Pacific Yew (*Taxus brevifolia*)

Northern California Climate Change Vulnerability Assessment Summary

Habitat Description

The range of Pacific yew includes much of the Pacific Northwest, from central California north to Alaska and east into the Rocky Mountains (Griffin & Critchfield 1972; Kauffmann 2012; Calflora 2019). Pacific yew is highly shade-tolerant and is typically scattered in the understory of productive mature and late-successional coniferous forests (Griffin & Critchfield 1972; Busing et al. 1995). It is often associated with riparian areas or sites with a high water table, and seedlings and young trees are susceptible to mortality following loss of shade from the forest canopy (Tirmenstein 1990). Common tree associates include Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), Port-Orford-cedar (*Chamaecyparis lawsoniana*), white fir (*Abies concolor*), and other species typical of mixed conifer and mixed evergreen forests (Franklin & Dyrness 1973). At very high elevations (above 1,500 m [5,000 ft]), this species also occurs in shrubby or krummholz form (Kauffmann 2012).

The relative vulnerability of Pacific yew in northern California was evaluated as moderate-high by regional experts (high confidence in evaluation).[1]

Sensitivity and Exposure

Pacific yew was evaluated by regional experts as having moderate-high overall sensitivity (high confidence in evaluation) and moderate-high overall future exposure (moderate confidence) to climate and climate-driven factors, changes in disturbance regimes, and non-climate stressors.

For Pacific yew, range contraction in northwestern California has been projected under multiple climate scenarios by 2100, while range expansion may occur in other areas of the species range (primarily the eastern Cascades and Rocky Mountains; Shafer et al. 2001). Some studies have already observed shifts in patterns of Pacific yew regeneration, with regeneration becoming more concentrated on cooler sites at northern latitudes and higher elevations (Monleon & Lintz 2015).

Climate stressors and disturbance regimes

Due to its dependence on relatively high soil moisture and high fire sensitivity, Pacific yew is likely sensitive to warmer, drier conditions that would reduce habitat suitability and increase fire risk.

- At higher elevations, **loss of snowpack** is likely to reduce soil moisture availability during the growing season and lead to longer periods of summer drought (Bales et al. 2011; Reba et al. 2011).
- **Changes in the amount and timing of precipitation** that contribute to **reduced soil moisture** during the growing season could limit the occurrence of this species (Vuln. Assessment Workshop, pers. comm., 2017).
- **More frequent and/or more intense wildfire** are likely to increase Pacific yew mortality, particularly where increased competition in dense forest stands has already increased tree stress (Vuln. Assessment Workshop, pers. comm., 2017). Pacific yew is highly sensitive to fire

[1] Vulnerability scores were provided by Redding workshop participants, and peer review for this document was provided by Julie Nelson (U.S. Forest Service).

due to thin bark, and is often associated with sites that experience relatively infrequent fires, such as riparian areas on east-facing slopes (Scher & Jimerson 1989; Tirmenstein 1990; Taylor & Skinner 1998).

Dependency on habitat and/or other factors

Although Pacific yew can grow on a variety of soil types and across a broad elevational range, it requires shade and high levels of soil moisture for seedling establishment (Vuln. Assessment Workshop, pers. comm., 2017). Because of its high shade tolerance and sensitivity to fire, Pacific yew is primarily associated with mature and late-successional forests across its range and is often used as an indicator of old-growth forests (Busing et al. 1995). However, established trees can adapt to overstory removal (Bolsinger & Jaramillo 1990).

Non-climate stressors

Non-climate stressors can exacerbate changes in climate factors by increasing tree stress and mortality rates, reducing genetic diversity and population connectivity in rare species such as the Pacific yew.

- Because Pacific yew is sensitive to even low-intensity fire, it may be negatively impacted during **prescribed burns** used in surrounding coniferous forests (Vuln. Assessment Reviewer, pers. comm., 2019).
- In the past, **commercial bark collection** from Pacific yew was the only known source of paclitaxel (Taxol), a medical compound used to treat cancer (Zhu & Chen 2019). However, this compound was only present in very low concentrations in Pacific yew bark, necessitating the collection of large amounts of bark. More recently, semi-synthesis of the drug and even more recent advances in extraction of this compound from genetically-modified fungi have meant that Pacific yew bark is no longer the primary source (Zhu & Chen 2019).

Adaptive Capacity

Pacific yew was evaluated by regional experts as having low-moderate overall adaptive capacity (high confidence in evaluation).

Species extent, status, connectivity, and dispersal ability

Because northern California is at the southern end of Pacific Yew range, the species is ecologically more restricted here than further north where temperatures are more moderate and fire intervals are generally longer (Vuln. Assessment Workshop, pers. comm., 2017).

Birds facilitate long-distance dispersal (up to 25 km [16 mi]), but Pacific yew establishment success depends on the availability of soil moisture and shade for seedlings (Vuln. Asessment Workshop, pers. comm., 2017). Because it is sensitive to mortality from even low-intensity fire (Tirmenstein 1990), wildfires can act as localized barriers to establishment; however, they have a relatively low impact on regeneration for the species as a whole (Vuln. Assessment Workshop, pers. comm., 2017).

Interspecific/life history diversity

Pacific yew populations are relatively distinct from one another, although genetic differentiation at a regional level is limited. Functionally, this means that the majority of the genetic diversity within the species occurs at the family or population level (Wheeler et al. 1995). The species also displays some phenotypic plasticity, as trees are able to adapt and thrive under the major changes in microclimate that result from overstory removal (DiFazio 1995).

