CENTER *for* BIOLOGICAL DIVERSITY

December 9, 2013

George Gentry, Executive Officer
California Board of Forestry and Fire Protection
P.O. Box 944246
Sacramento, CA 94244-2460

Re: 2014 Priorities

Dear Mr. Gentry:

Please include the following items on the 2014 Priorities Document: 1) addressing late-sucessional forest/late seral forest; 2) addressing snags; 3) addressing hardwoods, 4) addressing downed wood, and 5) creating ecological standards, per the 2009 and 2012 letters (attached) submitted by the Center for Biological Diversity.

Thank you.

Sincerely,

Justin Augustine

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Justin Augustine

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November 6, 2012

VIA EMAIL

Board of Forestry and Fire Protection
board.public.comments@fire.ca.gov

Re: Regulation and Priorities Review

Dear Board:

The Center for Biological Diversity respectfully submits the following comments regarding the Forest Practice Rules in regard to the "Regulation and Priorities Review" on the November Board agenda.

We note that we have raised the below issues before, beginning in 2009. Specifically, we have described the problems associated with protection of late-seral forest and large, old trees; retention of hardwoods; and the widespread use of even-aged management (and its associated fragmentation of forest habitat and loss of forest complexity). These issues have not yet been addressed by the Board.

We also note that "ecologically based standards" to conserve wildlife and its associated habitat have been sought for many years now, not just by us. As the Department of Fish and Wildlife noted in its 2007 "Wildlife Action Plan"[1]: "Using the best-available science, forest and wildlife managers should determine the extent, pattern, and pace for timber-harvest in a forest watershed or cluster of watersheds. Ecologically based standards or limits should be set for timber-harvest."

<u>Areas where questions exist on interpretation of the regulatory standards, including potential solutions</u>

- Definition of "Late Succession Forest Stands" (Rule 895.1)
  - Some foresters continue to take the position that they need not pay attention to late-seral forest less than 20 acres in size, or individual large, old trees, because, according to them, the definition of "Late Succession Forest Stands" only requires anyone to acknowledge "stands . . . at least 20 acres in size." This has created a situation, where in some circumstances, late-seral forest less than 20 acres in size is not even divulged, and is only discovered (if at all) if the Department of Fish

[1] http://www.dfg.ca.gov/wildlife/wap/report.html

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and Wildlife takes notice of it on the Pre-Harvest Inspection. Consequently, it is important to address this definition from both a disclosure point of view (e.g., informed decision-making), and from a habitat point of view (e.g., no wildlife biologist would find the "20 acre" aspect of the definition to be scientifically supportable). As noted in Mazurek and Zielinski 2004[2], "The results of our study beg us to consider habitat at a spatial scale that is smaller than that of habitat patches or remnant stands; we conclude that individual trees can have very important values to wildlife." (attached)

  - We recognize that other parts of the Forest Practice Rules, as well as the 2005 Cal Fire memorandum regarding "disclosure, evaluation and protection of large old trees" (attached), should result in disclosure and assessment of late-seral forest less than 20 acres in size, as well as of individual, large, old trees; however, because some foresters continue to adhere to the position that the definition of "late succession forest stands" precludes them from having to disclose anything of smaller size, there is clearly a problem that needs to be addressed

  - Solution: change the definition to eliminate the 20 acre aspect and to make clear that all late-seral forest, as well as all large, old trees, can matter ecologically speaking, and must be disclosed, accounted for, and addressed regardless of acreage or number

  - This issue should be easy and straightforward to tackle given that state agencies (e.g., Cal Fire, Department of Fish and Wildlife), and many foresters, already support addressing stands less than 20 acres in size, as well as individual trees

- Snags (Rules 919.1, 939.1, and 959.1, titled "Snag Retention")

  - The current Rules do not contain ecologically-based standards for retention and restoration of snags

  - Solution: a partial solution would be to remove exceptions d, e, and f in Rules 919.1, 939.1, and 959.1, as these exceptions swallow the rule. Those exceptions to the general rule ("all snags shall be retained") are as follows:

    > (d) Merchantable snags in any location as provided for in the plan, or
    >
    > (e) Snags whose falling is required for insect or disease control.
    >
    > (f) When proposed by the RPF; where it is explained and justified that there will not be a significant impact to wildlife habitat needs

[2] Mazurek, M. J. and W. J. Zielinski. 2004. Individual legacy trees influence vertebrate wildlife diversity in commercial forests. *Forest Ecology and Management* 193:321-334

- Ecologically based standards to conserve fish/wildlife and its associated habitat
    - The current Rules do not have meaningful, ecologically-based standards for retention and restoration of biological legacies, such as downed wood and snags
    - The current Rules do not have meaningful, ecologically-based standards for retention and restoration of hardwoods
    - The current Rules do not have meaningful, ecologically-based standards to address the impacts of even-aged management (e.g., to address habitat fragmentation, the loss of forest complexity, the loss of canopy cover, the loss of understory vegetation)
    - The current Rules do not have meaningful, ecologically-based standards for retention and restoration of late-seral or early-seral forest
    - Solution: as stated by the Department of Fish and Wildlife, "Using the best-available science, . . . ecologically based standards or limits should be set for timber-harvest."

Thank you for considering these comments.

Sincerely,

Justin Augustine

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Center for Biological Diversity

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Individual legacy trees influence vertebrate wildlife diversity in commercial forests

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Abstract

Old-growth forests provide important habitat elements for many species of wildlife. These forests, however, are rare where lands are managed for timber. In commercial forests, large and old trees sometimes exist only as widely-dispersed residual or legacy trees. Legacy trees are old trees that have been spared during harvest or have survived stand-replacing natural disturbances. The value of individual legacy trees to wildlife has received little attention by land managers or researchers within the coast redwood (*Sequoia sempervirens*) region where 95% of the landscape is intensively managed for timber production. We investigated the use of individual legacy old-growth redwood trees by wildlife and compared this use to randomly selected commercially-mature trees. At each legacy/control tree pair we sampled for bats using electronic bat detectors, for small mammals using live traps, for large mammals using remote sensor cameras, and for birds using time-constrained observation surveys. Legacy old-growth trees containing basal hollows were equipped with 'guano traps'; monthly guano weight was used as an index of roosting by bats. The diversity and richness of wildlife species recorded at legacy trees was significantly greater than at control trees (Shannon index = 2.81 versus 2.32; species = 38 versus 24, respectively). The index of bat activity and the number of birds observed was significantly greater at legacy trees compared to control trees. We found no statistical differences between legacy and control trees in the numbers of small mammals captured or in the number of species photographed using remote cameras. Every basal hollow contained bat guano and genetic methods confirmed use by four species of bats. Vaux's swifts (*Chaetura vauxi*), pygmy nuthatches (*Sitta pygmaea*), violet-green swallows (*Tachycineta thalassina*), and the long-legged myotis (*Myotis volans*) reproduced in legacy trees. As measured by species richness, species diversity, and use by a number of different taxa, legacy trees appear to add significant habitat value to managed redwood forests. This value probably is related to the structural complexity offered by legacy trees. The presence of a basal hollow, which only occur in legacy trees, was the feature that appeared to add the greatest habitat value to legacy trees and, therefore, to commercial forest stands. The results of our study call for an appreciation for particular individual trees as habitat for wildlife in managed stands. This is a spatial resolution of analysis that, heretofore, has not been expected of managers. The cumulative effects of the retention of legacy trees in commercial forest lands could yield important benefits to vertebrate wildlife that are associated with biological legacies.

