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As requested by Green Diamond Resource Company (hereafter referred to as Green Diamond), I conducted an independent review of the document titled *“Response of Wildlife and Aquatic Resources to Even-aged Management in Coastal Northern California”*, prepared by Dr. Lowell Diller. My review was conducted as part of Green Diamond’s sustainable forest management certification program, specifically to address a requirement of the Forest Stewardship Council (FSC) certification standard (FSC Indicator 6.3.g.1.b). Criteria that I used to evaluate the adequacy of the Green Diamond document included: 1) the breadth and depth of information that was used to substantiate findings, 2) Green Diamond’s interpretation of the scientific literature and whether the interpretation was consistent with my understanding of the research findings, and 3) how the report built upon a meaningful synthesis of available information. In support of my review, I conducted a Web of Science search using the key words *Sequoia sempervirens* (Latin name for redwoods) to double-check that the relevant literature was used in compiling the Green Diamond report. The Web of Science query produced 251 articles, ranging in publishing date from 2012 to 1904. After paging through results of the query, I am confident that the Green Diamond report adequately represents the literature on historical disturbance regimes and the ecological consequences of even-aged management in coastal redwood forests. The excellent literature review conducted by Lorimer et al. (2009) nicely encompassed much of the available literature.



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Green Diamond’s commitment to proactive research on ecological systems that are impacted by their timber harvest activities is commendable. I have worked on certification audits and research programs for multiple industrial forest landowners throughout the United States and I agree with Green Diamond’s assessment that the level of study and monitoring conducted in support of the California operation is likely unprecedented. Simply put, the organization has a solid, internal information base to substantiate assessments like the one that I reviewed. In my opinion, the “litmus test” for a company that supports research is whether results from the research are used to make more informed, and presumably better, land management decisions. Hence, I always look for more than a simple listing of projects that companies have supported; I specifically watch for evidence that the company is using the information to have a positive impact “on the ground”. Green Diamond’s substantial commitment to understanding native wildlife habitat (both terrestrial and aquatic) needs has resulted in products that have been used to guide land management plans and activities (e.g., multiple

Habitat Conservation Plans, Deadwood Management Plan, Sensitive Plant Conservation Plan). Particularly impressive is Green Diamond's commitment to conducting floristic surveys as part of all timber harvest plans; this is a substantial commitment to understanding the prevalence of rare, native species and offers the company a means to incorporate meaningful protection measures (if needed) into land management activities. I am completely convinced that the wildlife and plant research programs directly interface with the timber management program to produce on-the-ground results that help conserve native biodiversity. This is noteworthy because the FSC standard for acceptable use of even-aged silviculture requires a thorough understanding of native species response to land management activities. Results from Green Diamond's internal research programs, when coupled with the extant published literature, provides a solid foundation for assessing how even-aged silviculture interfaces with native animal and plant species in California.

According to the report and additional information I requested as part of my review, the California landscape managed by Green Diamond is dominated (>95%) by second and third growth forests that contain legacy habitat elements (downed wood, snags, large defective trees, unharvested riparian zones) that were retained for varying reasons. The argument is made, supported by the occurrence of multiple native wildlife species (some of which have exhibited high reproductive potential) often associated with mature, native forests, that managed forests with structural retention emulate older, native forest habitat conditions. I agree with this assessment, i.e., habitat elements (particularly legacy structures) that are retained during even-aged silviculture harvests are beneficial to current and future wildlife populations. Presumably the presence of retained structures as forests mature following timber harvest facilitates development of old-forest habitat conditions (e.g., multi-storied canopies, diverse species composition, elements of decadence like snags, downed wood, and defect). Most ecological research on silvicultural techniques in coastal redwood forests has focused on using different thinning regimes to expedite development of older forest conditions (e.g., O'Hara et al. 2010). The diversity of old-forest native wildlife species (e.g., spotted owls, Pacific fisher, tree voles) found on the second- and third-generation forests on Green Diamond ownership suggests that old forest conditions can also be retained using an even-aged management regime complimented by retention.

My perception is that Green Diamond is not making the case that even-aged management in the redwood landscape is replacing or mimicking the vegetation pattern produced by historical disturbance regimes. I agree. I do not believe that even-aged management should be viewed as a replacement to fire (or flooding or slope failure) in this system because fire was frequent but predominately of low to moderate severity and extent, resulting in broadly distributed uneven-aged forests. Rather, Green Diamond argues that even-aged management is a source of environmental disturbance that provides early successional habitats in the absence of other disturbances. As the report notes, the ecotone between prairies, Douglas-fir forests, and the redwoods were historically dynamic, and the flora and fauna should have evolved mechanisms to persist in this dynamic landscape (e.g., see my comments on reproduction for the major commercial tree species below). The occurrence of native animal and plant species on the Green Diamond ownership confirms that the redwood landscape, as currently managed under forest practices requirements and sustainability standards, is resilient to small-scale even-aged management. I found no evidence to contradict this statement.

