

Perceptions of Tree Diseases in Indigenous Communities: Native Alaskan and Hawaiian Insights

Kylle Roy,^{1,*} Susan J. Frankel,^{2,*,} Lauren E. Oakes,³ Kainana S. Francisco,⁴

Kekuhi Keali‘ikanaka‘oleohaililani,⁵ Rachael A. Sitz,⁶ Emily S. Huff,^{7,} and John Schelhas^{8,}

¹USDA Forest Service, Pacific Southwest Region, Forest Health Protection, Hilo, HI, USA (Kylle.Roy@usda.gov).

²USDA Forest Service, Pacific Southwest Research Station, Albany, CA, USA (susan.frankel@usda.gov).

³Department of Earth System Science, Stanford Doerr School of Sustainability, Stanford University, Stanford, CA, USA (leoakes@stanford.edu).

⁴USDA Forest Service, Pacific Southwest Research Station, Hilo, HI, USA (kainana.s.francisco@usda.gov).

⁵Hālau ‘ōhi‘a Hawai‘i Stewardship Training, Hilo, HI, USA (ohaililani@gmail.com).

⁶Davey Resource Group, Inc., Urban and Community Forestry Services, Atascadero, CA, USA (rachael.sitz@davey.com).

⁷Human Dimensions of Natural Resources Laboratory, Department of Forestry, College of Agriculture and Natural Resources, Michigan State University, East Lansing, MI, USA (ehuff@msu.edu).

⁸USDA Forest Service, Southern Research Station, Athens, GA, USA (john.schelhas@usda.gov).

*K.R. and S.J.F. are co-lead authors.

*Corresponding author email: susan.frankel@usda.gov

Abstract

Concern for tree mortality and damage, and preferences for management interventions, reflect people's values and cultures. We examine perceptions of tree diseases in two Indigenous communities to provide examples of the types of distress and attitudes that arise when tree diseases significantly damage cultural values. Summaries of yellow-cedar decline as perceived by Tlingit and Haida Alaska Natives and rapid ‘ōhi‘a death (ROD) and Native Hawaiian culture underscore the interconnections between local people and local forests and the ways forest diseases can impart a loss of culture and connections to ancestors. The complex relationships between Indigenous people, ecosystems, and tree diseases highlight the importance of the inclusion of diverse viewpoints to inform natural resource planning and management so that it may be conducted equitably and ethically.

Study Implications: Consideration of cultural and social impacts as criteria for prioritization of forest disease management requires knowledge of the types and intensity of impacts that forest diseases have on Indigenous and Western culture. A greater understanding of the diversity of perspectives toward forest diseases is needed to inform natural resource planning and management so that it may be conducted in an ecologically sound and inclusive manner.

Keywords: tree diseases, cultural values, social values, Indigenous natural resources

Tree diseases, like other disturbances, can alter practical and psychological attachments humans hold to thriving trees and forests, degrading the social values that forests support (Lindsay et al. 2023; Oakes et al. 2016; Schelhas et al. 2021). Forest diseases can diminish a sense of place, self-identity, and spiritual renewal as well as other cultural services that reflect the variety of human relationships to landscapes and ecosystems (de Mello et al. 2020; Jones 2011; Laband 2013; Millenium Ecosystem Assessment 2005).

Physical and spiritual connections to forests are particularly strong for Indigenous peoples whose cultures, livelihoods and identities are often tied to plants and animals (Anderson 2005; Daigle et al. 2019; Garibaldi and Turner 2004). Indigenous populations are likely to hold unique cultural values for local trees that need to be understood to allow for incorporation in forest management and planning, including disease prevention and mitigation.

Few publications address the social dimensions of tree diseases. A 2018 global analysis of over 25,000 journal publications concerning forest insects and diseases found less than 2% discussed aspects of the social sciences (Urquhart et al. 2018). The impacts of forest diseases on the traditional uses and values of Indigenous peoples' culture have not been well documented in the scientific literature (Alexander et al. 2017; D'Amato et al. 2023a, 2023b).

To counter the lack of cultural considerations in invasive species management, D'Amato et al. (2023a) developed a framework for tree species preservation aimed at incorporating cultural impacts into forest health management. For forest planning, the framework factors include ethical responsibility, (i.e., the concept that the natural world has a responsibility to maintain the dynamic relationships among beings) and cultural integrity (i.e., the preservation of cultural values and relationships between species, including culturally

significant derived materials that support traditions and life-ways). The authors call for adding cultural values and perspectives to guide invasive species response to augment how priorities have been set historically (D'Amato et al. 2023a), and to emphasize the reciprocal relationship of care between humans and land (D'Amato et al. 2023b).

