California Department of Fish and Wildlife Comments on the Forest Carbon Plan
Draft for Public Review - January 2017

Comments and suggested edits have been organized by the following subject areas:

- the carbon dynamics of old forests,
- the carbon dynamics of redwood tree, forests, ecosystems,
- silviculture effects on carbon potential of managed forests,
- additional considerations regarding large, old trees, and
- other/miscellaneous.

1) **Carbon dynamics of old forests:**

    - Enhance discussion on the carbon dynamics of older forests and ensure the document clearly addresses the disputed view that older forests are carbon neutral.

      Although some still argue that old-growth forests are "carbon neutral", i.e. no longer remove carbon from the atmosphere at significant rates, based on the commonly assumed Odum curve (Odum 1969), this has been disputed by new and more comprehensive research. Not only do older forests already store large amounts of carbon in their existing biomass (Luyssaert *et al.* 2008), they also continue to remove atmospheric carbon at substantial rates, making old-growth, late seral and large old trees integral to furthering carbon sequestration goals in management (Harmon *et al*. 1990, Stephenson *et al.* 2014, Sillett *et al.* 2010, Van Pelt *et al.* 2016).

    - Consider adding text to section 6.3 to describe the carbon storage dynamics of stands of trees in addition to single trees. For example, "Late-seral (mature/over mature) and old growth forests emerge over time from the general accumulation of growth, small disturbances, natural tree mortality, and colonizing species (Spies et al. 1994). Recent studies indicate old-growth forests remove carbon even when fully mature, and old forests are better than forest plantations at dependably removing carbon dioxide from the atmosphere (Luyssaert 2008). Carbon is sequestered for long periods in old-growth ecosystems, both in trees and down woody debris. Perhaps more importantly, large amounts of carbon are sequestered in the soils and old tree root systems of old-growth forests, where undisturbed they act as underground carbon storage reservoirs."

2) **Carbon redwood tree, forests, ecosystems:**

    - Redwoods' biomass and decay resistance make them especially suited as carbon sinks (Sillett *et al.* 2010). Their proven superiority warrants additional attention and inclusion in the Plans' discussions, implementations, and incentives, as well as bolstering the regional assessment in Appendix 1.1.5.

As redwoods age and grow larger, they invest increasing resources into decay-resistant heartwood. Sillett *et al.* documented in trees between ~20 and ~50 years of age, heartwood percentages are only ~8.6% on average, while in trees ~150 years, heartwood percentages are ~66%, reaching ~ 93% in the very oldest trees (~1800 years) (2010). Carbon sequestered in the heartwood is very slow to reenter the atmosphere, even after death. Therefore, these trees sequester more carbon for longer than some other, more carbon dense forests, which may grow quickly but also decay quickly, making their long-term carbon sequestration capacity limited. The biomass found in old-growth redwood forests far surpasses other forest types. Van Pelt and others recently found 2,500 metric tons of carbon per hectare in the redwood forests of Jedidiah Smith Redwood State Park, twice as much as any other forest worldwide (Van Pelt *et al.* 2016).

- The management of redwood forests, specifically on nonfederal lands should be carefully considered to optimize their carbon sequestration potential where possible. Much of the natural range of redwood forests has been recently impacted by land management. Figure 1 (below) depicts evenaged harvests over the last 20 years throughout a significant portion of the natural range of redwoods (shown in black hatching). Note that some planning watersheds are over 50% percent evenaged harvested (primarily clear-cut); this is significant when considering the storage potential of redwoods and the carbon goals of the State.

- With the magnitude of forest carbon sequestered in the Pacific Northwest, and in redwood ecosystems specifically, consider emphasizing this ecoregion as a focus for conservation easements, see bullet 1, page 25.