Keywords: Biodiversity; Legacy tree; Biological legacy; Forest management; Managed forests; Northwestern California; Redwood; *Sequoia sempervirens*; Basal hollows; Wildlife communities; Bats; Small mammals; Birds

1. Introduction

The conservation of old-growth forests has received much attention in recent decades with the heart of the

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debate focusing on the value of old-growth as habitat for wildlife. Structural components of old-growth forests, such as snags, living trees with decay, hollows, cavities and deeply furrowed bark, provide habitat for many species (Bull et al., 1997; Laudenslayer, 2002). However, remnant old-growth trees and snags are rare in landscapes that are intensively managed for wood products. Homogenous young stands lacking structural and compositional complexity reduce the habitat value for species associated with old-growth forests (McComb et al., 1993; Carey and Harrington, 2001). The value of individual old-growth structures to wildlife in managed landscapes has received little attention by land managers or researchers (Hunter and Bond, 2001).

In some forest ecosystems, lands managed for timber production occupy all but a small portion of the landscape. In coast redwood (*Sequoia sempervirens*) forests, only 3–5% of the original old-growth redwood forest remains, largely as fragments scattered throughout a matrix of second and third-growth forests (Fox, 1996; Thornburgh et al., 2000). The remnants vary in size from large, contiguous forest patches protected in state and federal parks to patches of only a few hectares in size, to individual legacy trees in managed stands. Individual old-growth trees that have, for one reason or another been spared during harvest, or have survived stand-replacing natural disturbances, are referred to as ''legacy'' trees (Franklin, 1990). We define legacy trees as having achieved near-maximum size and age, which is significantly larger and older than the average trees on the landscape. This distinguishes them from other 'residual' trees, which may also have been spared from harvest but are not always larger and older than the average trees in the landscape.

The rarity of old-growth forests in managed landscapes combined with the rising economic value of old-growth redwood increases the likelihood that legacy stands and individual legacy trees will be harvested. At this time, there is no specific requirement for the retention of legacy trees during timber harvests on private or public lands in California. Exceptions occur on lands owned by companies that are certified as sustainable forest managers (Viana et al., 1996; SmartWood Program, 2000) and as such, are required to maintain and manage legacy old-growth trees.

A number of studies have demonstrated the importance of legacy and residual trees to wildlife. In Douglas-fir (*Pseudotsuga menziesii*) forests, flying squirrel abundance and nest locations were most often found in second-growth forests containing residual trees (Carey et al., 1997; Wilson and Carey, 2000). In addition, horizontal structural complexity increased in stands containing residuals (Zenner, 2000). In eastern hardwood forests, residual trees provided important habitat elements to forest birds in regenerating clear-cut stands (Rodewald and Yahner, 2000). In young and homogenous stands of regenerating redwood forests, residual old-growth legacy trees appear to be important roosting, foraging, resting, and breeding sites for spotted owls (*Strix occidentalis*), fishers (*Martes pennanti*), bats, Vaux's swifts (*Chaetura vauxi*), and marbled murrelets (*Brachyramphus marmoratus*) (Folliard, 1993; Klug, unpublished data; Thome et al., 1999; Zielinski and Gellman, 1999; Hunter and Mazurek, in press). In the preceding studies, the value of legacy structures was identified only as a consequence of studies on the individual species of wildlife. Our goal was instead to focus our research effort on the rare habitat element itself (the legacy tree) and determine how a variety of wildlife taxa may use it, compared to commercially-mature trees in the same stand.

2. Methods

2.1. Study area

The research was conducted during 2001 and 2002 in Mendocino County, California, in the central portion of the redwood range (Sawyer et al., 2000) in the Northern California Coast ecoregion (Bailey, 1994). The study area was approximately 1750 km^2 in size and included lands owned and managed by the Mendocino Redwood Company (MRC), the California Department of Forestry and Fire Protection-Jackson State Demonstration Forest (JSDF), and Hawthorne Timber Company (HTC)/Campbell Timberland Management (Campbell). These landowners manage approximately 65% of all coast redwood timberlands in Mendocino County.

MRC lands comprise 94,089 ha of timberlands in Mendocino and Sonoma Counties and are certified as sustainable under the Forest Stewardship Council and the Smart Wood Programs (Certificate No. SW-FM/COC-128). HTC/Campbell land includes 74,264 ha of commercial redwood forest. JDSF is 20,639 ha of primarily second and third-growth redwood and Douglas-fir forests. Silvicultural prescriptions for each of the ownerships include about equal measures of even and uneven-aged harvest.

Elevations ranged from 44 to 576 m. Seasonal temperatures range from 18.2 to 9.4 °C in summer and from 13.3 to 5.5 °C in winter. Forests in this region are dominated by coast redwood. Other common trees species include Douglas-fir, grand fir (*Abies grandis*), tan oak (*Lithocarpus densiflora*), bigleaf maple (*Acer macrophyllum*), and Pacific madrone (*Arbutus menziesii*).

2.2. Site and tree selection

For the purposes of our research, we defined a legacy tree as any old-growth redwood tree that was >100 cm diameter at breast height (dbh) and possessed at least some of the following characteristics: deeply furrowed bark, reiterated crown, basal fire-scars, platforms, cavities, and one or more 'dead-tops'. Many legacy trees also had basal hollows ('goose pens') but absence of this trait did not exclude a tree from consideration. Legacy trees were represented by other species than coast redwood (e.g. Douglas-fir) but were not included in this study.

Thirty legacy trees were discovered using information provided by the landowners/managers and by our own reconnaissance. For a legacy tree to be selected for study the stand surrounding it must not have undergone timber operations at least 1 year prior to sampling nor could the stand have been proposed for alteration during the course of the study. The most recent harvest method varied from stand to stand but the majority of stands ($n = 27$) had been harvested under some type of selection method.

