced "mixed-severity wildfires" with combinations of surface, torching, and crown fire resulting in an overall mosaic of low and high intensity burned areas and patches of live and dead understory and overstory vegetation throughout the fire footprint (Agee 1993, Halofsky et al. 2011, Taylor and Skinner 1998). In recent decades California has experienced an increase in the frequency of high severity fire. Valliant et al. 2015 describe:

The transformation of fuel conditions, coupled with a changing climate, has altered the fire regime in coniferous forests typified by historically high-frequency and low-to-moderate-severity fires (e.g. Westerling et al. 2006; Miller et al. 2009; Mallek et al. 2013 ;Stephens et al. 2013; Safford and Van de Water 2014). In California, a recent analysis of fire return interval departure found low- and middle-elevation dry coniferous forests to be the most departed, meaning they have missed multiple fire cycles (Safford and Van de

Water 2014). In addition, when wildfires occur in these systems, they now often burn over a larger extent and at a higher severity than in the past (Miller et al. 2009; Mallek et al. 2013).

Future climate projections indicate fifty percent or greater increases in areas burned and doubling in the frequency of fires (Fried et al. 2004). In their comprehensive review of climate trends in the Pacific Northwest, Daton et al. (2013) note “Climate influences both vegetation growth prior to the fire season and short-term vegetation moisture during the fire season, which influence fire-season activity. Fire activity in most NW forests tends to increase with higher summer temperature and lower summer precipitation. In one study, regional area burned is projected to increase by 0.3, 0.6, and 1.5 million acres by the 2020s, 2040s, and 2080s, respectively” (p. xxx). Yet as Littell et al. (2009) note trends of increasing fire size may be less ecologically meaningful than measures of fire severity: “Differences in ecoprovince vegetation and climate-fire relationships also imply that the area burned by fire does not mean the same thing ecologically in all places. Fire severity is probably a much better indicator of the ecological effects of a fire, large or small, on an ecosystem. The relationship between climate and fire severity, measured across different vegetation types, might give better insight into the future effects of climate than area burned alone” (p. 1017). This increase in the size and frequency of high severity fire is a result of both climate change and non-tribal management actions that have increased fuel loads including fire suppression, changes in species composition and the contiguous nature of fuels, the establishment of even age plantations and untreated logging slash (Dalton et al. 2013).

The frequency and size of fires is also changing: Miller et al. (2012) found that across the four National Forests in Northern California during the nearly 100 year period from 1910 to 2008, both mean and maximum fire size and the total annual area burned had increased. While the increasing frequency of large fires is of concern to many, fire suppression has created a “fire deficit” within Karuk ancestral territory (Parks et al. 2015). Fires tend to be larger areas for longer periods of time when they are more severe,

“While the increasing frequency of large fires is of concern to many, fire suppression has created a “fire deficit” within Karuk ancestral territory.”

but cooler, low intensity fires may burn over large areas bringing many cultural and ecological benefits. This fire deficit in combination with the increasing trend towards warmer and drier conditions in light of climate change means that more fire is coming. One aim of this report is to enable the beneficial management of these future fires. Karuk DNR Deputy Director Bill Tripp notes, “The tribal perspective is that we need to embrace fire again and revitalize the culture of fire use, otherwise we stay with the fear-driven approach of the current fire suppression paradigm. We need to be managing the fires of the future through our actions today.” As the recommendations of this report will note, part of managing for the fires of the future entails a shift to managing fire intervals rather than fire ignitions (see Conclusion).

Karuk Use of Fire as Cultural and Ecological Practice

The ecology of the mid-Klamath region, including the distribution and abundance of species, has been fundamentally shaped by Karuk cultural practices, especially the use of fire. Over three quarters of Karuk traditional food and cultural use species are enhanced by fire (Personal communication; Tripp, 2013; intergenerational traditional ecological knowledge; Norgaard, 2013). Skinner et al. (2006) write that “Native people of the Klamath Mountains used fire in many ways: (1) to promote production of plants for food (e.g., acorns, berries, roots) and fiber (e.g., basket materials); (2) for ceremonial purposes; and (3) to improve hunting conditions” (p. 176). The Karuk Draft Management Plan notes that “[f]ire caused by natural and human ignitions affects the distribution, abundance, composition, structure and morphology of trees, shrubs, forbs, and grasses” (2010, p. 4). The practice of burning is also central to cultural, social and spiritual practices. As Bill Tripp describes:

They used to roll burning logs off the top of Offield Mountain as part of the World Renewal Ceremony in September, right in the height of fire season so that whole mountain was in a condition to where it wouldn’t burn hot. It would burn around to some rocky areas and go out. It would burn slow. Creep down the hill over a matter of days until it just finally went out. When it rained it would go out and that’s what we wanted it to do.

Karuk tribal members have responsibilities to tend to and care for the food and cultural use species we consider as relations. Amongst the activities that Karuk people are supposed to

do to fulfill our responsibility is to use fire as a form of management. People burned to facilitate forest quality for food species like elk, deer, acorns, mushrooms and lilies. We burned for basketry materials such as hazel and willow, and also to keep open travel routes. Karuk people managed for our own foods and uses, but our activities created abundance that benefited other species as well. Dr. Frank Lake, Karuk Descendant and USDA Forest Service research ecologist, describes what he was taught and learned of Karuk culture: “As a human, you have a caretaking responsibility. And so you managed areas to share acorns, to share mushrooms, to share berries to share grass seeds.”

From an ecological standpoint, the use of fire has benefits on multiple scales ranging from landscape level impacts to enhancing the conditions for specific species (Anderson 2005). Lake and Long (2014) note “Traditional burning practices served as a disturbance that not only maintained desired growth forms of individual plants, but also promoted desired plant communities across broader scales” (p. 179). Anderson (2005) describes the importance of burning to release phosphorus and encourage nitrogen fixing plants. She notes the multidimensional benefits of burning including:

Burning opened up areas to increased sunlight, allowing shade-intolerant herbaceous plants—some of which fire ecologists dub “fire-followers”—to come to life from hidden seed banks and quiescent bulbs. Sun-loving plants such as lilies, brodiaeas, soaproot, and wild onions appeared and attracted numerous wildlife species such as deer, bears, and gophers. The light fires characteristic of the indigenous style of burning increased the structural complexity of communities in two dimensions. Vertically, they increased the variety of plant physiognomies, helping to establish layers of herbs, shrubs, and trees at different, distinct heights. Horizontally, they increased the patchiness of the community, ensuring greater heterogeneity of leaf cover and species composition. For certain species, these fires also functioned to maintain a greater variety of age and size classes of individuals (pp. 238-239).

Specific uses of fire vary by cultural practitioner according to specific habitat types and family needs. Chapter Three contains further discussion of the Karuk use of fire within low, mid and high elevation forest types, high country, wet meadows and grasslands. A primary outcome of fire across many forest and grassland habitat types is reducing brush and conifer encroachment, with the resulting hydrological benefits to riverine systems, and the generation of an open forest canopy structure that supports the presence of the many

traditional foods and cultural use species that require such conditions (Anderson 2005). Lake and Long (2014) describe the complexity of habitat mosaics that result across the landscape from the use of fire: “Traditional burning practices occurred at different frequencies and during different seasons, with ignition strategies that varied according to the goals of fire use (Anderson 1999). These practices fostered a mosaic of vegetation types in different stages across landscapes, which promoted food security (Charnley et al. 2008, Kimmerer and Lake 2001)” (p. 179).

At the level of individual species, cultural burning enhances the growth and productivity of key food sources such as tanoak acorns and the many other species discussed in more depth in Chapter Three. Karuk knowledge of fire as a sophisticated pest management technique and to benefit deer and elk is reflected in a 1916 letter to the California Fish and Game Commission by Klamath River Jack, *Published 1916 in a Requa, California newspaper as, “An Indian’s View of Burning and a Reply:”*

“Indians have no medicine to put on all the places where bug and worms are, so he burn. Every year Indian burn. Fire burn up old acorn that fall on ground. Old acorn on ground have lots worm; no burn old acorn, no burn old bark, old leaves, bugs and worms come more every year. Fire make new sprout for deer and elk to eat and kill lots brush so always have plenty open grass land for grass. No fire brush grow quick and after while choke out all grass and make too much shade, then grass get sour, no good for eat. No fire then too much leaf stay on ground. No grass can grow up. Too much dead leaf, grass get sour. Indian burn every year just same, so keep all ground clean, no bark, no dead leaf, no old wood on ground, no old wood on brush, so no bug can stay to eat leaf and no worm can stay to eat berry and acorn. Not much on ground to make hot fire so never hurt big trees, where fire burn. Now White Man never burn; he pass law to stop all fire in forest and wild pasture . . .

Klamath River Jack, 1916

Of course, regular burning reduces the overall fuel load in the forest, greatly diminishing the probability of major damage to tanoak stands from intense fires.

The Mid Klamath area that makes up Karuk ancestral territory and homelands is known for its biological abundance (DellaSalla et al. 1999, Sawyer 2007, Sleeter et al 2012). This exceptional biological diversity has emerged in conjunction with sophisticated Karuk land management practices, including the regulation of the forest and fisheries through

ceremony and the use of fire (Kimmerer & Lake, 2001; Lake, Tripp & Reed, 2010; Salter, 2003; Anderson, 2005 and 2006). Indeed, the species abundance and diversity of this region cannot be understood outside the broader tribal management activities that produced them (Agee & Skinner, 2005; Lake, 2013; Anderson, 2002; Lewis, 1993; Martin & Sapsis 1992). Our region contains for example not just one, but many species of oaks valued as food.

Karuk fire management is specifically linked to biodiversity. Robert Martin's writes, "pyrodiversity creates biodiversity." Karuk fire regimes generate pyrodiversity on the

"The multitude of foods, materials and other products that come from Karuk environments are a manifestation of the profound diversity of Karuk fire regimes across the landscape."

landscape by extending the season of burn, decreasing average fire size, and shortening fire return intervals. The multitude of foods, materials and other products that come from Karuk environments are a manifestation of the profound diversity of Karuk fire regimes across the landscape. The presence of these hundreds of animal, plant, and mushroom species are evidence of the sophistication of Karuk knowledge, management practices and ability of people to maintain our relationships with the land.

By contrast, today we have regulatory requirements such as the need to protect Spotted Owl habitats that are in all reality a byproduct of fire exclusion.

Owls are known in Karuk culture to be messengers of sickness and death. In the face of a century of failed management policy, the Spotted Owl has emerged at the messenger of an unhealthy environment. The places where their prime nesting and roosting habitats once were are now dense plantation thickets. As a result, the owls don't have access to the food base hiding in these thickets, and the stand structure in areas of high insolation are transitioning to type of habitat typically identified as suitable for nesting and roosting. However, these areas are more prone to high severity fire that is a causal factor in the continued decline of the species and decline in forest health. In receiving the message the Spotted Owl provides, we must intervene and change the paradigm that will cause the extinction of the species, or the rest of the system will continue to crash.

Changing Patterns of Fire Behavior: Local and Global Management Actions

Land management techniques since the 1900s have emphasized fire suppression and the “exclusion” of wildfire. Fire exclusion has led to radical ecological changes including high fuel loads, decreased habitat for large game such as elk and deer, reduction in the quantity and quality of acorns, and alteration of growth patterns of basketry materials such as hazel and willow, to name but a few examples. From a Karuk perspective, the exclusion of fire from the landscape creates a situation of denied access to traditional foods and spiritual practices puts cultural identity at risk and infringes upon political sovereignty. On a more individual level, the altered forest conditions create social strain for the individuals who hold the responsibilities to tend to specific places and to provide food to the community for subsistence as well as ceremonial purposes (Norgaard 2014).

In their work on the Klamath mountain region, fire ecologists Skinner, Taylor and Agee (2006) identify “two periods with distinctly different fire regimes: (1) the Native American period, which usually includes both the pre-historic and European settlement period, and (2) the fire suppression period” (p. 176). The authors also note that

Over the 400 years prior to effective fire suppression, there are no comparable fire-free periods when large landscapes experienced decades without fires simultaneously across the bioregion (Agee 1991; Wills and Stuart 1994; Taylor and Skinner 1998, 2003; Stuart and Salazar 2000; Skinner 2003a, 2003b). Along with these changes in the fire regimes are changes in landscape vegetation patterns. Before fire suppression, fires of higher spatial complexity created openings of variable size within a matrix of forest that was generally more open than today (Taylor and Skinner 1998). This heterogeneous pattern has been replaced by a more homogenous pattern of smaller openings in a matrix of denser forests (Skinner 1995a). Thus, spatial complexity has been reduced (p. 178-179).

Across the western United States a similar pattern occurs. As noted in the [2012 Report of Phase III of the Wildland Fire Cohesive Management Strategy](#),

Practices such as pruning, burning and coppicing at regular intervals once contributed significantly to historic landscape resiliency and community livelihood. Access to abundant and quality hunting, fishing, and gathering areas as well as other traditional, ceremonial, or religious fire use factors have experienced significant decline following fire exclusion (USDA, 2012, p. 30).

[The Wildland Fire Cohesive Management Strategy](#) affirms that in the face of continued fire exclusion, Native American cultural identity and traditional ecological knowledge are both at risk (2012, p. 30).

Fire and Climate Change

As noted, climate change is contributing to increases in wildfires across the western United States (Joyce et al. 2014, Dalton et al. 2013, Mote et al. 2003), with overall trends towards more frequent, larger fires (Westerling et al. 2006), larger portions of fires burning at high intensity, and increased frequency of high severity fires (Valliant et al. 2015). The average number of fires over 1,000 acres has doubled in California since the 1970s and across the west the number of fires over 10,000 acres is now about seven times greater than it was in the 1970s (Odion et al. 2009). Odion et al. (2009) also find that “Large wildfire activity increased suddenly and markedly in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons” (p. 940). These changes in fire behavior are partly a function of changing patterns of precipitation and temperature, decreasing snowpack, earlier snowpack melt, and increasing pest infections resulting from global climate change (Dalton et al. 2013, Westerling 2016).

These climate drivers influence fire behavior through a complex interplay of factors. For example, longer and more intense droughts decrease soil moisture, causing direct tree mortality and providing fewer opportunities for precipitation to extinguish fires. Increase in the spread of insect pests can both weaken trees and cause direct mortality, making them more vulnerable to fire. As a result, warmer and drier years have generally correspond to increased fire activity (Heyerdahl et al. 2008, Marlon et al. 2008, Littell et al. 2009, Westerling et al. 2006). Increased biomass production in forests due to a combination of higher atmospheric carbon dioxide concentrations and longer growing seasons also increases fire likelihood in some parts of the West. Decreasing snowpack has led to an increase in fires at higher elevations that would otherwise be covered in snow (Westerling 2016). This pattern too has been observed in the mid-Klamath in recent years. Karuk fisheries biologist Toz Soto describes, “Fire behavior under drought conditions and climate change is different today than we’ve seen the past. In 2008, the “Panther Fire” killed large stands of old growth trees within riparian areas. Riparian areas typically do

not burn hot enough to kill large trees, but a new trend of stand replacing fire in riparian areas is major threat to water quality due to the loss of riparian shade where rising water temperatures are a problem for cold water dependent fish.”

Not only has there been an expansion of areas burned, the length of the fire season has also been increasing across California and fire behavior is different than expected (Westerling 2016). Higher winds together with drier conditions and a complex of other factors lead to rapidly spreading fires of much higher severity on the Klamath, especially in the last ten years. For example, in 2014, the “July Complex” fire started in the high country. Observers describe how sustained 50 mile per hour winds caused it to burn 12,000 acres in 6 hours with nothing surviving in its path. Another aspect of fire behavior seen recently on the Klamath concerns ignition sources. In 2014, fires in the July Complex started not only from the typical source of lightning strikes, but fire itself generated a pyro-cumulus cloud that started a dozen other spot fires. As Bill Tripp notes, “I believe the July Complex blowup caused something like 22 additional lightning strikes between Tanner Peak and the Oregon border starting about a dozen new fires. This is the first time I have seen a pyrocumulus cloud develop of this magnitude. I have never seen one actually start new fires via lightning ignition, I mean, that is approaching volcanic fire behavior.”

In their summary of climate impacts on the Six Rivers National Forest Butz and co-authors (2015) write:

“Data on forest fire frequency, size, and total area burned all show strong increases in California over the last two to three decades. Westerling et al. (2006) showed that increasing frequencies of large fires (>1000 acres) across the western United States since the 1980’s were strongly linked to increasing temperatures and earlier spring snowmelt. Northern California forests have had substantially increased wildfire activity, with most wildfires occurring in years with early springs (Westerling et al. 2006)” (P 13)

Attention to these increases in wildfire activity is gaining momentum and attention in the context of global, national, statewide and regional climate planning efforts. Understanding global and national trends in fire behavior is important for highlighting the influence of climate change. At the same time, the dynamics of changing fire behavior vary significantly according to local climatic conditions, forest habitat types and land use histories. Thus it is critical to couch any discussion of increasing wildfire activity resulting from climate change

in the context of increased fuel loading from fire suppression, changes in the species composition of forest stands, and logging practices. As Westerling et al. (2006) note: “Extensive livestock grazing and increasingly effective fire suppression began in the late 19th and early 20th centuries, reducing the frequency of large surface fires. Forest regrowth after extensive logging beginning in the late 19th century, combined with an absence of extensive fires, promoted forest structure changes and biomass accumulation, which now reduce the effectiveness of fire suppression and increase the size of wildfires and total area burned” (p. 940).

While forests across California have missed multiple fire cycles due to fire suppression, the low- and mid-elevation vegetation types such as oak woodlands and mixed-conifer forests that are the subject of this assessment are amongst those forest types missing the most fire cycles (see specific work by Safford and Van de Water 2014). Butz and co-authors (2015) note that the increases in wildfire activity in the Klamath region is “likely attributable to both climate and land-use effects” (p. 18) given that “More than 85 percent of Forest Service lands in NW California are burning either less frequently or much less frequently currently than under the pre-Euro-American settlement fire regime, as compared with 67 percent of Forest Service and National Park Service lands in the Sierra Nevada and 19 percent in southern California” (p. 18, see also Safford and Van de Water 2014). Such fuel build up is a significant contributing factor leading to the larger, more severe fires taking place in the Klamath region (Agee 2002, Arno and Allison-Bunnell 2002, Covington 2000).

“While forests across California have missed multiple fire cycles due to fire suppression, the low- and mid-elevation vegetation types such as oak woodlands and mixed-conifer forests that are the subject of this assessment are amongst those forest types missing the most fire cycles.”

In addition to fire suppression, other factors such as the prevalence of tree plantations and past logging activities are associated with the trends towards increasing fire severity. Odion et al. (2004) note “Even age silviculture can increase fire hazard by creating more combustible fuel complexes” (928, see also Weatherspoon and Skinner

1995). Plantations burn at higher severity than do “natural” forests (Key 2000, Weatherspon and Skinner 1995). Furthermore, the fact that high severity fires are often replanted with commercial species, creates a negative feedback loop leading towards more high severity fires in the future (Odion et al. 2004).

There is much use of the phrase ‘catastrophic fire’ in the literature on climate change. While the changing patterns of fire behavior can and do cause problems for particular landscapes and human communities at any given time, terms like ‘catastrophic’ are not only heavily value laden, they perpetuate the same fear-based orientation to fire that produced the paradigm of extreme fire suppression. Use of the term ‘catastrophic’ in relation to fire elevates this perception of fire as “dangerous” and “bad.” Use of the term further erodes Karuk tribal management authority by making it harder to use fire in a proactive way through prescribed burning.

Future Fire Forecasts

Regardless of the particular constellation of drivers for increasing fire trends in past decades, climate models point to significantly larger increases in fire activity in the future (Mote et al. 2003). At the state level climate projections forecast of summer temperature increases between 2 and 5°C and precipitation decreases of up to 15 percent (Running 2006). These and associated conditions such as pest outbreaks and increased biomass production, promote a continued increase in fire activity.

Global climate models operate on large spatial scales relative to fire regimes, and projections for precipitation in the western United States vary among individual models (Price et al., 2004). Climate projections for the western United States indicate average decreases in precipitation, yet the Northwest may be drier only during summers (IPCC, 2007, Seager et al., 2007) and some climate models even project an increase in annual average precipitation in California (Price et al., 2004). While there are fewer specific projections available for the Klamath, Butz et al. (2015) report

In the Pacific Northwest, longer, hotter, and drier fire seasons are projected under future climate change scenarios, and the area burned by wildfires is projected to increase as a result (Wimberly and Liu 2014). Temperature has been shown to strongly influence fire frequency and area burned, and increased temperatures will lead to increased fire frequency and size (Pausas

2004, Spracklen et al. 2009, Guyette et al 2012). Westerling and Bryant (2008) predict a 10-35% increase in large fire risk by midcentury in California and Nevada, and Westerling et al. (2011) projected increases in burned area of up to 4+ times the current levels in area shrublands and forestlands by the end of the century. The MC1 runs reported in Barr et al. (2010) project increases in annual fire area in the Klamath River Basin of 11-22% by 2100, resulting in as many as 330,000 acres (134,000 ha) burned in an average year” (p. 18).

Understanding precise relationships between global climatic trends, fuel loading and other forest management actions on the increasing severity of fires is difficult if not impossible to determine. Regardless, it is now clear that both global climatic drivers in the form of carbon emissions, and the local management actions that shape changes in fire behavior are the direct result of untenable non-Native management decisions. Climate change is anthropogenic, or human caused. Predicted climactic changes described here are not ‘inevitable’ acts of nature, but the direct result of the human use of fossil fuels and the generation of other climate gases. Nor is climate change an inevitable outgrowth of human activity. Humans have existed on earth for a long time. The organization of economic activity around fossil fuel extraction and use results from specific and very recent management decisions undertaken according to the logics of capitalism and colonialism.

"Our traditional management practices prevent the build-up of fuels that could lead to catastrophic fire events as well as manage for healthy stands of acorn bearing oaks, forage for large ungulates, and for other foods, fibers, and medicinal plants."

Regardless of the relative weight of influence from global climate change or fire suppression, a return to indigenous fire management is a beneficial proactive action to shape when, how and where fires occur. Our traditional management practices prevent the build-up of fuels that could lead to catastrophic fire events as well as manage for healthy stands of acorn bearing oaks, forage for large ungulates, and for other foods, fibers, and medicinal plants. Due in part to these thousands of years of purposeful fire management, the forests of this region are ecologically dependent on fires that are low in heat production, or “cooler” fires. Yet paradoxically large scale impacts from climate change are

exempt from regulation, while the potential solutions in the form of traditional management have imposed regulatory barriers (Wiedinmyer and Hurteau 2010). Achieving balance in the human interacted natural fire regime by restoring and managing landscape resilience to change with time tested TEK is a priority in Karuk country. Taking action sooner rather than later is however important as these climatic changes make it ever more difficult to conduct the lower intensity burns that best regenerate resilient forest habitat dynamics.

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Chapter Three

Vulnerabilities of Traditional Foods and Cultural Use Species

Kirsten Vinyeta, Frank K. Lake and Kari Norgaard

As Karuk people, we recognize other species in nature as part of an extended ecological family to whom we are related and have responsibilities. Leaf Hillman, Karuk Tishuniik ceremonial leader & DNR Director, describes this relationship and its associated responsibilities with reference to the Karuk Creation Story and the importance of World Renewal Ceremonies: “The rocks and the trees and the water and the air, the responsibility that I have, those are real relations. . . .We have not forgotten that we are related and that we have responsibility. And at the same time we give thanks to those other spirit people for helping to subsist us, and reminding them that we haven’t forgot that we owe them something too. So the renewal is renewing the bonds that exist.” This worldview has been referred to as “kincentricity” in the academic literature (Martinez 1995, Salmon 2000, Senos et al. 2006).

Across the landscape, traditional food, fiber and medicine and especially water are vitally important for Karuk people. Hundreds of species from salmon and acorns, to tobacco and wild celery (kíshvuuf) provide materials necessary for cultural continuity, spiritual practice and the preservation of traditional knowledge systems. Some 150 culturally utilized plants are catalogued in “Plants and the People: The Ethnobotany of the Karuk Tribe” (Davis and Hendryx 1991), the Karuk herbarium catalogues over 100 species, but even more are recognized and used.

Traditional foods and medicines support physical and mental health in multiple ways (Alves and Rosa 2007). Cultivating, harvesting, processing, preserving and consuming Native food and medicine provide the framework for the Karuk eco-cultural socialization process and religious belief. Karuk traditional foods, especially salmon, are higher in protein, iron, omega-3 fatty acids, zinc and other minerals and lower in saturated fats than market foods (Norgaard 2005). Nutritional data show that traditional foods produce stronger hearts, blood and muscle tissue (Jackson 2005). The omega-3 fatty acids found in such abundance in salmon (and anadromous fish such as Pacific lamprey eels) have been

linked with a number of significant health benefits including reduced risk of heart attacks, strokes, and Alzheimer's disease, improved mental health and improved brain development in infants (Norgaard 2005). The often strenuous tasks of acquiring traditional food provides exercise that keeps people in good physical condition. Because hunting, gathering, fishing, storing and preparing food are an integral part of daily life and seasonal celebration, traditional food holds great cultural, religious and social meaning as well. These activities also serve as an important social “glue” by bringing people together to work, socialize and pass down values and information from one generation to the next (See Brown et al. 2011, Risling Baldy 2013). Food is also central to some of the most serious social obligations for Karuk people – hospitality and caring for elders. Overall, the health benefits of eating traditional foods include better nutrient density, the availability of key essential nutrients, physical activity during harvesting, lower food costs, the prevention of chronic disease by consumption of more nutritious food, and “multiple socio-cultural values and traditions that contribute to mental health and cultural morale” (Kuhnlein and Chan 2000, p. 615, Cantrell 2001, Risling Baldy 2013, Fleishhacker et al. 2012).

Table 3.1 Multidimensional Importance of Karuk Traditional Foods, Fibers and Medicines

Basic sustenance	About 50% of tribal members living in Karuk ancestral territory get at least some portion of their food by hunting, fishing or gathering Native foods, whereby limited availability of these foods and the effects of climate change were seen by almost 40% of respondents to be barriers to sufficient healthy quantities.
Physical health	Eating traditional foods, especially salmon and acorns, prevents diet related diseases such as diabetes and heart disease. Cultivating and harvesting foods promotes both physical and mental health.
Emotional health	Participating in food related activities strengthens mental health both through contact with nature and engagement with physical activity, and combats low self-esteem associated with intergenerational trauma.

Cultural practice	Tending, harvesting, processing, storing and consuming traditional foods perpetuates Karuk culture (Salter 2003, Norgaard 2005).
Family structure and social relations	Sharing food is a social obligation. Tending, harvesting, processing, storing and consuming traditional food strengthens intergenerational relationships within families and across the community (Risling Baldy 2013).
Ceremonial practice	“Fix the World,” or Pikyávish Ceremonies are carried out to ensure abundant harvests and restore social and personal balance . (Kroeber and Gifford 1949) First Salmon Ceremony invokes the spring salmon run and regulates harvest management (Swezey and Heizer 1977, Powers 1872, Kroeber 1925, Harrington 1932, Roberts 1932, Driver 1938, Kroeber and Gifford 1949).
Traditional knowledge	Tending, harvesting, processing, storing and consuming traditional food perpetuates Karuk traditional ecological knowledge and its practice (Lake 2007, 2013).
Political sovereignty	Ongoing actions of tending, harvesting, processing, storing and consuming traditional food confirms Karuk occupancy on the land (Risling Baldy 2013).

This chapter examines the vulnerabilities to traditional foods and cultural use species in light of the increasing likelihood of high severity fire. Species of importance to Karuk people are impacted by other climate change related stressors that intersect with the vulnerabilities induced by the increasing instance of high severity fire. These other stressors, which include increased drought and temperatures, more variable weather, stronger storm systems, decreased snowpack, flooding, and increase in invasive species, are beyond the scope of this assessment, but may be mentioned here and are also discussed in Chapter One. As noted throughout this assessment, we take an intersectional approach to evaluating vulnerabilities resulting from high severity fire. This approach considers fire related vulnerabilities to Karuk foods and cultural use species in the context of past,

present and future fire related management actions. Throughout this assessment we underscore that while high severity fire is a serious and immediate dimension of climate change, Karuk ancestral territory is fire dependent. Humans are ecosystem components and fire is medicine in Karuk culture (see also Wells 2014).

Humans as Ecosystem Components

Not only is climate change the result of human activity, humans are integral components of the mid-Klamath ecosystem in very specific ways. Karuk people have shaped the ecology, fire behavior and species composition in their ancestral territory through traditional management to enhance species of cultural importance (Anderson 2005, Halpern 2016, Lake 2007). The impact of past and present traditional management on ecosystems is of such magnitude that some argue, correctly, that American Indian land management should be considered part of the reference ecosystem when attempting to restore degraded landscapes (Senos et al. 2006). “Inhabiting one of the most complex geographical areas of North America, the Karok [Karuk] benefitted from great diversity in flora and fauna. The number of species support by the Klamath Mountain province is reported to be among the highest of any comparably sized region on the [North America] continent” (AITS 1982: 143). Karuk resource management practices, including fire use, increased pyro-diversity of existing ecological communities. “A review of earlier ethnographic work and more recent oral history interviews of tribal elders conducted by the Karuk Tribe and myself [Lake] suggest that tribal TEK encompasses a core area of knowledge about discrete fire events that contribute to landscape fire regimes. Tribal knowledge of fire ecology is closely coupled with subsistence economies, ceremonial practices, and individual or family adaptive strategies. Tribal TEK may also be able to describe how climate and weather influence fire behavior, from the yearly to decadal scale, with generalized understanding of century-scale climate and fire regime changes” (Lake 2013:4).