Resistance and recovery

High sensitivity to fire and dependence on water and shade likely reduce resistance and recovery of Pacific yew under climate change (Vuln. Assessment Workshop, pers. comm., 2017).

Management potential

Pacific yew is not state-or federally-listed as threatened or endangered (Vuln. Assessment Workshop, pers. comm., 2017; CDFW 2019). However, this rare species is highly valued by northern California tribes as a source of wood for tools and bows (Tirmenstein 1990; Turner et al. 2011) and the needles and bark are used for various medicinal purposes (Schenck & Gifford 1952; Turner et al. 2011); thus, there is likely high potential for collaboration with tribes to conserve this species (Vuln. Assessment Workshop, pers. comm., 2017). Pacific yew has also historically valued as a source for Taxol, a drug derived from the tree's bark and used to treat cancer (Zhu & Chen 2019).

Caution is required when using prescribed burns for management of surrounding coniferous forests due to its sensitivity to light and temperature (Scher & Jimerson 1989). As a result, protection of this rare species should be considered in project planning and implementation (Vuln. Assessment Workshop, pers. comm., 2017). At the landscape level, conservation of Pacific yew may require large, unmanaged reserves and maintenance of old growth forest patches within managed forests (Busing et al. 1995). Over the long term, it is likely to be very difficult to alleviate the impacts of reductions in water and shade on this species (Vuln. Assessment Workshop, pers. comm., 2017).

Recommended Citation

Sims SA, Hilberg LE, Reynier WA, Kershner JM. 2019. Pacific Yew (*Taxus brevifolia*): Northern California Climate Change Vulnerability Assessment Summary. Version 1.0. EcoAdapt, Bainbridge Island, WA.

Further information on the Northern California Climate Adaptation Project is available on the project website (https://tinyurl.com/NorCalAdaptation).

Literature Cited

Bales RC, Hopmans JW, O'Geen AT, Meadows M, Hartsough PC, Kirchner P, Hunsaker CT, Beaudette D. 2011. Soil moisture response to snowmelt and rainfall in a Sierra Nevada mixed-conifer forest. Vadose Zone Journal **10**:786–799.

Bolsinger CL, Jaramillo AE. 1990. *Taxus brevifolia* Nutt. - Pacific yew. Pages 573–579 in R. M. Burns and B. H. Honkala, editors. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, D.C.

Busing RT, Halpern CB, Spies TA. 1995. Ecology of Pacific yew (*Taxus brevifolia*) in western Oregon and Washington. Conservation Biology **9**:1199–1207.

Calflora. 2019. Calflora: information on California plants for education, research and conservation, with data contributed by public and private institutions and individuals, including the Consortium of California Herbaria [web application]. The Calflora Database [a non-profit organization], Berkeley, CA. Available from http://www.calflora.org/ (accessed January 2, 2019).

CDFW. 2019. State and federally listed Endangered and Threatened animals in California: April 23, 2019. California Department of Fish and Wildlife, Sacramento, CA. Available from http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109405&inline (accessed May 8, 2019).

DiFazio SP. 1995. The reproductive ecology of the pacific yew (*Taxus brevifolia* Nutt.) under a range of overstory conditions in western Oregon. Master of Science thesis. Oregon State University, Corvallis, OR.

Franklin JF, Dyrness CT. 1973. Natural vegetation of Oregon and Washington. Gen. Tech. Rep. PNW-GTR-008. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Griffin JR, Critchfield WB. 1972. The distribution of forest trees in California. Res. Pap. PSW-RP-82. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Kauffmann ME. 2012. Conifer country: a natural history and hiking guide to 35 conifers of the Klamath Mountains. Backcountry Press, Kneeland, CA.

Monleon VJ, Lintz HE. 2015. Evidence of tree species' range shifts in a complex landscape. PLoS ONE **10**:e0118069.

Reba ML, Marks D, Winstral A, Link TE, Kumar M. 2011. Sensitivity of the snowcover energetics in a mountain basin to variations in climate. Hydrological Processes **25**:3312–3321.

Schenck SM, Gifford EW. 1952. Karuk ethnobotany. University of California Press, Berkeley, CA.

Scher S, Jimerson TM. 1989. Does fire regime determine the distribution of Pacific Yew in forested watersheds? Pages 160–161 in N. H. Berg, editor. Proceedings of the symposium on fire and watershed management; October 26-28,1988; Sacramento, California. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Albany, CA.

Shafer SL, Bartlein PJ, Thompson RS. 2001. Potential changes in the distributions of western North America tree and shrub taxa under future climate scenarios. Ecosystems **4**:200–215.

Taylor AH, Skinner CN. 1998. Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. Forest Ecology and Management **111**:285–301.

Tirmenstein DA. 1990. *Taxus brevifolia*. In: Fire Effects Information System [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available from https://www.fs.fed.us/database/feis/plants/tree/taxbre/all.html (accessed October 26, 2018).

Turner NJ, Deur D, Mellott CR. 2011. "Up on the mountain": ethnobotanical importance of montane sites in Pacific Coastal North America. Journal of Ethnobiology **31**:4–43.

Wheeler NC, Jech KS, Masters SA, O'brien CJ, Stonecypher RW, Timmons DW, Lupkes A. 1995. Genetic variation and parameter estimates in *Taxus brevifolia* (Pacific yew). Canadian Journal of Forest Research **25**:1913–1927.

Zhu L, Chen L. 2019. Progress in research on paclitaxel and tumor immunotherapy. Cellular & Molecular Biology Letters **24**:40.