Legacy trees included those with and without basal hollows. Basal hollows occur as a result of periodic fires that produce repeated scarring and healing (Finney, 1996). To qualify as a hollow, the internal height must have been greater than the external height of the opening. Otherwise, the structure was considered a fire-scar when the cambium of the tree showed clear signs of effects from fire. We assumed that legacy trees did not need to have basal hollows to be of value to wildlife, therefore 15 legacy trees were selected that contained hollows and 15 did not.

The first step in selecting a control tree was by locating several (range $= 3-10$) of the largest commercially-mature trees from 50 to 100 m of a legacy tree. The set of candidates was reduced by eliminating from consideration all trees that did not share the same general environmental features with the legacy tree (i.e., similar distance to water and roads, similar slope and aspect). One control tree was randomly selected from the candidates that remained.

2.3. Wildlife sampling

2.3.1. General

An initial inspection was conducted of all trees that contained basal hollows ($n = 15$) and fire-scars ($n = 14$) by examining the interior of the hollow or fire-scar using a flashlight. These surveys were conducted during the initial portion of the study so as to not interfere with protocols designed to sample focal taxa (i.e., bats, small mammals). The hollow ceiling was searched for bats and nests of birds and mammals. The interior substrate of the hollow or fire-scar was inspected for evidence of use (e.g., feces, feathers, hair, prey remains, rest sites). Legacy and control trees were also visited regularly during the application of taxa-specific survey methods. Each time a tree was visited, field personnel would conduct an initial inspection for signs of use by wildlife.

2.3.2. Bats

We used Anabat II bat detectors (Titley Electronics, Australia) to record bat vocalizations at the trees, following the methods of Hayes and Hounihan (1994). The total number of vocalizations ('bat passes': Krusic et al., 1996; Hayes, 1997) was used to compare activity in the immediate vicinity of the legacy and control trees. To account for temporal variation in bat detections, we used a paired design and sampled simultaneously at the legacy and control trees at each site (Hayes, 1997). Bat detectors were located between 5 and 10 m from the trees, placed 1.4 m above the ground and at a 45° angle directed at the tree, a configuration that maximizes detection rates (Weller and Zabel, 2002). Each pair was sampled four times for two consecutive nights each (total = 8 nights), between either June (2002) or July (2001) and September.

Guano sampling occurred only at trees with basal hollows, using guano collection methods outlined by Gellman and Zielinski (1996). In addition to sampling guano in the 15 legacy trees with basal hollows, we also installed traps in three legacy trees with fire-scars. The oven-dried weight of guano served as a monthly index of bat use. A sample of 100 guano pellets was selected and subjected to genetic analysis to identify species. Species-specific genetic markers were developed from a 1.56 kilobase region of mitochondrial DNA spanning the majority of the 12S and 16S ribosomal RNA genes (Zinck et al., in press). We selected pellets for analysis by choosing one pellet from each tree sampled each year, and then selecting one pellet per tree sampled each season (i.e., spring and summer) until we reached 100 pellets. All trees sampled contributed at least one pellet for analysis. Eight species that occur in our study area can be identified using this method and one group of three species (*Myotis evotis*, *M. lucifugus*, and *M. thysanodes*) can be distinguished from others but not from each other (J. Zinck, pers. comm.).

2.3.3. Small mammals

We sampled non-volant mammals using live traps. Each tree selected for study was sampled using six Sherman live traps (8 cm × 9 cm × 23 cm) and two Tomahawk live traps (13 cm × 13 cm × 41 cm) placed at the base. Also, two Sherman traps and one Tomahawk trap were elevated 1.5 m and attached to the sides of the tree in an attempt to capture arboreal mammals. Traps contained seed bait and a small amount of polyester batting for insulation and bedding. We recorded the species, age, sex, reproductive status, and weight (g) of each mammal captured. A small amount of fur was clipped from the rear hindquarter (on the left if captured at the legacy tree; on the right if captured at the control) to distinguish individuals. Two, 5-day trapping sessions were conducted at each tree between June and August.

2.3.4. Time-constrained visual observation

Time-constrained observations were conducted from May to September. We observed each legacy and control tree for evidence of use or occupancy by wildlife. In 2001 we conducted one 30 min observation session in each of the three time intervals: (1) 2 h centered at dawn, (2) mid-day centered between 1100 and 1400 h, and (3) 2 h prior to sunset. In 2002, we conducted one 30 min observation session within 2 h of sunrise and sunset. All wildlife observed on, or within 5 m of the tree was recorded. Each time an animal was observed, the observer would note one occurrence (incident) per individual, the species, the amount of time spent at the tree, and the activity. Observations were categorized as perching, fly/perch, foraging, roosting, fledging, or 'present' (for non-avian species).

2.3.5. Remote photographic sampling

Animals present at the base of each tree were photographed using a remotely-triggered camera system (Trailmaster TM550, Trailmaster Infrared Trail Monitors, Lenexa, KS). The combination infrared and activity sensors and cameras were directed at the base of each tree from a distance of a few meters. We restricted the field of view of the sensor such that only animals directly in front of the tree base would be detected. Cameras were checked one day after installation and then approximately every 5 days for 3 weeks. Cameras operated simultaneously at each legacy and control tree in a pair. Each photo of an animal was considered a single detection, but we excluded all but one of a set of photographs of the same species taken consecutively during any 24 h period. This eliminated instances where animals would be present at the tree for several hours. We also excluded photographs of all small mammal species that were captured during the trapping sessions. All cameras operated during April–September.

2.4. Vegetation sampling

We collected physical measurements of each tree and of all basal hollows using variables described in Gellman and Zielinski (1996). We also measured vegetation attributes in the immediate vicinity of a random sample of 15 pairs of trees to determine whether the structure of the vegetation surrounding legacy and control trees differed. If such differences existed, it is possible that they would affect the use of the trees by wildlife, independent of the characteristics of the legacy and control trees themselves. We used variable-radius plot methods to estimate basal area (20-factor prism), and each tree that was included in the prism sample was also identified to species and its diameter, height, and condition was recorded. Within an 11.3 m fixed radius plot, and centered on the legacy or control tree, all logs >25.4 cm diameter were recorded by species and their length and diameter measured. Canopy, shrub, herbaceous, and ground cover (duff and downed wood) were estimated visually within a 5 m fixed radius plot.

2.5. Species diversity

We used the Shannon index (Magurran, 1988, p. 34) to characterize the diversity of species detected at legacy and control trees. Diversity indices were calculated separately for the results from the small mammal sampling, time-constrained observation surveys, remote camera surveys, and for these three survey methods combined. We used the number of individuals captured (small mammal surveys), the number of detections (camera surveys) and the number of incidents (visual observation surveys) to calculate the proportion of individuals observed for all species. Our diversity calculations for the visual observation surveys (both individual and combined with the two other surveys) excluded species that were engaged in nesting activities that included frequent forays to and from a nest site (i.e., pygmy nuthatches (*Sitta pygmaea*) and violet-green swallows (*Tachycineta thalassina*)). We also calculated species evenness, a measure of the ratio of observed diversity to maximum diversity (Pielou, 1969), for each survey type described above.