I found the section in the Green Diamond report on scale (Page 14) very relevant. It offered a perspective on how animals likely perceive different habitats in a landscape. Even-aged management undoubtedly increases inter-patch-level habitat heterogeneity and, when coupled with within-patch retention practices, a diverse forest landscape results. This multi-scale pattern of habitat complexity that results from even-aged management in coastal California appears to support healthy populations of native wildlife, including spotted owls, fisher, and woodrats. Variability at smaller scales appears to be an inherent component of coastal landscapes. For example, Wimberly et al. (2000), using a simulation model, demonstrated that smaller-scale (i.e., 40,000 ha) variation in the amount of native old growth forests historically ranged from 0-100%, suggesting that the age distribution of native forests across landscapes was highly variable. Although the results from Wimberly et al. (2000) are based on a different forest system than that found in coastal California, one could legitimately argue that the coastal California forests are even more variable than Oregon coast forests because of a higher likelihood of fire as a major historical disturbance factor.

The Green Diamond assessment on the importance of woodrats as a prey species for spotted owls and fisher (two important native forest indicators in this region) highlights the importance of habitat heterogeneity in some Pacific Northwest landscapes. The importance of riparian zones and brushy early successional habitats to woodrats is well documented in the literature in multiple studies ranging from central Oregon through California. I concur with the Green Diamond assessment that woodrats have an affinity for shrubby areas with adequate woody and herbaceous forage; vegetation conditions that result from disturbance. I also agree that the spatial extent of vegetation resulting from natural disturbances (primarily fires) has been restricted and thus, the only reliable process for creating dispersed and broadly distributed early successional habitats in industrial forested landscapes is timber management. Some of this early successional habitat is provided by the network of oak-prairie woodlands associated with ridge tops and south facing-slopes, which are climate and topography regulated.

I believe the argument in favor of even-aged management could be strengthened even further by including a section on the regeneration capabilities of native tree species and how those species are adapted to disturbance. Lorimer et al. (2009) substantiate this argument. Although I suspect that Green Diamond plants even-aged harvest units to expedite forest establishment, several of the tree species are well-adapted to naturally regenerate in smaller-sized openings which further strengthens the argument that coastal California tree species evolved in the presence of small scale disturbances. For example, studies suggest that even-aged harvest units up to 40 ac in size can be naturally reseeded by redwoods. Additionally, most of the seeds produced by Douglas-fir fall within 330 ft of seed trees or stand edges. Juvenile growth of both redwoods and Douglas-fir is best in full sunlight. With restrictions on average clearcut size in California keeping harvest units in the 20-30 ac size range, in combination with the legacy structure retention programs employed by Green Diamond, it seems like the major commercial tree species are well-adapted to naturally regenerate in the smaller openings created by even-aged management. Of course, the spatial distribution of even-aged units becomes an important consideration, i.e., an entire landscape of young forests will function differently than a mosaic of

young and older forests, but again the attention to riparian set asides, legacy retention, and forest practices restrictions on clearcut size and adjacency help provide diversity to intensively managed landscapes. Thus, the argument could be made that forest elements and the wildlife community are well-adapted to small-sized, even-aged management, as long as the management is coupled with retention of important habitat elements.

In conclusion, I believe that Green Diamond successfully argued, substantiated by the scientific literature and internal data, that native plants and animals can persist in coastal California redwood forests that are managed with even-aged techniques. I do not believe that the value of even-aged management is to “recreate openings” (from the FSC standard) that existed under historical disturbance regimes, but rather to add landscape-level heterogeneity that was undoubtedly a characteristic of historical landscapes. The Green Diamond approach to even-aged management in coastal California, which includes retention of habitat elements and protection of riparian zones (which will help ensure connectivity of old forest conditions) undoubtedly contributes to structural diversity at both the patch and landscape scales and is therefore consistent with FSC Indicator 6.3.g.1.b as directed by the Guidance Language. As evidence in support of my conclusions I note the occurrence and successful reproduction of native forest wildlife in the second and third-generation forests that are being managed by Green Diamond, the fact that historical coastal California landscapes were subjected to fire, flooding, and slope failure that maintained forest age and structural diversity, and the fact that some of the high profile native species (e.g., spotted owls, Douglas-fir, redwood) have evolutionary strategies that seemed to have evolved in a disturbance prone landscape. I believe that Green Diamond’s even-aged approach to silviculture in the redwood forests of coastal California plays an important role in conserving biological diversity in this region.

Literature Cited:

O’Hara, K. L., J. C. B. Nesmith, L. Leonard, and D. J. Porter. 2010. Restoration of old forest features in coast redwood forests using early-stage variable-density thinning. *Restoration Ecology* 18(s1):125-135.



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