Consideration of cultural and social impacts as criteria for forest disease management requires knowledge of the types and intensity of impacts that forest diseases have on Indigenous and Western culture. However, a comprehensive analysis of how human well-being is diminished by disease-caused tree damage and mortality is difficult to conduct. The losses or benefits to cultural and social values caused by tree diseases can vary based on many factors, dependent on the host tree species, the extent and distribution of the tree mortality, disease type (e.g., infectious or noninfectious, abiotic or biotic), the diverse values and lifestyles of the affected communities and individuals, and other factors. Although difficult to assess, a greater understanding of the diversity of perspectives toward forest diseases could help inform natural resource planning and management so that it may be conducted equitably, inclusively, and ethically (D'Amato et al. 2023a; Hagerman and Satterfield 2014).

Concern for tree damage and tree mortality, as well as preferences for interventions to address tree disease impacts to forest ecosystems, reflects people's values and cultures. We examine perceptions of tree diseases within two Indigenous communities to provide examples of the types of concerns that arise when tree diseases significantly damage cultural values. We explored (1) yellow-cedar decline as perceived by Tlingit and Haida Alaska Natives and (2) rapid 'ōhi'a death (ROD) and Native Hawaiian culture. Each summary briefly describes the cause and history of the tree disease and then focuses on perceptions of the disease by Native people.

Methods

At a 2022 workshop to develop a US Forest Pathology Assessment convened by the USDA Forest Service, Research and Development in Pittsburgh, Pennsylvania, participants identified significant forest diseases with complex socioecological impacts on Indigenous peoples and based on available information and expertise, selected yellow-cedar decline in Tlingit and Haida communities in Alaska and rapid 'ōhi'a death in Native communities in Hawai'i for further documentation. Experts on these disturbances conducted literature reviews on the history of the disease outbreaks and the social impacts incited by the changes in forest condition to develop short summaries to serve as qualitative investigations on cultural impacts of a tree disease in its real-life context.

For the example of yellow-cedar decline, data from forty-five semi-structured interviews were used. Interviews were conducted in 2013 in Southeast Alaska (Juneau, Sitka, Hoonah, Tenakee Springs) with Tlingit and Haida peoples, investigating social responses to yellow-cedar decline (Oakes 2015, 2018; Oakes et al. 2016). For ROD in Native communities in Hawai'i, three local Native Hawaiian women, two of whom are ROD scientists, provided their observations based on more than 8 years each of field and personal experience. The Alaska yellow-cedar data used in this manuscript come from interviews conducted by co-author Lauren E. Oakes, and is available at leoakes@stanford.edu. The rapid

'ōhi'a death summary data are the observations of Kylie Roy, Kainana Francisco, and Kekuhi Keali'ikanaka'oleohaililani and is available from those authors.

Tlingit and Haida Responses to the Climate-Induced Dieback of Yellow-Cedar Trees

People throughout Southeast Alaska have valued and used yellow-cedar trees (*Callitropsis nootkatensis*) for millennia, giving it ecological, economic, and cultural importance. Tlingit and Haida Indigenous people in Southeast Alaska have developed relationships with yellow-cedar by living among them and harvesting tree parts for shelter, carving and bark weaving, and using it in ceremonial and spiritual activities. The golden inner bark (phloem) is an exceptional source of fiber, and the wood has many uses—for totem poles, bentwood boxes, and masks, for example (Oakes et al. 2016). Yellow-cedar wood is resistant to decay, making the wood highly valuable (Hennon et al. 2016). Ecologically, yellow-cedar plays critical roles in the forest community by providing habitat and regulating nutrient and hydrologic cycling (Hennon et al. 2016).

Yellow-cedar has undergone a pronounced dieback in North Pacific coastal rainforests during the past 100 years (Hennon et al. 2012, figure 1). The widespread mortality is not associated with biotic agents, such as pathogens and insects but with changing climate conditions. Late winter and early spring freeze events kill fine roots (Schaberg et al. 2008) where trees are shallow-rooted and snowpack is absent (Beier et al. 2008; D'Amore and Hennon 2006; Hennon et al. 2012; Oakes et al. 2014). In these mixed-species forests, yellow-cedar roots are uniquely vulnerable to cold soils (Hawkins et al. 2021; Schaberg et al. 2011). Warming has reduced the snowpack that insulates roots from lethal temperatures, but the periodic cold weather events that cause injury are continuing even in a warmer climate (Beier et al. 2008).