Karuk fire management is specifically linked to biodiversity (Lake 2013). Anderson (2005) highlights many uses of Karuk cultural burning, including as a means to reduce forest diseases and pests, increase seed and grain production, reduce the fuel load in forests, and enhance the quantity and quality of, and access to food and cultural use species such as oaks, hazel, beargrass, and native tobacco. Karuk fire regimes generate

pyrodiversity on the landscape by extending the season of burn and shortening fire return intervals (Lake 2013, Martin and Sapsis 1992). The multitude of foods, materials and other products that come from Karuk environments are in turn evidence of the profound diversity of fire regimes that are required to maintain relationships with hundreds of animal, plant, and mushroom species (Anderson 2005, Lake 2007 & 2013, Anderson and Lake 2013). “For example, drier years have potentially greater fire spread and less resource productivity and required tribal groups to modify fire use and adapt foraging strategies. Tribal seasonal travel and resource strategies were likely linked to differing fire patterns across a range of similar vegetation types, but with each type having been burned at different frequencies. Thus developed a staggering of seral stages of similar vegetation communities across the landscape, differing by time since burn and by severity of burn. A landscape with burns in different years with mixed severities provided greater diversity of seral stages among vegetation types that facilitated tribal acquisition of valued resources” (Lake 2013:12-13)

The vulnerabilities faced by species of importance to Karuk people in the context of high severity wildfire do not occur in a vacuum. These vulnerabilities must be understood in the context of existing species susceptibilities (e.g. threatened and endangered status, mobility, range limitations), as well as the past, present and future management actions of Tribal and non-Tribal land managers. Not only does high severity wildfire hold the potential to negatively affect some species more than others for biological reasons, species that are already at risk or which have more difficulty in adapting will be at greater risk in the event of frequent large-scale high severity fires (Dale et al. 2001). Furthermore, past management actions from logging, road building or fire suppression interact with fire events to influence the level of vulnerability, as do management actions taking during a fire and those that may follow in the long term (Odion et al. 2004). Again, we consider the intersectional dimension of vulnerability to high severity fires in the context of past, present and future management actions.

Since 1910, the activities of the U.S. Forest Service have shaped the ecosystems of the region in different ways. Fire suppression has been a dominant human influence, as have logging, road building, and the replacement of complex forest stands with even age, single species conifer “plantations” (Odion et al. 2010). Logging slash left on the forest

floor and fire suppression dramatically increase the risk of high severity fires (Taylor and Skinner 2003). When high severity wildfires occur impacts to ecosystems and species of importance vary dramatically. Because the mid-Klamath region is fire adapted, even high severity fires have many positive dimensions for particular species and in particular time frames. For example, hydrological erosional processes contributing post fire sediment plumes to lower gradient creeks and rivers may smother salmon eggs or reduce fish habitat suitability in the short term if they come at the wrong time of year, but also bring needed woody material and replenish substrate (sand, gravel, rocks) which form longer-term habitat complexity (Wondzell and King 2003). The exact relationships between fire events and species impacts are sometimes debated. In light of the changing patterns of fire behavior, impacts of repeated high severity fire are often unknown. On the whole however, it is clear that while Karuk ancestral territory is adapted to repeated lower intensity mixed severity fires (Perry et al. 2011), the increased frequency of high severity fires creates serious vulnerabilities to the mid-Klamath ecosystem and particular species of importance to Karuk people. Impacts of high severity fire are complex and vary across space and time. We evaluate vulnerabilities at three temporal scales: those that occur during fire events, those occurring in the immediate aftermath of fires and long term vulnerabilities.

When high severity fires occur, they are the subject of additional management actions, usually some form of fire suppression (which has various degrees of success). Activities from back burning to the use of fire retardants are often carried out by agencies who are unaware of the intricate economic, cultural and spiritual relationships Karuk people have with species such as tanoak and madrone trees in the forest, or lamprey in the rivers. Fire suppression actions all too frequently cause further vulnerabilities to Karuk traditional foods, fibers and medicines. And long after fires have ceased to burn, management actions such as re-seeding, sediment control, road building and salvage logging cause further, often long term damage (Karr et al. 2004, Noss et al. 2006). Such activities create lasting impacts on the landscape by bringing in new species (i.e. invasives) that come into direct competition with culturally important Karuk species, increasing the future likelihood of high severity fires (Brooks et al. 2004), increasing sedimentation, and causing vegetation assemblage shifts. Understanding the climate-induced vulnerabilities in relation to high severity fire faced by particular species therefore requires an

interdisciplinary multi methods approach that takes into consideration not only biological factors and fire science, but also traditional ecological knowledge and an understanding of the socio-political dimensions of land management in Karuk ancestral territory.

Recognizing that fire influences both individual species and landscape structure, we consider the impacts of high intensity fire on traditional foods, fibers and medicines first with a general discussion of six habitat zones, followed by single page species profiles that highlight how a given species is affected by cultural burning, versus how it is affected by high severity fire, and finally how fire related federal management decisions affect that species' vulnerability. We use a culture-centric perspective on vegetation zones centered on the cultural keystone species of Tanoaks and Chinquapin (see Garibaldi and Turner 2004 for other species). We consider Riverine and Riparian species, Low Elevation Forest (defined as the Tanoak band), Grasslands, Middle Elevation Forest (defined as the Chinquapin band), High Elevation Forest (defined as above Chinquapin but below montane zone), Wet Meadow and High Country (montane and subalpine). This culture-centric zone model corresponds to the ecological model developed by Briles et al. (2005), but links vegetation to cultural keystone places across the landscape (Cuerrier et al. 2015).

For each habitat zone we provide a general discussion of the influences of fire in the ecology of each zone, describe potential threats in the face of increased fire severity and frequency, and discuss how the management actions of federal land managers intersect with the vulnerabilities engendered by high severity fire in the face of climate change. Where possible, these discussions are supplemented by tables to aid in organizational clarity. Information compiled in this chapter reflects a combination of Karuk traditional ecological knowledge and western science. These different habitat zones face distinct threats in light of increasing high severity fires for particular areas or the larger landscape. Some zones will have more species emphasized than others, yet while we use the zone approach to highlight the relationships between species in close proximity, it is important to understand that the zones also matter for their connections to one another. For example, wet meadows provide water storage that minimizes flooding in lower elevations, while low elevation tan oak is critical winter foraging habitat for elk who are in turn needed to sustain wolf populations. Where less information is presented or fewer species discussed, it does not mean that the zone is of lesser importance. For example, lamprey are a key food

source, but have been less emphasized by western scientists, limiting information available for this profile (Peterson Lewis 2009, Miller 2012). . There are relatively more profiles included for riparian and low elevation habitat zones where many species are used directly. Yet the high country habitat zone is critical for its influence on hydrological dynamics in lower elevations. The grassland zone was historically significant for a number of important species including elk, camas, brodiaea and medicinal forbs. Today a majority of grasslands have disappeared due to lack of burning (see Skinner 2005), thereby impacting the depth and abundance of traditional ecological knowledge related to grassland habitats (Lake 2013). Restoring fire processes and function is in part about restoring the human responsibility to these species.

Following discussion of each habitat zone we provide an in depth profile for particular species occurring in that zone. Karuk people utilize hundreds of plants and animals for food, fiber and medicine; the species profiled here reflect only a small portion of all those that are culturally and ecologically vital, and were chosen to represent a range of elevation bands, flowering times and dimensions of vulnerability. Many of the profiled species are regalia species that are vital to traditional ceremonies. Many would be considered cultural keystone species (Garibaldi and Turner 2004). To the extent possible, each profile compiles information regarding the influence of cultural burning on the species, as well as the vulnerabilities resulting from the increasing frequency of high severity fire at three scales (during fires, in the immediate aftermath and long term). Many species occur across multiple zones, or move across zones seasonally. In such cases profiles are included within the zone for which habitat is most critically limited.

What we have outlined below is not intended to be an exhaustive, definitive list, but is instead a starting point meant to illustrate inter-species, inter-habitat, and human/fire relationships—relationships which must be understood in order to formulate a course of action. Some or all of the species listed below may be considered focal, or indicator species in future management practices, or perhaps other indicators will emerge under adaptive management principles. Regardless, the foundational premises and values underlying the ecological management principles and concerns outlined in these habitat and species profiles are of enduring relevance.

It is also important to note that while high severity fire, particularly when occurring in rapid succession, is considered a threat to the eco-cultural health of the region, it also inevitably brings with it some of the same ecological benefits that result from Karuk cultural burning. It is not fire, or even the occasional high severity fire per se, that is the problem, but the repeated occurrence of high severity fire (resulting from climate change) combined with land management practices that not only promote a cycle of increasingly frequent high severity fires, but that also have negative impacts on habitats and species of cultural importance. In this chapter, we tend to highlight the negative implications of high severity fire, while focusing on the benefits of cultural burning practices. However, there are instances in which we also note benefits that may result from high severity fire. It is possible for high severity fire to be detrimental for some habitats and species, while simultaneously benefitting other habitats or species. It is also possible for fire to benefit a species or habitat in one way, while being detrimental in a different way.

Riverine Vulnerabilities

Karuk ancestral territory encompasses several hundred miles of riverine habitat along the middle portion of the Klamath river, the lower portion of the mainstem Salmon River, and many key tributaries. Species from riverine systems hold significant cultural and spiritual significance and provide over fifty percent of the calories and protein of traditional Karuk diets (Kroeber and Barrett 1960, Chartkoff and Chartkoff 1975), Salmon (coho (achvuun), spring (ishyat) and fall chinook (áama)) and other riverine species including green sturgeon (ishxíkihar), lamprey (Klamath and Pacific (akraah)), steelhead trout (sáap), river otter (pay saruk/amváamvaan), and freshwater mussels (axthah) are important for food, culture and ceremonies.

Riverine systems are especially at risk in the face of changing patterns of precipitation, increasing temperatures and decreasing winter snow pack resulting from the changing climate (Mote et al. 2003, Barr et al. 2010). Beamish and Bouillon 1993). At the same time, local conditions within riverine and forest systems play a significant role in habitat quality and species vulnerability projections (Isaac et al. 2010). Wildfire from both human and natural ignition has been an integral component of the riverine systems in the mid-Klamath region. Fires are particularly important for shaping the local quality of riverine habitats in the face of climate trends (Hamlet 2011).

Relationships between fire and riverine habitats are complex and vary by species, fire intensity, fire severity and time frame (Isaac et al. 2010, Rieman et al. 2003)). While Karuk use of fire is often noted in relation to forest systems, cultural burning is also critical for riparian and riverine habitats (Lake 2007). Many riverine species of importance, including salmon, require complex habitats with large woody debris. Fires bring sediments and large woody debris into stream systems critical for both stream productivity and habitat complexity (Arkle and Pilioid 2009 and 2010). Low intensity fires are important for stream flows as they clear out brush that uptakes water, while high intensity fires are needed to generate debris inputs Biswell 1989). High intensity fires may have negative short term impacts on riverine species, but are nonetheless critically important in the long run, since high intensity fires in particular provide additions of gravel and logs, and

generate the canopy opening that form a habitat mosaic of more and less productive stream habitats (Arkle and Pilioud 2009 and 2010, Davis 2016).

Fire influences on riverine systems also vary across time. During fire events reduction in vegetative evapotranspiration often increases stream flow (Biswell 1989). Larger regional or multiple local fires burning during atmospheric high pressure, coupled with river canyon smoke inversions (Robock 1988 and 1991) can be beneficial to spring salmon (see Strange 2010 for cold fronts/clouds similar to the effects of smoke). The smoke may cool river temperatures during critical warm periods, creating better conditions for various fish species and age classes, including fall migration and spawning of Chinook salmon (Lake and Tripp, personal communication, David and Lake 2016). On the other hand, high intensity fires may cause elevated stream temperatures and direct mortality of fish and other species, especially in smaller systems (Hitt 2003).

In the immediate aftermath of high intensity fires (e.g. roughly 24 months) the absence of riparian vegetation that would otherwise provide shade may elevate stream temperatures (Dwire and Kauffman 2003, Isaak et al. 2010, Pettit and Naiman 2007). Post fire debris flows may reduce fish numbers and negatively alter fish habitats (Burton 2005). Yet many of these events are short term, while longer-term impacts of fires include increases in stream productivity and beneficial changes in fish diet (Malison and Baxter 2008 and 2010). Work by Flitcrof et al. (2016) on fire and Spring Chinook habitat quality in stream networks, and work by Isaak et al. (2016, 2010) on stream temperatures examine the complex conditions in which a beneficial 'pulse' disturbance turns into a possibly less beneficial 'press' disturbance. In general, unless species are vulnerable or populations are highly fragmented, populations usually rebound successfully (Rieman et al. 2003).

Over the long run regular fire on the landscape reduces the amount of brushy vegetation (i.e. shrubs and younger vigorously growing trees) withdrawing water from creeks, which affects stream flow and thereby stream temperatures. Post-fire floods can remove fine sediments and provide much needed gravel, cobble, woody debris, and nutrients. Longitudinal studies by Burton (2005) found that fire restores stream habitats, resulting in higher fish productivities than were present pre-fire. High intensity fire in particular leads to larger debris flows and tree mortality (Gresswell 1999). The disturbance mosaic resulting from high intensity fire is like a patchwork quilt of habitats across stages

Riverine

of recovery. This mixed severity burned landscape releases moderated amounts of sediment and water streams through springs and seeps, improving larval habitat for species such as Pacific and Klamath Lamprey. These effects of cultural burning on the riverine system are summarized in Table 3.2 below.

Table 3.2 Effects of Karuk Cultural Burning On Riverine Systems Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">• Smoke from fire may block light from the water's surface and reduce water temperatures.• Reduced vegetative evapotranspiration increases stream flow	<ul style="list-style-type: none">• Gravel and wood debris enters aquatic systems following fire and enriches salmon habitat• Increased system productivity as fire releases nutrients into the food chain• Reduction in brush means more water in riverine system	<ul style="list-style-type: none">• Patchwork quilt disturbance mosaic provides flood protection• Forest habitat complexity is associated with riverine habitat complexity• Frequent low intensity fire prevents negative impacts of high severity fire
Sources: Soto 2016	Sources: Soto 2016	Sources: Lake 2007, 2010

Vulnerabilities Resulting from Increased Frequency of High Severity Fire

While both high and low intensity wildfires are important to the riverine systems of the mid-Klamath, less is understood about how increase in the frequency of high severity wildfire will impact riverine systems (Flitcroft et al. 2016). Extensive areas of large high severity fires burning across streams, creeks, and rivers can have negative impacts on stream temperatures and can generate fish mortality during fire events, especially in smaller systems. Frequent high severity wildfires can eliminate foliage needed for slope stabilization, leading in turn to more frequent and larger landslides and debris flows, which can degrade fish habitat in the short term by increasing temperatures and more. Aquatic species are particularly sensitive to such habitat disruptions given their dependence on clear, cold water and their limited ability to relocate (Fagan 2002).

Perhaps most importantly, increases in the frequency of high severity fires cause habitat shifts that reduce forested habitats that develop under lower frequency or mixed severity fire regimes and promote the presence of shrub and herbaceous assemblages that thrive under higher frequency fire conditions. Essentially the surrounding forest could shift to an early seral stage that has a higher risk to (re-) burns again and again, unable to return to mature forest condition (burning seed sources before re-establishment of trees). Such a shift of the forests surrounding riverine systems to brush fields would have very serious

Riverine

consequences for river temperatures, species composition and the structure of riverine habitats. From a physical standpoint, the complex forest structure that results from repeated mixed severity fire leads in turn to complexity of riverine habitats (Bisson et al. 2003, Perry et al. 2011). Indeed the complexity of stream habitats is directly linked to habitat complexity in the surrounding forest landscape (Bisson et al. 2003, Flitcroft et al. 2016). This is true in part because fires are a form of disturbance that shapes physical characteristics of upslope forests and riparian environments, including opening canopy and enhancing regeneration (Hessburg et al. 2005 and 2007, Perry et al. 2011, Swanson et al. 2011). In the event that forests were entirely or partially converted to brush such forested complexity would no longer exist. Water temperatures would elevate as flows dropped and less shading occurred from vegetation. Warming stream temperatures in turn enhance suitability for non-native fishes (Durham et al. 2003).

Table 3.3 Effects of Increasing Frequency of High Severity Fire in Riverine Systems Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Direct heat mortality, especially in small streams • Smoke inversions reduce vegetation evapotranspiration (water use) increasing temporary water yield. They also reduce air and water temperatures, which may benefit aquatic species 	<ul style="list-style-type: none"> • Elevated stream temperatures in absence of vegetation • Heavy sedimentation and infilling of pools may occur as a result of flooding and other post-fire hydrologic impacts Too much sediment is not good for spawning, infilling of pools is bad for rearing. 	<ul style="list-style-type: none"> • Riverine systems evolved with high disturbance, but if high severity disturbance events are too frequent more difficult for system to recover • Riverine systems require forest complexity (not brush fields) for stream complexity.

Vulnerabilities from High Severity Fire Exacerbated by Non-Tribal Management Actions

The vulnerabilities riverine systems face in light of the increasing frequency of high severity fire must be understood in the context of actions taken by other public and private land managers prior to, during and after high severity fires. Riverine systems are already threatened in the mid-Klamath area due to existing pre-fire management actions that include a combination of dams, water diversions, water quality impairments from agricultural inputs, logging activity, fire suppression and failing roads. In particular, fire

Riverine

suppression has removed the many benefits of fire to rivers and streams including limiting the natural 'disturbance mosaic,' thereby limiting beneficial wood and gravel debris, reducing stream flows and the additional water inputs to streams and rivers after fires (Gresswell 1999, Noss et al. 2006). This disturbance mosaic provides a high diversity of habitat types and gives different species options. Fire suppression has had a direct impact on specific species including salmon and lamprey as well. A Karuk tribal community member quoted in Peterson (2006) notes: "Ammocoetes that are in the fine mouth of these tributaries aren't getting the kind of hydrograph with the quantity and quality of water that they had historically" (p. 70). Fire suppression has also created vulnerabilities in the riverine system by leading to more frequent and extensive high severity fires (Taylor and Skinner 2003), and the associated vulnerabilities described above.

During high severity fire events the management actions of federal and state agencies, especially the US Forest Service, may exacerbate vulnerabilities to the riverine system. Detrimental fire suppression activities such as: Fire retardants spill into springs, creeks, rivers and lakes. Road building (opening decommissioned or closed roads), creation of fire lines, safety zones or escape routes (dozer/equipment clearings) in vicinity of riverine systems, excessive felling of mature/old growth trees in riparian areas. After fires, Forest Service management actions including salvage logging sales, limited road building and replanting with conifers which affect riverine health and future high severity fire potential (Dwire and Kauffman 2003, Noss et al. 2006, Stephens and Ruth 2005). These impacts are detailed in Table 3.4 below.

Table 3.4 Effects of High Severity Fire and Intersecting Management Actions Across Time

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> • Fire suppression alters beneficial wood and gravel debris, and additional water that would normally enter streams and rivers after fire • Suppression-based practices that prohibit cultural burning prevent beneficial smoke from cooling riverine environments 	<ul style="list-style-type: none"> • Fire retardant chemicals that enter aquatic systems may affect the survivability of Chinook salmon, particularly in earlier life stages prior to marine transition • While smoke may benefit aquatic habitat, it may be detrimental to human health • Large scale burnouts in undesirable conditions or implemented in a rushed fashion can increase fire severity 	<ul style="list-style-type: none"> • Salvage logging takes trees that could have otherwise benefitted salmon habitat • Planting conifers in areas that are otherwise naturally reforesting increases future high severity fire vulnerability • The lack of prescription burn planning, and the planting of trees creates and "investment to protect" and perpetuates the suppression paradigm
Sources: Soto 2016	Sources: Dietrich et al. 2012	Sources: Soto 2016, Noss et al. 2006

Riverine

In order to further illustrate the complex of vulnerabilities high severity fire poses for Karuk species of importance in riverine systems we provide species profiles for spring chinook salmon (áama) and Pacific lamprey (akraah).

Salmon / Ishyá'at / *Oncorhynchus tshawytscha*



www.westcoast.fisheries.noaa.gov

Cultural Importance

Ishyá'at is among the most critical foods for Karuk people, and key to ecosystem health. Ishyá'at spring runs have experienced severe declines as a result of hydroelectric dams, reduced flows and warmer water temperatures. Restoring the health of spring runs is critical to Karuk eco-cultural and spiritual well-being. Ishyá'at is the one of the largest salmonids in the Pacific Northwest and the most rare. It is an anadromous fish born in freshwater streams and rivers, to which it returns to spawn after spending time in the ocean. Cool water temperatures are critical to ishhyá'at as are spring to early summer high water flows that ishhyá'at requires to reach summer holding areas, access spawning grounds.

Ishyá'at and Fire

Salmon benefit from pulse disturbances such as fire. Gravel and wood debris that washes into rivers and streams after fire provide fish habitat, and fire in the watershed often increases water yields. Smoke can block solar radiation, cool air and subsequently water temperatures, and thus reduce otherwise higher physiological stress levels during the summer. High severity fire can have negative impacts on ishhyá'at — yet not as damaging as fire suppression, which reduces fire frequency and can increase watershed impacts.

Effects of High Severity Fire On Ishyá'at Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Smoke from fire may block light from the water's surface and reduce water temperatures, benefitting salmon. Smoke inversions reduce vegetation evapotranspiration (water use) increasing temporary water yield. Stand characteristics supporting cultural use of site specific species altered. 	<ul style="list-style-type: none"> Burned canopies increase stream temperatures. Moderate light increases improve aquatic productivity when coupled with higher water yields Severe post-fire erosion can reduce spawning habitat High severity difficult to burn in prescribed fire/ cultural burning situation. Patches serve as natural fuel breaks for followup burning. 	<ul style="list-style-type: none"> High severity patches contribute sediment and woody material replenishing downstream habitat. Fires that reduce excessive tree density reduce evapotranspiration and can increase pulses of water in sub-drainages Brush susceptible to repeated high severity fire
Sources: Toz Soto, Robock 1991	F Lake, Dwire and Kauffman 2003	FLake, Dwire and Kauffman 2003

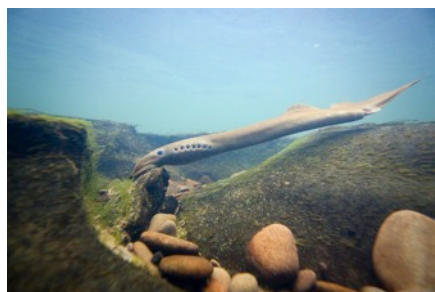
Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Smoke may lower air and water temperatures, benefitting salmon Smoke may increase water yields by reducing evapotranspiration Altered evapotranspiration may increase surface fuel moisture 	<ul style="list-style-type: none"> Gravel and wood debris has entered aquatic systems following fire and enriched salmon habitat Water flows may increase as a result of burned landscape 	<ul style="list-style-type: none"> Mosaics of burning patches reduce evapotranspiration, and contribute sediment and debris for in-stream habitat. Reduces large high severity fires, provides fuel break for adjacent fires
Sources: Toz Soto, Robock 1991	Sources: Toz Soto, Frank K. Lake	Sources: Frank K. Lake

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
Suppression limits debris that would normally enter streams after fire Plantations prone to high severity fire	<ul style="list-style-type: none"> Fire retardants may affect survivability of Chinook salmon, particularly in earlier life stages 	<ul style="list-style-type: none"> Salvage logging takes trees that could have otherwise benefitted salmon habitat
Bisson et al. 2003, Noss et al. 2006	Dietrich et al. 2013, Noss et al. 2006	Soto, Noss 2006, Karr et al. 2004

Pacific Lamprey (Eel) / Akraah / *Lampetra tridentata*



@ Jeremy Monroe, oregonstate.edu

Cultural Importance

Akraah is an important food source for Karuk people, harvested during the upstream migration. The start of river fishing for eels is traditionally considered after the dogwoods bloom and extends through the end of the migration. (Karuk DNR 2010)

Life Cycle & Habitat

As an adult, akraah is a parasitic species that feeds on various marine and anadromous fish. Adults live in the ocean for a few years before returning to freshwater, where they spend a year before spawning in gravel nests. After spawning, adults die, and their eggs hatch into larvae that reside and filter feed in silty or sandy substrates in freshwater for up to 7 years. Eventually, they transform into juveniles that migrate to the ocean, where they develop teeth on their sucking disks and take their adult form. One generation of lamprey occurs over the course of 2-3 generations of salmon. Their life cycle is long and they require fine sediment for their longest life stage—the larval stage. (Streif 2008)

Akraah and Fire

Fire leads to increased sediment in streams, which can greatly benefit akraah in the larval phase. However, certain fire management strategies associated with high severity fire, such as the use of fire retardant, can have detrimental effects on these very larvae (CBB 2015, Soto 2016)

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Smoke shading of river and potential inversion cooling benefits lamprey 	<ul style="list-style-type: none"> High severity burned watershed with erosion impact downslope/stream habitat quality and suitability 	<ul style="list-style-type: none"> After initial post-erosion sediment geomorphic stabilization, potential fine sand substrates increase ammonite habitat.
Sources:	Sources: Peterson 2006	Sources: Peterson 2006

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Patch, stand, and landscape mixed-severity fire regimes buffer extreme climate or fire disturbance events on hydrology and habitat for lamprey 	<ul style="list-style-type: none"> Mixed severity burned landscapes release moderated amounts of sediment and water exfiltration (springs/seeps) into rivers and streams, improving larval habitat 	<ul style="list-style-type: none"> Cultural burning across the landscape as mixed-severity fire buffer extreme climate or fire disturbance events on hydrology and habitat
Sources: Peterson 2006	Sources: Soto 2016, Peterson 2006	Sources: Peterson 2006

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Fire suppression prevents fire from contributing vital sediments and flows to aquatic systems 	<ul style="list-style-type: none"> Fire retardants, suppression fuel-petrol (vehicle, equipment, drip torch) enter aquatic systems affect survival of lamprey, particularly in larval stage 	<ul style="list-style-type: none"> Salvage logging may increase erosion and detrimental sediment pulses to aquatic habitat (lower gradient creeks near confluence with rivers)
Sources: Peterson 2006, p. 70, 74	Sources: CBB 2015	Sources: Peterson 2006

Riparian Vulnerabilities

Riparian areas are key sites for many food, fiber and medicinal species of importance to Karuk people. Focal species include (but are not limited to) Pacific giant salamander (puff puff), aquatic garter snake (asápsuun), beaver (sahpihnîich), mink (Xanchun'ámvaanich), cedar waxwing (akravsiip), yellow-breasted chat, big leaf maple (saan), mock orange (xávish), huckleberry (púriith), horsetail (chimchîikar), and multiple willow and fern species including woodwardia (tip-tip) and five-finger/maiden hair ferns. Some of these species are also discussed under the section on vulnerabilities to riverine systems and wet meadows. The health of riparian areas is also important for the functioning of riverine and forest systems and the habitat quality for the species within.

Fire is an important component of riparian systems in the mid Klamath and cultural burning in the surrounding forest has key impacts on riparian habitat quality (Lake 2013). The Karuk Draft Eco-Cultural Management Plan outlines how riparian species composition, vegetation structure and hydrology are shaped by the use of fire: “Certain trees and shrubs utilize water more than others, fire affects this relationship (Fites et al. 2006). The distribution of forests, shrubs, and grasslands, affects the process of infiltration from precipitation and resultant levels of evaporation with how those plants utilized water (DeBano et al. 1998). The balance of water in and water out, leading to the amount of moisture in the soil and the quantity and quality of springs is influenced by fire (Biswell 1999:157)” (Karuk DNR 2010). Karuk fisheries biologist Kenneth Brink describes this relationship:

We did our fire management, which enabled to put more water into the tributaries, say like on a drought year, you take all your understory out, like all these blackberries and stuff would never be here. These alders would not be all big. There might be one or two big ones making a shade instead on all these little suckers. With burning in the past, you didn't see the alder or the willow trees, you had willow brush. All this foliage takes up a lot of water.

Lower intensity mixed severity cultural burning further affects dynamics within riparian systems by releasing nutrients to the soil. Many specific riparian species of importance to Karuk people also benefit from low intensity cultural burning. For example, the Cedar waxwing (a regalia species) needs fire to maintain an open understory along riparian areas for breeding habitat. The yellow-breasted chat is is dependent on willows within

Riparian

cottonwood galleries along riparian sandbars at lower elevations (Lake, pers. comm. Bagne and Purcell 2011). In other cases, frequent fire is necessary to produce specific qualities in plants needed for cultural uses (e.g. straight shoots for basketry Anderson 1999). Beavers benefit from fire in that fire promotes plant species critical for the beaver diet, such as willow, and also affects riparian structure and hydrology in ways that benefit beaver habitat, for example the input of woody debris resulting from cultural burning provides material for dam construction. Beaver are in turn an important component of riparian and riverine systems for the benefits they bring to other species. For example, beaver dams benefit juvenile coho salmon by modifying the velocity, cover and depth of low gradient cold-water refugia.

Effects of Karuk Cultural Burning On Riparian Systems Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Reduced vegetative evapotranspiration increases stream flow to riparian system • Rejuvenate flood/disturbance adapted plants between flooding episodes. • Increase human and animal access to forage/post-fire growth. 	<ul style="list-style-type: none"> • Gravel and wood debris enters aquatic systems following fire and enriching habitat for some species • Increased system productivity as fire releases nutrients into the food chain • Reduction of vigorous vegetative growth can provide more water in riparian system 	<ul style="list-style-type: none"> • Water balance of riparian areas benefits from burning in surrounding forest • Frequent low intensity fire prevents negative impacts of high severity fire • Rejuvenate flood/disturbance adapted plants between flooding episodes. • Increase human and animal access to forage/post-fire growth.
Sources: Soto 2016, Lake 2007	Sources: Soto 2016	Sources: Dwire and Kauffman 2003

Vulnerabilities Resulting from Increasing Frequency of High Severity Fire

Moist conditions in riparian areas provide a relative degree of protection from direct mortality as compared to species in forests or grasslands, yet with high severity fires, direct mortality during fires may still occur (Dwire and Kauffman 2003). Large debris flows that occur following high severity fires may also cause direct species mortality. Serious threats to riparian areas may result if increases in the frequency of high severity fires cause habitat shifts that reduce forested habitats which develop under lower frequency or mixed severity fire regimes and promote the presence of shrub and herbaceous assemblages which thrive under higher frequency fire conditions. Such a shift of surrounding forests would have

Riparian

potentially serious consequences for riparian species composition, hydrology and structure. Riparian areas in the context of their landscape setting/position is also important to consider, as wide flood plain willow-cotton wood forest compared to mountain alder-maple/conifer dominated topographically steep areas (see Pettit and Naiman 2007)

Effects of High Severity Fire in Riparian Systems Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">Smoke inversions reduce vegetation evapotranspiration (water use) increasing temporary water yield.	<ul style="list-style-type: none">Elevated stream temperatures in absence of water shading vegetationHeavy sediment from flooding	<ul style="list-style-type: none">Composition, hydrology and structure of riparian systems changed if forests become brush fields

Vulnerabilities Exacerbated by Non-Tribal Management Actions

The vulnerabilities riparian systems face in light of the increasing frequency of high severity fire must be understood in the context of actions taken by other agencies prior to, during and after high severity fires (Dwire and Kauffman 2003, Bisson et al. 2003). Riparian systems are already threatened in the mid-Klamath area by logging, roads and fire suppression. Fire suppression intersects with climate change to increase the likelihood of more frequent high severity fires (McKenzie et al. 2004). Sediment from past logging and road building activities, as well as poorly maintained roads has increased stream temperatures in riparian areas. Inputs of fine sediments, alter stream hydrology, may eliminate salmon spawning habitat by filling it in with sand, and can smother salmon redds, suffocating eggs (Gresswell 1999, Rieman et al. 2003).