2.6. Statistical analyses

Species diversity indices were statistically compared using the methods of Hutcheson (1970), which calculates a variance for each diversity statistic then provides a method of calculating *t*-values to test for significant differences between samples (Magurran, 1988, p. 35). Small mammal trapping, time-constrained observation and remote photograph (medium and large mammals only) data were analyzed using matched-pair *t*-tests. We were unable to normalize the results of the camera (all animals) data and thus used a non-parametric signed-rank test (*S*) to compare the number of detections by photograph at legacy and control trees. We used a mixed-effects analysis of variance model to compare bat detections between legacy and control trees.

Vegetation characteristics in the immediate vicinity of the legacy and control tree were compared using either *t*-tests (continuous variables) or χ^2-tests (categorical variables). All statistical analyses were conducted using SAS, Version 8.2 (SAS Institute, 2001, Cary, NC). Statistical significance was implied if P was <0.05.

3. Results

As expected, legacy trees were larger in diameter (mean dbh = 293 cm (S.D. = 82.3)) and height (mean = 53 m (S.D. = 14.8)) than the control trees (mean dbh = 73 cm (S.D. = 15.2), mean height = 32 m (S.D. = 10.2)). However, the mean diameter of control trees was 72.5 cm dbh, which is considered a commercially-mature size (R. Shively, pers. comm., 2001, Mendocino Redwood Company).

3.1. General wildlife observations

Initial examinations of the trees indicated that most of the hollows and fire-scars in legacy trees ($n = 19$; 63%) had evidence of small mammal use on the basis of the discovery of feces, food remains, or nest evidence (usually dusky-footed wood rat *Neotoma fuscipes* middens, $n = 5$). One hollow contained four roosting bats and six hollows (40%) contained guano, evidence of bat use. Four hollows or fire-scarred legacy trees (13%) had evidence of use (i.e., claw marks) by large mammals and feces or nests indicated that 10 legacy trees (33%) were used by birds.

The general inspection of trees resulted in several noteworthy observations of reproductive activity:

(1) On 16 June 2002, two adult pygmy nuthatches were observed repeatedly entering and exiting a cavity in a legacy tree. The birds were observed entering the cavity with food, which was followed by vocalizations of young.
(2) A legacy tree contained a large cavity that was occupied by barn owls (*Tyto alba*) during both years of the study. Fresh feces and food pellets were observed during each visit to the tree.
(3) On 16 July 2002, violet-green swallows were observed repeatedly entering and exiting a cavity in a legacy tree. These behaviors, and the time of

year, suggest the birds were nesting within the cavity.

(4) Vaux's swifts nested for two consecutive years in the basal hollow of a legacy tree.

(5) On 23 July 2002 a large number of bats was observed in a hollow that had conspicuous guano accumulation and in which was discovered, on 31 July 2001, a dead juvenile long-legged myotis. Collectively, this evidence suggests that this legacy tree was used as a maternity colony.

3.2. Bats

3.2.1. Acoustic sampling

We recorded a total of 10,799 bat passes over the two sample years. The mean index of bat activity was significantly greater at the legacy trees compared to the control trees ($F_{1,45.7} = 17.66$, $P < 0.0001$) (Fig. 1). The mean index of bat activity at legacy trees with and without hollows was 34.8 (S.D. = 33.4, $n = 15$) and 22.6 (S.D. = 15.9, $n = 15$), respectively, a difference that was not statistically significant ($t = 1.27$, $P = 0.21$).

3.2.2. Guano sampling

We collected guano monthly from July to October 2001 and April to October 2002. All hollows and fire-scars showed evidence of bat use during some portion of the survey period. Average guano weight declined from August to October during both years (Fig. 2).

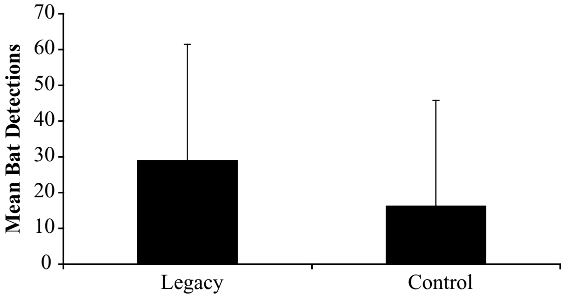

Fig. 1. Mean bat detections and standard deviation for legacy and control trees ($F_{1,45.7} = 17.66$, $P < 0.0001$) in Mendocino County, California, 2001 and 2002.

Sixty-eight of the 100 guano samples submitted for analysis amplified adequate amounts of DNA for species analysis. Four species were verified to use legacy trees, with the long-legged myotis the most common (46%) (Table 1). The California myotis (*Myotis californicus*) was the species detected at the greatest number of hollow-bearing trees (73%) and the total number of trees (hollow-bearing and fire-scarred (66%)). The big brown bat (*Eptesicus fuscus*) and the California myotis were the only species identified from the four guano samples that originated from fire-scars (Table 1).

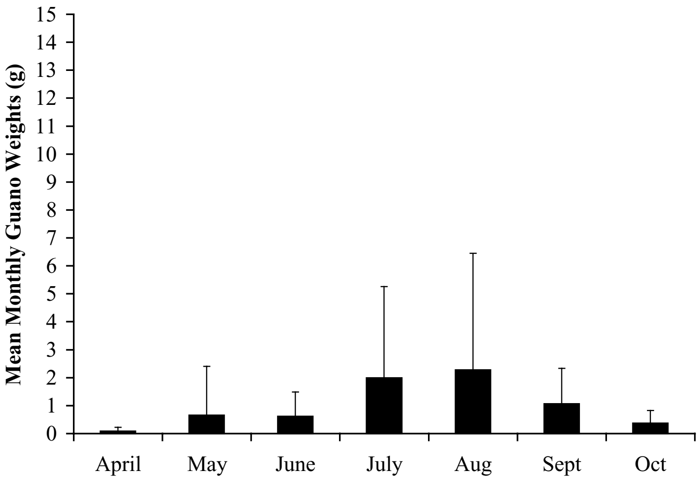

Fig. 2. Mean monthly guano weights (g) and standard deviation (April–October) at 14 hollow-bearing trees in Mendocino County, California, 2001 and 2002.