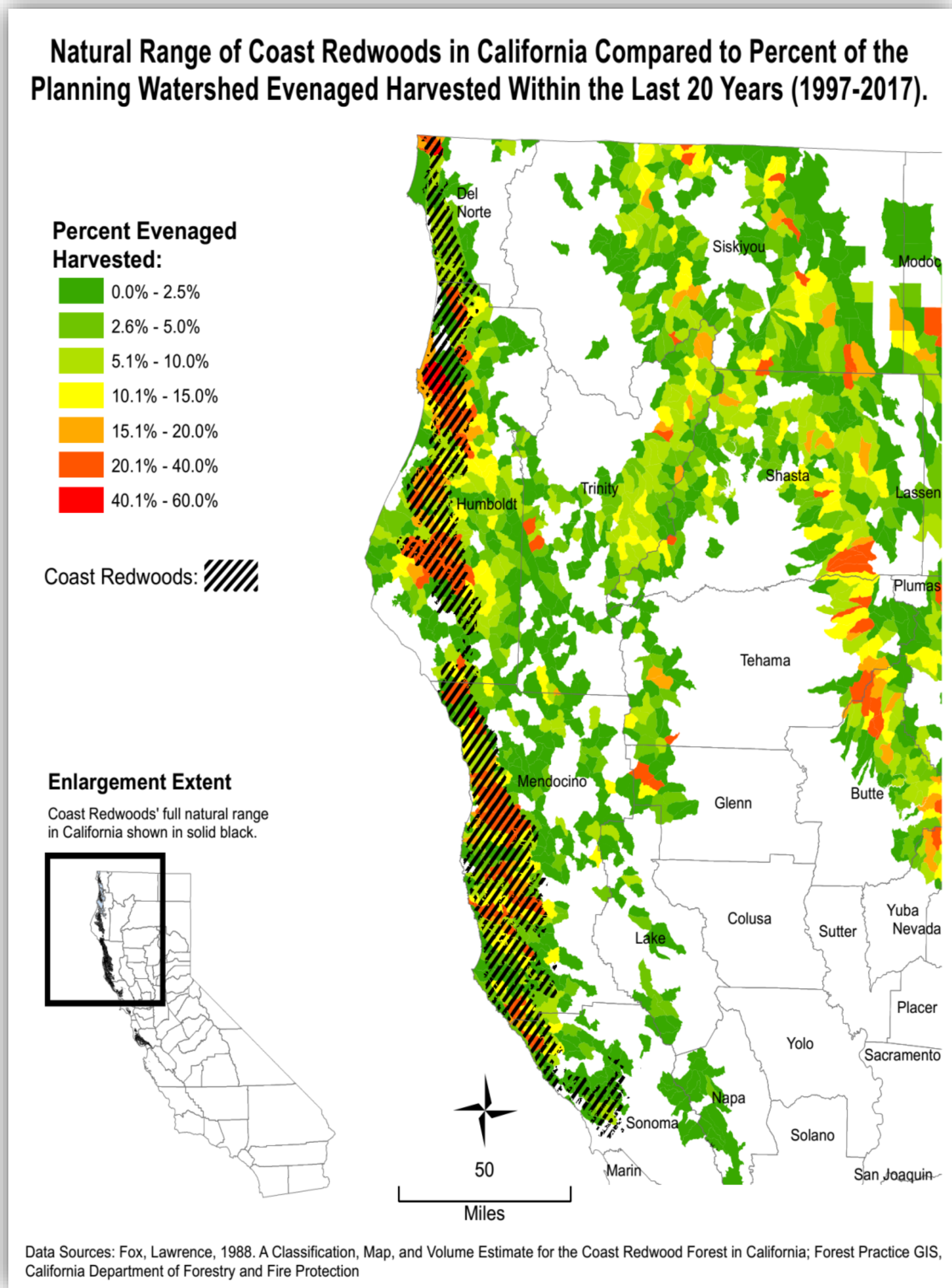

Figure 1. Current, natural redwood range in Northwest California compared to percent of planning watershed harvested via evenaged silviculture methods since 1997 (Data source: Cal Fire THP database, accessed January 20, 2017 ftp://ftp.fire.ca.gov/forest/)

3) Silviculture effects on carbon potential of managed forests:

- Document is lacking comprehensive discussion of silviculture methods and their effect on the carbon sequestration potential of a stand. Consider adding text to address this topic if appropriate to the scope of the Plan. Additional locations for possible reference to silviculture methods include the following:

  - Consider adding the bracketed text* to the existing bullet, 3.2.2. Target for Nonfederal Forest Lands: "Ensure that timber operations *[*and silviculture methods]* conducted under the Forest Practice Act and Rules contribute to the achievement of healthy and resilient forests that are net sinks of carbon."
  - Consider adding the bracketed text* to Proposed Actions, A. 6. (page 3): "Ensure that timber operations *[*and silviculture methods]* conducted under the Forest Practice Act and Rules contribute to the achievement of healthy and resilient forests that are net sinks of carbon."