During high severity fire events riparian systems face additional threats from fire fighting activities (Noss et al. 2006). Road building and the use of bulldozers and the cutting of trees are allowed to occur without NEPA process as an “emergency exemption for an act of nature” during high severity fire events. While the use of fire retardants is not permitted in riparian areas, accidents occur on a regular basis. Lastly, the longer-term aftermath of high severity fires is increasingly characterized by proposals for salvage logging operations (Karr et al. 2004, Noss et al. 2006). Here too normal procedures set in

Riparian

place for water quality protections have been waived, reducing protections on riparian systems.

Effects of High Severity Fire and Non-Tribal Management Actions Across Time

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Riparian systems already vulnerable due to past actions including dams, water diversions, logging, road building and fire suppression Increased fuel loading increases risk of higher intensity/severity burning. 	<ul style="list-style-type: none"> Fire retardants enter aquatic systems Use of bulldozers, other motorized equipment and large diameter tree falling allowed in riparian area without NEPA process Logging (tree felling), road building (fire line and water access construction) allowed in riparian area without NEPA process 	<ul style="list-style-type: none"> Salvage logging, road building leading to sedimentation Salvage logging, and re-seeding with conifers increase future potential of high severity fires Reduced ecological connectivity from lowlands to higher elevations
Sources: Dwire and Kauffman 2003	Sources: Noss et al. 2006	Sources: Karr et al. 2004

To illustrate the threats high severity fire poses for Karuk species of importance in riparian habitats we provide species profiles for four riparian species of cultural importance: Pacific giant salamander (púfpuuf), aquatic garter snake (asápsuun), beaver (sahpihnîich), and yellow-breasted chat.

Pacific Giant Salamander / Púfpuuf / *Dicamptodon tenebrosus*



Californiaherps.com

Cultural Importance

In Karuk beliefs, púfpuuf is a spiritual being who transform into a salamander who monitors spring and creek water quality and quantity. As an indicator species, Karuk people consider púfpuuf the keeper of pure cleaner water. The healthy presence of púfpuuf is indicative of a healthy riparian freshwater ecosystem.

Life Cycle & Habitat

Púfpuuf occurs in moist and riparian forests in or near clear, cold streams and rivers, springs, creeks, lakes, and ponds. Population densities are highest in creeks with many large rock/stones and woody material in or under which púfpuuf can take shelter. Larvae

are born in water where they swim using an enlarged tail fin and breathe with filamentous external gills. They eventually transform into four-legged salamanders that live on the ground and breathe air with lungs. Some adults retain their gills and continue to live in water. (Californiaherps.com 2016).

Púfpuuf and Fire

High severity fire has the potential to burn terrestrial adults, their prey and shelter (woody material), as well as have mid-term effects on forest moisture levels that are vital for salamander habitat. Cultural burning provides benefits to aquatic salamander habitats by increasing stream productivity. In addition, mixed severity cultural burning serves as an intermediate renewal process that reduces high severity detrimental fire effects.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Death by fire for terrestrial adults inhabiting upland spaces Reduction in prey and shelter in upland settings Alterations to microclimate that could affect survivability 	<ul style="list-style-type: none"> Drier forests as a result of a more open canopy can compromise the habitat of terrestrial adults Debris flows with excessive sediment can reduce instream and riparian suitable habitat 	<ul style="list-style-type: none"> Removal of forest density and cover can increase water yield and instream habitat. Legacy of debris flows contribute to pulses of structural habitat
Sources: GTR-NE-288, Bury et al. 2002 in GTR-NE-288,	Sources: Bury et al. 2002 in GTR-NE-288, Pettit and Naiman 2007	Bury et al. 2002 in GTR-NE-288, Pettit and Naiman 2007

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Takes into account salamander life cycle and avoids burning while salamanders are most vulnerable to death by fire 	<ul style="list-style-type: none"> Potential benefits from increased stream productivity resulting from fire. Recruitment of wood material from dead trees to aquatic and riparian systems 	<ul style="list-style-type: none"> Diversified fire effects from mixed fire severity regime provide temporal and spatial complexity of habitat. Reduction of high severity fires.
Sources: Karuk ECRMP 2010 , Pilliod et al. 2003	Sources: Bury et al. 2002 in GTR-NE-288, Dwire and Kauffman 2003	Sources: Perry et al. 2011

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Fire excluded riparian habitats increases fuel loading/fire risk 	<ul style="list-style-type: none"> Certain fire retardant chemicals can be highly toxic to amphibians 	Higher severity burned riparian area reduce suitable habitat
Sources: Dwire and Kauffman 2003	Sources: Pilliod et al. 2003	Sources: Pilliod 2003, Bury 2004,

Aquatic Garter Snake / Asápsuun / *Thamnophis atratus*



@ Gary Nafis, californiaherps.com

Cultural Importance

For Karuk people, asápsuun is a cultural indicator of healthy aquatic and riparian systems. In Karuk territory, people have reported seeing fewer and fewer "water snakes," a fact that they attribute in part to the impact of fire suppression on aquatic systems (Lake 2007).

Life Cycle & Habitat

Asápsuun is a highly aquatic snake that uses water for both foraging and protection. It prefers shallow, rocky creeks and streams in forested or grassy areas. It feeds primarily on amphibians at various life stages, including frogs, tadpoles, newts, salamanders, salamander larvae and juvenile fish. Courtship occurs during the spring, and young are born in late summer to early fall (Californiaherps.com I 2016)

Asápsuun and Fire

Fire can benefit aquatic garter snakes if it enhances the productivity of aquatic systems by depositing nutrients and debris into waterways. These deposits can enhance habitat for amphibians that form a vital part of asápsuun's diet. High severity fire, however, can burn forest canopies, leading to sunnier and drier understory conditions that may not be able to sustain amphibians inhabiting more upland settings. This may have negative consequences for aquatic garter snakes.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Death by fire for snakes dwelling further from water Removal or degraded habitat and foraging opportunities 	<ul style="list-style-type: none"> Canopies that have been burned create more exposed and dry understory conditions affecting upland dwelling amphibians that form part of asápsuun's diet. 	<ul style="list-style-type: none"> Burned and salvaged logged areas become less suitable habitat as micro-climate become warmer and drier, reducing terrestrial prey habitat.
Sources: Bury 2004	Sources: Bury 2004	Sources: Bury 2004

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Lower to mixed severity burns maintain diversified habitat requirements 	<ul style="list-style-type: none"> Burn releases nutrients and debris that can wash into waterways, benefitting amphibians and therefore snakes. 	<ul style="list-style-type: none"> Lower to mixed severity landscape burn patterns maintain diversified habitat requirements Reduced landscape vegetation and ET increases/maintains spring and water yield
Sources: Bury 2004	Sources: Bury 2004	Sources: Perry et al. 2011, Bury 2004

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Fire suppression reduces stream productivity, limiting the amount of prey available to the aquatic garter snake. 	<ul style="list-style-type: none"> Fire retardant that accidentally enters aquatic systems may affect sensitive amphibians that form a large part of asápsuun's diet 	<ul style="list-style-type: none"> Continued fire suppression and associated increased fuel loading predisposes forest to higher severity burns
Sources: Lake 2007, Bury 2004	Sources: Pilliod et al. 2003	Sources: Bury 2004

Beaver / Sahpihnñich / *Castor canadensis*



@ Ginger Holser, wdfw.wa.gov

Cultural Importance

Sahpihnñich alters ecosystems in ways that benefit other species. Beaver dams are known to improve juvenile Coho salmon habitat (Colleen and Gibson 2001). Karuk people value beaver as a teacher of how to intervene in natural processes for the greater good. Sahpihnñich is considered nearly locally extirpated and in need of reintroduction (Karuk DNR 2010).

Life Cycle & Habitat

Beaver habitat must possess a stable aquatic system, channel gradients of less than 15 percent, and a sufficient supply of quality food species. Normally, beavers don't forage further than 300 ft from water, and prefer herbaceous over woody plant material. Prime food species include quaking aspen, willows, alders, and dogwood. The center of beaver activity is the beaver lodge, often

constructed in the water or against a bank. (Tesky 1993)

Sahpihnñich and Fire

Sahpihnñich can benefit from fire if it keeps waterways open, promotes new vegetative growth, and replaces conifers with early successional, non-coniferous species (Tesky 1993). However, in drought conditions, and/or in the presence of large ungulate populations, fire can further strain beaver populations and lead to significant declines in lodge occupancy (Hood et al. 2007)

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> May force beavers to forage further from water's edge, increasing predation. Wildfire is more likely to occur in periods of drought, compounding impacts on beaver 	<ul style="list-style-type: none"> Increased debris flows and elevated sedimentation can alter or reduce beaver created habitat, modify hydrology and geomorphology not desired by beavers 	<ul style="list-style-type: none"> Repeated, high severity fire may combine with other environmental stressors to drive beaver from the area
Sources: Hood et al. 2007	Sources: Dwire and Kauffman 2003	Sources: Hood et al. 2007

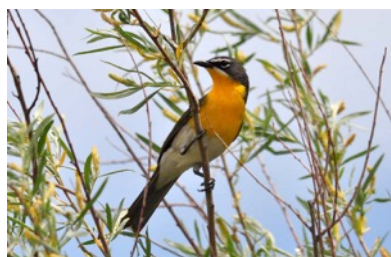
Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Removal or reduction in riparian wood material that can hinder beaver mobility and foraging Short-term post fire rejuvenation and maintenance of vigorous riparian vegetation between flooding events 	<ul style="list-style-type: none"> Promotes new early successional growth (sprouting hardwoods and shrubs), benefiting sahpihnñich's diet Increased mobility and foraging opportunity 	<ul style="list-style-type: none"> Can be timed to avoid drought and other stressors, thereby protecting beaver populations lodges, and rearing habitat
Sources: Lake 2007	Sources: Tesky 1993	Sources:

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression promotes coniferous encroachment and reduces vegetative renewal, affecting beaver diets 	<ul style="list-style-type: none"> Fire suppression related water with drawl/pumping can disturb beaver 	<ul style="list-style-type: none"> Increased erosional sediment and woody material transport can temporarily reduce beaver habitat suitability.
Sources: Tesky 1993	Sources:	Sources:

Yellow-Breasted Chat / *Icteria virens*



@ 2014 Christopher L. Christie

Cultural Importance

The yellow-breasted chat is a seasonal migrant that features in Karuk stories in which it welcomed as the true harbinger of spring (Salter 2003). The yellow feathers of its breast have traditionally been a part of tribal regalia.

Life Cycle & Habitat

This migratory species depends on riparian areas, especially sandbars, in which willows and cottonwoods predominate. It nests in dense thickets, while it uses the larger trees as singing perches (Dunn and Garrett 1997). It feeds primarily on insects and wild fruit (Myers n.d.). While this chat is not endangered federally, in California it is listed as a species of special concern (Myers n.d.)

Yellow-Breasted Chat and Fire

In the California desert, fire had a short-term impact on yellow-breasted chats in that it prevented nesting on the year of the fire, but the population returned to pre-burn number three years later (Cardiff 1993, 1996). The habitat on which this chat depends is comprised of early seral species that benefit from disturbance such as fire. Without fire, conifers can encroach riparian areas, competing with willows and cottonwoods for light and water reducing the chat's preferred habitat.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Fires that occur just before or during nesting season can affect survivability and reproductive success. 	<ul style="list-style-type: none"> Fires can temporarily reduce perching snags, but creates new ones. 	<ul style="list-style-type: none"> Increased frequency of high severity fires could modify chat habitat
Sources: Cardiff 1993, 1996	Sources:	Sources:

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Cultural burning of riparian areas may be timed to avoid nesting season 	<ul style="list-style-type: none"> Conifers have been held back by burn, and willow, cottonwood, etc. are given space to thrive post-disturbance 	<ul style="list-style-type: none"> Burning at proper intervals keeps the habitat viable for chat by promoting early seral species in riparian areas.
Sources:	Sources:	Sources:

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression allows for coniferous encroachment of riparian areas, compromising the stability of chat habitat. 	<ul style="list-style-type: none"> Fire suppression water with drawl activities (helicopter dipping, water tender pumping) can disrupt chat foraging 	<ul style="list-style-type: none"> Large extensive burned riparian valley forests can remove or degrade preferred chat habitat
Sources:	Sources:	Sources:

Low Elevation Forest Tanoak Zone

Low Elevation Forest: Tanoak Zone Vulnerabilities

Lower elevation forest habitat (roughly 500-3,000') within Karuk ancestral territory and homelands is characterized by the presence of tanoak trees (xunyê'ep) as cultural keystone species. Not only have tanoak acorns traditionally constituted a high percentage of the calories and protein of Karuk diets (Norgaard 2005), tanoaks are culturally and spiritually significant. Low elevation tanoak forests contain an abundance of species of direct importance for Karuk food, fiber and medicine. These include fungi: tanoak mushrooms (xáyvi'ish, commonly known as matustake), black trumpets, hedge hogs, fang, and other mushrooms (see Anderson and Lake 2013), herbs:princess pine (xunyêpsurukhitihan), Oregon grape, Yerba Buena-mint, shrubs: huckleberry (púritih), California hazel, mock orange, service berry, ceanothus, ocean spray; trees-, black oak, port orford cedar, California bay (pahiip), canyon live oak (xanputtin), madrone (kusrippan), ponderosa pine (ishvirip), white oak (axveep); animals: pileated woodpecker (iktakatákkahe'en), black-tailed deer, fisher, coyote (pihneefich), black bear (virussur), ringtailed cat (tapukpuukanach), gray squirrel (axruuh), and the winter range of elk (ishyu'ux). In addition to the direct importance of this habitat zone to particular species, the stand dynamics and fire regimes of low elevation tanoak forests significantly shape riparian and riverine health.

Both the composition and overall stand structure of low elevation tanoak forests is a direct result of their long term intensive management by Karuk people through the use of fire (Anderson 2005, Bowcutt 2013, Halpern 2016, Karuk DNR 2010, Martinez 1995, Lake 2007 and 2013, McCarthy 1993). Frequent fires limit the encroachment of competing shrubs and conifer species (Turner et al. 2011, Perry et al. 2011). Low intensity fire favors oaks over conifer species in part because oaks can re-sprout and thereby reestablish after fires (Hosten et al. 2006, Cocking et al. 2012). By contrast, competing species such as cedar, fir and pines reproduce with seedlings that will burn up (Plumb 1981). The open structure of these forests is important for many other species including madrone, white and black oak, pileated woodpeckers and elk. Indeed, as is true for many other California Indians, the majority of species Karuk people use thrive in either open forest conditions or full sun (Anderson 2005, p. 152). At the larger scale, traditional burning at multiple fire frequencies

Low Elevation Forest Tanoak Zone

promotes a mosaic of vegetation types in different stages of response to fires. This diversity of food species in multiple phases across the landscape supports food security for Karuk people (Busum 2006, Kimmerer and Lake 2001, Lake 2013). The frequent use of low intensity fire is especially important for overall stand structure given that tanoak trees are quite vulnerable to high severity fire (Bowcutt 201, McDonald and Vaughn 2007). Stands that are clear of underbrush can be burned again with lower risk of damaging mature oaks. Fire exclusion has reduced the diversity of resource patches in the landscape causing what had been distinct bands of groupings that were burned in their own cycles to blend together (Lake pers comm, re ecotones of oak-dominated habitats with more forested or grasslands, see Lake 2013).

Frequent burning also affects the water dynamics within low elevation forests. These relationships between brush, conifer reduction and groundwater are also of critical importance to species in the riverine and riparian zone. Low intensity fire breaks down organic matter, releasing nutrients to the soils where they become available for plant use. Tanoak mushrooms also have a symbiotic relationship with tanoak trees and other species including huckleberry (see Anderson and Lake 2013 for Karuk tanoak forest uses) and make nutrients available across species through their mycorrhizae.

In addition to the importance of frequent low intensity fire for the overall forest structure, frequent use of fire benefits many species in this zone directly (Skinner et al. 2006). McCarthy (1993) writes "In addition to promoting a variable distribution of oaks in the woodland community, the use of fire may positively affect individual trees and their yield" and quotes Scheneck and Gifford (1952) in noting that "Karuk women reported that the trees are better if they are scorched by fire each year. This kills disease and pests" (p. 221). Burning around trees enhances their health and the quality of acorns by reducing populations of filbert weevil and filbert worms (Halpern 2016).. Elk who especially use low elevation tanoak forest in winter, have been described as a "fire-follower" as they benefit from the effects of fire on their food sources (Patton and Gordon 1995). Elk in particular prefer a mosaic landscape that combines open areas for foraging, and forested areas for cover (Long et al. 2008). Pileated woodpecker benefit from the presence of intermediate scales of mixed severity burn patches across the landscape that foster nesting, roosting, and foraging habitats (Bull et al. 2007, Hartwig et al. 2004). Regular burning benefits

Low Elevation Forest Tanoak Zone

tanoak mushrooms by minimizing forest duff. This protects the mushroom's mycelium that can otherwise encroach into the duff where it becomes vulnerable to fire (Anderson and Lake 2013). Burning of the mycelium affects not only the mushroom itself, but the nutrient transfer system between tanoak trees and other species including huckleberry (Lake pers. comm., Anderson and Lake 2013). However, for the tanoak mushrooms, cultural burning is a more secondary benefit in that burning benefits the other species with whom the mushroom is a functional cohort. For example, once tanoaks reach 16-18 inches in diameter the production of mushrooms around them increases (Lake 2007).

Effects of Karuk Cultural Burning on Low Elevation Tanoak Forests Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">• Kills encroaching smaller diameter younger conifers• Reduces brush and understory fuel loading• Promotes grove and acorn health by periodically reducing predatory insect populations• Releases nutrients to system	<ul style="list-style-type: none">• Healthy tanoak groves sustained by low intensity fires sustain other culturally vital species and ecosystem health• Increase deer and elk forage quality for understory shrubs, forbs, grasses and ferns.	<ul style="list-style-type: none">• Resource patch mosaic leads to food security• Frequent burning prevents high severity fires
Sources: Karuk DNR 2010	Sources: Bowcutt 2013	Sources: Bowcutt 2013

Vulnerabilities Resulting from Increasing Frequency of High Severity Fire

While low intensity fires are an integral component of the tanoak forest zone, the increasing frequency of high severity fire in light of climate change poses serious vulnerabilities for this forest type (Bowcutt 2013). High severity fire creates vulnerabilities for individual species and for stand dynamics as a whole. Harrington (1932) quotes “a Karuk woman” “the tanoak is not good when it is burned off, the tree dies. When they are burning, they are careful lest the trees burn (p. 65).” While tanoaks are able to re-sprout after low intensity fire, their thin bark makes them highly susceptible to damage or mortality from hot (higher temperatures and durations of heat) fires. During high intensity or high severity fires the thin bark of this species may heat up and burn quickly leading to damage and scarring of the inner cambium and in turn cause disease and heart rot (see McCarthy 1993, Plumb and Gomez 1983). Tanoak trees produce a thick smoke when burning which is reported to have negative human health impacts (Lake pers. comm.). High severity fire events may also cause direct mortality to tanoak mushrooms if reproductive

Low Elevation Forest Tanoak Zone

mycelial mats are damaged. High severity fires consume snags and logs used by pileated woodpeckers for nesting, rooting, and foraging, and reduces insect populations as well as nut and berry sources that are vital to the woodpecker diet.

Ultimately the greatest vulnerability from the increasing frequency of high severity fire would occur in the event that tanoak stands (e.g. tribal food orchards) become ceanothus brush fields rather than mixed hardwood woodlands. With repeated very hot fires the structural integrity of tanoak stands might be destroyed. Given that many of these species depends on moisture and cool temperatures provided by shade from larger trees there is concern that high severity fire over time could reset (shift to an alternate vegetation state) the entire system, leading to the replacement of these important food and cultural use species to brush and chaparral. Tanoak stumps may sprout back as a large number of shrubby sprouts that do not produce cover needed to support shade tolerant species such as huckleberry. Without understory these brush stands lack microsite diversity. Brush fields may have be grassy component that can also cause the stand to burn more frequently preventing the return of mature larger diameter, trunked trees. If entire tanoak stands are destroyed by high severity fire, the many other species with which they are interdependent including tanoak mushrooms would in turn also be unable to repopulate given their symbiotic relationships with the oaks.

Effects of High Severity Fire in Low Elevation Forests Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">• Direct mortality of many species including tanoaks• Tanoaks produce thick smoke that is hazardous to human health	<ul style="list-style-type: none">• Loss of snags and logs that form habitat for woodpeckers and others	<ul style="list-style-type: none">• Lack of microsite diversity• Repeated burning at high severity keeps mature forest from developing• Loss of forests and associated species

Vulnerabilities Exacerbated by Non-Tribal Management Actions

Vulnerabilities to species in the tanoak forest zone in light of high severity fire are magnified by the actions of other agencies prior to, during and after high severity fire events, see Table 3.5 below. Low elevation tanoak forests within Karuk ancestral territory

Low Elevation Forest Tanoak Zone

have been significantly impacted by the past 100 years of fire exclusion (Skinner et al. 2006). Fire exclusion has led to a buildup of fuels and “dramatic increase in the likelihood of high severity fires (Taylor and Skinner 2003). During fire events tanoak stands may be subject to destruction through back burning and the building of fire lines. Fire lines cutting through tanoak stands may damage or destroy the tanoak’s mycelium net. In the immediate aftermath of high severity fires activities such as salvage logging and associated road building also impact tanoak stands (although the tanoaks themselves not the target species).

Table 3.5 Effects of High Severity Fire and Non-Tribal Management Actions Across Time

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> • Fire exclusion and logging increase risk of high severity fires • Increased fuel loading increases fire risk and ignition potential 	<ul style="list-style-type: none"> • Fire suppression activities including fire lines, cutting of snags and back burning kill tanoaks, madrones and other species of central importance 	<ul style="list-style-type: none"> • Salvage logging damages these forest stands
Sources: Bowcutt 2013	Sources: Bull et al. 2007	Sources: Bull et al. 2007

In order to further illustrate the complex of vulnerabilities high severity fire poses for Karuk species of importance in this elevation zone we provide species profiles for tanoak (xunyêep), tanoak mushrooms (xáyviish), elk (íshyuux), huckleberry (púrith), and pileated woodpecker (iktakatákaheen).

Low Elevation Forest Tanoak Zone

Tanoak / Xunyêp / *Lithocarpus densiflorus*



oregonstate.edu

Cultural Importance

Xunyêp is an ecologically, culturally, and economically important species. Tanoak acorns (xuntápan) are a staple food for Karuk people and are also vital for many wildlife species. Additionally, the roots of tanoak trees support the growth of another important food, tanoak mushrooms.

Life Cycle & Habitat

Xunyêp is an evergreen hardwood tree endemic to California and southern Oregon. It is versatile and varies in form, from shrub to tree, depending on the environment. It can grow as an understory species, while also benefitting from extra light resulting from openings in the forest canopy. It can take 30-40 years for xunyêp to produce acorns in abundance. Ripe acorns are harvested in the fall. The most critical environmental factor determining the fate of tanoaks is fire. (Bowcutt 2013, Hillman 2016, OWIC 2016)

Xunyêp and Fire

Xunyêp is very susceptible to high intensity fire (Karuk DNR 2010, OWIC 2016), but can benefit from cultural burning that decreases tree and acorn pests, and reduces competitive vegetation (Bowcutt 2013).

Effects of High Intensity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Fire may destroy entire groves that are critical to people and wildlife When burned, tanoak generates thick smoke and particulate matter that can have health repercussions 	<ul style="list-style-type: none"> Vital species that depend on tanoak groves for habitat and food, such as tanoak mushrooms, black-tailed deer, various bird species, etc., may experience impacts as they cope with fire-related grove impacts. 	<ul style="list-style-type: none"> If able to regenerate, groves that have been lost to high intensity fire may take decades to once again produce acorns in abundance
Sources: Karuk DNR 2010	Sources: Bowcutt 2013	Sources: Hillman 2016

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Promotes grove and acorn health by periodically reducing predatory insect populations 	<ul style="list-style-type: none"> Reduces competition from other tree species and brush, making grove more productive 	<ul style="list-style-type: none"> Healthy groves sustained by low intensity fires sustain other culturally vital species and ecosystem health
Sources: Hillman 2016, Karuk DNR 2010, Bowcutt 2013	Sources: Hillman 2016, Bowcutt 2013, Halpern 2016	Sources: Bowcutt 2013

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression practices lead to overgrown understories that compete with tanoak Suppression leads to fuel loads that increase future fire risk 	<ul style="list-style-type: none"> Fire lines cutting through tanoak stands may damage or destroy the tanoak's mycelium net. Higher severity fires that kill overstory trees (host), and damage soil productivity reduce mycorrhizal connectivity 	<ul style="list-style-type: none"> Structural conversation of tanoak dominated forest from larger trunked trees to shorter multi-stemmed brushy growth form. Reduced suitable habitat for many forest animal species
Sources: Bowcutt 2013	Sources:	Sources:

Low Elevation Forest Tanoak Zone

Tanoak Mushroom / Xáyviish / *Tricholoma magnivelare*



www.shroomery.org

Cultural Importance

Xáyviish is prized as a traditional food and medicine (Anderson and Lake 2013). The tanoak mushroom, also known as the pine mushroom or matsutake, is highly prized in the global market and has at times had very high commercial value, making it vulnerable to overharvest by outsiders (Hosford et al. 1997, Peters and Ortiz 2016).

Life Cycle & Habitat

In Northern California, xáyviish can be found scattered or growing in groups in well-drained soil or duff under tanoak, golden chinquapin, madrone, or pine trees with which it forms a mycorrhizal, symbiotic relationship (Richards and Creasy 1996, Richards 1997, Anderson and Lake 2013). In addition to rainfall, this mushroom requires low temperatures, and a pattern of warming and cooling. (Viess 2016, Hosford et al. 1997)

Xáyviish and Fire

Fire can have direct effects on xáyviish by destroying its mycelian mats from which the fruiting body emerges, compromising the continuity of burned patches (Hosford et al. 1997). Additionally, given the tanoak mushroom's dependence on certain tree species such as the tanoak, high severity fire can have indirect effects on the mushroom's present and future population if it destroys large groves of host trees (Hosford et al. 1997, Karuk DNR 2010, Anderson and Lake 2013).

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Mycelial mats may be burned and destroyed preventing them from fruiting into harvestable mushrooms and compromising survivability of the population 	<ul style="list-style-type: none"> Xáyviish may struggle to populate or repopulate areas if entire stands of host species have been destroyed by high severity fire. 	<ul style="list-style-type: none"> The moisture and cool temperatures that xáyviish depends on may be less available in forests with repeated high-severity fire
Sources: Hosford et al. 1997, Karuk DNR 2010	Sources: Hosford et al. 1997	Sources: Hosford et al. 1997

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Can avoid or minimally impact tanoak mushroom patches while still burning tanoak stands and acorn piles to prevent pests that affect tanoak health. 	<ul style="list-style-type: none"> Lower intensity, mixed severity burn patches that benefit mushroom eco-mycorrhizal host rejuvenate and maintain viable shiro colonies. 	<ul style="list-style-type: none"> Maintains host tree and shrub vitality, and retains duff and some litter (reduced surface fuels), fostering healthy mushroom populations.
Sources: Karuk DNR 2010, Anderson and Lake 2013	Sources: Hosford et al. 1997, Anderson and Lake 2013	Sources: Anderson and Lake 2013

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Pine and oak forests with high tree densities, canopy cover, and duff/litter facilitate productive mushroom areas but have a greater risk of high severity fires. 	<ul style="list-style-type: none"> Fire suppressed forests are more susceptible to climate stressors of drought and wildfire. Higher fuels and dense forests may burn at higher severities. 	<ul style="list-style-type: none"> Salvage logging may indirectly reduce or eliminate mushroom fruiting until the re-establishment of older aged host trees and shrubs.
Sources: Hosford et al. 1997, Anderson and Lake 2013	Sources: Skinner et al. 2006.	Sources: Hosford et al. 1997.

Low Elevation Forest Tanoak Zone

Roosevelt Elk / Íshyuux / *Cervus occidentalis*



Photo: Kirsten Vinyeta

Cultural Importance

Elk are important game traditionally used for food, clothing (hides), regalia, and implements, as well as in their role in shaping ecosystems. The management of elk populations, and the protection and restoration of habitats that elk depend on are of vital importance to the Karuk Tribe. (Karuk DNR 2010)

Life Cycle & Habitat

Elk are associated with a mosaic landscape that combines open areas for foraging, and forested areas for cover. They are gregarious animals that navigate in herds year-round. The nature of these herds changes depending on the time of year and the reproductive cycle. Dietarily, elk prefer grasses, followed by forbs, then deciduous browse, and as a last resort, coniferous browse. (Innes 2011)

Íshyuux and Fire

Íshyuux has been described as a "fire-follower" as it benefits from the effects of fire on plant communities that are important food sources (Patton and Gordon 1995). However, high-intensity fire that burns entire stands may reduce covered habitats that are important to elk for protection.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Heard or individual displacement, stress, and death from wildfire. Removal of forage and cover habitat. 	<ul style="list-style-type: none"> Burns that destroy entire stands may force elk to find other forested areas in which to find cover. Browse/forage may be increased. Fuels (down logs/limbs) may inhibit access and travel mobility. 	<ul style="list-style-type: none"> Elk may re-inhabit former high severity patches as conifer and shrub species (browse) are reestablished.
Sources:	Sources: Swanson et al. 2014	Sources: Karuk TEK

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Ash and charcoal provide opportunities for elk to reduce parasites. Regrowth of vegetation provides forage. 	<ul style="list-style-type: none"> Conifer encroachment of meadows is controlled, thereby protecting critical íshyuux calving and winter habitat 	<ul style="list-style-type: none"> A diverse landscape mosaic that fosters the various habitat needs of íshyuux is promoted through fire management
Sources:	Sources: Sachro et al. 2005, Swanson et al. 2014	Sources: Lake 2007

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression-based practices have led to the tree encroachment of meadows, thereby reducing elk habitat 	<ul style="list-style-type: none"> Fire suppression activities may <u>displace elk from desired habitat.</u> 	<ul style="list-style-type: none"> Fire lines may increase or inhibit elk travel and mobility. BAER or other associated erosion control treatments may hinder elk feeding and mobility
Sources: Karuk DNR 2010, Norgaard 2014	Sources:	Sources:

Low Elevation Forest Tanoak Zone

Evergreen Huckleberry / Púrith / *Vaccinium ovatum*



www.nwplants.com

Cultural Importance

Púrith is an important food source for the Karuk with many nutritional and health benefits. The berry's high antioxidant content is among the properties that make this plant a medicinal food (Taruscio et al. 2004).