Table 1
Number of 68 guano samples collected from 15 basal hollows and three fire-scars that could be identified to species

Species	Guano sample		Hollows		Fire-scars		Trees total	
	Number	Percentage of samples	Number	Percentage of hollows	Number	Percentage of fire-scars	Number	Percentage of trees total
Big brown bat (*E. fuscus*)	9	13	5	33	3	100	8	44
California myotis (*M. californicus*)	17	25	11	73	1	33	12	66
Myotis 3[a]	11	16	5	33	0	0	5	27
Long-legged myotis (*Myotis volans*)	31	46	9	60	0	0	9	50

[a] *Myotis lucifugus*, *M. evotis*, and *M. thysanodes* are not currently distinguishable, but guano from these three species can be distinguished from other species.

3.3. Small mammal sampling

There was a slightly greater number of total small mammal captures at legacy trees compared to control trees (Table 2). There was also a greater number of individuals captured at the legacy trees compared to control trees, though this relationship was not statistically different ($t = 0.5$, $P = 0.62$). Two of the insectivores (shrew mole (*Neurotrichus gibbsi*) and Trowbridge's shrew (*Sorex trowbridgii*)) were the only species of small mammals that appeared to be trapped more commonly at the base of legacy trees.

3.4. Observation surveys

Each legacy and control tree was sampled at least twice, resulting in a total of 132 surveys and 114.5 h of survey effort (Table 3). There was a significantly greater number of incidents ($t = 16.6$, $P < 0.0001$) and time spent ($t = 4.05$, $P = 0.0004$) at legacy trees compared to control trees (Table 3). Wildlife (primarily birds) was observed about nine times as frequently at legacy trees compared to control trees and there were also more species observed at legacy trees compared to control trees (Table 4).

Of the activities observed, 82% was either perching or flying. There was twice as much foraging activity at legacy trees (22 incidents) compared to control trees (10 incidents). Woodpeckers, nuthatches, and some swallows were observed only at legacy trees; acorn woodpeckers used a legacy tree as a food storage location (i.e., granary). The majority of individuals observed were pygmy nuthatches, violet-green swallows, or unknown passerines.

Remote cameras operated a total of 1278 survey hours. We photographed 18 species at legacy and control trees; 13 species were detected only as a result of the camera surveys (Table 5). The total number of photographic detections was 38 at legacy trees (mean = 1.4, S.D. = 2.4, $n = 27$) and 17 at control

Table 2
Summary of small mammal captures by species at study sites in Mendocino County, California, 2001 and 2002

Species	Total captures		Total individuals captured		Individuals captured at both legacy and control pair
	Legacy	Control	Legacy	Control	
Trowbridge's shrew (*S. trowbridgii*)	33	18	30	16	0
Fog shrew (*S. sonomae*)	2	4	2	3	0
Shrew mole (*N. gibbsii*)	5	0	5	0	0
Short-tailed weasel (*Mustela erminea*)	0	1	0	1	0
Dusky-footed wood rat (*N. fuscipes*)	62	88	23	37	0
Redwood (yellow-cheeked) chipmunk (*Tamias ochrogenys*)	93	51	39	31	3
Deer mouse (*Peromyscus maniculatus*)	150	133	67	61	1
Western red-backed vole (*Clethrionomys californicus*)	20	37	13	19	0
Total	365	332	179	168	4

Table 3
Summary of visual observation results[a]

Tree type	Total			Survey period					
	Total survey effort (h)	min/h	Number of incidents	a.m.		Mid		p.m.	
				min/h	Number of incidents	min/h	Number of incidents	min/h	Number of incidents
Legacy	57.5	0.0998	188	0.1035	170	0.002	4	0.1938	14
Control	57.0	0.0105	34	0.0143	27	0.003	6	0.0024	1

[a] Total survey effort, duration (min/h of survey effort) that individuals were observed and the total number of incidents of wildlife observed for three time periods; a.m. (within 2 h of sunrise), mid (2 h centered around mid-day) and p.m. (2 h within sunset).

trees (mean $= 0.63$, S.D. $= 1.3$, $n = 27$); the means were not statistically different ($S = 37.5$, $P = 0.10$). When we restricted detections to include only medium and large mammals the total numbers of detections were 14 (mean $= 0.52$, S.D. $= 0.64$) and 10 (mean $= 0.37$, S.D. $= 0.88$) at legacy and control trees respectively, but were not statistically different ($t = 0.78$, $P = 0.44$).

Table 4
Species observed at legacy and control trees and the number of incidents (number of times a species was observed) during time-constrained visual observations in Mendocino County, California, 2001 and 2002

	Legacy	Control
Species at legacy only		
Acorn woodpecker	12	0
Common raven	2	0
Downy woodpecker	1	0
Hairy woodpecker	3	0
Northern flicker	2	0
Osprey	1	0
Pygmy nuthatch	25	0
Red-breasted nuthatch	1	0
Turkey vulture	1	0
Unknown flycatcher	1	0
Unknown owl	1	0
Unknown swallow	11	0
Unknown woodpecker	4	0
Vaux's swift	3	0
Violet-green swallow	52	0
Winter wren	2	0
Species at control only		
Golden-crowned kinglet	0	1
Hutton's vireo	0	8
Species at both legacy and control		
Brown creeper	4	2
Chestnut-backed chickadee	4	2
Hermit warbler	1	1
Pacific-slope flycatcher	1	1
Redwood chipmunk	1	1
Steller's jay	10	7
Unknown passerine	44	10
Western gray squirrel	1	1

3.5. Vegetation sampling

There were no differences in the vegetation characteristics in the area immediately surrounding the legacy and control trees. Basal areas, tree diameters, tree heights, log volumes, canopy cover, shrub cover, and herbaceous cover were statistically indistinguishable (Table 6). In addition, there were no significant

Table 5
List of species and the number of detections (photographs) at legacy and control trees during remote camera surveys in Mendocino, California, 2002[a]

	Legacy	Control
Species at legacy only		
Bat (species unknown)	1	0
Brush rabbit (*Sylvilagus bachmani*)	7	0
Sonoma vole (*Arborimus pomo*)	1	0
Winter wren (*Troglodytes troglodytes*)	1	0
Species at control only		
Gray fox (*Urocyon cinereoargenteus*)	0	2
Raccoon (*Procyon lotor*)	0	1
Species at legacy and control		
Black bear (*Ursus americanus*)	4	1
Black-tailed deer (*Odocoileus hemionus*)	1	1
Bobcat (*Lynx rufus*)	4	1
Douglas' squirrel (*Tamiasciurus douglasii*)	5	4
Spotted skunk (*Spilogale gracilis*)	1	1
Striped skunk (*Mephitis mephitis*)	4	3
Western gray squirrel (*Sciurus griseus*)	9	3

[a] Each detection represents only one photo per species per tree per 24 h period.