Interview data revealed that tree mortality is the loss of culture and a severing of links to ancestors. One interviewee described their experience of being in the forests affected by the decline, "There's something disheartening about it ... like going to a graveyard" (Oakes et al. 2016). For Alaskan Indigenous peoples, the death of the yellow-cedar is associated with a loss of connection to nature, (e.g., feeling attached, fostering mutual respect between humans and nature) and loss of well-being (e.g., lost feelings of happiness, gratitude, calmness). The trees were a way to communicate with ancestors, perceived as an avenue for retaining cultural identity partly through markings of ancestors retained in bark. The trees also inspired a spiritual feeling of reverence inspired through meditation (Oakes et al. 2016). For some uses, people could substitute dead trees or other species for yellow-cedar, thereby adapting to the changing forests. But yellow-cedar also gives individuals and their communities identity. People derive intangible values, such as aesthetic appreciation and a sense of heritage, from the trees, and there is nothing that can replace those specific values. As one interviewee explained, "I put myself in the presence of cedar on a regular basis. You almost have to. They're such different personalities ... you have to go spend time with them on their own" (Oakes et al. 2016).

Attachment to the species was deeply intertwined with the use values that various respondents described deriving



Figure 1 Yellow-cedar decline in Southeast Alaska. Credit: Lauren E. Oakes, Stanford University.

from the species. There are functional attachments, formed mainly by a history of direct use, and emotional attachments that come from intangible values. Tribal people have much to lose. The deeper the relationship, the more there is at stake.

These sentiments were expressed by remarks such as:

- “If we don’t have our trees, we don’t - we can’t be who we are.” Tlingit, Hoonah, Alaska.
- “Working with cedar, mentally you’re connected to the Earth ... you’re connected to your ancestors at the same time. It becomes a spiritual connection.” Tlingit, Hoonah, Alaska.
- “I love ‘em, it’s just love. The standing dead trees – make me uncomfortable. I feel loss – just loss.” Tlingit, Sitka, Alaska.

Most interviewees were concerned about personal and local loss as well as the global implications of this dieback. People have been forced to change their use of the trees, cope with the loss of what could not be replaced and confront the enormity of the cause—climate change. Some worked to adapt psychologically to the changes occurring (Oakes et al. 2016).

Teri Rofkar, a Tlingit Native weaver in Sitka, Alaska, who passed away in 2016, described the ecosystem changes as: “There are the amphibians. There are the cedars. There are those in our ecosystems that are the ones to warn us. I think that’s what they’re doing right now, and they have been for quite some time.”

Resilience and Restoration of Hawaiian Culture in the Face of Rapid ‘Ōhi’a Death

Hulihia ka mauna, wela i ke ahi a ka wahine. Wela na ‘ōhi’a o Kūlili i ka ua. Wela a nōpu ke ahi o ka lua!

The mountain has metamorphosed, in the heat produced by the woman. The ‘ōhi’a of Kūlili is hot even in the rain. The influences of volcanic connections swell in the high temperature (Tangarō 2007).

The threat of the fungal disease, rapid ‘ōhi’a death, to ‘ōhi’a lehua (*Metrosideros polymorpha*) has triggered events in Native Hawaiian communities that can be personified through the story of Pele and Hi‘iaka, an epic Hawaiian saga of disturbance and restoration. This mythic tale tells of two sisters as they travel from Kahiki to Hawai‘i in search of a new home (Emerson 2005). Pele is the keeper of fire and creator of new land through volcanic phenomenon, and Hi‘iaka has the power to heal and restore life. The sisters’ journey pushes them to their fullest potential: they transform into deities to become physical manifestations of the Hawai‘i landscape, with Pele building and rebuilding new land through volcanic activity and Hi‘iaka restoring and regreening the newly created landscape in vegetation. The cycle depicted in this relationship between the sisters is referred to as “hulihia” and “kūlia,” a balance of events that cause upheaval followed by resolution (Emerson 2005; Tangarō 2007). Hulihia translates to “upheaval, or extreme transformation,” a change that occurs on global, societal, landscape, and internal scales. Kūlia is to “strive, restore, or regenerate” the scales that were imbalanced in the hulihia (Pukui and Elbert 1986).



Figure 2A: A stand of ‘ōhi‘a severely damaged by rapid ‘ōhi‘a death in Hawai‘i. Credit: R.F. Hughes, USDA Forest Service, Pacific Southwest Research Station.



Figure 2B: Small unmanned aerial system (sUAS) image taken over a forest on Hawai‘i island experiencing extensive ‘ōhi‘a mortality. Credit Ryan Perroy, University of Hawai‘i.