Life Cycle & Habitat

This understory shrub is found in coastal forests and mountains of the Pacific Northwest and northern California, and is most abundant in forests that have a higher level of canopy cover. New leaves and flowers emerge in spring, followed by fruit that develops in summer and fully ripens by fall. While this slow-growing, shade-tolerant species depends

on a mostly covered filtered light understory habitat, flower and berry production increases with light and soil moisture in the presence of forest gaps produced by moderate disturbance related to fire, timber harvest, or thinning (Lake 2015).

Púrith and Fire

Púrith is adapted to some disturbance including fire, but its slower reproductive tendencies make it more vulnerable to climate change than other huckleberry species (Lake 2015). High intensity fire may open up the forest canopy, increasing light and limiting moisture, factors that could lead to this species being outcompeted by others that thrive in drier, sunnier conditions.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">May strike during flowering and fruiting season, affecting the harvest as well as the plant's ability to seedDirect removal of foliage (wildlife habitat) and berries (food) by fire	<ul style="list-style-type: none">An open canopy resulting from high severity fire may reduce the abundance of púrith by creating drier, sunnier conditions in which it may be outcompeted	<ul style="list-style-type: none">Although, fire adapted with burl/lignotuber resprouting capacity, increased severity of fires can reduce re-establishment vigor and site dominance.
Sources:	Sources: Lake 2015	Sources:

Effects of Karuk Cultural Burning Across Time

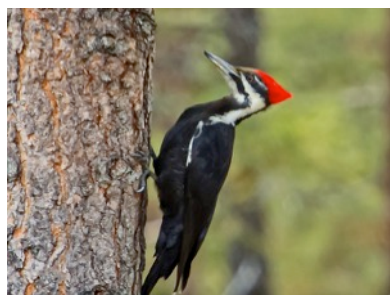
Immediate	2-Year	Long-Term
<ul style="list-style-type: none">Can take into account plant's life cycle and avoids burning important cultural patches when plants are flowering and fruiting	<ul style="list-style-type: none">Plant abundance is maintained by preserving much of the canopy, while still promoting forest gaps that enhance flower and fruit productionSoil nutrients are enhanced	Maintenance of productive huckleberry patches across the landscape among different soil and aspect types.
Sources:	Sources: Lake 2015, Vance et al. 2001	Sources: Lake 2013

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none">Fire suppression increases high intensity fire risk and reduces forest gaps that assist flowering and fruiting	<ul style="list-style-type: none">Fire suppression actions, fire line construction can temporarily reduce tribal/wildlife foraging of berries	<ul style="list-style-type: none">Salvage logging may contribute to a highly lit understory that compromises huckleberry habitat
Sources:	Sources:	Sources:

Low Elevation Forest Tanoak Zone

Pileated Woodpecker / Iktakatákaheen / *Hylatomus pileatus*



USFS Boise National Forest

Cultural Importance

The feathers of iktakatákaheen are used in Karuk regalia (Driver 1939). Iktakatákaheen is seen as an ecosystem engineer that creates cavities that can then be used by up to 20 species of birds and mammals and promotes nutrient cycling in the forest through its excavations (USFS PNRS 2003).

Life Cycle & Habitat

The largest woodpecker in North America, Iktakatákaheen typically resides in older deciduous or mixed deciduous-coniferous forests. Pileated woodpeckers mate for life, and use large snags and decadent trees to excavate nesting cavities as well as roosts in which the members of the pair roost individually to reduce the risk of predation (Bull et al. 2007). The pileated diet consists primarily of insects (with ants often comprising over 40% of their diet) as well as wild fruits and nuts (USFS PNRS 2003)

Iktakatákaheen and Fire

Iktakatákaheen depends on aging forests in which snags and large decadent trees are present for nesting and roosting. High severity fire that burns entire stands greatly reduces the presence of viable snags and trees. Additionally, fire can temporarily reduce ant and other insect populations that comprise a large percentage of the pileated diet. (Bull et al. 2005 & 2007, USFS PNRS 2003)

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">Fire consumes snags and logs vital to woodpecker habitat and reduces the availability of foods like insects, nuts and berries.Individuals may die if they can't escape flames/smoke.	<ul style="list-style-type: none">Snags and decadent trees on which pileated woodpeckers depend for shelter and insect excavation have been burned and are unusable, or new snags and logs are created.	<ul style="list-style-type: none">Burned stands take time to reach forest maturity and sustain iktakatákaheenSmaller sized patches of higher severity burns create and maintain snag/log habitat
Sources: Bull et al. 2005	Sources: Bull et al. 2007	Sources: Bull et al. 2005 & 2007

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">Can be carried out in small tracts of forest to preserve adequate food supplies for woodpeckerNesting birds can be protected from fire via local scale TEK regarding the location of nests.	<ul style="list-style-type: none">Low-intensity fire is less likely to reduce the forest of snags, logs, and decadent trees that are vital for nesting and roosting	<ul style="list-style-type: none">Maintenance of intermediate scales of mixed severity burn patches across the landscape that foster nesting/roosting, and foraging habitats.
Sources: Bull et al. 2005	Sources: Bull et al. 2005 & 2007	Sources: Bull et al. 2007

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none">Fire excluded, dense, high fuel load stands promote nesting/roosting habitat, but also higher fire risk	<ul style="list-style-type: none">Fire suppression, snagging and fire line construction can reduce habitat trees and logs.Frequent burns can eliminate desired woodpecker habitat	<ul style="list-style-type: none">Salvage logging reduces existing and future woodpecker wood feeding and nesting habitat
Sources:	Bull et al. 2007, Swanson et al 2014	Sources: Bull et al. 2007

Low Elevation Forest Tanoak Zone

Wolf / Ikkâavnamich / *Canis lupus*



@ fws.gov

Cultural Importance

Wolves once inhabited Karuk territory, but by the 1920's were decimated by Euro-American hunting, trapping and poisoning. Federal protections have led to an increase in wolf populations and wolf has returned to California and has been observed just east of Karuk Territory. Karuk people welcome the return of the wolf as an animal that is important to tribal spiritual practices and ecosystem stability.

Life Cycle & Habitat

Ikkâavnamich habitat tends to be more prey dependent than land cover dependent. In the West, wolves are known to follow large ungulate herds from their lowland wintering grounds to their upland pastures.

Ikkâavnamich creates its own den in meadows near water, rock outcroppings, under tree roots, or even old beaver lodges. To succeed as a pack, wolves need large, remote areas free from much human disturbance (Snyder 1991)

Ikkâavnamich and Fire

In Karuk territory, deer and elk would be the primary prey of ikkâavnamich. Given that these ungulates benefit from the effect of fire on plant communities, ikkâavnamich indirectly depends on burns to sustain the dietary and habitat needs of its primary prey species (Snyder 1991). High intensity fire that destroys large stands, however, can reduce the cover needed by elk and deer, and force them to relocate, straining the herd. Given their small numbers, wildfire can also affect the wolves directly if individuals, particularly pups, are subject to high-intensity wildfire

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">Wildfire could kill pups in the den or elsewhere if they lack fast mobility. Given the small population numbers, the impact of this loss could be significant.	<ul style="list-style-type: none">Burns that destroy entire stands may force ungulates to seek new forested areas, straining the herd and thus affecting wolves' diets.	The conversion of forest to shrub or meadow habitat could benefit the prey and subsequently wolves.
Sources:	Sources: Snyder 1991	Sources:

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">Areas with known dens can be avoided during the pack's most vulnerable times to ensure survivability.	<ul style="list-style-type: none">Woody encroachment of meadows is controlled, protecting elk wintering habitat and therefore promoting prey abundance for wolves.	<ul style="list-style-type: none">Meadows, tan oak groves and quality browse is maintained, ensuring healthy ungulate populations that can sustain wolves long-term.
Sources:	Sources: Snyder 1991	Sources:

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none">Suppression compromises ungulate habitat and diet, thereby reducing prey availability.	<ul style="list-style-type: none">	Longer climatically driven changes in the precipitation (snow depth) and fire regimes could affect prey (e.g. elk) and wolf populations.
Sources: Snyder 1991	Sources:	Sources: Hebblewhite 2005

Grassland Vulnerabilities

Grasslands also known as prairies historically occurred in mid to upper montane areas on ridges, in both large and small patches up to elevations of 3,280 feet, especially on shallow ultramafic soils (Anderson 2005, Skinner et al. 2006). Today a majority of the grasslands that once existed within Karuk ancestral territory have disappeared due to lack of fire (Skinner 1995, Lake 2013). Traditional. Traditional Karuk knowledge about grasslands has unfortunately also been lost. Yet place names contain references to species such as wild oats. Grasslands have been historically significant for many species of broad-leaved herbs, native annual and perennial grasses, insects, birds, mammals, reptiles, and amphibians (Swanson et al. 2014). Amongst these are important Karuk foods and cultural use species such as Elk, Iris and other grasses used for twine, and a group of geophyte plants known as “Indian potatoes” which include multiple members of the Lilly family, Blue Dicks, White Hyacin, Golden Lantern, Soap Root, Yellow Globe Lilly (Lanctot and Lake ND, Anderson 2005, Schenk and Gifford 1952). Anderson (2005) notes the importance of prairies and grasslands for Indian people across California and lists a number of species of importance in these areas:

“Among the important grass species in California’s coastal prairies were Idaho and red fescues (*Festuca idahoensis* and *F. rubra*), California oatgrass (*Danthonia californica*), and bent grass (*Agrostis exarata*). Characteristic broad-leaved species were Douglas iris (*Iris douglasiana*), California buttercup (*Ranunculus californicus*), and blue-eyedgrass (*Sisyrinchium bellum*). Other species were yampah (*Perideridia kelloggii*), goldfields (*Lasthenia* spp.), and tidy-tips (*Layia platyglossa*)...

Anderson goes on to note the significance of the diversity of these grassland habitats:

California’s coastal prairies provide a good, well-researched example of how native practices promoted vegetational heterogeneity and high biodiversity. According to the ecologist Mark Stromberg, “The coastal terrace prairies in California and Oregon are the most diverse grasslands in North America. If you count the number of species in a square meter of California’s coastal terrace prairie you average 22.6 species—more than the inland prairies of the Midwest, which have between 8 and 12 species” (pers. comm. 2001). (66)

Grassland

Grasslands in particular require frequent burning to maintaining the open prairie structure. Burning prevents conifer encroachment and enhance conditions for key food species, including reducing competition for geophytes such as brodiaea and camas and increasing soil productivity by releasing nutrients. (Anderson 2005, Stone 1951). Fires enhance the production of bulblets of many of the species known as Indian potatoes. Until about 1850, grasslands were so extensive they covered nearly one-fifth of California (Anderson 2005, 28). Anderson notes “The coastal prairies were burned to produce more food, reduce brush or trees, produce new grass for thatch, drive grasshoppers, enhance cordage materials, and increase forage for ungulates. Indian-set fires modified the grassland to fire-resistant species and expanded the grassland vegetation type (2005, 167). Local traditional knowledge of geophytes was emphasized by Harrington: “But they (Karuk People) knew indeed that where they dig cacomites (bulbs/corms) all the time, with their digging sticks many of them grow up, the following year many grow up where they dig them. They claim that by digging Indian potatoes, more grow up the next year again. There are tiny ones growing under the ground, close to the Indian potatoes” (Harrington 1932:73).

Vulnerabilities Resulting from Increasing Frequency of High Severity Fire

While burning is essential for grassland habitats, high severity fire has the potential to scorch soils. Former prairie-grasslands that have been encroached and colonized by trees develop higher carbon-rich biomass that can burn with detrimental effects to soil productivity. Frequent lower to mixed-severity fires that gradually reduce fuel loading can buffer negative impacts to soil (Neary et al. 1999). The anticipated effects of climate change on prairie ecosystems involved synergistic disturbances from management and ecological processes (Bachelet et al. 2011).

Vulnerabilities Exacerbated by Non-Tribal Management Actions

Probably the main intersecting vulnerability to grasslands comes from their severely reduced range due to fire exclusion (Skinner 1995). Grasslands are a threatened ecosystem type due to fire exclusion. Anderson writes “in the absence of fire, grassland ecosystems become choked with detritus, and productivity and reproduction fall drastically. Other

Grassland

studies show that grain production in most native perennial grasses dwindles in the absence of some kind of intermediate disturbance, such as herbivory, fire, or flooding. Furthermore, many of the herbaceous plants with edible seeds have high light requirements and grow only in open grasslands or light gaps in forests and shrublands” (2005, 178-179). To illustrate the vulnerabilities high severity fire poses for Karuk species of importance in grasslands we provide a species profile for Indian potato (tayiith),

Indian Potato / Tayiith / *Brodiaea coronaria*, etc.



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calphotos.berkeley.edu

Cultural Importance

Indian potatoes refer to a variety of geophytes the bulbs and tubers of which are harvested by Karuk people for consumption including *Brodiaea* spp., *Dichelostemma* spp., *Triteleia* spp., *Calochortus* spp., *Lilium* spp., and *Fritillaria* spp. (Karuk DNR 2010). *Brodiaea coronaria* serves as a good indicator for other Indian potato species, as it responses to soil moisture, precipitation/rain-fall, and ecological disturbances.

Life Cycle & Habitat

Indian potatoes grow in prairies and meadows in a variety of settings. Historically, species of Indian potato grew thick as grass in certain valleys in California (Anderson 2005). Karuk and other Native California peoples know proper harvesting techniques that further proliferate these species by promoting bulblet production. As with many prairie and meadow species, Indian potatoes have experienced declines as a result of land cover change, fire suppression, and a reduction in the ability of indigenous peoples to steward the landscape (Anderson 2005).

Mahtáyiith and Fire

Anderson (2005, p.300-301) describes the importance of cultural burning in the management of geophyte populations. Burning recycles nutrients, eliminates competitive grasses and shrubs, and may activate bulblet production. Burning also maintains prairies and meadows by reducing woody encroachment, which otherwise shade out and compromise Indian potato species Anderson 1997).

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Trees, shrubs, and fuel loading are removed (consumed by fire) and residual geophytes express and become a dominant species. 	<ul style="list-style-type: none"> Open grassland/forb Indian potato dominated habitats increase flowering and provide pollinator forage. 	<ul style="list-style-type: none"> Forests and shrublands are converted to grassland, increasing the landscape potential for Indian potatoes.
Sources:	Sources:	Sources:

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Competition from grasses and shrubs is reduced, and bulblet production is enhanced 	<ul style="list-style-type: none"> Soil nutrients released by fire enrich prairie and meadow soils, benefitting Indian potato species. 	<ul style="list-style-type: none"> Woody encroachment is controlled cultural burns, maintaining prairies and meadows open benefit of Indian potato species
Sources: Anderson 1997, 2005	Sources: Anderson 2005	Sources: Anderson 2005

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression leads to encroachment of meadows and prairies in which Indian potatoes grow, and prevents fire from adding valuable soil nutrients 	<ul style="list-style-type: none"> In high density heavy fuel load areas, geophytes impacted if soil productivity reduced Fire line construction can degrade geophyte habitat patches 	<ul style="list-style-type: none"> Post-fire BAER treatments can retard geophyte establishment Salvage logging can disturb geophyte colonies in the soil.
Sources: Anderson 2005	Sources:	Sources:

Middle Elevation Forest: Chinquapin Band

Middle Elevation Forest: Chinquapin Band Vulnerabilities

The middle elevation chinquapin forest habitat (roughly 2,500 to 3,500') is comprised of a number of culturally critical species that contribute important traditional foods and regalia. These include chinquapin (sunyíthih), black oak (xánthiip), saddler oak (yávish), white oak (axvê'ep), live oak (xanpúttip), yew (xupári'ish), port orford cedar (check elevation) (kúpri'p), pacific fisher (tatkunuhpíithvar), and black tailed deer (púufich), prince's pine, ponderosa pine (ishvirip), Douglas fir (itharip), hazel (surip/aththip), incense cedar (chuneexneeyaach), huckleberry (púríth), jeffrey pine (ishvirip), knobcone pine (ishvakippis) and porcupine (kaschiip).

As is the case with the lower elevation forest, the continued persistence of this forest type is highly dependent on fire and indigenous cultural burning (Anderson 2005, Cocking, Fryer 2007, Lake 2013, Lake and Long 2014, Long et al. 2016, Morgan and Sheriff 2012). The composition and structure of these middle elevation forests are fire adapted (Skinner et al. 2006). McCarthy (1993) writes that "Black oaks in particular would not have either their present distribution or their frequency with fire, and studies have shown that fire begun by natural causes (i.e. lighting) would not have occurred frequently enough to create that disturbance" (p. 220).

Middle elevation forests with black and other oaks, chinquapin, Douglas fir, hazel, and gooseberry would traditionally be burned as frequently as every 5-7 years (Lake pers. comm. based on Skinner unpublished studies, see also Pullen 1996 for Karuk burning). Black oak acorns in particular are food for a variety of wildlife and the trees provide valuable pacific fisher denning habitat (North 2012, Long et al. 2016). Karuk management created a system of temporally staggered "resource patches" in the landscape. Burning promotes the production of a series of resources in the stand over time (Lake 2013). The first spring after fires generates a lush re-sprout of forbs and greens that in turn draw in deer and quail for hunting. As grasses become outcompeted over time, another set of foods and medicines becomes available; this next series of plants draws in a new set of associated species to the forest patch. Two years after the fall burning will be good for the production of basketry materials, after 3 years black cap raspberries will begin fruiting again, whereas bracken fern comes in after 7 or 8 years. At this point the acorns begin to get buggy and the

Middle Elevation Forest: Chinquapin Band

burning cycle is ideally repeated (see Aubrey in Lake 2007 about cultural burning and food plots). In the absence of fire, however, the middle elevation chinquapin forest band is susceptible to encroachment by shade-tolerant conifers (Stuart and Salazar 2000).

Individual species in the chinquapin forest zone also benefit from the frequent occurrence of lower intensity fire. Karuk cultural burning sought to optimize berry production. For example the roughly ten year Karuk burning cycle keeps huckleberry into an optimal intermediate disturbance phase that maximizes production and cover (Lake, pers. comm.). In the absence of fire conifers compete with the oaks for resources. Conifers not only increase fuel loads within the stand, they reduce the crown openings needed for robust oak or other hardwood mast production (Cocking et al. 2012). Chinquapin is dependent on frequent disturbance to retain a competitive foothold in the forest (OWIC II 2016). Animal species in this forest type are also fire dependent. Black-tailed deer depends on a mosaic of burned and unburned habitat (Innes 2013), and pacific fisher benefit from burned landscapes for tribal hunting and foraging (Hanson 2013, Long et al. 2016).

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">• Burning releases nutrients to soil• Pests are eliminated via low intensity burns that protect acorn-bearing adults• Burning promotes the production of a series of resources in the stand over time.• Reduction of brush increases water to streams	<ul style="list-style-type: none">• Cultural burning creates viable conditions for black oak reproduction either via root crown sprouting or acorn seeding, both processes which benefit from fire• Black-tailed deer depends on a mosaic of burned and unburned habitat• Pacific fisher benefit from burned landscapes for hunting and foraging	<ul style="list-style-type: none">• Competition from shade tolerant coniferous saplings is eliminated via routine burning, allowing oak stands to endure• Frequent low intensity fire protects mid elevation stands from high severity fire
Sources: Anderson 2005	Sources: Fryer 2007, Hanson 2013	Sources: Fryer 2007

Vulnerabilities Resulting from Increasing Frequency of High Severity Fire

While this forest band is fire-dependent, stand dynamics and individual species in this forest type face vulnerabilities in light of the increasing frequency of high severity fires. A few species such as deer benefit from high severity fires, when the proportion or extent of burn severities (low to high) are diverse. Oaks are not highly fire resistant and even mature black oak trees are susceptible to topkill by fire. Black oaks may re-sprout, but it takes time

Middle Elevation Forest: Chinquapin Band

for these trees to reach maturity for acorn production (Cocking et al. 2012, Stephens and Finney 2002). Fisher dens and denning habitat can be decreased when hardwoods are burned or fall down and no longer suitable habitat.

Vulnerabilities Exacerbated by Non-Tribal Management Actions

Federal fire suppression practices that have prevailed over the past century have led to declines in black oaks and other fire-dependent species (Fryer 2007). Under fire suppression coniferous saplings that would normally be eliminated by fire mature into fire resistant diameters with thick enough bark or structure where they may outgrow and shade the light-dependent species on the chinquapin forest band. During high severity fire events many fire suppression actions create further vulnerabilities to species in this forest elevation zone. Fire fighting tactic of “burning out” along the fire lines creates areas of very high severity fire (Lake pers comm as Resource Advisor). Timber fallers often intentionally cut chinquapin and black oaks considered “hazard trees” during fire suppression activities preemptively because they may have cavities in which fire can ignite and then pose a threat to the fire line control capacity. However such cavities are important habitat for pacific fisher (Long et al. 2016). Black oaks snags are also often fallen with fire line construction activities. Deer benefit even from high severity fires, but if fires are very hot and fire fighters don’t leave any islands of green for refugia, deer may face direct mortality and significant impacts from lack of forage, or literally being burned out of animal safe sites of interior unburned portions of the larger wildfire. To further illustrate the complex of vulnerabilities high severity fire poses for Karuk species of importance in this elevation zone we provide species profiles for chinquapin (sunnyíthih), black oak (xánthiip), Pacific fisher (tatkunuhpíithvar), black-tailed deer (púufich), and porcupine (kaschiip).

Middle Elevation Forest: Chinquapin Band

Chinquapin / Sunyíthih / *Castanopsis chrysophylla*



oregonstate.edu

Cultural Importance

The nuts of sunyíthih are among the various tree fruits important to the Karuk traditional diet (Schenck and Gifford 1952).

Life Cycle & Habitat

Sunyíthih is an evergreen member of the beech family that can grow up to 80 ft tall and live up to 500 years. The tree's fruit ripens the second autumn after pollination, and consists of one to three nuts encased in a spiny bur. Sunyíthih is particularly

competitive in dry, infertile sites. On sites with more moisture and fertile soil conditions, disturbance such as fire is necessary to preserve a chinquapin forest component. Rarely does chinquapin occur in pure stands (OWIC II 2016). The rotten wood areas of the tree's trunk and larger limbs may be burned and cleaned out forming wildlife dens (e.g. fisher, raccoon, etc.).

Sunyíthih and Fire

While sunyíthih is highly competitive as an early succession species and on sites that may be too harsh for the success of other species, it requires disturbance in order to remain competitive on more fertile, moist sites. As such, chinquapin may benefit from a fire regime that will restore its competitiveness among other species. (OWIC II 2016)

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> High intensity fire could kill older tree specimens that reliably produce fruit and wildlife den habitat 	<ul style="list-style-type: none"> General reduction in nuts and loss of den/cavity areas for wildlife 	<ul style="list-style-type: none"> If mature single to multiple trunked trees are burned too frequently then the bushy growth multiple stem growth from will be more abundant reducing dens/cavities.
Sources: Donato et al. 2009	Sources: Donato et al. 2009	Sources: Donato et al. 2009

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Cultural burning can introduce beneficial disturbance into a site while preserving older, nut-bearing specimens 	<ul style="list-style-type: none"> Reduced understory fuel loads (surface and ladder) improve tribal and wildlife access and foraging to nuts and understory vegetation 	<ul style="list-style-type: none"> Routine, cultural burning in stands with old chinquapins reduces competition and keeps a chinquapin component in the forest.
Sources:	Sources: Lake 2013	Sources:

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression limits the disturbance that is necessary to keep a chinquapin component in high quality forests 	<ul style="list-style-type: none"> Agency burnouts or higher intensity fires reduce suitable live and dead trees with dens/cavities for wildlife. 	<p>Tree growth from is transformed to more brushy multi-stem growth and nut production potential is reduced.</p>
Sources: OWIC II 2016	Sources:	Sources: Donato et al. 2009

Middle Elevation Forest: Chinquapin Band

Black Oak / Xánthiip / *Quercus kelloggii*



@ Michael Yager, fs.fed.us

Cultural Importance

While tanoak acorns are the most prized among Karuk people, black oak acorns are also an important traditional food. Having various acorn sources in the forest ensures dietary diversity and resilience in the event of impacts to any one species. Black oak dominated habitat includes many culturally valued species (Anderson 2007, Long et al. 2016).

Life Cycle & Habitat

Xánthiip occurs in mixed-conifer forests as well as in mixed hardwood forests (Long et al. 2016, McDonald 1990). In the highly diverse Klamath-Siskiyou area, black oak has many overstory plant associates. It is a highly drought tolerant species that reproduces primarily by sprouting from the root crown, but also by acorns (Fryer 2007, Lininger 2004, Long et al. 2016)

Xánthiip and Fire

Xánthiip is a fire adapted species with thick protective bark, and can sprout from the root crown following fire. Without fire, coniferous saplings growing beneath adult oaks are able to grow undisturbed and eventually outcompete black oaks for light (Cocking et al. 2012, Long et al. 2016). Cultural burning has historically been critical to maintain black oak stands. Aside burning off competing species, cultural burning also reduces insect pests that can affect both the trees and acorns (Long et al. 2016). Black oak numbers have declined as a result of fire suppression regimes in the last several decades (Anderson 2007, Fryer 2007, Long et al. 2016).

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">May destroy acorn bearing stands that are culturally vital	<ul style="list-style-type: none">Black oaks may retain post-fire dominance over non-sprouting conifers in high severity burn patches or areas of the landscape	<ul style="list-style-type: none">Black oaks may be retained as shrubby, multi-stemmed, low height, growth form.
Sources: Long et al. 2016	Sources: Cocking in Long et al. 2016	Sources: Cocking, Long et al. 2016

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">Pests that could affect both tree health and acorn quality are eliminated via low intensity burns that protect acorn-bearing adults	<ul style="list-style-type: none">Promotes black oak reproduction either via root crown sprouting or acorn seeding, both processes which benefit from fire	<ul style="list-style-type: none">Competition from shade tolerant saplings is eliminated via routine burning, allowing oak stands to persist
Sources: Anderson 2007, Long et al. 2016	Sources: Long et al. 2016	Sources: Anderson 2007, Long et al. 2016

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none">Fire suppression promotes shade tolerant species that are able to outcompete black oaksHigh tree density and fuel loads threaten acorn-producing oaks that are drought and competition stressed.	<ul style="list-style-type: none">Intense burning in dense forests top kill larger, older, acorn producing black oaks.Fire suppression activities, such as fire line tree felling or burnouts remove mature acorn bearing trees.	<ul style="list-style-type: none">Repeated higher severity burns will reduce the abundance of mature acorn producing trees or induce a greater proportion of shrubby growth structural form
Sources: Cocking in Long et al. 2016	Sources: Kauffman and Martin 1987, Cocking et al. 2012, Long et al. 2016	Sources: Cocking et al. 2012, Long et al. 2016

Middle Elevation Forest: Chinquapin Band

Pacific Fisher / Tatkunuhpíithvar / *Pekania pennanti*



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Cultural Importance

The fur of tatkunuhpíithvar is traditionally used in Karuk regalia. The Pacific fisher has experienced significant declines in Karuk territory (Zielinski et al. 2010). The Tribe seeks to facilitate range expansion or reintroduce fisher into the landscape. (Karuk DNR 2010)

Life Cycle & Habitat

Tatkunuhpíithvar prefers hardwood forests with significant canopy cover, with large trees and snags where it convert large cavities into a den. More open habitats may be used for hunting and foraging. Among the most important prey for fishers is porcupine, a species that has also experienced regional declines. The restoration of porcupine is vital to the successful reintroduction of fisher. (Golightly 2006, Hanson 2013, Karuk DNR 2010)

Tatkunuhpíithvar and Fire

For some time, the assumption among Western scientists had been that fire represents a significant loss of habitat for tatkunuhpíithvar. However, a recent study (Hanson 2013) reveals that fishers may actually benefit from managed wildfire and mixed-severity prescribed burns. The study reveals a "bedroom and kitchen" effect in which fishers prefer recently unburned forest for denning and resting, while preferring burned areas for foraging and hunting.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Dens may be destroyed and fishers killed during fire event Loss of habitat and prey for immediate use. 	<ul style="list-style-type: none"> The destruction of large hardwood stands reduces fisher denning habitat Burned areas may attract fisher prey and enhance hunting 	<ul style="list-style-type: none"> Extensive high severity burned landscape may affect fisher hunting and denning opportunities and reduce habitat connectivity
Sources: Hanson et al. 2013	Sources: Hanson 2013, Zielinski et al. 2010	Sources: Hanson 2013, Zielinski et al. 2010, Davis et al. 2007

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Either avoids burning in known fisher denning areas, or burns at lower intensities so as to protect dens and canopy cover. Cultural burning at a specific season (e.g. fall) would reduce impacts to mothers and juveniles. 	<ul style="list-style-type: none"> Burned areas attract prey that fisher depends on, benefitting fisher hunting habitat. Some hardwoods with recent burns may have enhanced new or existing cavities. 	<ul style="list-style-type: none"> Creates a burned/unburned mosaic that improves fisher hunting habitat while preserving denning habitat Maintenance of oak dominated woodlands serve multiple fishers life history requirements
Sources:	Sources: Hanson 2013	Sources: Hanson 2013

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Fire suppression may reduce fisher hunting habitat while promoting high value denning habitat at a high risk of fire. 	<ul style="list-style-type: none"> Snags needed for denning often cut as preemptive fire fighting tactic. 	<ul style="list-style-type: none"> Salvage logging removes standing wood, and future wood debris that is important to fisher habitat
Sources: Hanson 2013, Slauson and Zielinski 2016, Zielinski et al. 2010	Sources: Lake pers. obs. As READ on local wildfires	Sources: Slauson and Zielinski 2016, Zielinski et al. 2010

Middle Elevation Forest: Chinquapin Band

Black Tailed Deer / Púufich / *Odocoileus hemionus*



Photo: Dr. Madeline Kalbach, fws.gov

Cultural Importance

Púufich is among the most important traditional Karuk foods and sources of utilitarian and ceremonial items. In 2005, over 65% of Karuk households reported hunting púufich for food (Norgaard 2005). The meat, sinew, bones, hide/skin, fur, antler, and hooves have been used extensively for traditional functions from tools to regalia.