Table 6
Means and standard deviations (S.D.) for habitat variables sampled in the immediate vicinity of legacy (L) and control (C) trees in Mendocino County, California, 2001 and 2002[a]

Vegetation characteristic	Tree type				t	P
	L		C			
	Mean	S.D.	Mean	S.D.		
Basal area (m^2/ha)	55.6	22.5	56.8	27.5	0.17	0.87
Tree dbh (cm)	46.7	23.2	49.2	23.6	0.38	0.71
Tree height (m)	24.6	7.7	26.2	8.3	0.87	0.40
Log volume (m^2)	1.27	1.4	0.79	0.86	1.08	0.30
Canopy cover (%)	83.6	7.6	84.4	8.2	0.42	0.68
Shrub cover (%)	12.8	16.5	16.1	21.2	0.63	0.54
Herbaceous cover (%)	24.9	36.8	16.7	23.6	1.19	0.30

[a] Legacy and control trees were excluded from calculations. t-values and P-values are from the results of matched-pair t-tests.

differences in tree species, tree condition, log species, log condition, the amount of duff, or the amount of downed wood (Table 7). Thus, we concluded that there were no systematic differences in the physiognomy of vegetation surrounding legacy trees when compared to control trees.

3.6. Diversity indices

The number and diversity of species using legacy trees was greater than those using control trees using data from only the time-constrained observation surveys, or when we combined the results from the time-constrained observation surveys, camera surveys, and small mammal trapping (Table 8). Species richness was about 1.5 times as great at legacy trees ($n = 38$) than at control trees ($n = 24$) for all surveys. Using data from the timed observation surveys only, the species richness was more than twice as great at legacy

Table 7
Frequency of occurrence for habitat variables sampled in the immediate vicinity of legacy (L) and control (C) trees in Mendocino County, California, 2001 and 2002[a]

Vegetation characteristic		Frequency for tree type		χ^2	P
		L	C		
Tree species	Coast redwood	22	22	2.03	0.36
	Other conifer	15	12		
	Hardwood	20	10		
Tree condition	Live	40	33	2.42	0.3
	Declining	13	5		
	Dead	4	5		
Log species	Coast redwood	31	27	0.63	0.73
	Other conifer	10	9		
	Hardwood	4	6		
Log condition	Class 1	2	1	1.05	0.9
	Class 2	8	8		
	Class 3	15	11		
	Class 4	13	12		
	Class 5	7	9		
Downed wood	High	7	8	0.13	0.72
	Low	8	7		
Duff	High	13	12	NA	NA
	Low	2	3		

[a] Legacy and control trees were excluded from calculations. Statistical values are from χ^2 goodness of fit tests.

Table 8
Number of individuals (small mammals) or detections (other taxa), species richness, evenness and diversity indices by survey method for legacy (L) and control (C) trees in Mendocino County, California, 2001 and 2002[a]

Survey method	Tree type	Number of individuals or detections	Richness (number of species)	Evenness	Shannon diversity index	t statistic	d.f.	P
Observation	L	111	22	0.73	2.25	2.13	95	0.05–0.02
	C	34	10	0.82	1.88			
Trailmaster	L	38	11	0.88	2.11	0.64	54	>0.5
	C	17	9	0.93	2.04			
Mammal trapping	L	179	7	0.82	1.60	0.26	350	>0.25
	C	168	7	0.82	1.58			
Overall	L	328	38	0.77	2.81	5.05	481	<0.001
	C	219	24	0.73	2.32			

[a] Tests statistics refer to the Shannon diversity indices.

trees ($n = 22$) than at control trees ($n = 10$). The Shannon diversity indices were statistically higher at legacy trees (2.81) than control trees (2.32) for the combined surveys and for the observational surveys (human observer) (Table 8), but we did not find differences in the richness or diversity of small mammals captured in traps or for the species detected by cameras, when these data sets were analyzed separately (Table 8). Evenness was greater at legacy trees compared to control trees for the combined surveys only (Table 8).

4. Discussion

As measured by species richness, species diversity, and use by a number of different taxa, legacy trees appear to add important foraging and breeding habitat value to redwood forests managed for timber. The use of legacy trees by wildlife was demonstrated by evidence of their nesting, roosting and resting; behaviors which were not observed at control trees. This difference is probably related to the structural complexity offered by redwood legacy trees (Bull et al., 1997; Laudenslayer, 2002). Control trees were smooth-boled with very few large horizontal limbs, few cavities, and no basal hollows. Legacy trees possess these structural features, which probably account for their greater attractiveness to a variety of wildlife species.

The presence of a basal hollow, which only occur in legacy trees, was the feature that appeared to add the greatest habitat value to legacy trees and, as a result, to commercial forest stands. However, we did not sample specifically for wildlife that may benefit from the presence of large horizontal branches (e.g. platform nesting wildlife). Basal hollows were used by every taxa sampled, but appear to be particularly important to bats and birds. In addition to the fact that guano was collected at every hollow we sampled, individual bats were observed in hollows, and reproduction was documented. Use of basal hollows by bats has been observed in other redwood regions (Gellman and Zielinski, 1996; Zielinski and Gellman, 1999; Purdy, 2002) and there are several previous reports of basal hollows used by bats for reproduction (Rainey et al., 1992; Mazurek, in press). Hollows also appear to be important nest sites for some bird species, in particular Vaux's swifts (Hunter and Mazurek, in press). Because roost and nest availability can limit the populations of birds and bats (Humphrey, 1975; Kunz, 1982; Brawn and Balda, 1988; Christy and West, 1993; Raphael and White, 1984), basal hollows may play a critical role in the redwood region if they provide roost and nest sites in forests that are otherwise deficient. The increased use of legacy trees by insectivorous birds and bats may also be because the rugosity of the bark may harbor a greater diversity and abundance of insects (Ozanne et al., 2000; Willett, 2001; Summerville and Crist, 2002). Bark gleaners, such as brown creepers (*Certhia americana*), have been correlated with the abundance of spiders and other soft-bodied arthropods that are significantly associated with bark furrow depth (Mariani and Manuwal, 1990); this may also explain the disproportionate use of legacy trees by nuthatches and woodpeckers. Finally, basal hollows not only benefit the wildlife that use them but the trees in which they are found. The feces of animals that are attracted to hollows can be an important source of nutrients for trees that may be on nutrient-poor sites (Kunz, 1982; Rainey et al., 1992).

The mammal data (bats excluded) did not suggest a disproportionate association with either legacy or control trees. Possible exceptions include two insectivores, which were captured more at legacy trees, and the dusky-footed woodrat, whose nests were found in five of 15 basal hollows. Shrew moles are associated with older forests (Raphael, 1988; Carey and Johnson, 1995) and are infrequently found in logged areas (Tevis, 1956). Several studies also found that Trowbridge's shrews have a similar association with mature forest conditions (Gashwiler, 1970; Hooven and Black, 1976; Carey and Johnson, 1995).