This cycle of huihilia and kūlia is occurring in Hawaiian forests, where ‘ōhi‘a, a keystone biocultural tree, is threatened by invasive fungal plant pathogens, *Ceratocystis lukuohia* and *C. huliohia*, which causes ROD (Barnes et al. 2018; Keith et al. 2015, figure 2A, 2B). ‘Ōhi‘a are the first trees to grow on lava fields, which creates the forest foundation and supports countless flora and fauna with water, food, and habitat (Mueller-Dombois et al. 2013). ‘Ōhi‘a comprise over 350,000 ha across the archipelago (Gon et al. 2006) and are a core element to stories, songs, chants, and traditional practices such as hula (dance), lā‘au lapa‘au (healing and medicine), hale (structures), wa‘a (canoes), kālai (carving), imu and mahi‘ai (food and agriculture), lawai‘a and lokoi‘a (fishing and aquaculture), and other spiritual practices (Abbott 1992; Krauss 1993; Krauss 2011; Malo 1951, figure 3A, 3B).

Hawai‘i began experiencing an intense huihilia around 2010 but identified it in 2014, when the native landscape was transformed by ROD: over one million ‘ōhi‘a trees

have died (J.B. Friday, letter to author, May 22, 2020). Symptoms include a rapid onset of browning leaves, progressing into leaf drop and canopy dieback; *C. lukuohia* is more aggressive due to its capability to systemically spread within the xylem (Barnes et al. 2018; Hughes et al. 2020; Keith et al. 2015).

Authors Roy, Francisco, and Keali‘ikanaka’oleohaililani are deeply invested in the physical restoration, conservation, and care of ‘ōhi‘a, all essential parts of the kūlia process in restoring the health and vitality of the ‘ōhi‘a family. For Kānaka Maoli, the Indigenous people of Hawai‘i, the idea of kūlia encompasses much more than physical actions that can be done for the tree itself; it is equally important to restore and strengthen the deep familial bond with ‘ōhi‘a and to express aloha (love) through prayers, chants, and dances for their living, breathing family member that happens to have roots and branches. Roy’s research has pinpointed invasive ambrosia beetles (Coleoptera: Curculionidae) in the spread of the fungal pathogens, both phoretically and through their



Figure 3 ‘Ōhi’a blossoms used in lei adornments for ceremony and celebrations. 3A: Pa’u rider (woman horseback rider) adorned in an ‘ōhi’a lei. Credit: A. Wong, University of Hawai’i. 3B: ‘Ōhi’a blossoms can be red, yellow, orange, or pink. Credit: J.B. Friday, University of Hawai’i Cooperative Extension.

frass, which can spread in wind, soil, and water (Atkinson et al. 2017, 2019; Atkinson and Roy 2023; Cannon et al. 2022; Hughes et al. 2023; Roy et al. 2018, 2020a, 2020b, 2021, 2023a; Yelenik et al. 2020). Roy et al. (2020b) determined decontamination methods to prevent the spread of ROD, including the use of 70% isopropanol or ethanol on boots and tools, to effectively kill the pathogens when embedded in beetle frass. In addition, her research has tested repellents to deter beetle attack to ‘ōhi’a trees (Roy et al. 2023b). Francisco is leading community-based restoration efforts and the establishment of a ROD-resistant ‘ōhi’a program with promising results (Luiz et al. 2023).

In 2015, a paradigm shift towards kŭlia began when the ROD Working Group, a collection of ROD scientists, land managers, and educators, sought guidance from Kekuhi Keali’ikanaka’oleohaililani, a hula master and educator, regarding concerns for the possible spread of ROD during Merrie Monarch Festival, the largest Hawai’i cultural hula event. The vibrant red and yellow blossoms and leaf shoots of ‘ōhi’a typically adorn many dancers and festival-goers, although the Hawai’i Department of Agriculture has banned the movement of ‘ōhi’a plant parts and soil inter-island (HDOA 2016). Keali’ikanaka’oleohaililani encouraged the group to speak with hula practitioners in a way that resonated with their values: how could they maintain and encourage the well-being of ‘ōhi’a for the perpetuation of hula, culture, and the islands? Discussions resulted in the development of the Pua’ena’ena ceremony, a fire ritual designed to allow festival participants and visitors to offer their adornments made of ‘ōhi’a with thoughts of full forest recovery. Ashes from the fire ritual were later scattered in a ROD-affected forest.