Life Cycle & Habitat

Púufich has a home range in response to available resources, often influenced by fire severity burn patterns. Fire created edge habitats (pyro-ecotones) provide opportunities for varied forage as well as cover. The púufich diet is comprised of the tender shoots of various woody species, tree lichens, forbs (particularly in spring and summer), acorns, and fungi. Mating takes place in fall, after which does give birth to one or two fawns in the spring. (Innes 2013)

Púufich and Fire

Púufich is a fire-dependent species. Fire not only leads to higher nutrient content in forage, it can promote a landscape mosaic of severity patches that makes for suitable deer habitat. However, high-intensity, large-scale severity fire may reduce the mosaic composition and make large swaths of land unusable by deer. (Innes 2013, Karuk DNR 2010)

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> High severity, large-scale fire may burn a significant portion of black-tailed deer's home range Oak groves burned by high-intensity fire can reduce deer diets rich in acorns 	<ul style="list-style-type: none"> If soil moisture is available, resprouting foliage is viable forage. Extensive high severity burns reduce habitat and increase vulnerability to predators. 	<ul style="list-style-type: none"> Smaller patches of high severity fire that maintain more open shrub, fern, forb, and grasses promote higher quality forage and dispersal for deer.
Sources: Innes 2013	Sources: Lake pers obs.	Sources: Dasmann and Dasmann 1963

Effects of Karuk Cultural Burning Across Time

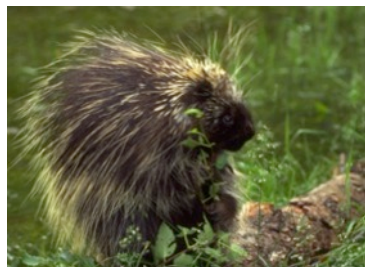
Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Low-intensity fire can release soil nutrient productivity that promotes nut crops, fruits, greens and shoots that are important food sources for deer 	<ul style="list-style-type: none"> Coniferous encroachment of meadows and forest openings is controlled, protecting foraging habitat with cover/protection. Increase acorn (reduced pests) and browse plants quality. 	<ul style="list-style-type: none"> Promotes landscape ecological diversity and productivity that benefit deer at individual, herd, and population scales.
Sources: Karuk DNR 2010	Sources: Kremaster and Bunnell 1992, Lake 2007, 2013m Busum 2006	Sources: Lake 2013, Dasmann and Dasmann 1963

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression leads to declines in forage quantity and quality, leading to púufich declines. 	<ul style="list-style-type: none"> Burnout/back burn operational fires can kill deer if can't escape. Fire suppression or repair activities disrupt or disturb deer. 	<ul style="list-style-type: none"> Burn Area Emergency Repair post-fire treatments may disrupt deer foraging, travel/access desired habitats.
Sources: Karuk DNR 2010, Garton et al. 1976	Sources: Lake Pers. obs.	Sources: Grifantini et al. 1992

Middle Elevation Forest: Chinquapin Band

Porcupine / Kaschiip / *Erethizon dorsatum*



Gerald and Buff Corsi © California Academy of Sciences

Cultural Importance

Kaschiip's quills are used by Karuk people in the production of basketry and regalia. Ideally the quills are harvested via non-lethal methods, and then the porcupine is re-released. Kaschiip has historically held important ecological roles as a species that maintains oaks woodlands and reduces conifer encroachment, and as important prey for the Pacific fisher. The Karuk Tribe aims to restore a healthy local porcupine population, which may in turn assist the recovery of other habitats and species. (Karuk DNR 2010)

Life Cycle & Habitat

Kaschiip depends on early seral, hardwood/forb dominated, and post-fire habitats in summer, while relying on coniferous stands in winter. During the winter, Kaschiip commonly dens in congregations in rock outcroppings. The porcupine diet consists of herbaceous plants, twigs, and particularly in the winter, coniferous bark and needles. As a result of habitat loss, naturally low reproductive rates, and former Federal and State eradication programs to protect timber harvests, porcupines are now rare in much of California. (Karuk DNR 2010, Lewis 1993, Sweitzer 2012, Yocom 1971)

Kaschiip and Fire

While kaschiip inhabits and can thrive in post-fire habitats, high severity burn areas that significantly reduces vegetative cover and potentially destroys entire coniferous stands can affect survivability by increasing chances of predation and reducing their winter food supply.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">• Fire may kill individuals who are unable to escape• Reduced vegetative cover resulting from fire may increase chances of porcupine predation	<ul style="list-style-type: none">• Winter porcupine habitat and diet may be compromised by the burning of entire coniferous stands	<ul style="list-style-type: none">• High severity burned watershed with little cover or foraging vegetation can reduce porcupine habitat quality.
Sources: Band 1996	Sources: Band 1996	Sources:

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none">• Small scale patch burning reduces the threat of mortality to individuals.	<ul style="list-style-type: none">• Post-fire habitats that are critical to porcupine can be promoted using low-intensity burns	<ul style="list-style-type: none">• Cultural burning regimes foster landscape patch diversity of multi-aged and diverse forests.
Sources:	Sources:	Sources:

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none">• Suppression practices make scarce the post-fire habitats that are important to kaschiip	<ul style="list-style-type: none">• Fire exclusion practices that increase tree density and fuel loads threaten beneficial fire-vegetation diversity, increase drought stress and fire risk	<ul style="list-style-type: none">• Extensive high severity burn areas reduce habitat quality for porcupines and dispersal/foraging.
Sources:	Sources:	Sources:

High Elevation Forest

High Elevation Forest Vulnerabilities

High elevation forest are defined here as those existing above the chinquapin band (note however that the shrub form chinquapin may be found at these elevations -but is this non-producing?). Like their lower elevation counterparts, the high elevation forests within Karuk ancestral territory are biologically rich and incredibly species diverse. Taylor et al. (2006) note, "The conifer component of montane forests can be quite diverse and up to 17 conifer species have been identified in some watersheds in the north central Klamath Mountains" (p. 175). Karuk foods and cultural use species occurring in this forest type include the Sugar Pine, Port Orford Cedar, Incense Cedar, Green Leaf Manzanita, Saddler oak, Gooseberry, Black Cap Raspberries, Trailing Black berries, Lilies (tiger/Cascade lilies) and Beargrass (which especially occurs towards coast where has fog). Wolf (ikxâavnamich) is also important here.

Karuk Cultural burning enhances species in the high elevation forest type, making nutrients available in soils, releasing the seeds in sugar pine cones, stimulating growth and flowering of beargrass and minimizing fuel loads to protecting from high severity fires. Cultural burning at roughly 5-10 year intervals across the landscape creates multiple good gathering areas for beargrass (Hummell et al. 2012).

Vulnerabilities Resulting from Increasing Frequency of High Severity Fire

While this forest type benefits from regular low severity fire, high severity fires can damage trees and burn duff into soil deep enough to destroy bear grass rhizomes (Hummel et al. 2012). Damage to forest duff from very hot fires can delay or prevent the re-establishment of beargrass. Mature trees stressed by fire injury are susceptible to bark beetle and other insects which increases future fire severity (Fettig et al. 2013). In the longer-term aftermath of multiple high severity fires, there is risk of loss of these forest types to brush fields (Donato et al. 2009). With repeated high severity fires brush and down woody material can hinder Sugar pine reestablishment and increase risk of repeated high severity fires. Diseases such as white pine blister rust, coupled with fire exclusion also threaten the persistence of sugar pines (van Mantgem et al. 2004).

High Elevation Forest

Vulnerabilities Exacerbated by Non-Tribal Management Actions

Fire fighting tactics themselves have particular negative impacts on species in the high elevation forest zone. For example Sugar Pines are intentionally cut down preemptively during fire line construction because they “could burn” since these trees form snags and fire can enter their cavities (Lake pers. comm., obs READ experience). If salvage logging takes place after fires, Sugar pines are often targeted as economically valued species (Sessions et al. 2004).

High Elevation Forest

Sugar Pine / Ússip / *Pinus lambertiana*



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Cultural Importance

Ússip is used by Karuk people for ceremonial and subsistence purposes. The snags possess high quality “black pitch” which is not only a traditional form of money, but is also utilized in the ignition of cultural burns (Hillman 2016). Sugar Pine groves were family owned and managed for nuts (food), pitch (medicine), and roots (basketry) (Scheneck and Gifford 1952).

Life Cycle & Habitat

Ússip occurs in mixed-conifer forests, and in Karuk country is of particular value when occurring within or adjacent to tanoak or black oak stands. It reproduces via large, heavy seeds held within cones. It can take sugar pines around 150 years to become good cone producers. The seeds are not highly mobile, and unless moved by animals do not stray far from the parent tree. (Habeck 1992, Hillman 2016).

Ússip and Fire

Mature sugar pines are drought-tolerant and resistant to low- to moderate-severity fires. They possess a thick, fire-resistant bark and open canopy limb structure that retards aerial-canopy fire spread. Fire facilitates the release of seeds from the sugar pine's cone. Additionally, the exposed mineral soil after low-severity fire enhances sugar pine seed germination. However, high severity fire can damage sugar pine stands, especially if it reaches the canopy with heavy surface and ladder fuel connectivity. (Habeck 1992, Hillman 2016)

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Fire that reaches the canopy via dense understory ladder fuels can decimate sugar pine individuals and stands. 	<ul style="list-style-type: none"> High severity patches can limit seed dispersal and establishment in burn areas. Mature trees stressed by fire are susceptible to insect predation 	<ul style="list-style-type: none"> Brush and down woody material can hinder sugar pine reestablishment and increase risk of reburn prior to trees reaching cone producing age
Sources: Thompson and Spies 2010	Sources: North et al. 2007, Shatford et al. 2007, Fettig et al. 2013	Sources: Odion et al. 2010

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Exposes mineral soil may benefit sugar pine germination Fire facilitates sugar pine cones' release of seeds Removal of understory vegetation reduces competition for water, nutrients, and light 	<ul style="list-style-type: none"> Low-intensity fire reduced disease and encouraged germination while protecting the canopy The benefits of fire, including pest reduction, result in higher nut quality 	<ul style="list-style-type: none"> Fuel loads are kept manageable in sugar pine stands, reducing the severity of future wildfires and thus protecting stands Maintenance of sugar pines as components of the landscape
Sources: Habeck 1992, Hillman 2016	Sources: Habeck 1992	Sources: Habeck 1992

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression increases competition, reduces germination, and allows disease to fester in stands 	<ul style="list-style-type: none"> High fuel loading threatens sugar pines in burnout/back burning activities. Fire suppression actions, sometimes remove sugar pines. 	<ul style="list-style-type: none"> Salvage logging targets economically valued sugar pines that are ecologically and culturally important
Sources: Hillman 2016	Sources:	Sources:

High Elevation Forest

Bear Grass / Panyúrar / *Xerophyllum tenax*



@ Kirsten Vinyeta

Cultural Importance

Panyúrar is an important plant species for Karuk basket weavers and regalia makers. The long blades of grass are among the materials used to make traditional baskets and regalia. The blades are considered best for basket weaving the first year after a fire (Crane 1990, Hummel et al. 2015, Hummel and Lake 2015).

Life Cycle & Habitat

Bear grass is a perennial, subalpine herb that inhabits upper slopes, often near or beneath coniferous forests. Flowering typically occurs on a 5-7 year cycle. After fruiting, plants die off but are replaced by vegetative reproduction via rhizomes. Bear grass flower stalks are browsed by ungulates such as deer and elk. (Crane 1990, Hummel et al. 2012)

Panyúrar and Fire

Panyúrar can be stimulated by fire, and is adapted in that it can sprout from rhizomes following fire, or reestablish by seed. At the same time, the part of the rhizome capable of sprouting can be damaged by fires that are hot enough to remove most or all of the duff layer in a site. Whether bear grass can re-inhabit a site after hot fire destroys existing rhizomes depends on how suitable the site's conditions were for bear grass to begin with (Crane 1990, Hummel et al. 2012.)

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> High intensity fire may burn duff into soil deep enough to destroy bear grass rhizomes, delaying or preventing post-fire re-establishment 	<ul style="list-style-type: none"> Depending on site conditions, panyúrar may still struggle to re-inhabit a formerly occupied site in which vegetative reproduction was compromised by fire. 	<ul style="list-style-type: none"> Reestablishment of beargrass in the understory depends on soil productivity and reduced competition with coarse woody material, shrubs, and trees
Sources: Crane 1990, Hummel et al. 2012	Sources: Crane 1990	Sources: Hummel et al. 2012.

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Cultural burning can take place during seasons and under conditions that reduce the chance of bear grass rhizomes being severely scorched 	<ul style="list-style-type: none"> Fire, particularly low intensity fire that preserves the plant's rhizomes, can rejuvenate bear grass and stimulate growth and flowering. 	<ul style="list-style-type: none"> Cultural burning at desired frequencies (5-10 yrs.) in different geographic areas helps maintain preferred gathering source areas.
Sources: Anderson and Lake 2016, Hummel and Lake 2015	Sources: Crane 1990, Hummel et al. 2012	Sources: Hummel and Lake 2015

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Fire suppression deprives bear grass of the stimulating effect fire can have under mix severity burning circumstances 	<ul style="list-style-type: none"> Fire suppression activities, such as line construction can remove beargrass patches. 	<ul style="list-style-type: none"> Burn Area Emergency Response treatments, associated with soil erosion mitigation can reduce beargrass reestablishment.
Sources: Hummel et al. 2012, Hummel and Lake 2015	Sources: Hummel et al. 2014	Sources: Lake pers. obs.

Wet Meadow

Wet Meadow Vulnerabilities

Karuk ancestral territory contains a number of higher elevation wet meadow systems which are both critical habitat for species and important for hydrologic, ecological and fire dynamics in lower elevations (below the meadows). Wet meadows are found scattered throughout the higher elevation forest and high country. Important species occurring in wet meadows include black bear, elk and deer (summer), trailing blackberry, Mariposa and Panther lilies, Wild Turnip, and multiple kinds of Indian potatoes (e.g. *Brodiaea coronaria*). Wet meadows not only contain many species of importance, they are important indirectly for their connection to other habitat types. Wet meadows are dependent upon snowpack from upper elevation high country, and in turn provide a steady release of water that gives protection from flooding to forested areas below.

Wet meadow systems are dependent upon ignitions from human and natural sources (Dwire and Kauffman 2003, Turner et al. 2011, Lake and Long 2014). In the absence of fire, the encroachment of conifers leads to a cycle in which the water table to drop and meadows dry up. As the soil in formerly wet meadow areas dries out, upland species that cannot have their roots saturated and therefore formerly excluded by the higher soil moisture can now thrive and enter the former wet meadow system as competitors. These drier soils are more conducive to Douglas fir, true firs (*Abies* spp) and other hardwood trees which were kept out before, continuing a cycle of transition away from the meadow system (Halpern et al. 2010). Numerous wet meadows within Karuk ancestral territory are being lost through this process, especially at the middle to high elevations. This same cycle of fire suppression, conifer encroachment, changing soil moisture dynamics leading to further encroachment of conifers and other species also takes place around springs, causing springs to dry up.

Vulnerabilities Resulting from Increasing Frequency of High Severity Fire

Wet meadow systems under various climatic regimes, generally are relatively protected from fires due to site moisture (soil and live vegetation). Nonetheless recent observations of fires in Karuk territory indicate expansion of fire into riparian zones where it did not previously occur. While burning is essential for the maintenance of wet meadow habitats,

Wet Meadow

high severity fire has the potential to cause direct mortality to species. Historically, fire occurrence at higher elevations was controlled by biophysical parameters (slope position, aspect, soil types, topography) and the fuel loading receptive to ignition and fire spread. Tree and shrub encroachment into meadow can alter the fuel load properties in the soil and above. High severity fires which burn from the forest to meadow transition can increase the depth and persistence of higher severity more lethal fire effects to species associated with meadow habitats

Vulnerabilities Exacerbated by Non-Tribal Management Actions

Probably the main intersecting vulnerability to wet meadows comes from their severely reduced range due to fire exclusion since wet meadows are a generally threatened ecosystem type. Other climate related drivers such as changing patterns of precipitation and temperature are however likely more dominant threats to these systems than the increasing frequency of high severity fires per se.

Leopard Lily / Mahtáyiith / *Lilium pardalinum* ssp. *Wigginsii*



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calphotos.berkeley.edu

Cultural Importance

Mahtáyiith is among the most prized bulbs in the Karuk diet. It is dug in the fall and is traditionally cooked in an earth oven like many other bulbs (Schenk and Gifford 1952).

Life Cycle & Habitat

In the Klamath Mountains, leopard lily is found in high country wet meadows, especially on serpentine soils. This rare and endangered herb grows from bulbs that are small and often clustered, and typically blooms in July (CNPS 2016).

Mahtáyiith and Fire

According to Pacific Forest Trust (2016), "mountain meadows are among California's most threatened habitats due to fire exclusion." In the absence of fire, conifers and other woody species encroach upon these meadows, lowering the water table and thus compromising the stability of this wet habitat. As such, mahtáyiith depends on fire to maintain the wet, open high country meadows in which it is found (Pacific Forest Trust 2016). Anderson (2005, p.349) describes conditions in which leopard lily populations that had produced harvestable bulbs for 30+ years collapsed as a consequence of fire suppression that led to overly shaded meadow conditions.

Effects of High Severity Fire Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Removal of competing tree and shrub vegetation, and fuel loading favors post-fire lily response 	<ul style="list-style-type: none"> Reduced vegetation (trees and shrubs) and surface fuels (duff and litter) promotes lily flowering and animal foraging which can re-establish or spread lily populations 	<ul style="list-style-type: none"> Continued high severity burns could favor or enhance lily persistence across the landscape
Sources:	Sources:	Sources:

Effects of Karuk Cultural Burning Across Time

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> Removal of competing tree and shrub vegetation, and fuel loading favors post-fire lily harvesting 	<ul style="list-style-type: none"> Saplings that were encroaching the meadow have been burned and the meadow remains open, benefitting mahtáyiith 	<ul style="list-style-type: none"> Repeat cultural burns prevent woody encroachment, helping retain the water table at a level that can continue to supply the wet meadows in which mahtáyiith lives.
Sources:	Sources: Anderson 2005	Sources: Anderson 2005, Pacific Forest Trust 2016

Effects of Federal Fire Management Strategies on Species' Climate Change and Fire Resilience

Prior to Fire	During Fire	After Fire
<ul style="list-style-type: none"> Suppression leads to coniferous encroachment and desiccation of meadows where leopard lily is found, and has directly affected leopard lily populations. 	<ul style="list-style-type: none"> Fire line construction can damage short-term lily populations. 	<ul style="list-style-type: none"> BAER treatments to control or mitigate erosion may prevent lily recovery.
Sources: Anderson 2005, Pacific Forest Trust 2016	Sources:	Sources:

High Country Vulnerabilities

High country is defined as montane and into the subalpine zone where sugar pines drop out (see Taylor et al. 2006). Although the high country may have fewer species used directly for food, fiber and medicine than areas lower down, this habitat zone is nonetheless critically important in relation to the health of other parts of the ecosystem. For example healthy meadow systems in the high country provide a buffer for flooding, sustaining water throughout the summer and decreasing the potential impacts of erosion in lower elevations. The high country is key for Karuk cultural and spiritual activity (Chartkoff 1983, Wylie 1976). Especially during summer, families and individuals journey from lower elevation zones to harvest and process foods, materials and medicines, to hunt, fish, and pray. Fires are set on Offield mountain (Ma' and Sa'Tue'yee [upper and lower mountain peaks] in particular as part of World Renewal ceremonies in late summer (Kroeber and Gifford 1952). Foods, fibers and medicines of particular importance to Karuk people occurring in the high country include: kishvuuf, wild onion, beargrass, huckleberry, princess pine, Oregon grape, and sugar pine (at lower portion of this zone). Turner et al. (2011) write, "these environments and their plant resources have received little detailed attention in ethnographic literature, and their importance to Indigenous Peoples often remains unrecognized."

Karuk people have used fire to tend this habitat zone since time immemorial. Burning in these areas often occurs along trail networks, targeting meadow areas and patches of particular food and cultural use species such as huckleberry.

Increasing Frequency of High Severity Fire: Vulnerabilities to High Country

While species in the high country have been adapted to relatively frequent low intensity fire, predicted increases in the frequency of high severity fires pose vulnerabilities to the high country. Historically, this habitat zone was protected from such fires by the presence of snowpack (Olson et al. 2012). The high country is also vulnerable in light of other climate impacts, especially extended drought and the loss of snow given trends towards greater percentage of precipitation falling as rain (Olson et al. 2012).

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Chapter Four

High Severity Fire and Vulnerabilities to Program Capacity

The Karuk Tribe governs reservation and trust lands, tribally owned fee parcels and the rights and interests of the tribe and its members/descendants as it relates to the air waters, lands, plants, animals, and ecosystem processes within Karuk Aboriginal Territory. Managing for climate change requires long-term institutional capacity within the Tribe, yet climate change itself simultaneously holds the potential to undermine tribal capacity. Threats to Karuk program capacity resulting from the increased frequency of high severity fire occur in the context of the remote location and specific jurisdictional context of the Tribe. The Karuk Tribe is a self-governance Tribe, employing roughly ~231 staff and with an annual operating budget of ~\$37 million. The Tribe has developed programs, policies and departments to administer services to Karuk people and to uphold responsibilities to care for the land. The governmental structure includes nearly twenty departments, programs, and services organized into three service districts. The area is remote with a single major highway connecting the 120 miles along the Klamath river between these districts. Administrative offices, government operations and the Karuk People's Center are located in Happy Camp, the Department of Natural Resources is located in Orleans and Somes Bar, and the Karuk Judicial System is located in Yreka. Health clinics, education and elders programs, housing authority offices, community computer centers, tribal court services, and human services/Indian Child Welfare programs are located in each of the three main population centers.

Tribal functions take place within an infrastructural context that includes power supplied by Pacific Gas and Electric in the Orleans community and Pacific Power in Happy Camp, water systems supplied by local municipalities (Orleans and Happy Camp), phone lines from Siskiyel and private satellite carriers, and highway maintenance by CalTrans and Siskiyou and Humboldt counties. In addition, the US Forest Service operates hundreds of miles of dirt roads in the region. A sizable section of Karuk ancestral territory is entirely off the grid (homes along roughly 60

highway miles through ancestral territory totaling 46 Karuk tribal members and descendants in 19 households).

While all tribal programs may face general impacts during high severity fires such as transportation interruptions, air quality impacts or power outages, all but one of the programs most directly impacted from the increased frequency of high severity fire are located within the Karuk Department of Natural Resources (KDNR). The [2015 KDNR Strategic Plan](#) describes the history and the organization of the department as follows:

Founded with a single employee after Congressional appropriations were allocated to support fisheries management and the restoration efforts of the Tribe, DNR has grown into a multi-program department that has included over one hundred (100) employees during fire events – all sharing the common mission of protecting, promoting and preserving the cultural/natural resources and ecological processes upon which the Karuk depend. A focus of the department is to integrate traditional management practices into the current management regime, which is based on certain principles and philosophy. This is noted in the [Department's Eco-Cultural Resources Management Plan \(ECRMP\)](#):

As guardians of our ancestral land, we are obligated to support practices that emphasize the interrelationships between the cultural and biophysical dimensions of ecosystems. The relationships we have with the land are guided by our elaborate religious traditional foundation. For thousands of years, we have continued to perform religious observances that help ensure the appropriate relationship between people, plants, the land, and the spirit world. We share our existence with plants, animals, fish, insects, and the land and waters. We are responsible for their well-being. Our ancestral landscapes overflow with stories and expressions from the past, which remind us of who we are and direct us to implement sound traditional management practices in a traditional and contemporary context.

In recent years the KDNR has successfully spearheaded the adaptation of the first Tribal Cultural Beneficial and Subsistence Uses for the TMDL process in the State of California, won litigation ending suction dredge mining throughout the State, and played a leading role in historic relicensing and settlement processes regarding the removal of four main-stem Klamath river dams. The Karuk DNR headquarters are

located at 39051 Highway 96 in Orleans, with a workstation located eight miles upriver in Somes Bar and the office of the Sínpuuk Digital Library, Archives and Museum two miles downriver in Orleans.

Multiple Jurisdictions and Limited Recognition of Tribal Authorities

The Tribe operates within a complicated cross-jurisdictional terrain in which Karuk management authority is often unacknowledged and misunderstood. Federal non-Tribal management agencies are operating in Karuk territory include the US Forest Service, Bureau of Indian Affairs, US Fish and Wildlife Service, Bureau of Reclamation and the Environmental Protection Agency (which oversees State implementation of air and water quality). State and regional entities include California Fish and Wildlife Department, California Department of Forestry and Fire Protection (CALFIRE) and the Northwest Regional Water Quality Board. Most of the Karuk Tribe's ancestral territory is within the National Forest System.

Lack of recognition of tribal jurisdiction limits Tribal program capacity at multiple levels. On the day to day, this lack of recognition requires enormous staff time to engage in an often contentious manner with other entities, while in the bigger picture, it affects the Tribe's ability to establish and maintain effective Tribal programs under the current budget formulas,

laws and policies of the United States. While climate change, and here the effects of high severity fire in particular stresses the program infrastructure and capacity of the Karuk Tribe, the actions taken by these other entities during and after high severity fires can be as great or greater a problem for tribal program capacity as the fires themselves. Furthermore, the fact that tribal staff must work with two different National Forest units who have had two very different approaches to forest

"While climate change, and here the effects of high severity fire in particular stresses the program infrastructure and capacity of the Karuk Tribe, the actions taken by these other entities during and after high severity fires can be as great or greater a problem for tribal program capacity as the fires themselves."

management including fire also poses challenges to program capacity.

Communicating and interfacing with so many agencies takes a great deal of time and effort, even under normal circumstances. In the context of climate change, meaningful engagement given current budgetary and staff constraints is often

"Climate change is rapidly reshaping the managerial and legal landscape, with the result being that multiple new agency plans and action items are put forward by new configurations of individuals and groups who may not have training or familiarity with tribal trust responsibilities."

difficult, if not impossible. Climate change is rapidly reshaping the managerial and legal landscape, with the result being that multiple new agency plans and action items are put forward by new configurations of individuals and groups who may not have training or familiarity with tribal trust responsibilities. This situation puts tribal staff into defensive mode of responding to queries and projects coming from other entities regarding actions of their design. In addition, in the face of climate change agency actions come more often in the form of crisis situations that invoke emergency timelines and management protocol exceptions. Forest

Service personnel in particular have frequent turnover and a tendency to make short-term decisions that have long-term adverse impacts. Bill Tripp included the following statement in his comments to the EPA Climate Change Adaptation Plan Webinar in 2012:

Typical agency turnover in Karuk country is also an issue. Hiring of agency positions in rural areas has a tendency to bring in employees that have never experienced the local situation. These individuals also have a tendency to remain in place for only a short period of their career. This imposes fundamental problems with the ability of a community in place to maintain a culture of intuitive interaction and learning throughout the landscape. Agency personnel have a tendency to make short-term decisions that have long-term adverse impacts for communities of place.

The KDNR has limited staff that can participate in these regulatory processes, and staff time for such engagement is not written into the deliverables of grants, which form the majority of KNDR funding.

Constraints of Project Based Funding

The fact that Karuk tribal jurisdiction is not recognized by all agency actors further limits capacity across a range of programs because BIA base funding availability is not scaled up to reflect the area that the Tribe seeks to manage. Whereas the Karuk Constitution is inclusive of all Karuk ancestral lands, according to the Indian Self Determination and Education Act, the formula used for funds allocation is based on a Tribe's reservation land base. If however, the formula were calculated for a Tribe's territory rather than a reservation it would enable the management of a much larger area. Instead, because much of Karuk DNR funding comes from grants there is no general funding for programs, staff must constantly chase down resources and there are limits in the flexibility of staff to respond in emergency scenarios or to take a proactive approach in response to issues that arise in the moment.

Impacts to Program Capacities During High Severity Fire Events

Karuk ancestral territory is a fire-adapted ecosystem. The presence of fire must be understood as a regular seasonal aspect of tribal operation and life. However, in the context of fire exclusion and the changing patterns of temperature and precipitation fires have significantly increased in severity and size. The average number of fires over 1,000 acres has doubled in California since the 1970s. Challenges to program capacity in the face of high severity fires then, occur in this general context.

Challenges that are experienced across programs include loss of internal staff who are needed to participate on fires, difficulty reaching Forest Service staff who may also be out on fires, disruption of transportation routes, or the need to stay home from work in order to protect one's own home. Staff from the Bureau of Indian Affairs and other agencies with fiduciary trust or other consultation responsibilities also go on fires causing additional layer of complexity in communication, coordination and consultation efforts. See Table 4.1 general descriptions of impacts

common across programs. More detailed descriptions of impacts for specific programs are provided in the following sections.

Table 4.1 High Severity Fire and Vulnerabilities to Tribal Program Capacity

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Program staff may be unable to access KDNR office or field sites • Program staff may be pulled from existing program tasks onto the fire or on emergency relief detail • Insufficient emergency response capacity for scale of position responsibility • Equipment wear and tear • Staff fatigue from over-work and extended exposure to heavy concentrations of smoke 	<ul style="list-style-type: none"> • Difficulty in completing grant tasks due to loss of staff during fire • Program staff use time and energy addressing post fire management actions of other agencies, forcing long hours and transition from hourly to salaried status costing even more in minimum salary rates under the Fair Labor Standards Act. • Program staff use time and energy addressing impacts to watershed from poorly constructed roads including flooding, sedimentation • Staff burn out and turn-over 	<ul style="list-style-type: none"> • With repeated events program capacity may be weakened to the point of jeopardizing overall functionality as well as relationships with partners and funders. • Relationships with agencies may be jeopardized from contentious litigation • Lack of funding for engagement with longer term fire and climate planning • Extreme alteration of ecosystems may exceed management capacity • Extended workloads, emergency response related PTSD and compounded effects intergenerational trauma on tribal member employees will likely drive tribal people that should be assuming leadership roles in their community to increased risk of physical, mental and emotional instability.

“Everything seems to stop when we have a fire.”

Multiple people noted, “Everything seems to stop when we have a fire.” Diversion of staff resources and time in conflict and consultation over fire management decisions exacerbate existing institutional vulnerabilities, leaving fewer resources for

progressing actions in positive, proactive directions (e.g. directions that builds upon traditional ecological knowledge, preserves living culture, and enables tribal members to serve a traditional role in a contemporary context).

Infrastructure Impacts During Wildfire Events

The function of tribal programs also requires reliance on infrastructure, including roads and utilities (water, power, telephone, internet), most of which are supplied by non-tribal entities. Karuk ancestral territory is mountainous with the transportation routes almost entirely constricted to the river corridor. Program capacity is often significantly impacted by loss of power and especially by disruption in transportation routes. Municipal water systems have been impacted during fire events and do not have adequate capacity. When one elder's house burned down the town water supply was drained and the fire could not be put out. In the aftermath of the 2008 fires the Tribe instigated an emergency preparedness division which assisted with development of training a tribal Type 3 incident management team to handle Stafford act responses. This team was deployed in 2013 to set up an evacuation center and clean air center, but being grant funded the program disbanded after the two years of initial grant when continuation funding was not granted.