- Section 9.1, page 103 states, "Where forests are managed for sustainable timber production, carbon is removed in the short-term, in the form of harvested trees. Longer term, working forests managed for sustainable timber production can provide greater carbon storage than unmanaged forests."

  While we are suggesting the report endorse new preservations of old growth forests, the above should be balanced with the recognition of and clarification with recent research which has also shown the contrary, that the theoretical maximum carbon storage (saturation) in a forested landscape is attained when all stands are in old-growth state (Harmon *et al.*1990, Nabuurs *et al.* 2007, Stephenson *et. al.* 2014, Sillett *et al.* 2010). The Intergovernmental Panel on Climate Change (IPCC) has echoed this sentiment, highlighting the best way to preserve the carbon stored in a forest is to preserve the forest itself, and that the theoretical maximum carbon storage (saturation) in a forested landscape is attained when all stands are in an old-growth state (Nabuurs et al. 2007). Harmon and Franklin (1990) calculated that rotations lengths of 50, 75, and 100 years store carbon that are at most 38%, 44%, and 51%, respectively of their old-growth equivalent.

4) Additional considerations, large old trees

- Clarify and elaborate in Section 8.5 "Wildlife Habitat" that the large old trees that sequester more carbon (Harmon *et al*. 1990, Stephenson *et al.* 2014, Sillett *et al.* 2010, Van Pelt *et al.* 2016) also have substantial wildlife benefits (Mazurek and Zielinski 2004).

  The habitat elements offered by large-diameter trees are important for forest species. These trees not only provide dominant canopy positions, they also present structural characteristics including Large diameter branches, cavities, reiterated crowns, platforms, dead tops, furrowed or loose bark and basal hollows (Franklin 2002, Mazurek and Zielinski 2004). Mazurek and Zielinski (2004), disclose that individual legacy trees support the most numbers of wildlife species and diversity compared to non-legacy trees of merchantable size. Additionally, they found that legacy trees were used more often for nesting, roosting, resting, and foraging.

- Consider an additional proposed action or recommendation for implementation (pages 3-5) that would provide incentives to retaining more large old trees on the landscape, especially in redwood and Douglas-fir nonfederal forest lands as these species have shown to be highly superior as carbon sinks, with storage potential only increasing with age (Christensen *et al.* 2008, Sillett *et al.* 2010, Van Pelt *et al.* 2016).

5) Other comments and edits

- Section 2.2.2, page 13: Please revise the last sentence on this page ("The State Wildlife Action Plan provides additional analysis of potential shifts in vegetation"). The SWAP itself does not provide an analysis of potential shifts in vegetation, but a related resource does. Consider editing to read "A Climate Change Vulnerability Assessment of California's Terrestrial Vegetation*, developed in association with the 2015 State Wildlife Action Plan update, provides additional analysis of potential shifts in vegetation."
    - *Citation: Thorne, J.H., R.M. Boynton, A.J. Holguin, J.A.E. Stewart, & J. Bjorkman. (2016) A climate change vulnerability assessment of California's terrestrial vegetation. California Department of Fish and Wildlife (CDFW), Sacramento, CA. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=116208&inline

- Section 4.1.2, page 37: In the funding sources box, under CDFW's funding sources, consider deleting reference to the Wetland GHG Reduction program if appropriate. CDFW has funded mountain meadow restoration through this program in the past, but has not received additional GGRF funding since 2015, and so will not have funds available through that program for the foreseeable future. If the box is meant to capture previous funding sources, please leave in the reference, but if it is meant to point to future funding sources for forest restoration, consider deleting.

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