The camera data did not reveal disproportionate use of legacy trees by mammals. Relatively few mammalian carnivores were detected at either type of tree, perhaps because some species (i.e., the marten (*Martes americana*) and the fisher (*M. pennanti*)) are sensitive to forest habitat loss and fragmentation (Buskirk and Powell, 1994) and have been either extirpated from the region or are very rare (Zielinski et al., 1995, 2001). With the exception of the two insectivores and wood rats, none of the non-volant mammals we sampled appeared to be strongly associated with the legacy trees. Unlike the passerine birds, which use the structurally complex bark of legacy trees for foraging and cavities for nesting, and the bats, which roost in hollows and bark crevices, our data do not indicate that legacy trees have exceptional value for rodents or for the species of carnivorous mammals that still occur in the region.

Our conclusions about the value of legacy trees to wildlife in the redwood region are supported by the results of studies on individual species of wildlife elsewhere. Legacy trees (also described as old-growth residuals) are used by northern (*Strix occidentalis caurina*) and California (*S. o. occidentalis*) spotted owls for nesting and roosting (Moen and Gutiérrez, 1997; Irwin et al., 2000). Fishers use legacy conifers, and residual hardwoods, as daily rest sites in public Douglas-fir forests (Seglund, 1995) and private redwood forests (R. Klug, pers. comm.). Flying squirrels were twice as abundant when legacy trees were retained in managed areas (Carey, 2000) and their diet was found to be more diverse in legacy stands (Carey et al., 2002).

Our work was directed at assessing the value of individual *legacy* trees in stands, but there is a considerable body of research on the related question of what value *residual* trees and patches have in maintaining wildlife diversity in forests. Residual structures may not be as old as the legacy structures we studied, but they can add important structural diversity to which many species of wildlife respond. Songbirds in a variety of coniferous mixed, and hardwood forest types have benefited from the retention of residual trees (Hobson and Schieck, 1999; Rodewald and Yahner, 2000; Schieck et al., 2000; Tittler et al., 2001; Whittman et al., 2002; Zimmerman, 2002). Southern red-backed voles (*Clethrionomys gapperi*), a late-successional associated forest species, are also more common in harvested areas as the basal area in residual trees increases (Sullivan and Sullivan, 2001). The retention of residual structure during logging appears to have benefits to wildlife, but additional research will be necessary to distinguish the effects of retaining commercially mature—but relatively young—trees for wildlife from retaining and managing legacy trees, which are typically much older.

The goal of this study was to document the pattern and frequency of use of legacy and control trees so that we might better understand how young and old elements are used within the matrix of commercial redwood forests. To do so we compared the occurrence of species and individuals, but did not evaluate how individual trees contribute to *survival* or *reproduction* (i.e., fitness) of individual species. Measures of abundance, or indices of abundance, are not sufficient to completely evaluate the effects of variation in habitat on wildlife populations; in some cases they can even mislead because not all places where animals occur are suitable for reproduction (Van Horne, 1983). Our observations of reproductive behavior by a number of birds and at least one species of bat, however, suggest that legacy trees may influence the fitness of some species as well. We also believe that the potential survival value of access to legacies was probably underestimated in our study because we evaluated use only during the climatically benign summer months. We expect that benefits of access to legacy trees would be the greatest during the winter when they would be used as refuges from inclement weather (e.g., Carey, 1989).

If legacy trees provide one of the few choices for nesting and reproductive sites, and they are rare, then it is possible that they may be easily located and searched by predators making them population ‘sinks’ (Pulliam, 1988). Tittler and Hannon (2000) did not find increased predation in this respect, but their study evaluated residual trees, which were more numerous and probably not as distinctive and obvious foraging locations as are the more structurally distinctive redwood legacy trees. It is clear, however, that the risks that wildlife may be subjected to when using, and perhaps congregating at, legacy structures will need to be evaluated with respect to the benefits.

5. Conclusions

Our traditional view of conservation reserves is of large protected areas. However, few landscapes provide us with the opportunity to preserve large tracts of land and we must consider conserving biodiversity within the matrix of multiple use lands (Lindenmayer and Franklin, 1997). Given the fragmented nature of mature forests in the redwood region, remnant patches of old-growth and individual legacy trees may function as ‘mini-reserves’ that promote species conservation and ecosystem function. Legacy structures increase structural complexity in harvested stands and, as a result, can provide the 'lifeboats' for species to re-establish in regenerating stands (Franklin et al., 2000). Although the lifeboat function may not be entirely fulfilled for vertebrates with large area needs, these habitat elements may make it possible for some species to: (1) breed in forest types where they may otherwise be unable, and (2) secure a greater number of important refuges from climatic extremes and predators. In addition, these functions may allow legacy trees to provide some measure of habitat connectivity ('stepping stones') to larger more contiguous tracts of old-growth forests (Tittler and Hannon, 2000; Noss et al., 2000).

Because of their rarity in commercial forests, the first step in the management of legacy trees is to determine their locations and protect them from logging or from physical degradation of the site. Because legacy redwoods with basal hollows are even more rare, locating and protecting these should be the highest priority. In addition, the circumstances that lead to their genesis will be difficult to recreate, especially on commercial timberland. Hollows form by repeated exposure of the base of trees to fire (Finney, 1996), and because most fires on private land are suppressed, prescribed fire would need to be repeatedly applied to trees that would be designated as 'future legacies' and which would be excluded from harvest in perpetuity. We hasten to add, however, that legacy trees without basal hollows appear to have significant benefits to wildlife. Even without management to encourage basal hollows we suggest that managers plan for the recruitment of trees that are destined to become legacies. This will require their protection over multiple cutting cycles. We expect that new silvicultural methods will be required to prescribe the process of identifying, culturing, and protecting residual legacy trees. Although we do not believe that any one tree will protect a species, we do believe that the cumulative effects of the retention, and recruitment, of legacy and residual trees in commercial forest lands will yield important benefits to vertebrate wildlife and other species of plants and animals that are associated with biological legacies.

The results of our study beg us to consider habitat at a spatial scale that is smaller than that of habitat patches or remnant stands; we conclude that *individual trees* can have very important values to wildlife. More research would be helpful, however, to specify the level of individual tree retention required to maintain biodiversity in managed lands (Lindenmayer and Franklin, 1997). It would help to know, for example, whether the fitness of individual species, and the diversity of wildlife communities, is greater in landscapes in which legacy trees are common compared to landscapes with very few legacy trees. It is possible that because legacy trees are rare—despite their apparent values to wildlife—that they do not affect wildlife diversity or productivity over large areas. It would also advance our knowledge to determine whether legacy trees in legacy-rich landscapes can function to maintain connectivity between protected stands of mature and old-growth forests. If so, the landscape context will be an important component of managing residual legacy trees and planning their recruitment across landscapes. For now, however, this study makes clear that protecting legacy trees will protect important habitat features that receive disproportionate use by many wildlife species. The protection and management of these trees can enhance wildlife conservation on lands where the opportunities to do so can be limited.