Emergency Management Mode

During fires, the decision-making process moves to a short timeframe and hierarchical structure in which NEPA is not required for significant management actions such as the use of fire for back burning or road building and cutting trees in riparian areas. Individuals within the U.S. Forest Service and California Department of Forestry and Fire Protection (CALFIRE) make decisions with long-term consequences for the Tribe and ecosystem very quickly with little information about Karuk knowledge, values or presence. These individuals do not have long-term connections to the watershed, and base their decisions according to non-Tribal criteria. Actions in riparian and wilderness areas that are not normally allowed are given emergency exemptions. As a result of the imposition of this outside

emergency decision making structure, significant tribal staff time and effort is spent responding to and “cleaning up after” actions taken as emergency measures such as restoring damage to streams from fire lines and road construction. In the words of one staff member “That the Forest Service gets to decide what is a crisis in general is a problem.” When asked how much program time is spent responding to decisions made during crisis situations, Karuk Tribe Fisheries Program Manager Toz Soto replied “almost all of it.” Decisions made by non-Tribal entities about what is to be protected and how to protect it—including the use of back burning, the creation of fire lines and the use of chemicals and fire retardants—require staff time and energy to respond to and diminish limited capacity within the Department of Natural Resources. Others have noted that as high severity fires happen with increased frequency, more planning should take place in advance: “Events that happen predictably every year shouldn’t qualify for emergency exemptions.” Instead, regulatory waivers should apply to the solution rather than the problem. Exposure levels mitigated or remediated, or otherwise balanced over time should be a measure of success in supplying such waivers.

Program Capacity in the Immediate Aftermath of Fires

In the aftermath of high severity fires, erosion, flooding and landslides from the fires or from poorly constructed roads may occur as increased sediment may cause landslides onto roadways. Mitigating this situation takes time and energy, especially from staff in the fisheries, transportation, and watershed restoration programs. Blocked travel routes can be very significant impacts to program capacity if people are unable to get to the workplace, or of those who work in the field cannot access field sites.

In addition, the actions of other agencies in the 1-2 year period after fires may require program staff intervention. This emergency management structure may be extended beyond the wildfire event, as occurred in 2016 when emergency water quality exemptions were requested and granted for salvage logging after the 2014 fire. In 2016, KDNR staff that were working on the proactive approach of the [Western Klamath Restoration Partnership](#) were pulled from this project to engage

in litigation in an effort to protect tribally important species impacted by the Westsides timber sale. Such diversion of resources affects both program capacity and tribal management authority. Over time excessive workloads leads to staff burn out and turn over – a problem that has added challenges in the rural community where there are few people qualified or afforded the opportunity to gain the experience to do many important tasks.

Long Term Effects of High Severity Fire on Program Capacity

If program capacity has been severely weakened during and post fire events the overall functionality of programs may be jeopardized in a number of ways. Whereas relationships and collaborations are needed more than ever in light of climate change, these relationships with other agencies, academic collaborators and funders may be impacted by contentious litigation concerning post fire management activities, or by unfulfilled grant deliverables and incomplete research data as a result of fire interruptions. Climate change in general and the increasing instance of high severity fire compels additional management planning, yet the limitations of grant funding structure make meaningful engagement in such activities nearly impossible. Severe alteration of the Klamath River ecosystem from repeated high severity fires could ultimately exceed the ability of the Karuk Tribe to manage.

"Climate change in general and the increasing instance of high severity fire compels additional management planning, yet the limitations of grant funding structure make meaningful engagement in such activities nearly impossible."

These are general capacity impacts faced by many programs as a result of high severity fire. In the next section impacts to Food Security, Transportation, Water Quality, Fisheries, Health, Integrated Wildland Fire Management, and Watershed Restoration Programs are addressed in more detail.

High Severity Fire and Vulnerabilities to Transportation Program

The mission of the Karuk Tribe Department of Transportation is to provide safe reliable transportation facilities for all users. The Karuk Tribe Department of Transportation (Karuk DOT) is funded through the United States Department of Transportation Tribal Transportation Program. In coordination with the Bureau of Indian Affairs, the Karuk Tribe, acquired funding and first established a Transportation Department in 1992. Throughout the years the Tribe has built a solid foundation for growth and in 2010 entered into a Tribal Transportation Program Agreement with the US Department of Transportation (USDOT) Federal Highway Administration (FHWA). This agreement allows the Tribe to work directly with FHWA and receive federal funding for the administration of the Karuk Tribes Tribal Transportation Program (TTP). A prime objective of the TTP is to contribute to the economic development, self-determination, and employment of Indians and Native Americans.

The Karuk DOT is tasked with constructing and maintaining Tribal transportation facilities exclusively on Tribal Lands. Additionally, the Karuk DOT coordinates and partners with adjacent Federal, State and local agencies to ensure safe reliable transportation facilities for all user groups.

Traditional Tribal Transportation facilities are an important part of the transportation system; we recognize the river and tributary corridors, as well as, earthen foot trails as facilities that were principal means of village to village access, ceremonial needs, cultural resource utilization and commerce preceding European influx into Karuk ancestral territory. The Karuk Tribe is compelled to recognize social justice challenges that have impacted the Tribe since European influx; these issues are still ubiquitous today in the way of low economic opportunity, restricted access to traditional cultural resources, employment, schools, food sources, medical facilities, emergency evacuation routes. All forms of transportation are a vitally important to lessen the impacts from these challenges.

Today, state highways and county roads that traverse through Karuk ancestral territory are recognized as main access routes to population centers locally and regionally. While tribal, state and county transportation facilities are utilized within communities to provide access to general services, education, health services and employment, as well as, ceremonial needs and cultural resource utilization.

Although modern day transportation facilities provide general access, the Karuk people are stewards of this land with the inherent responsibility to pass on knowledge of and access to ceremonial sites, traditional foods and responsible cultural resource utilization. Karuk DOT is committed to scheduled assessments, maintenance and preservation of traditional tribal transportation facilities. Karuk ancestral territory is mountainous with the primary travel routes and only thoroughfare roads along the Klamath and Salmon River corridors. Highway 96 is the main travel route through approximately 72 miles of Karuk ancestral territory. This highway connects the region to Interstate 5 in the East and to Highway 299 to the southwest. The Salmon River Road begins in Somes Bar, traverses another 31.2 miles of road through Karuk ancestral territory and connecting to CA State Route 3 in Etna, CA, with connections to Interstate 5 and CA State Route 299. The Salmon River road is a one-lane route over much of its course. Multiple roads connect to the high country. In addition there are many logging roads maintained by the USDA Forest Service.

The increased likelihood of high intensity wildfire presents risk to travel throughout Karuk territory both due to direct Forest Service and California Department of Forestry and Fire Protection (CALFIRE) road closures during fire events, and from flooding and landslides in the immediate (2 year) aftermath of high intensity fires. While these transportation closures may be relatively short term (in the period of days or weeks), transportation systems are especially vulnerable due to the steep forested topography and the fact that there may be no alternate routes for travel increases the severity of the situation. Road closures during wildfire events cut off the community from the outside, potentially affecting escape routes, access to emergency service and food supplies. In the aftermath of high intensity fires erosion, flooding and landslides may occur as increased sediment may cause

landslides onto roadways. Blocked culverts may cause flooding as upstream flows accumulate behind the culvert. Culvert blockages from increased sediment may damage or destroy main travel routes, as well as travel routes into the high country.

Road managers within the Tribe and CalTrans already contend with these climate-related impacts. However climate change is expected to alter their frequency and intensity. Furthermore, as other climate related events such as flooding, storm surge and sea level rise become more severe, resources of agencies such as CalTrans are likely to be increasingly tapped, making it possible that services and repairs take much longer than usual. Rural regions are commonly under-served due to their low population sizes. Transportation vulnerabilities for the Karuk Tribal community may be further underscored by the fact that the 2014 CalTrans climate assessment for Humboldt County rated Hwy 96 region at middle point of criticality for roads in relation to climate change (2014, p. 2). While Highway 96 may not be the most vulnerable road in the county, this categorization is likely to mean that limited resources will be distributed to other road systems.

The increased likelihood of high intensity and severity wildfire may affect the Karuk Tribe transportation department in various ways. The potential effects of high intensity fire due to climate change are well noted as a priority concern by the Karuk DOT. As multiple routes traverse throughout the heavily forested Karuk ancestral territory, high intensity fire events create short term emergencies, while the impact of fire is long-term to community residents and their transportation facilities. The Karuk DOT recognizes our responsibility to the Karuk People in providing safe ingress/egress for general services, education, health services and employment, as well as, ceremonial needs and cultural resource utilization. We continue to diligently address increasing issues of climate change, as well as, the need for redesign of current transportation facilities with innovative low maintenance solutions to the impacts and aftermath of high intensity fire events. Our ultimate all inclusive goals are to meet the mission of the Karuk DOT in providing safe reliable transportation facilities for all users. During fire events road closures may occur depending on fire location. Working with a small obsolete heavy equipment reserve the Karuk DOT is still compelled to assist in evacuations and

emergency service ingress/egress. To ensure timely accomplishment of emergency tasks new more efficient equipment is greatly needed. Additionally and although not funded, the Karuk DOT must develop and adhere to multiyear monitoring and maintenance schedules directly associated with site specific road and infrastructure stabilization, drainage and debris removal, while and after high intensity fire events.

In general the increasing frequency of high severity fires causes detrimental long lasting impacts to our goal of providing safe and reliable transportation facilities. Realizing the compelling data regarding the effects of climate change and continued inconsistent and inefficient forest management, fire suppression and management techniques by the federal government agencies we have cause for great concern. The Karuk Tribe has acknowledged accessing additional funding with a focus on increased staffing, planning and heavy equipment procurement as a urgent priority to ensure safety while and after an emergency incident.

Table 4.2 Potential Effects of High Intensity Fire On Transportation Program Capacity

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Program staff may be unable to access KDNR office or field sites • Program staff may be pulled from existing program tasks onto the fire or on emergency relief detail • During a local fire events the Karuk DOT assist with ICS tasks (i.e.: equipment operation and structure protection). 	<ul style="list-style-type: none"> • Post fire transportation facility maintenance tasks become impediments to implementing regular construction and maintenance schedules. • Program staff may need to spend time and energy addressing post fire management actions of other agencies 	<ul style="list-style-type: none"> • Due to post high intensity fire event impacts on soil stability, drainage and sediment deposits, the Karuk DOT adopts multiyear monitoring and maintenance schedules for transportation facilities on or adjacent to fire events managed by federal land management agencies.

High Severity Fire and Vulnerabilities to Food Security Program

Traditional food, fiber and medicine are vitally important for Karuk people. Not only do they provide materials necessary for cultural continuity and the preservation of traditional knowledge, they also support physical and mental health. Cultivating, harvesting, processing, preserving and consuming Native food and medicine provide the framework for the Karuk socialization process and religious belief. Rooted first and foremost in this broader importance of traditional food, Karuk food security exists when people have the physical, social and economic access to enough safe and nutritious Native foods needed to maintain an active and healthy life.

This document takes a dual approach to food security. Access to healthy foods in general, including foods that may be purchased in stores or procured in home or local gardens, is also considered here. With one highway frequently closed due to slides, major accidents and wildfire, and the minimum distance to a comprehensive grocery store being roughly 94 miles from the heart of Karuk ancestral territory at Katimiin, the mid Klamath region is considered a food desert.

The potential for increased fire size and severity in the face of climate change creates vulnerabilities to food security across all three levels of our analysis: impacts to traditional foods, impacts to program infrastructure, and impacts to management authority. While cooler burns enhance growing conditions for nearly all Karuk traditional foods, high severity wildfire can negatively impact species of key cultural significance as well as those that make up the majority of the total calories and protein source in traditional diets – namely tan oak acorns and salmon.⁴ Other species vital to food security include deer, huckleberries, tan oak mushrooms and elk. Negative impacts to these species have profound ramifications for nourishment and hunger, physical and emotional health, economic stability, social relations, cultural and ceremonial practice, and political status. Additionally, the Karuk Department of Natural Resources (KDNR) has a thriving Food Security

⁴ See details of how cultural burning enhances these species as well as how high severity fire and the effects of other management impair particular species in the Species Profiles in Chapter Three

Division which can be negatively impacted in light of high severity fire. The [Karuk DNR Strategic Plan](#) lists the goal of this program as achieving:

a sustainable food system that results in revitalized traditional ecological knowledge and practices, healthy communities, restored healthy ecosystem, and healthy economy grounded in traditional subsistence . . . Efforts include but are not limited to: measuring and monitoring designated plots in order to document the efficacy of land management techniques on the quantity and quality of food and fiber species; implementing and evaluating events and activities to inform the tribal community on traditional land and resource management, food and fiber harvest, preparation and storage; and improving agro-forestry management to increase supply of traditional foods.

High severity wildfire may affect the Food Security Division’s capacity in multiple ways. As with other vulnerabilities discussed in this report, we consider potential impacts across three time scales. During a high severity wildfire event, division staff may be pulled away from other responsibilities, may be unable to work due to lack of access to field sites and/or KDNR office location in Orleans if transportation, power supplies or phone service are impacted.

Table 4.3 Potential Effects of High Severity Fire On Food Security Program

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Program staff may be unable to access KDNR office or field sites • Program staff may be pulled from existing program tasks onto the fire or on emergency relief detail 	<ul style="list-style-type: none"> • Difficulty in completing tasks due to loss of staff during fire or alteration of field sites due to wildfire • Program staff may need to spend time and energy addressing post fire management actions of other agencies that threaten traditional foods 	<ul style="list-style-type: none"> • May damage ecosystem to the point that Food Security Division can no longer function • Limited compact funding consumed covering increased operating costs leading to potential loss of key leadership and support staffing.

In the immediate aftermath of a high severity wildfire, division staff may be delinquent in meeting responsibilities and grant-funding deliverables if they have lost staff or time during the fire event. Additionally, staff may be called upon to spend time and energy engaging with post-fire management actions of the USFS or

other agencies that cause further harm to traditional use species. “Fire season and its aftermath seriously impact our objectives’ effectiveness,” reports Karuk Food Security Division Coordinator Lisa Hillman. “Half the time, we’re asked to meet with agency representatives or respond to queries in regard to cultural species protection; the other half, we have to look over their shoulder to ensure that they actually do what we’ve requested. At the same time, we have neither the time to fulfill our own job responsibilities, nor is our time fiscally compensated. Who’s going to be there to protect cultural species when our project funding runs dry?” As a result of the sheer commitment to their work, people do such tasks on top of their existing obligations. We have salaried staff working in excess of 60 hours a week, which equates to about \$15.33 an hour for an employee working at a \$47,840 salary rate. When you add the cost of using personal vehicle use on top of that without the time, energy or budget to file paperwork to charge mileage, and people are working because they care, not because they are advancing financially in life.

Karuk Water Quality Program

The Klamath River and its tributaries are essential for the cultural, spiritual, economic and physical health of Karuk people. Water quality is imperative for access to healthy foods, and necessary for multiple economic, social, spiritual and cultural activities to occur. Water quality TMDL standards are set in the context of Karuk subsistence and cultural uses. Water quality impacts matter for their impact on species of concern, and on human health from drinking as well as the human health consequences of consuming contaminated traditional foods.

Table 4.4 Multidimensional Importance of Water Quality

Basic sustenance	All tribal members living in Karuk ancestral territory get their water from Klamath River tributaries. While those who live in Happy Camp and Orleans have water provided by service districts, people who live outside of these communities draw water directly from streams and creeks.
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Physical health	Access to clean water is a critical issue of human health. In addition swimming in the Klamath and tributaries provides exercise. Eating foods that are free of contamination is critical for good health. Access to a healthy environment is a key dimension of environmental justice.
Emotional health	Interacting with the river and its tributaries and knowing that these are in good health is key for mental health both through contact with nature and physical activity, and combats the low self-esteem associated with intergenerational trauma. Access to a clean environment is key emotional component of environmental justice.
Cultural practice	There are many cultural practices that involve interactions with the Klamath River and its tributaries including fishing, sweats, bathing, cooking and drinking. In addition good water quality matters for the health of the many other species that are connected to Karuk cultural practices.
Family structure and social relations	Water quality is essential for healthy foods the sharing of which is a social obligation. Water quality is necessary to support many food practices including but not limited to fishing. These food-related activities strengthen intergenerational relationships within families and across the community.
Ceremonial practice	Ceremonies require bathing and drinking from the Klamath river.
Traditional knowledge	Tending, harvesting, processing, storing and consuming traditional food perpetuates traditional ecological knowledge.
Political sovereignty	Ongoing actions of fishing, processing, and consuming traditional riverine and other foods confirms Karuk occupancy on the land.

The [Karuk DNR Strategic Plan](#) notes:

The Water Quality Program conducts monitoring and research along 130-miles of the Klamath River and tributaries. This includes data collection on temperature, dissolved oxygen, sediment, nutrients,

phytoplankton, toxins, etc. This data informs state and federal processes and policies. Additionally, the Water Quality management level staff represent the concerns of the Karuk Tribe on Klamath Basin watershed management activities and promote sound water management practices that improve and restore water quality conditions. This program includes a Water Quality Coordinator, Program Project Coordinator and Technicians as needed. . . the Watershed Restoration Program also conducts cross-programmatic work that has a direct effect on improving water quality and quantity.

High severity fire affects the capacities of the Karuk Water Quality Program in a variety of ways. Program staff participate in regionally coordinated monitoring programs and collect samples for multiple agencies in the course of their duties. These activities require staff to collect samples at specific times and places throughout the watershed. Road delays and closures – a normal and frequent occurrence during wildfire events – can prevent arriving at sampling sites at the required time and thus have serious impacts on program functionality. Furthermore, once taken, samples must be sent out for processing in very specific and short time frames. Karuk Water Quality Biologist Susan Corum notes “If you work in 110 degrees for 8 hours you don’t want the data to be worthless because you missed the Fed Ex person.” Transportation delays and road closures can not only invalidate a day’s work, but impact the quality of entire data sets. Multiple gaps in seasonal data sets damage the overall quality of the program’s work and may affect funders or relationships with partners.

Because water quality staff work long hours in the field their respiratory and emotional health may be significantly impacted by smoke, which has both immediate and longer term impacts on program capacity through staff burn out and turn over. These impacts are multiplied when staff work all day in heavy smoke for multiple days in a row. Road closures and delays can make a 10 hour work day into a 14 hours, a situation which impacts morale as well as health. Additional workload during fires may occur for water quality staff when there are spills of fire retardant in the river or lakes. The water quality program is not set up to monitor such events as grant funding is generally not available to conduct such work, nor is funding set aside from responsible agencies to address these eventualities.

During the months following high severity fires the water quality program faces continued impacts. As previously discussed, road closures as a result of sedimentation and flooding frequently occur up to several years following a high severity fire. Road closures from these events can impact daily field work as described above. Increased sedimentation is an important water quality problem, yet like the impacts from retardant drops, this is not one that the Tribe's water quality program is set up to monitor. In the immediate aftermath of a high severity wildfire, division staff may be behind or delinquent in meeting responsibilities and grant-funding deliverables if they have lost staff or time during fire events. In the time period following fires, staff may be called upon to spend time and energy engaging with post-fire management actions of the USFS or other agencies that cause further harm to traditional use species. In 2016 the release of the Westsides salvage timber sale (following the 2014 July Complex Fire) requested emergency water quality exemptions from the Environmental Protection Agency.

Table 4.5 Potential Effects of High Severity Fire On Water Quality Program

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Program staff may be unable to access KDNR office or field sites in timely manner needed for work. • Water samples need to be collected at very specific times each day • Fatigue and respiratory problems from working in smoke for long hours • Water samples need to be transported by UPS 	<ul style="list-style-type: none"> • Difficulty in completing tasks due to loss of staff during fire or alteration of field sites due to wildfire • Program staff may need to spend time and energy addressing post fire management actions of other agencies that threaten water quality such as impacts to riparian areas and retardant drops 	<ul style="list-style-type: none"> • Damage to relationships with collaborators and project funders if past work not completed

Karuk Fisheries Program

Fisheries are vital for the food, health, culture and well being of Karuk people. Salmon are a staple in Karuk diet. The Karuk as the first peoples of the Klamath Mountains have been the managers of salmon since time immemorial. Our ceremonial practices and principles not only revolve around the life cycles of salmon

and steelhead, they historically dictate the harvest seasons for all uses of salmon in the watershed. Contemporary harvest management regulations do not recognize this fact, and in many cases operate in under opposing principles and we have experienced significant decline in species abundance as a result. The [Karuk DNR Strategic Plan](#) lists the goal of this program as:

...garnering a greater understanding of ecological processes that support fisheries through research and monitoring, as well as enhancing fisheries habitat through restoration activities. Research and monitoring informs practices such as river flow and harvest management.

The Karuk Fisheries Department started with funds in the amount of \$150,000 since this initial annual funding was received in the late 80's, the fisheries department has leveraged those funds to establish a full-fledged Department of Natural Resources with a annual budget of over \$2.5 million that exists primarily due to constantly shifting grant funded projects. The program currently employees between 7 and 15 people depending on the season.

High severity wildfire may affect fisheries program capacity in multiple ways. As with other vulnerabilities discussed in this report, we consider potential impacts across three time scales. During a high severity wildfire event program staff may be pulled away from other responsibilities, may be unable to work due to lack access to workplace sites at the Department of Natural Resources office in Orleans or in the field if transportation, power supplies or phone service are impacted.

Table 4.6 Potential Effects of High Severity Fire On Karuk Fisheries Program

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Staff may be unable to access office/field sites • Office may be affected by electrical or phone outages • Fisheries staff suffer from reduced availability of leadership that are consumed by fire response activities. 	<ul style="list-style-type: none"> • Difficulty in completing tasks due to alteration of field sites due to wildfire • Program staff spend time and energy addressing post fire management actions of other agencies that threaten aquatic resources 	<ul style="list-style-type: none"> • May damage ecosystem to the point that fisheries resources no longer exist

Karuk Watershed Restoration Program

Karuk ancestral territory contains hundreds of miles of unmaintained and poorly maintained logging roads that pose a threat to watershed processes, water quality, and aquatic habitats via sedimentation. The [Karuk DNR Strategic Plan](#) describes the purpose of the Watershed Restoration Division as “to protect the habitat of anadromous fish by decreasing the sedimentation caused by the road networks within watersheds of critical concern.”

The Watershed Restoration Program was established in 1999 with the purpose of identifying, planning and implementing projects including the repairing and upgrading of roads, road decommissioning and slope stabilization, restoration forestry, streambank stabilization, stream habitat protection and enhancement. The Watershed Restoration program works with the Fisheries Program to re-establish hydrologic connectivity, promote fish passage, and establish and maintain coldwater refugia in key Klamath and Salmon River tributaries. This program employs a Watershed Restoration Coordinator, Heavy Equipment Operators and Restoration Laborers as needed.

High severity fire affects the capacities of the Karuk Watershed Restoration Program in a variety of ways. During and immediately following fires restoration to remediate soil disturbance is needed and is a major component to the work of the Watershed Restoration Program. Because there are few qualified individuals in this rural community and programs are small, key individuals are often needed in multiple places at once, especially during the crisis climate generated during high severity fires. Tribal staff within this program may be pulled from immediate duties in order to participate as monitors on fires, or other tasks. Equipment is also often needed during fires. While equipment may be reimbursed on a per diem basis, reimbursement formulas do not adequately cover the actual costs of equipment wear and tear.

During the months following high severity fires the Watershed Restoration program faces continued duties in responding to road closures as a result of sedimentation and the flooding which frequently occur up to several years following a high severity fire, especially if large areas of hillsides are denuded. In the

immediate time period following fires, staff may be called upon for their expertise to engage with post-fire management actions of the USFS or such as salvage logging that involve road building and pose risks for future sedimentation. Tasks which staff may desire to execute, but which there is often inadequate time or funding include soil mapping, vegetation correlation, and erosion and sediment control as a result of run-off from high-intensity fires. Soils are a major consideration in the NEPA process and constitute an important specialty area for management of forest road systems. These NEPA related planning tasks pose long-term challenges to program capacity that are potentially amongst the most significant faced by a DNR program. These NEPA related planning tasks have until recently been focused on response to other agency planning efforts instead of a reliably funded proactive approach like that currently being demonstrated by the tribally led [Western Klamath Restoration Partnership](#).

Impacts to program capacity are interwoven with impacts to management authority. The Watershed Restoration Program's goal is to protect watersheds that serve as habitat for Tribal trust species while maximizing the Tribe's and local communities long-term economic and cultural benefits. Lack of knowledgeable traditional stewardship on behalf of the USFS and other agencies has created landscape conditions that have ignored and devastated traditional resources and now threatens the well being of both the forests and the forest based communities. Management policies of the current land managers have undermined traditional avenues of access to resources for this program. These existing conditions are exacerbated in the context of high severity fires given that much of the work of the watershed restoration program is in response to the past management actions of the Forest Service. For example, in the event of increased likelihood of high severity fires the Forest Service can be less willing to decommission roads given the perception they may be needed as future fire breaks.

Table 4.7 Potential Effects of High Severity Fire On Watershed Restoration Program

Immediate	2-Year	Long-Term
• Program staff may be	• Program staff may need to	• May damage ecosystem

pulled from existing program tasks onto the fire or on emergency relief detail	spend time and energy addressing post fire flooding as well as post fire management actions of other agencies that impact watersheds, e.g. sedimentation from logging, road building	to the point that Watershed Restoration Division can no longer function
<ul style="list-style-type: none"> Vehicles and equipment used on fires not fully reimbursed 	<ul style="list-style-type: none"> Due to the extremely rural population of the Mid-Klamath and Salmon River sub-basin can be difficult to find people to cover additional projects 	

Integrated Wildland Fire Management Program

The Karuk Integrated Wildland Fire Management Program began as the Fire and Fuels program in 1994 and has recently expanded to include restoration forestry activities and landscape level planning for future fires. The program has three full time staff positions and employs up to 30 people on fuels reduction projects.

A major goal of this program of direct relevance to this vulnerability assessment is the implementation of traditional fire management regimes. As noted throughout this document, forestlands within Karuk ancestral territory have been severely impacted by extractive timber production, single species management, road building, massive fuel loading, and fire suppression. One dimension of this program is to restore natural forest processes and historic forest composition that promote biological diversity and multi-aged ecosystems, with standing dead trees, downed trees, and logs present in riparian zones and streams. These actions can be achieved through management activities such as timber harvest and stand improvements (i.e. thinning), silvicultural treatments, riparian restoration, and prescribed and cultural burning and managed wildfire. The program does not currently have necessary the leadership or capacity to implement the restoration forestry goals relating to the wildland management and restoration forestry, thus more work day to day is carried out with regards to fuels reductions. The [Karuk DNR Strategic Plan](#) describes:

The Wildland Fire Program is principally concerned with protecting life, property, and cultural/natural resources from uncharacteristically intense wildland fires. It is the Tribe's intention to achieve this by restoring traditional fire regimes on a landscape scale within Karuk ancestral homelands and implementing restorative forestry practices. An important element of this work is ensuring a well-trained, highly professional local fire and fuels management workforce. It also includes having a collaborative interagency body that can coordinate, communicate, and agree on management methods during wildland fire events, as well as preventive measures including the reintroduction of prescribed and cultural burning throughout Karuk ancestral homelands. This is a large part of the eco-cultural revitalization approach being instituted by DNR, as described in the [ECRMP](#). Currently, this program staffs an Assistant Fire Management Officer/Fuels Planner and Fire and Fuels Operations Specialist, in addition to necessary Squad Bosses, Crew Bosses, and Crew Members, based on seasonal need as funding allows.

The Integrated Wildland Fire Management Program capacity is significantly affected during, immediately after and in the longer-term aftermath of high severity fires. Indeed, the capacity of this program is likely the most affected of any DNR program.

During fire events themselves staffing levels, interagency coordination, and communication increase significantly. The Deputy Director of Eco-Cultural Revitalization is responsible for an untenable work and supervisory load and the program does not meet the necessary supervision requirements. On top of this workload, the task at hand is enormous with much at stake given that many of the vulnerabilities faced by specific cultural use species in light of increasing high severity fire discussed in Chapter Three occur in fact due to fire suppression actions. Decisions made by USFS and CALFIRE about what is to be protected and how to protect it including the use of back burning, the creation of fire lines and the use of chemicals and fire retardants have all created profound damage for the ecology of the region and for culturally important food species and gathering areas. Diversion of staff resources and time in conflict and consultation over these decisions exacerbate the abovementioned institutional vulnerabilities leaving fewer resources for progressing our actions in positive, proactive directions (e.g. directions that builds upon traditional ecological knowledge, preserves our living culture, and

enables tribal members to serve a traditional role in a contemporary context). Fire fighting activities of high severity fires also hold the potential to interfere with the ability of Karuk tribal members to perform cultural practices and erode the Karuk Tribe's sovereignty over tribal lands, resources and constitutional jurisdiction. Staff within this program sit at the interface, attempting to influence these outcomes.

Furthermore decisions made and actions taken during fire suppression set up cycles for future fire outcomes. Program staff and especially program leadership is at the interface between traditional Karuk understanding of fire, cultural consequences and the top down hierarchal fire fighting machine of CALFIRE

As if the above weren't enough, leadership within the Integrated Wildland Fire Management Program has the near impossible job of attempting to protect critical tribal cultural resources under conditions of limited recognition of the Tribe's management authority (see Chapter Five for detailed discussion). Staff in this position are under quite significant pressure. On top of this, frequent turnover in Forest Service and CALFIRE staff means that conversations, decisions happen again and again. These conditions create enormous fatigue. Deputy Director of Eco-Cultural Restoration and traditional practitioner Bill Tripp describes the devastating emotional impacts of trying to communicate Karuk perspective on fire and protect cultural resources in the face of Forest Service presence fighting the large fires of 2008.

On these fires, every two weeks you are dealing with new people, and you're going over the same things, and you are trying to re-justify every decision that was made where you were barely able to hold onto protection of one little piece of something. And then you're losing a piece of that cause new people came 14 days later. And then you're losing another piece of that and another. And you spend your whole time going over everything that you just went over again, and again, and again. And losing a little bit every time. And it causes some serious mental anguish.

Beyond the fire events, infrastructure within this program is tapped in ways that are not sustainable long term. The [Karuk DNR Strategic Plan](#) describes how "use of the KCDC as fiscal agent and equipment provider (e.g. vehicles) for fire and fuels program, which creates unnecessary complexity, chain of command issues, slows

fiscal processes, and causes other administrative concerns regarding separation of managerial and enterprise roles.”