Beyond the annual Merrie Monarch Festival, ROD has triggered kŭlia within the local and Native Hawaiian community

where relationships with ‘ōhi’a are being restored. Aloha for ‘ōhi’a is being shared widely through various forms of art and design, such as in fashion and tattoos. The purchase and planting of ‘ōhi’a for urban landscaping and restoration has increased (Rick Barboza, Hui Kū Maoli Ola, email message to author message to author, 2022), and hula and lei practitioners continue to avoid the use of ‘ōhi’a. In 2022, Hawai’i Governor Ige signed SB2059, designating ‘ōhi’a as the Hawai’i state endemic tree (Hawai’i State Legislature 2022). Also, the disease has spurred an increased commitment to biocultural literacy in the Hawai’i conservation community through programs such as Hālau ‘Ōhi’a and embracing the sacred relationships we have with the people and places we steward (Keali’ikanaka’oleohaililani and Giardina 2016; Keali’ikanaka’oleohaililani et al. 2018, 2019, 2021; McMillen et al. 2020).

After nearly 10 years facing ROD, despite the tree mortality, the three Hawaiian women authors are encouraged by the profound interrelationship between ‘ōhi’a and the community that the disease has revealed. The Hawaiian and local community is collectively working towards restoration of their ‘ōhi’a family and Hawai’i landscapes. This mindset resonates with the root words of ‘ōhi’a: “‘ohi,” meaning to gather or collect, and “hi’a,” to form a network or to bind (Pukui and Elbert 1986).

Kŭlia e Uli. Ka pule kānana ola i mua o ke kahuna. Kauila i ke ‘Ālohilani. Kŭlia i kupupupu o luna nei. ‘O wai Kupukupu?

O do rise to your station, o profound-Darkness. You who strain ailments from the living, stand before your priestess. Lashed to the heavenly temple of burning brilliance. May the rise to heightened awareness germinate. Who then will rise to the call? (Tangarō 2009).

Discussion

These summaries display the close interconnections between people and local forests and the ways forest diseases impart a sense of cultural loss, a severing of the links to ancestors, and other social concerns. In Alaska, the loss of yellow-cedar is felt directly, expressed as the loss of close personal connections with individual trees and the forest environs. The cause of the yellow-cedar mortality is related to climate warming, considered an abiotic forest disease (Sturrock et al. 2011). That climate change is driving the tree mortality adds another complex dimension to the processing and attitudes of the residents (Smith et al. 2012).

In Hawai'i, rapid 'ōhi'a death prompted Indigenous researchers to look to origin stories and cultural history for resilience in response to on-going tree mortality. This is similar to the response of other Indigenous cultures that sustain a multidimensional dependence on forests that positions them to be particularly sensitive to changes in the forest. However, they are also potentially resilient because of stories and other cultural traditions that help with coping and understanding environmental change (Daigle et al. 2019; Kuru et al. 2021). The summaries provide support to show that Indigenous peoples' concerns for tree damage and mortality are grounded in the lifeways, spiritual traditions, and experiences that contribute to traditional ecological knowledge (Bussey et al. 2016; Daigle et al. 2019).

The summaries are not exhaustive, but they encapsulate concerns spawned in the wake of tree damage in these communities, thereby reflecting the importance and meaning of these tree species and the ecosystems they support to the local cultures. They provide a sampling of the concerns evinced by individuals or communities in response to the loss of trees and insight into how local tree mortality sparks emotional reactions from community members. The local context, attitudes toward, and uses of trees influence individuals' and communities' reactions to tree disease epidemics (Alexander and Lee 2010; Urquhart et al. 2018). Further research is needed to identify and articulate the range of cultural and social values of trees in diverse communities and how tree diseases and other disturbances affect provisioning of cultural services.

Indigenous knowledge is often overlooked in policy and decision-making, yet the people are profoundly affected by forest insects and diseases that affect the native plants relied on for cultural purposes (Kuru et al. 2021). An inclusive approach to forest health management would elevate and recognize the importance of Indigenous knowledge and strengthen relationships with Indigenous peoples to improve biosecurity (Kuru et al. 2021).

Forest disease management decision-making would benefit from incorporation of the social dimensions of forest diseases, particularly engagement of diverse stakeholders. Socioecological approaches to forest disease management and policy that use adaptive collaborative approaches and account for the values of diverse communities are best suited to reconcile the tensions often inherent to managing tree diseases. These conflicts include the benefits of disease management for the collective good versus private property rights, uneven distributions of cost and benefits of disease management, and different needs across diverse populations (D'Amato et al. 2023a; Fischer 2018; Schelhas et al. 2021). Increased consideration of human dimensions of forest diseases and how they can be best incorporated into disease management would

improve forest health and human well-being (D'Amato et al. 2023a). Moreover, policies that incorporate social and cultural preferences may be more effective and socially acceptable when preventing and mitigating the negative consequences of tree diseases. The complex relationships between Indigenous people, ecosystems, and tree diseases highlight the importance of inclusive and engaged research and action rooted in dialogue among scientists, land managers, and Indigenous communities.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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