In the bigger picture the Integrated Wildland Fire Management Program has visionary goals for the restoration of traditional fire regimes to Karuk ancestral lands. These goals are more vital than ever in light of climate change. However, erosion of program capacity is a significant barrier to implementation of this important vision. Program capacity regarding wildland management and restoration forestry is growing, but is slowed by the fact that program staff are frequently pulled onto fires. This situation keeps the Integrated Fire and Wildland Management Program in a more defensive short-term structure, slowing the long-term goal of implementing the traditional fire management regimes that are especially needed in light of climate change.

In the longer term, the Karuk DNR continues to pursue cooperative agreements with the U.S. Forest Service, BIA and other agencies/institutions to enhance restoration forestry activities within Karuk ancestral territory. For example the Tribe is a key leader in the [Western Klamath Restoration Partnership \(WKRP\)](#). This is an open group comprised of the Federal, Tribal, and Non-governmental Organization (NGO) participants with the inclusion of facilitators and additional invitees. This Partnership allows diverse stakeholders to come together to accomplish work by identifying Zones of Agreement where all parties agree upslope restoration needs to occur. The Somes Bar Integrated Fire Management Project utilizes [WKRP](#) developed strategies to restore fire process in the WUI after a century of fire exclusion. The Proposed Action consists of mechanically and/or manually treating, then introducing controlled fire on the landscape of 6,500 acres of National Forest System land for fuels reduction and forest health. Once fuelbreaks have been created by mechanical and/or manual treatments, prescribed fire will be introduced into this landscape at regular intervals by the Tribe and/or the US Forest Service using known practices and tribal knowledge to continue to improve and maintain the health of the Forest.

In addition to the Somes Bar project, planning has begun for two additional pilot projects in Happy Camp and Forks of Salmon aimed at reintroducing good fire

on over 40,000 acres in the WUI. These projects demonstrate both how fire can be returned to the WUI after long periods of fire exclusion, and how in areas where several recent fires have burned, fire processes can be restored relatively quickly and easily to reduce future wildfire expenditures. The Tribe's ability to take a leadership role in this process is key to success, yet managing a complex, multi-agency collaborative network is a complex and time consuming task for program staff. Furthermore, the increased frequency of high severity fires may affect the success of such proactive programs as a growing public fear of fire, increasing drought and other climatic factors increase the day-to-day challenges of cultural burning.

Table 4.8 Effects of High Severity Fire On Integrated Wildland Fire Management Program

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Program staff may be pulled from existing program tasks onto the fire or emergency relief detail • Addressing turnover within Forest Service extremely taxing for Program Staff • Relationship with the State and CALFIRE are nonexistent. CALFIRE facilities not present in Karuk Territory. The BIA gives CALFIRE jurisdiction despite Karuk constitutional jurisdictional claims. CALFIRE trades protection responsibility with USFS for acres closer to their offices. • Vehicles/equipment not fully reimbursed • Increasing fire severity drives suppression oriented decisions, perpetuating the problem 	<ul style="list-style-type: none"> • Program staff may need to spend time and energy addressing post fire flooding as well as post fire management actions of other agencies that impact watersheds, e.g. sedimentation from logging, road building • Staff continuously pulled onto fires, unable to develop capacity and training for proactive projects relating to Wildland Management portion of program. • Due to the extremely rural population of the Mid-Klamath and Salmon River sub-basin can be difficult to find people to cover additional projects 	<ul style="list-style-type: none"> • Weakened program capacity slows goal of returning traditional fire management regimes that are needed more than ever in light of climate change and increased frequency of high severity fires. • PTSD, fatigue, physical, mental and emotional distress may cause overload and staff turnover

Health Program

The Karuk Tribal health Program provides service throughout the Karuk Service Territory- 150 miles along Klamath Corridor from Yreka to Bluff Creek with clinics three service areas (Happy Camp, Orleans and Yreka). The Karuk Tribal health program faces a number of challenges during high severity fires. In 2014 fires burning in the northern edge of Karuk ancestral territory had such hazardous air quality that it was unsafe for people to be outside for over a week. On five of these days, fine particle pollution exceeded local air quality meter measurability.

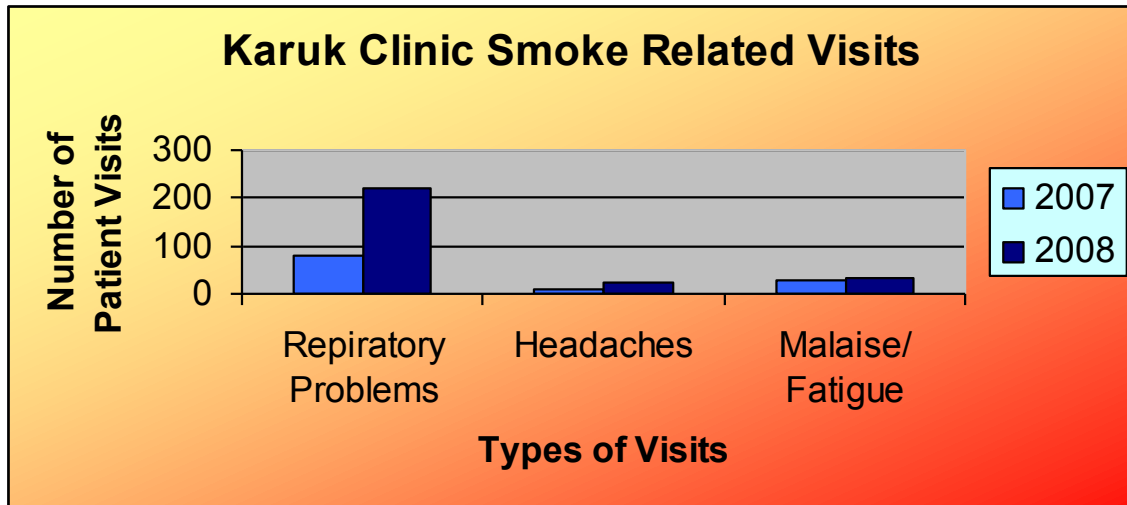
Fires can and do cause direct loss of life, as well as other injuries to which the health clinics respond. But more importantly, smoke from wildfires creates widespread and pervasive respiratory impacts to human health across the community to which clinic staff attempt to respond. Smoke from forest fires consists of carbon dioxide, water vapor, carbon monoxide, ozone, particulate matter, hydrocarbons and other organic chemicals, nitrogen oxides, trace minerals and several thousand other compounds (Lipsett et al. 2008, p. 3). Of these it is actually the particular matter in smoke from forest fires that is often the most dangerous. In their report on smoke for the state of California Lipsett et al. (2008) note:

...fine particles are linked (alone or with other pollutants) with increased mortality and aggravation of pre-existing respiratory and cardiovascular disease. In addition, particles are respiratory irritants, and exposures to high concentrations of particulate matter can cause persistent cough, phlegm, wheezing and difficulty breathing. Particles can also affect healthy people, causing respiratory symptoms, transient reductions in lung function, and pulmonary inflammation. Particulate matter can also affect the body's immune system and make it more difficult to remove inhaled foreign materials from the lung, such as pollen and bacteria. The principal public health threat from short-term exposures to smoke is considered to come from exposure to particulate matter (p. 4).

The report notes that exposure to smoke from forest fires leads to symptoms that "range from eye and respiratory tract irritation to more serious disorders, including reduced lung function, bronchitis, exacerbation of asthma, and premature death." (p. 3). Respiratory impacts intersect with other health conditions and are especially significant for the elderly and young children. High severity large-scale fires burn for much longer than traditional cultural burning of the past, leading to particularly

significant health impacts. As noted by staff in the Integrated Wildland Fire Management Program, “With fire exclusion we have a wider pendulum between fires and no fires, between smoke and no smoke, such that when fires occur there may be very large with heavy smoke for periods of weeks at a time. These circumstances tend to be particularly difficult for respiratory problems.” Indeed cultural burning is less impacting to human health than the high severity fires that result in its absence. In their work on pyrohealth, Johnston et al. (2016) note this contrast: “While no studies on smoke exposure from traditional indigenous landscape burning exist, the smaller mosaic of patch burning promotes small low intensity fires, which overall produce relatively lower emissions, due to the smaller spatial size and lower fuel loads under such fire regimes” (p. 3). Johnston et al. (2016) further write: “The cessation of indigenous burning, active fire suppression, introduced species, and a warming climate are all contributing to increasingly frequent, large-scale, intense fires in many flammable landscapes. Emissions from large landscape fires can be transported for long distances affecting large and small population centres far from the fires themselves. Smoke episodes from severe landscape fires result in measureable increases in individual symptoms and in population indices of ambulance call outs, admissions to hospital and mortality (p. 3).

The increased frequency of high severity fire thus creates very serious potential impacts to the Karuk Health Program given that exposure to outdoor smoke from landscape fires is strongly associated with increasing respiratory symptoms which tend to occur during the fires, but also the deterioration of existing respiratory diseases, hospital admissions and deaths from respiratory causes which cause longer term impacts on not only the health program but of course the Tribal community. Information gathered in the 2007 and 2008 fires found significantly increased clinic visits to Tribal Clinics during these fires, see Table 4.9 below.



(Table 4.9 courtesy of Erin Hillman)

In addition to the higher patient load in clinics, the Tribe has stocked residential household size HEPA air purifier for distribution. Given that the Tribe no longer has a formalized department of emergency services, the health program attempts to fill the void in responding to these air quality dangers by distributing the air purifiers. The Karuk Tribe participates in ongoing collaborations with Siskiyou County OES, including Preparedness Training and is a member of the steering committee for the Siskiyou County Natural Hazard Mitigation Plan. However, affected area residents are isolated and separated by great distances. All too frequently the Karuk Tribal Health Program attempts to respond to smoke hazards across ancestral territory ask with minimal available resources from outside agencies due to number of fires in the state.

In addition to more acute cases and the concerns of youth and elders who face particular vulnerabilities, thick smoke creates a general background hazardous working conditions for all people living in its vicinity. As Bill Tripp notes, “Poor air quality impacts are not limited to respiratory issues. Poor visibility suspends air support for fire fighting, but also suspends air transports to hospitals for emergency patients, a problem which we will likely face because of the character of the terrain that these fire fighters are working in.”

The [Karuk DNR Strategic Plan](#) notes “The Karuk DNR currently approaches minimizing the potential for long-term exposure from poor air quality related to

wildlife fire by restoring traditional fire regimes to the point where seasonal ignitions would burn at relatively lower intensity and extent over time. The Tribe does not currently have dedicated air quality staff, however, there are research and development needs related to air quality monitoring, as well as education and outreach to the local communities regarding the science behind traditional fire management, policies, and practices as related to effects on air quality.”

Johnston, F. H., Melody, S., & Bowman, D. M. 2016. The pyrohealth transition: how combustion emissions have shaped health through human history. *Phil. Trans. R. Soc. B*, 371(1696), 20150173.

Lipsett, M., B. Materna, S. L. Stone, S. Therriault, R. Blaisdell, and J. Cook. 2008. Wildfire Smoke: A Guide for Public Health Officials
<http://www.arb.ca.gov/smp/progdev/pubeduc/wfgv8.pdf>.

Petty AM, Bowman DMJS. 2007 A satellite analysis of contrasting fire patterns in Aboriginal-and European-managed lands in tropical north Australia. *Fire Ecol.* **3**, 32–47.

Chapter Five: High Severity Fire and Vulnerabilities to Tribal Management Authority

As a sovereign government, the Karuk Tribe claims jurisdiction over membership, lands and territory including the right to manage air, lands, waters and other resources as specified in the Karuk Constitution. This jurisdiction is recognized in Article II, Sections 4 and 5 of the Karuk Constitution which states: "The laws of the Karuk Tribe shall extend to:

4. All activities throughout and within Karuk Tribal Lands, or outside of Karuk Tribal Lands if the activities have caused an adverse impact to the political integrity, economic security, resources or health and welfare of the Tribe and its members; and
5. All lands, waters, natural resources, cultural resources, air space, minerals, fish, forests and other flora, wildlife, and other resources, and any interest therein, now or in the future, throughout and within the Tribe's territory."

The Karuk Tribe has developed programs, policies and departments to administer services to Karuk people and to uphold responsibilities to care for the land. Ultimately, tribal management authority emerges from Karuk occupancy and presence. This jurisdiction is based upon the fact that Karuk people have performed the practices of traditional management including fishing, hunting, tending, gathering, burning and more on their ancestral territory since time immemorial. Karuk people have never ceded title to these ancestral lands and retain reserved rights to continue the cultural and spiritual practices of caring for the land and species with whom they are related. Treaties signed in 1851 and 1852 were never ratified by the U.S. Congress, instead Karuk people have maintained a continued presence on the land conducting cultural and land management activities (Norton 2013, Risling 2013, Salter 2003). Karuk responsibilities to manage ancestral territory are referenced in the Karuk Creation Story as told here by Leaf Hillman:

"At the beginning of time, only the spirit people roamed the earth. At the time of the great transformation, some of these spirit people were transformed into trees, birds, animals, fishes, rocks, fire and air – the

sun, the moon, the stars... And some of these Spirit People were transformed into human beings. From that day forward, Karuk People have continually recognized all of these spirit people as our relatives, our close relations. From this flows our responsibility to care for, cherish and honor this bond, and to always remember that this relationship is a reciprocal one: it is a sacred covenant. Our religion, our management practices, and our day-to-day subsistence activities are inseparable. They are interrelated and a part of us. We, Karuk, cannot be separated from this place, from the natural world or nature...we are a part of nature and nature is a part of us. We are closely related. "

Karuk management principles have been central to the evolution of the flora and fauna of the mid-Klamath ecosystem (Anderson 2005, Lake et al. 2010, Skinner et al. 2006). This ongoing environmental management is a manifestation of culture, relationships with the land, traditional knowledge, economic prosperity, spiritual practice and political sovereignty. Karuk tribal management authority is fundamental to self-determination, and is thus further supported by the Indian Self-Determination and Educational Assistance Act and multiple articles in the 2007 United Nations Declaration of the Rights of Indigenous Peoples ([UNDRIP](#)), which the United States has endorsed as aspirational. The [UNDRIP](#) states that:

Indigenous peoples have the right to self-determination (Article 3) . . . autonomy or self-government in matters relating to their internal and local affairs (Article 4) . . . to participate in decision-making in matters which would affect their rights (Article 18) . . . and States shall consult and cooperate in good faith with indigenous peoples concerned through their own representative institutions in order to obtain their free, prior and informed consent before adopting and implementing legislative or administrative measures that may affect them (Article 19) (United Nations 2008).

Article 29 section 1 further notes "Indigenous peoples have the right to the conservation and protection of the environment and the productive capacity of their lands or territories and resources. States shall establish and implement assistance programmes for indigenous peoples for such conservation and protection, without discrimination"⁵ (United Nations 2008). [UNDRIP](#) Articles 5, 18, 24, 25, and 31 also

⁵ Note that the term "states" here refers to "member states."

apply directly to Karuk traditional management authority in the face of climate change (see [UNDRIP](#)).

Other principles, statutes and actions that underscore Karuk management authority include the Tribal Trust doctrine (Kronk Warner 2015, Tsosie 2003, Wood 2014), Executive Order 13175 regarding consultation with tribes, the 2009 Presidential Memorandum on Tribal Consultation, Secretarial Order 3206 *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act*, and Secretarial Order 3289 *Addressing the Impacts of Climate Change on America's Water, Land and Other Natural and Cultural Resources*. Secretarial Order 3289 asserts that “climate change may disproportionately affect tribes and their lands because they are heavily dependent on their natural resources for economic and cultural identity,” emphasizes the primary trust responsibility of the Federal government to tribes, and affirms that “tribal values are critical to determining what is to be protected, why and how to protect the interests of their communities” (USDI 2009).

These and other principles underscoring tribal management authority are summarized in [Tribal Climate Change Principles: Responding to Federal Policies and Actions to Address Climate Change](#) (Gruenig et al. 2015) which underscores that “As sovereigns preexisting federal and state governments, tribes have government authority that they exercise over reservations, trust lands, and Tribal members who live within service-area jurisdictions that are not designated as trust lands” (p.4). Gruenig et al. (2015) also outline federal responsibilities towards tribes, stating “As recognized by the U. S. Supreme Court the United States has the highest moral obligation to act in the best interests of federally recognized Tribes” (p. 1). The principles outlined by Gruenig et al. (2015) have notably been adopted as part of resolutions developed by United States tribal organizations such as the National Congress of American Indians, the Great Lakes Indian Fish and Wildlife Commission, and the Affiliated Tribes of Northwest Indians.

In addition to statutes and orders directly recognizing tribal authority, Presidential Executive Order 12898 requires federal agencies to achieve environmental justice by identifying and addressing the disproportionately high and

adverse human health or environmental effects of their actions on minorities and low-income populations and communities. This Executive Order also requires that agency decisions reflect an equitable distribution of related benefits and risks.

As this chapter will discuss, climate change in general and high severity wildfire in particular, creates vulnerabilities for Karuk tribal management authority. Here too the federal government explicitly acknowledges the application of the trust responsibility to protect lands from the impact of climate change affirming that, “the Department will ensure consistent and in-depth government to government consultation with tribes and Alaska Natives on the Department’s climate change initiatives” (Salazar 2009). Commitment to tribal engagement is explicitly noted in the President’s Climate Action Plan.

An emerging literature describes how tribes face a complex multitude of political threats in light of climate change (Cameron 2012, Donatuto and O’Neil 2010, Hanna 2007, Maldonado et al. 2013, Marino 2012, Stumpff 2009, Tsosie 2013, Whyte 2013, Williams and Hardison 2013, Wood 2014). Indeed, U.S. laws and policies are themselves increasingly exacerbating climate vulnerabilities for tribes. These political threats vary in part due to the wide variety of tribal political circumstances and compounded by new cross-jurisdictional complications that are overlaid in the face of climate change. In addition to differences concerning federal recognition and treaty status, climate change compels complicated cross-jurisdictional coordination between multiple agencies. These agencies exhibit a range of understanding of and commitment to their tribal trust responsibilities. Vinyeta and Lynn (2015) document the challenging and complex intergovernmental landscape faced by Pacific Northwest tribes when interacting with federal agencies in regards to the Northwest Forest Plan. A similarly, if not more complex intergovernmental context is bound to form part of climate change adaptation planning and implementation efforts, given that climate change is an all-encompassing challenge the impacts of which transcend single departmental or agency agendas.

Particular emphasis has been paid to the circumstances of treaty tribes, evaluating concerns such as how tribal harvest allocations and other important

agreements assume stable ecological conditions (Goodman 2000), or the ways that coastal trust lands may be directly impacted due to sea level rise. For example, the Treaty Indian Tribes in Western Washington produced an important report in 2011 that concluded that the federal government is not fully implementing its treaty rights obligations (TITWW 2011).

Analysis of the broader impacts to tribal sovereignty and management authority, especially for tribes without treaties, is needed. To date little attention has been paid to how the particular climate stressor of increasing high severity wildfire may impact the political circumstances of tribes. We hope this chapter will be of use to tribes from a broad range of political backgrounds, especially those seeking to manage so-called off-reservation lands. We also hope that the focused attention given to high severity wildfire in particular will benefit both tribes and federal agencies seeking to uphold their tribal trust responsibilities.

Vulnerabilities to Karuk management authority in the context of high severity wildfire do not occur in a vacuum. These vulnerabilities must be understood in the context of the complicated existing cross-jurisdictional terrain in which Karuk management authority is often unacknowledged and misunderstood, and is compounded by the past, present and future actions of non-tribal land managers that jeopardize the ability of Karuk people and the Karuk Department of Natural Resources to sustain environmental management.

Agencies making decisions impacting Karuk Tribal Lands and resources include the EPA, USFWS, BIA, NRCS, USFS, California Department of Forestry and Fire Protection (CALFIRE), the State Water Board, and California Department of Fish and Wildlife. In particular, Karuk ancestral territory is located within the National Forest System. The Karuk Tribe maintains that it has never relinquished possession of these lands; the lack of recognized ownership or jurisdiction limits of the Tribe's ability to care for traditional foods and cultural use species, as well as establish and maintain effective tribal programs. As noted in the [Karuk DNR Strategic Plan](#), "Forestlands within Karuk ancestral homelands have been severely impacted by extractive timber production, single species management, road building, massive fuel loading, and fire suppression." Past management actions involving logging, road

building and fire suppression interact with fire events to influence the Karuk Tribe's present management authority, as do federal agencies' management actions during, immediately after, and in the years following a fire. The next section outlines four general limitations to Karuk management authority in the face of climate change, and then details how these unfold in light of high severity fire at three scales: during fire events, and in the immediate and long term aftermaths of high severity fires.

Management Authority and Traditional Ecological Knowledge

As stated throughout this report, Karuk management authority is grounded in tribal occupancy and presence, including the longstanding practice of traditional management. Traditional management is in turn grounded in traditional ecological knowledge (TEK), including critical knowledge concerning the use of fire. Protections for TEK are part of the federal trust responsibility to tribes, are part of multiple government responsibilities to tribes in light of climate change (CTKW 2014), and are explicitly outlined in the United Nations Declaration on the Rights of Indigenous Peoples (United Nations 2008), which states in Article 24 section 1: "Indigenous peoples have the right to their traditional medicines and to maintain their health practices, including the conservation of their vital medicinal plants, animals and minerals." Additionally, Article 31 section 1 states:

Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs, sports and traditional games and visual and performing arts. They also have the right to maintain,

"Past management actions involving logging, road building and fire suppression interact with fire events to influence the Karuk Tribe's present management authority, as do federal agencies' management actions during, immediately after, and in the years following a fire."

control, protect and develop their intellectual property over such cultural heritage, traditional knowledge, and traditional cultural expressions.

The importance of utilizing TEK in relation to climate change is underscored by Secretarial Order 3289 which notes “The Department will support the use of the best available science, including traditional ecological knowledge, in formulating policy pertaining to climate change” (USDI 2009).

Ironically, the increasing severity of wildfire poses a direct threat to TEK itself by heightening fear of its application. Traditional ecological knowledge is a living practice that must be carried out on the landscape through continued application and use. When the Tribe is unable to carry out traditional management species and culture, both decline. Threats to Karuk management authority are therefore also threats to Karuk traditional ecological knowledge and cultural practices. The [Phase III Western Regional Science-Based Risk Analysis Report](#) developed as part of the National Wildland Fire Cohesive Management Strategy affirms that in the face of continued fire exclusion, Native American cultural identity and traditional ecological knowledge are both at risk (USDA 2012, p. 30). In 1995, fire management comprised approximately 16% of the USFS budget; In 2015, that percentage had reached an unprecedented 50% of the agency's budget (USDA 2015). With these dramatic increases in Forest Service activity and budget directed towards fire suppression⁶, the [Cohesive Strategy](#) has focused on how the prohibition of cultural burning constitutes both an ecological problem and spiritual violation. The exclusion of fire from the landscape creates a situation of denied access to traditional foods and spiritual practices, puts cultural identity at risk, and infringes upon political sovereignty (Lake 2007, Norgaard 2014a and 2014b and 2014c). Attention to the relationships between management authority, traditional ecological knowledge and the use of fire becomes even more important to understand now that the instance and frequency of high severity fire is increasing with climate

⁶ See the USDA's 2015 Report "[The Rising Cost of Wildfire Operations: Effect on the Forest Service's Non-Fire Work](#)," available at <http://www.fs.fed.us/sites/default/files/2015-Fire-Budget-Report.pdf> for details.

change. Continued denial of cultural burning damages the ecological functions and diminishes the availability of and people's access to cultural use species. Fire exclusion thus constitutes a direct violation of [UNDRIP](#) article 31 section 1 (United Nations 2008). Similarly, because fire suppression as well as firefighting activities

"Because fire suppression as well as firefighting activities interfere with the ability of members of the Karuk Tribe to perform cultural practices, these activities hold the potential to erode the Karuk Tribe's sovereignty over Tribal Lands and cultural resources."

interfere with the ability of members of the Karuk Tribe to perform cultural practices, these activities hold the potential to erode the Karuk Tribe's sovereignty over Tribal Lands and cultural resources. These relationships in the face of climate change are described in detail in the reports ["Karuk Traditional Ecological Knowledge and the Need for Knowledge Sovereignty: Social, Cultural and Economic Impacts of Denied Access to Traditional Management"](#) (Norgaard 2014b) and ["Retaining Knowledge Sovereignty: Expanding the Application of Tribal Traditional Knowledge on Forest Lands in the Face of Climate Change"](#) (Norgaard 2014c).

Tribal Capacity, Funding Structure and Management Authority

"To respond to the impacts of climate change, Indigenous Peoples must have access to the financial and technical resources that are required to assess the impacts of climate change on their cultures, air, land and water, economies, community health, and ways of life, and address those impacts through adaptation and mitigation."

- [Tribal Climate Change Principles](#) (Gruenig et al. 2015).

An abundance of environmental and climate justice literature emphasizes that poor people, people of color, women, and Native Americans are and will continue to be more vulnerable in the face of climate change (Bennett et al. 2014, Cuomo 2011, Lynn et al. 2011, Maldonado et al. 2013, Shonkoff et al. 2011, Vinyeta et al. 2015).

For tribes, these impacts from climate change come not only from the relatively intact relationships tribal communities may have with impacted ecological systems, but from the unequal financial and infrastructural capacities of tribal governments to respond vis-à-vis other entities. A central corroborating aspect of this problem is that Karuk management authority is not recognized or even understood. The Karuk Tribe faces challenges not only in terms of total funding available for climate related work, but in the structure of that funding in the form of grants. Grants are tied to specific projects with deliverables attached and staff hours that must be accounted for, as opposed to the broader flexibility from operating on BIA base funds. These capacity-related challenges, discussed in detail in Chapter Four, translate into vulnerabilities in relation to management authority especially when jurisdiction is not acknowledged or when the emergency crisis mode of fires cause existing tribal authorities to be over-ruled or ignored as will be discussed here. When federal decisions and actions compromise tribal lands and rights, time and resources that tribal staff could have invested into the advancement of tribally-led initiatives that build upon traditional ecological knowledge, preserve living culture, and nurture traditional roles, is suddenly diverted towards long, complex, intergovernmental conflict resolution and consultation processes, exacerbating the abovementioned institutional vulnerabilities faced by tribes. Tribal capacity is needed more than ever to assert sovereignty and management authority in the context of climate change, yet climate change itself holds the potential to undermine that very capacity and with it the ability of the Karuk Tribe to assert management authority.

New and Rapidly Shifting Jurisdictional Terrain

Climate change is also rapidly reshaping the legal landscape as changing ecological conditions and political dynamics are generating numerous planning efforts, judicial rulings, policies, and collaborative configurations of state and federal actors (Bronen 2011, Burkett 2011, Kronk Warner 2015, Mawdsley et al. 2009, Ruhl 2009). These collaborations and measures are necessary responses in the face of circumstances that clearly exceed prior jurisdictional boundaries. Yet, in part because there are still very few comprehensive federal laws applying to either the adaptation or

mitigation of climate change, regional, state, and local efforts have emerged ad hoc. In the absence of an overarching legal framework at the federal level, tribes face potential loss of acknowledgement of their jurisdiction if they are excluded from or cannot keep up with the multiple and rapidly changing dynamics between federal and local actors.⁷ Awareness and emphasis on federal tribal trust responsibilities – frequently overlooked in the best of times – are further lost in the midst of this new rapidly shifting policy terrain where the sense of crisis may be further impetus for their negation. The [Tribal Climate Change Principles](#) reports:

“Over the last several years, more than fifteen climate change committees and working groups have been formed within and among federal agencies. Many of these did not or do not include Tribal representation. Simultaneously, many of the committees that did or do include Tribal representatives only had or have nominal representation” (Gruenig et al. 2015, p. 5).

Multiple examples of regulations and planning efforts developed in light of climate change that failed to uphold federal tribal trust responsibilities and/or adequately engage the Karuk Tribe have emerged just in the short time frame of this climate vulnerability assessment. For example, the EPA rules for ground level ozone developed during 2015-2016 challenge both Karuk program capacity and management authority. Ground level ozone, which poses a hazard to human health, is increasing with warmer air temperatures resulting from the changing climate (Luber et al. 2014). Ground level ozone is also produced during forest fires, and the new EPA rule applies to prescribed burns as part of the federal response to health-related dimensions of climate change. There is, however, no exemption for cultural burning which is instead treated as an anthropogenic

"Awareness and emphasis on federal tribal trust responsibilities – frequently overlooked in the best of times – are further lost in the midst of this new rapidly shifting policy terrain where the sense of crisis may be further impetus for their negation."

⁷ E.g. while the Department of Interior has a Secretarial Order on climate change, the Department of Agriculture does not.

pollutant alongside vehicle emissions. In essence cultural burning is treated as part of the problem rather than a path to a potential form of climate mitigation. This regulation thus becomes yet another constraint undermining the Karuk Tribe's efforts to apply prescribed fire and restore cultural burning at a landscape scale.

By contrast, the 2005 Western Regional Air Partnership Joint Forum on Fire Emissions⁸ relates to Tribal Authority under the Clean Air Act. This document contains guidance on categorizing natural vs. anthropogenic emissions sources, and identifies a process for classifying tribal cultural burns as a natural emissions source along with wildfires (prescribed fire is an anthropogenic source). The categorization of tribal cultural burns for maintenance purposes as natural would mean that tribes do not need to obtain permits or to conduct planning to carry out cultural burns, thereby alleviating the costly and bureaucratic barriers. By contrast, recognition of the longstanding use of fire to shape the landscape approach is not reflected in the new EPA ozone rule. Bill Tripp noted this circumstance on a call with the EPA, "Our situation [longstanding proactive use of fire as management tool] is not reflected in this process." He was informed that although the final rule was out, there would be additional opportunities for comment. But as Bill Tripp asserts, "we don't have the capacity to respond. Federal agencies are responsible for making sure that tribal consultation takes place, but this has not occurred. Tribal consultation cannot occur effectively in part because the Karuk Tribe does not have capacity to engage." Thus, in the face of federal assumptions about what is part of the "natural" background condition (climate induced wildfire but not cultural burning), rules that fail to fit the complexity of the Tribe's political and jurisdictional experiences, rules written by one agency and implemented by another, and tribal staff and budgetary shortages that limit tribal capacity, the system is so unfavorable for effective and positive tribal engagement that Bill Tripp commented that "it is better not to consult because then you have to come into compliance."

⁸ This key document has the potential to be a powerful tool for maintaining Tribal sovereignty regarding use of fire and expansion of TEK in the landscape, but has yet to enter policy or regulation. The formal adoption of this idea into policy and regulation would also serve as explicit acknowledgement of Tribal sovereignty and jurisdictional authority over air resources.

A second example comes from climate planning efforts developed by the U.S. Forest Service. As of 2016, the U.S. Forest Service is engaged in planning efforts within Karuk ancestral territory and homelands through revisions to the Northwest Forest Plan and eventual revisions to the Forest Plans on the Six Rivers and Klamath National Forests. Climate planning is relevant for both efforts, but explicitly considered in the revisions for the Northwest Forest Plan. Executive Order 13175 and other statutes referenced earlier in this chapter affirm the obligation of federal agencies to protect tribal resources, tribal rights to self-governance, and engage in government-to-government consultation on issues that will impact tribal rights and

"It is particularly important that federal climate adaptation planning engage tribes not only due to the unique tribal needs and perspectives, but because the regulations themselves can and do negatively impact tribes."

resources, and to ensure that tribal resources are protected in the face of climate change. It is particularly important that federal climate adaptation planning engage tribes not only due to the unique tribal needs and perspectives, but because the regulations themselves can and do negatively impact tribes.

In 2015, and as part of the above-mentioned efforts, the U.S. Forest Service hired a consulting firm known as EcoAdapt to conduct a climate vulnerability assessment for multiple forests across Northern California including the Six Rivers and

Klamath National Forests that are situated within Karuk ancestral territory. Neither EcoAdapt nor the U.S. Forest Service initiated government-to-government consultation with the Karuk Tribe. Instead, members of the Karuk and other regional tribes were contacted in the same manner as stakeholders, and treated as such in the process (TRT 2016). As a result of the lack of consultation, Karuk tribal staff and consultants had to invest valuable time and resources to bring this problem to the attention of both the Forest Service and EcoAdapt, and to call for a legitimate government-to-government consultation process. Considerable time was

also required on the part of Forest Service staff and consultants. Ultimately, the U.S. Forest Service's failure to engage the Tribe as a sovereign entity led to an inefficient process for all involved.

The [National Climate Assessment](#) and the Secretary of the Interior have made strong statements concerning the increased vulnerabilities tribes face in light of climate change. There is also an increasing emphasis on the need for collaboration and consultation across tribal and non-tribal jurisdictions. However, attention to tribal needs and tribal trust responsibilities is often lost in this rapidly shifting policy terrain. For example, when the Council on Environmental Quality released their final guidance on considering greenhouse gas emissions and the effects of climate change in NEPA reviews in August of 2016, the document contained no mention of the words Native, tribes, indigenous or consultation.

The exclusion of tribal trust responsibilities, tribal needs and perspectives within these ongoing climate processes represents more than just a legal or moral failure; it creates enormous inefficiencies and ultimately jeopardizes possibilities for successful outcomes. The [Tribal Climate Change Principles](#) notes the expertise and leadership that tribes bring to the table concerning climate change:

“The exclusion of tribes is detrimental to the federal government for several reasons. First, tribes are established experts in resiliency and adaptation given their long record of adapting to various historical stressors – genocide, removal, climatic events, etc. Next, as separate sovereigns, tribes possess the capacity to enact their own tribal laws. As a result, multiple tribes across the country are already using their tribal laws to innovate in the field of climate change adaptation. There are valuable lessons that the federal government can learn from these innovative tribal “laboratories” (Gruenig et al. 2015, p.6).

Crisis Management and Emergency Exemptions

Climate change is widely perceived to be an unprecedented circumstance -- the largest crisis humans have faced. Urgent action is needed to promote ecosystem-wide changes, positive feedback loops, and the necessity for direct response lest conditions decline further. Certainly climate change compels immediate and large-scale response. Yet this sense of crisis and emergency – especially on behalf of non-Native agencies - underscores a range of emergency actions that further undermine

Karuk management authority. Numerous policies set in place regarding tribal trust responsibility, tribal consultation, tribal needs and the importance of unique tribal perspectives are inadequately carried out on the ground. The federal-tribal relationship must be carried out effectively to ensure that tribes have the capacity to address the impacts of climate change on lands, natural resources, and uses both on and off-reservation. Under conditions of crisis management, such measures are even less likely to be engaged.

Focus and Interest of non-Native Researchers in Klamath Basin

Karuk ancestral territory is part of the Klamath-Siskiyou bioregion that has long been considered ecologically important for its rich species diversity and endemism (Briles et al. 2011, Sawyer 2007a and Sawyer 2007b, Whittaker 1961). While the region is at risk for increasing high severity fire, it also represents an area of California and the Pacific Northwest with relatively high biological, geological, and topographic diversity on the one hand, and less urban development on the other. In light of these factors the region is again being considered an important potential climate refugia, where species may be able to move northward or into higher elevations in the coming centuries. Indeed, the high levels of biological diversity occur in part because the region has been a refuge in past climate change events – a place conducive to the persistence of species vulnerable to climate change to which migration has occurred (Olson et al. 2012). This situation is an enormous ecological benefit, yet it too can pose challenges for Karuk tribal management authority, as scientists from outside the Klamath Basin take an interest in the region in light of the challenges faced by species across the West. These scientists who, with the right knowledge and under the right conditions, could develop mutually beneficial, collaborative relationships with the Tribe, might also undermine tribal authority by lacking awareness of tribal presence, knowledge, cultural practices, and the federal trust responsibility. This lack of awareness results in part from a long historical tendency, dating back centuries and implicit in the colonial discourse of manifest destiny, in which the presence, importance, and continuity of Native American tribes

has been minimized or erased by Euro-American institutions, in an effort to legitimate the prior and ongoing abuses towards indigenous communities.

Tribal presence, needs and management authority are frequently overlooked even by those closer to home. Several climate vulnerability assessments have been conducted focusing on Karuk ancestral territory with little mention of the Tribe's presence, much less acknowledgement of the role of humans in shaping ecosystem processes, understanding of ongoing tribal management desires, or the opportunities emergent from continued existence of Karuk traditional ecological knowledge (see 2nd Nature 2013, Barr et al. 2010, Cook et al. 2014, GHD et al. 2014). A review of articles on the importance of the Klamath-Siskiyou region as a climate refugia follows this same pattern. Such omissions represent modern-day examples of disregard for, and erasure of a Tribe that is very much present and vital to the region. This is particularly unfortunate given that much could be (and has been!) gained from collaborative processes in which the Tribe is acknowledged and incorporated as a sovereign partner with vast knowledge, stewardship experience, and management authority.

Taken together, the above factors of capacities and funding structure, new and rapidly shifting jurisdictional terrain, crisis management and emergency exceptions, and the focus and interest of non-native researchers in the Klamath Basin represent potential threats to Karuk management authority that emerge in the face of the increasing frequency of high severity fire that will be discussed next.

Vulnerabilities to Karuk Management Authority With Increasing Fire Severity

This next section considers the vulnerabilities to Karuk management authority that arise in the context of increasing size and frequency of high severity fires. Following the format used throughout this assessment, these vulnerabilities are examined at three temporal scales: those occurring during high severity fire events, those occurring in the immediate (roughly two year) aftermath of such fires, and, last, how increasing incidence of high severity fires negatively affects management authority over time. Table 5.1 summarizes vulnerabilities discussed here.

Table 5.1 Potential Effects of High Severity Fire On Karuk Management Authority

Immediate	2-Year	Long-Term
<ul style="list-style-type: none"> • Transportation routes and access within Karuk territory restricted • Fire “fighting” activities such as back-burning, road building, retardant drops may impact traditional food, fiber and medicines • Crisis framing during fires justifies over-riding of existing tribal authorities and environmental regulations • Frequent turnover in organization of Forest Service fire staff inhibit enforcement of tribal authorities (e.g. tribal trust responsibilities) • Tribal staff taken from other duties to engage with other agencies in attempt to mitigate actions • Fire fighting activity may interfere with cultural practices creating noise disturbance during ceremonies and other religious activities 	<ul style="list-style-type: none"> • Crisis orientation to fire continues to facilitate exemptions in existing tribal authorities and environmental regulations e.g. concerning water quality in 2016 Westsides salvage sale • Actions taken by other agencies in response to fires including re-seeding with undesired species, salvage logging, road building 	<ul style="list-style-type: none"> • Discourse of fire as catastrophic impedes ability to use fire as a long term management tool • As more funding is diverted for fire suppression, less is available for proactive fire management • Species movement and disappearance has implications for cultural survival and tribal sovereignty • Loss of critical habitat inhibits pro-active planning efforts for some species • Long term planning efforts in light of climate change may exclude Karuk perspectives, e.g. Forest Plan Revisions

Karuk Management Authority During High Severity Fire Events

Just as the general forest management policy of fire suppression emerged from a non-Native value orientation focused on commercial timber, activities carried out in response to high severity fires reflect the economic, political and cultural values of the dominant non-Native world. During high severity fire events, firefighting activities interfere with the ability of Karuk people to perform their cultural

practices, potentially eroding the Karuk Tribe's sovereignty over Tribal Lands and cultural resources. Coupled with fear of fires, general public ignorance of Karuk traditional management processes related to fire further negatively affects the Karuk Tribe's management authority during fires themselves. Non-tribal decisions regarding what is to be protected and how, and the fire management activities that follow— such as back-burning, road building, and retardant drops— rarely support tribal values or perspectives and in fact often profoundly damage culturally important food species and gathering areas.

When high severity fires occur, large numbers of firefighters with little knowledge of Karuk presence -- much less the federal tribal trust responsibility -- descend upon the area. Noise and intrusion from the use of helicopters when ceremonies are underway and the use of "federal closures" that denies people access to public lands are a de facto form of martial law, especially when armed officers enforce closures by arresting people for trespassing on their own public lands. Transportation within ancestral homelands and access to its cultural resources may be restricted. Fire lines and roads may be placed through culturally important areas, vital tree species such as tanoak or black oak may be intentionally cut down or severely burned as fire breaks, and snags that are important habitat for other cultural use species, including Pacific fisher, are likely to be cut as a pre-emptive tactic (Lake, pers. comm.). Actions such as falling trees, or use of heavy equipment or road building that are not normally allowed in riparian or wilderness areas will be given emergency exemptions during a fire. Cultural Vegetation Characteristics remnant of past traditional fire management practices of the Karuk people are bulldozed or burned in a manner uncharacteristic of the intended use. For example; ridge systems with a significant beargrass component are typically bulldozed to create a fireline, when in a cultural management scenario they would be frequently burned in a manner that the vegetation type itself would serve as a natural fuel break (B Tripp, pers. comm.). Revitalization of this frequent fire management practice would lessen the workforce needed over time, and would virtually eliminate the need to call in additional people and equipment during wildland fire events in these areas.

Fear of fire coupled with ignorance regarding tribal responsibilities support a crisis mentality in which emergency actions are taken without considering the long-term implications these actions may have for the Tribe or the ecosystem. The command and control organization of the Forest Service fire response, together with frequent personnel turnover, also limits the ability of Karuk tribal staff to communicate and influence management decisions. Karuk Eco-Cultural Restoration Specialist and traditional practitioner Bill Tripp describes the devastating emotional impacts of trying to communicate Karuk perspectives on fire and to protect cultural resources in the face of Forest Service presence fighting the large fires of 2008.

"Fear of fire coupled with ignorance regarding tribal responsibilities support a crisis mentality in which emergency actions are taken without considering the long-term implications these actions may have for the Tribe or the ecosystem."

"In my situation I find myself quite a few times just to the point of asking why am I even here trying to do this? I should just go and be happy somewhere. On these fires, every two weeks you are dealing with new people, and you're going over the same things, and you are trying to re-justify every decision that was made where you were barely able to hold onto protection of one little piece of something. And then you're losing a piece of that because new people came 14 days later. And then you're losing another piece of that and another. And you spend your whole time going over everything that you just went over again, and again, and again. And losing a little bit every time. And it causes some serious mental anguish."

The use of fire retardants is another issue that directly impacts tribal people and species of importance given that a high percentage of tribal members get their food and water directly from the forest. Use of chemical retardants occurs without awareness or regard for this circumstance, and the Karuk Tribe has little to no ability to assert tribal authority regarding the use of retardants. Criteria for retardant use are set without regard for human occupancy, there is no long term monitoring or consideration of cumulative effects on water supplies, and

recordkeeping for locations of retardant drops is haphazard at best (e.g. gps is not used to identify locations). Even when retardant drops have occurred into the river or other water bodies, tribal staff have been prevented from accessing the site to gather follow up water samples (S. Corum pers. Comm.). One Karuk elder, Marge Houston described how the Forest Service dropped fire retardant onto her prime acorn and mushroom gathering area, a site that was just 100-200 feet from her home:

"This summer that there was a less than an acre fire here on the Indian allotment and what happened was the Forest Service came in after it was under control they come in and did a Borate drop, or some fire retardant. They wanted to come down and do another one til we had to get out there and start screaming at them. And basically they said, "Well, we'll only do two drops." But you know there's some big issues there. Because first of all that fire was under control. Second, it was less than an acre of fire. And now we have a contaminated subsistence harvest area along with other culturally sensitive areas... They cut down my acorn trees. And they missed the fire to begin with.... Sprayed it everywhere but on the fire. I couldn't even breathe for three days. All the oyster mushrooms that I got up here on this [fire] I cannot eat. 'Cause they come up and they're pink. Just like the chemical that they sprayed. I can't eat that. I'm not going to be able to eat a mushroom off that tree again. Damn."

Present day threats to management authority during fire events intersect with past management actions of other agencies. Dr. Frank Lake has described how historic trails along ridges are places where fire had been used frequently to keep open travel routes and access gathering sites. Ironically in the early days of fire suppression, these ridges and trails were the most easily accessed and became the focus of fire suppression activities, in turn causing particularly large fuel build up over time. Now during fire events these same ridges and trails are often used for fire lines, meaning that sections will be "blackened" – a practice that causes direct mortality even to fire resistant cultural use species, and sterilizes the soil. As a result of this combination of past fire suppression and the creation of fire lines, culturally significant trails and ridges have some of the highest degree of imposed alteration of their historic cultural fire regimes.

Karuk Management Authority in the Immediate Aftermath of Fires

High severity fires impact the mid Klamath ecosystem in the immediate aftermath (roughly two years) in a number of ways. Karuk management authority is often challenged by non-tribal management actions such as re-seeding and re-planting, sediment control, road building, and salvage logging that occur when a state of “emergency” takes precedence over adequate government-to-government consultation. Re-seeding and re-planting activities can modify the make-up of the forest, create conditions that compromise culturally critical trees and herbs, and sometimes introduce genetically modified specimens that are not in accordance with tribal values. Areas developed as fire breaks are often used as roads, which affects Karuk management authority by further enabling commercial resource extraction. Salvage logging undermines Karuk management authority by removing woody forest material that is vital to various species of cultural importance. In the past ten years, the two National Forests occupying Karuk ancestral territory have proposed timber sales in order to ‘salvage’ trees burned during high severity fire. This trend is consistent throughout the Pacific Northwest; the majority of timber sales now take the form of salvage logging operations. In 2016 the Westsides salvage timber sale (following the 2014 July Complex Fire) proceeded with emergency water quality exemptions from the Environmental Protection Agency despite opposition from the Tribe.

Long Term Effects of Fire on Karuk Management Authority

In the longer-term aftermath of high severity fires, impacts to tribal management authority continue via both direct and indirect changes in the landscape. Species movement and disappearance have implications for cultural survival and tribal sovereignty, and long term planning in response to high severity fire may continue to limit Karuk traditional management. Over the long run, the continued crisis orientation to fire may shape management decisions, precipitate exemptions in existing regulations on logging and other post fire management activities, and inhibit the ability of the Tribe to conduct cultural burning in fire footprints. And, as

more funding is earmarked for fire suppression, less is available for proactive fire management such as prescribed burns that can be carried out safely at appropriate times of the year.

Given that Karuk management authority is tied to traditional ecological knowledge as a living practice, the radical alteration of the land has potentially dire political consequences as Karuk Cultural Biologist and dipnet fisherman Ron Reed explains in this passage from Chapter Two:

"... the traditional foods that we need for a sustainable lifestyle become unavailable after a certain point. So what that does to the tribal community, the reason we are going back to that landscape is no longer there. So the spiritual connection to the landscape is altered significantly. When there is no food, when there is no food for regalia species, that we depend upon for food and fiber, when they aren't around because there is no food for them, then there is no reason to go there. When we don't go back to places that we are used to, accustomed to, part of our lifestyle is curtailed dramatically. So you have health consequences. Your mental aspect of life is severed from the spiritual relationship with the earth, with the Great Creator. So we're not getting the nutrition that we need, we're not getting the exercise that we need, and we're not replenishing the spiritual balance that creates harmony and diversity throughout the landscape."

Over the long run, repeated high severity fire holds the potential to reset much of Karuk ancestral territory to an early seral condition that has a tendency to burn at high severity over and over again. The process for such conversions varies by forest type, but essentially can occur if very severe fires occur in rapid succession before canopy cover can develop. At that point, the stand is unable to develop a fire resistant stand structure and will remain as fire-prone brush field. Future forest climate scenarios indicate that once high severity fire occurs, conifers in particular may not be able to reproduce in that area. Along with this potential is the loss of species that may cause a domino effect through the entire ecosystem. Such landscape alteration may be exacerbated by post-fire management actions of the Forest Service, including re-seeding burned areas with commercially valuable but fire-prone conifer species to create plantations for future harvest.

The increased instances of high severity fire will shape the long-term forest planning process. Of immediate importance in this regard is the role that climate change in general and increasing high severity fires in particular will play in shaping the Forest Plan revisions process for both Six Rivers and Klamath National Forests. As mentioned earlier, critical climate research relevant to forest planning has already been proceeding in the Klamath Basin in the absence of tribal consultation. It is essential that climate adaptation planning by the Forest Service and other federal agencies centrally involve tribes, as these policies directly affect resources of importance to the Karuk Tribe and, as it stands, the planning process currently ignores tribal management authority. Diversion of staff resources and time in the face of these conflicts leaves fewer resources for advancing the positive, proactive directions that are especially needed in light of climate change.

Conclusion

Traditionally, Karuk and other Tribes in the Klamath Basin use fire to manage the landscape. Our traditional management practices prevent the build-up of fuels that could lead to severe fire events as well as manage for healthy stands of acorn bearing oaks, forage for large ungulates, and for other foods, fibers, and medicinal plants. Due in part to thousands of years of purposeful fire management, the forests of this region have benefited ecologically from fires that are low in heat production, or “cooler” fires. Paradoxically, large scale impacts from climate change are exempt from regulation, while the potential solutions in the form of traditional management have imposed regulatory barriers (Wiedinmyer and Hurteau 2010). Restoring balance in the fire regime and managing landscapes with time-tested traditional ecological knowledge is a priority in Karuk

"Restoring balance in the fire regime and managing landscapes with time-tested traditional ecological knowledge is a priority in Karuk country, particularly as climate change impacts begin to intersect with the effects of decades of non-tribal land management."

country, particularly as climate change impacts begin to intersect with the effects of decades of non-tribal land management. Now that there is collaboration on the Six Rivers National Forest, their Forest Plan may be revised. The development of this Vulnerability Assessment is the first step towards a Climate Adaptation Plan that can then be integrated into the new Forest Plan revisions. The Federal Lands Policy and Management Act of 1976 (FLMPA) states in Sec. 202. [43 U.S.C. 1712] (b); “In the development and revision of land use plans, the Secretary of Agriculture shall coordinate land use plans for lands in the National Forest System with the land use planning and management programs of and for Indian tribes by, among other things, considering the policies of approval tribal land resource management programs.”

Climate change is happening on such a large scale that it can appear to be a natural force, even as we know it to be anthropogenic. Climate change results from the emissions and build up of carbon dioxide and other climate gasses in the atmosphere. These emissions are in turn the result of political and economic systems organized around fossil fuel combustion. Ultimately, climate change is the product of unsustainable Western land management practices and the rise of political and economic systems for which indigenous people hold little to no responsibility.

In this context, the crisis posed by climate change is also a strategic opportunity not only for tribes to retain cultural practices and return traditional management practices to the landscape, but for all land managers to remedy inappropriate ecological actions, and for enhanced and successful collaboration in the face of collective survival. Recent recognition of the validity of traditional ecological knowledge coupled with the recognition of the need for collaboration in the face of high severity wildfire (e.g. [FLAME Act of 2009](#), [Western Regional Strategy Committee 2012](#)), and recognition of the failures of existing Western scientific perspectives and existing management approaches including the focus on single commodities and single species management, have combined to create an exciting political moment in which tribes are uniquely positioned to lead the way. In the

mid-Klamath region specifically, many goals in the Forest Service's own management plan can be best achieved through restoring Karuk tribal management.

"As political sovereigns, Tribes are able to practice stewardship and apply traditions, practices, and accumulated wisdom to care for their resources, exercise co-management authorities within their traditional territories, and strongly influence and persuade other political sovereigns to protect natural resources under the public trust doctrine. As signatories to treaties, some Tribes are able to call upon the obligations of the United States to protect their reserved rights to fish, hunt, trap, and gather on FS lands. Tribes that do not have ratified treaties still retain reserved rights. Both treaty and non-treaty Tribes seek to manage off-reservation lands."

-- Intertribal Timber Council, 2013, p.15

This need for a new and active landscape management strategy has specifically been initiated in the context of both wildfires and climate change. As indicated by the Intertribal Timber Council (2013), "Tribal, FS, BIA land managers recognize the importance of active landscape management to reduce the need for and cost of fire suppression. Treating the cause of the problem (overstocking, excessive fuel buildup, etc.) instead of the symptoms (through suppression) leads to more efficient and effective resource management. Implementing these treatments requires a wide range of actions, including timber harvest, biomass utilization, thinning, fuel treatments, and judicious use of prescribed and natural fire" (p. 7).

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Conclusion

Climate change poses a threat not only to the Klamath ecosystem, but to Karuk culture which is intimately intertwined with the presence, use and management of cultural use species (Karuk Tribe 2010, Lake et al. 2010, Norgaard 2005). The larger concept of “climate change” refers to systems at the atmospheric level that are quite abstracted from local circumstances. This report engages one dimension of the changing climate – that of the increasing frequency of high severity wildfire. Several things are clear from our efforts. While both the causes and consequences of increasing high severity fires are complex, there are multiple opportunities for proactive action. In the context of climate change, Karuk tribal knowledge and management principles regarding fire can be utilized to protect public as well as tribal trust resources (Karuk Tribe 2012). Prescribed fire is now understood as a means of reducing not only fire intensity and severity, but also carbon emissions (Wiedinmeyer and Hurteau 2010). Restoring fire processes and function is about restoring the human responsibility. The development of tribal climate change programs that reflect the nature of indigenous rights to these lands, territories and resources is a critical part of ensuring sustained access to and preservation of cultural resources, life ways, and identity of the Karuk people. While a detailed Climate Adaptation Plan is needed in follow up to this Climate Vulnerability Assessment, we nonetheless note these preliminary recommendations:

- Conduct additional Climate Vulnerability Assessments to evaluate the ways in which cultural use species, tribal program capacity, and tribal management authority may be affected by additional climate stressors such as changing patterns of temperature and precipitation, and species invasions.
- Develop a Climate Adaptation Plan based on this assessment and expand upon it as additional vulnerabilities are assessed.
- Coordinate Climate Adaptation Plan outcomes with Forest Service Land and Resource Management Plan Revisions.

- Expand Capacity of the Department of Natural Resources Eco-cultural Revitalization Branch to manage fire, and forestry proactively at the landscape scale:
 - Shift to management of fire intervals rather than fire ignitions in order to manage for the fires of the future; use planned and unplanned ignitions in the context of managing the fire event or interval in and adjacent to affected management unit(s)
 - Build capacities of Pikyav Field Institute/Environmental Education Program to progress research, monitoring, and adaptive management on an intergenerational level.
 - Build Capacity of NEPA/Environmental Planning Program to assist in forest plan revision and help progress NEPA coverage for landscape level fire resilience projects in perpetuity.
 - Build capacity of Integrated Wildland Fire Management Program to enable a multi-organizational type 3 prescribed fire, cultural burning, and managed wildfire training, implementation, and workforce development facility.
 - Develop pro-active plan to allow shift from status quo suppression approach to suppressing fire when critical fire weather will be coupled with extreme fire behavior conditions; while enabling planned ignitions to address deferred risk caused by taking suppression action.
 - Develop comprehensive database of fire activity, fuel loading, focal indicators and management priorities as basis for fire management response.
 - Expand landscape restoration efforts to reduce hazardous fuel loading utilizing prescriptions that manage for fire process and function as primary driver for vegetative composition and structure.
 - Expand use of cultural burning/prescribed fire and managed wildfire to restore and maintain appropriate fire frequency.
- Reducing the extent of high severity fires with point protection fire management actions when unacceptable risk to shared values is identified. Address deferred risks for interval on shoulder season.
- Develop strategies for returning cultural burning and other mitigation/fire remediation options for each of the habitat zones discussed in Chapter Three (e.g. low, middle and high elevation forest, grasslands, wet meadows, etc).
- Develop strategies for returning cultural burning and other mitigation/fire remediation options for each of the species identified in the species profiles in Chapter Three; narrow focus to fewer indicator or focal species as further correlated with desired characteristic and desired uncharacteristic conditions in a given biophysical setting or deficit habitat type.

- Develop specific adaptations for new forest conditions, e.g. how to continue burning when forest conditions are drier.
- Develop specific fire ecology research priorities.
- Ensure that future climate adaptation plans align with, or build upon, the management objectives and future desired conditions specified in the [Karuk ECRMP](#). [ECRMP](#) management objectives that have been integrated or considered when developing this vulnerability assessment include reduction of fuel loading in various habitats, appropriate management response during wildland fire events, restoration of wetlands and associated wet/dry meadow habitats, upgrade and maintenance of transportation systems, and extirpated species reintroduction. A future, more comprehensive assessment should continue to reference (and more thoroughly fulfill the management objectives of) the [Karuk ECRMP](#).
- Ensure that future fire-related climate adaptation plans take into account the objectives and approaches of the [Western Klamath Restoration Partnership \(WKRP\)](#) and integrates the on-the-ground fire management and administrative lessons learned during the course of this partnership to date. The [WKRP](#) can serve as a model of collaborative land and fire management planning and implementation involving tribal, federal, local partners, as well as non-governmental organizations (NGOs). Examples of [WKRP](#) approaches that can be incorporated into a future climate adaptation plan include:
 - Develop community based Incident Management Teams to implement prescribed fire/cultural fire training exchange programs.
 - Create more efficient mechanisms to leverage local, tribal, state, federal, and NGO programs.
 - Increase capacity of diverse groups of fire practitioners to address policies and regulations that impede the large scale use of prescribed fire/cultural fire.
- Consider re-securing funding for an official emissions inventory in Karuk aboriginal territory to have strong documentation outlining air particulate trends for the region. This can help monitor air quality in relation to human health, and can also provide data related to how different fire types affect particulate matter and how particulate matter levels benefit or negatively impact different species. Make air particulate data available to Tribal Clinics that can inform patients and help them prepare to cope with the impacts of high particulate exposure.
- Incorporate material related to climate change, high severity fire and cultural burning into tribal environmental education programs for both youth and adults. When (and if) appropriate, involve tribal youth in cultural burning

practices so traditional ecological knowledge regarding these practices is steadily passed on.

- Develop or strengthen existing tribal GIS mapping efforts documenting geographic and fire-related information that may assist the Tribe in planning and interagency communication efforts. GIS layers that might be developed include fire occurrence, spread of fire, fire duration, intensity, severity and ignition cause, location of current structures (dwellings, tribal buildings, etc.), location of both main and traditional transportation routes, location of cultural use species, location and span of different habitat types in Karuk territory, and tribal management regimes and activities for these various habitats. Measures would be taken to omit or protect sensitive traditional ecological knowledge when developing GIS data and maps.
- Assess the ways in which Karuk land management strategies in response to increased high severity fire risk may align or conflict with current Northwest Forest Plan (NWFP) requirements. The [ECRMP](#) includes a management objective for reduction of fuel loading in and adjacent to degraded spotted owl habitat, which aims to protect existing owl populations and encourage dispersal to new stands. Future adaptation plans and actions should account for NWFP requirements. Where necessary, the Karuk Tribe should call for federal-tribal consultation to inform future forest plans and advocate for the habitat benefits of Karuk land management.
- Develop legal mechanisms to ensure enforcement of existing federal tribal trust responsibilities at the local level.
- Strengthen inter-governmental relationships at regional and national level as leverage to ensure local compliance to existing tribal trust responsibilities. Use the Tribe's experience leading the [WKRP](#) effort as a model for future intergovernmental collaborative efforts. Challenges or hurdles faced during the [WKRP](#) process can also inform future collaborations.
- Strengthen relationships with local collaborators and agencies to build capacity and expand understanding of Karuk tribal expertise and management goals.
- Collaboratively develop inter-governmental fire response plan that prepares agencies and the Tribe for the subsequent fire seasons ahead of time, thereby reducing or entirely eliminating the need for emergency exemptions that lead to quick agency-led decisions that often have detrimental consequences for the Tribe and the region's ecosystems.

- Build upon the progress of the [Western Klamath Restoration Partnership](#) to restore fire process and function to Karuk Territory and beyond; engage our neighbors so they can help lead the way into a similar future.
- Develop a proposal or other document that highlights the ways in which Karuk land management and expertise, particularly cultural burning, reduces burden of wildfire management and suppression on federal land managers, advances the objectives of the [National Cohesive Strategy](#), and promotes environmental justice. Use this document to propose future management strategies and collaborations at the intergovernmental level.
- Develop informational/training materials that describe Karuk presence, the importance of Karuk land management and traditional ecological knowledge in the Klamath basin, federal trust responsibilities, and tribal environmental justice and climate change concerns that can be delivered to federal agency staff, non-tribal firefighting personnel, and scientists working, or demonstrating interest in, the region, for the purposes of educating potential collaborators and reducing impacts to the Tribe and the region's ecology due to uninformed decision-making.
- Expand support for the Karuk Transportation Department in preparation for increased fire-related impacts to main access routes as well as traditional routes.
- Expand support for Karuk Health Clinics to respond to fires, e.g. reviving the Department of Emergency Management and stocking Hepa filter air purifiers and clean air facilities

These and other steps are preliminary recommended actions based on this assessment. Yet the Karuk Tribe faces limitations in program capacity to implement these steps, and institutional barriers to their enactment. A number of these barriers would be alleviated simply by agencies following existing Federal Tribal Trust responsibilities (see Norgaard 2014a and 2014b). In other cases barriers to the proactive expansion of these strategies would be alleviated in the course of following through with non-binding more and ethical principles, such as those outlined in Article 26 of the [United Nations Declaration on the Rights of Indigenous Peoples](#) which states, *“Indigenous peoples have the right to the lands, territories and resources which they have traditionally owned, occupied or otherwise used or acquired.”*

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