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State of California

The Resources Agency

Memorandum

To: Region Chiefs
Assistant Region Chiefs
Unit Chiefs
Forest Practice Staff
All Registered Professional Foresters
Review Team Agencies

Date: March 2, 2005

R3

Telephone:

Website: www.fire.ca.gov

From: **Duane Shintaku, Assistant Deputy Director**
Forest Practice
Department of Forestry and Fire Protection

Subject: **Disclosure, evaluation and protection of large old trees**

The Board of Forestry and Fire Protection (Board) recognizes the potential biological, cultural, historical and aesthetic value or significance of stands of large old trees, as well as some individual specimens. The Board has asked the California Department of Forestry and Fire Protection (CDF) to provide a guidance letter to inform Registered Professional Foresters (RPFs), CDF personnel and Review Team members of the expectation that potential significant adverse impacts pertaining to large old trees must be adequately disclosed, evaluated and mitigated within the context of the existing Forest Practice Rules (FPRs), California Environmental Quality Act (CEQA) and the California Endangered Species Act (CESA). This memo is written as a reminder that disclosure of potential significant adverse impacts pertaining to large old trees is required, even in those situations involving a single tree or small stand of trees less than 20 acres in size (i.e. does not meet the minimum stand acreage for Late Succession Forest Stands per 14 CCR § 895.1).

Disclosure in Plans of Potential Impacts to Large Old Trees:

During Plan preparation, the RPF should identify large old trees and stands of trees having significant or unique characteristics and those activities or operations having the potential to affect such trees, resulting in significant adverse impacts on the environment. If the RPF determines a significant impact is likely to occur, the Plan should include the location and description of the trees and the nature of the impacts, including impacts to associated resource subjects. In conducting an assessment, the RPF must distinguish between individual on-site impacts and cumulative impacts or the interactions of proposed activities that may not be significant when considered alone, with impacts of past and reasonably foreseeable future projects. It seems most appropriate that specific disclosure information be included in the cumulative impacts section (Technical Rule Addendum #2) or be included as part of the general description of the plan area pursuant to 14 CCR § 1034(jj). The RPFs are expected to submit sufficient information to support their findings, which shall be based upon whether or not a fair argument with substantial evidence[1] can be made that the proposed timber operations may result in a significant adverse impact to the environment. Disclosure may be required even in those settings involving an individual tree or aggregate of trees situated in group(s) smaller than the 20 acre minimum stand size associated with Late Succession Forest Stands.

Mitigation to avoid significant impacts to large old trees:

RPFs and Review Team members should consider the range of procedures provided in the FPRs and other mitigation to avoid or substantially lessen significant individual or cumulative adverse effects to the identified large old tree(s) and associated resources. Forest Practice inspectors and CDF review team staff are not expected to spend an inordinate amount of time when there is no indication that significant adverse impact potentials exist, even though large old trees are present in the plan area.

Forest Practice Rule References:

The following are examples of rule sections that provide direction for disclosure, evaluation and mitigation of potential significant adverse impacts associated with Plans where large old trees are present:

895.1 Definitions:
- Late Succession Stand
- Decadent and Deformed Trees of Value to Wildlife
- Functioning Nesting Habitat
- Predominant Trees

897 (b)(1)(c) Implementation of the Act Intent

898 Feasibility Alternatives

Technical Rule Addendum No.2 CWE, Biological Resources:
- a. Snags/Den/Nest trees
- b. Down Woody Debris
- f. Late Seral (Mature) Forest Characteristics
- g. Late Seral Habitat Continuity
- h. Special Habitat Elements

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[1] CEQA Guidelines, 14 CCR, Division 6, § 15064(f)(5): *Argument, speculation, unsubstantiated opinion or narrative, or evidence that is clearly inaccurate or erroneous, or evidence that is not credible, shall not constitute substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts.*

Forest Practice Rule References (continued):

919.16, 939.16, 959.16 Late Succession Forest Stands

921.3 Silvicultural Methods [Coast, Special Treatment Area]

1034 (m) (1) Contents of Plan

1034 (jj) General Description Information

1038 Exemptions

1051 (a)(15) Modified THPs

1090 NTMPs

1104.1 Conversion exemptions

CENTER *for* BIOLOGICAL DIVERSITY

November 3, 2009

VIA EMAIL

Board of Forestry and Fire Protection
Policy Committee
Attn: George Gentry
board.public.comments@fire.ca.gov
george.gentry@fire.ca.gov

Re: Policy Committee public comment addressing the following: 1. Areas where questions exist on interpretation of the regulatory standards, including potential solutions; 2. Issues encountered in achieving compliance with the regulatory standard of rules, including potential solutions; 3. Suggested regulatory modifications which would either 1) clarify existing rule language to better achieve the intended resource protection, or 2) which would reduce regulatory inefficiencies and maintain the same or better level of protection.

Dear Policy Committee:

The Center for Biological Diversity ("CBD") submits the following comments that they believe would help better address the problems associated with implementation of the Forest Practice Act, California Environmental Quality Act, Endangered Species Act, California Endangered Species Act, and the associated regulations.

1. Areas where questions exist on interpretation of the regulatory standards, including potential solutions

Likely the most significant area where questions exist regarding interpretation of regulatory standards is cumulative impacts analyses. And within that subject heading, the question of how to properly address baseline conditions still persists. CEQA case law states that where the environmental baseline demonstrates existing significant impacts, this heightens, rather than reduces, the scrutiny that must be applied in the resulting cumulative impact assessment. *See, e.g. ,Los Angeles Unified School Dist. v. City of Los Angeles* (1997) 58 Cal. App. 4th 1019, 1026 (additional increase in noise level of another 2.8 to 3.3 dBA was significant given that the existing noise level of 72 dBA already exceeded recommended maximum of 70 dBA); *Communities for a Better Environment* (2002) 103 Cal. App. 4th 98, 117 (CEQA regulation that "compares the incremental effect of the proposed project against the collective cumulative impact of all relevant projects" is contrary to CEQA); *id.* at 114 ("[E]nvironmental damage often occurs

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incrementally from a variety of small sources. These sources appear insignificant when considered individually, but assume threatening dimensions when considered collectively with other sources with which they interact."); *id*. at 120 ("the greater the existing environmental problems are, the lower the threshold for treating a project's contribution to cumulative impacts as significant."); *Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal. App. 3d 692, 720 ("[p]erhaps the best example of [a cumulative impact] is air pollution, where thousands of relatively small sources of pollution cause a serious environmental health problem"); *id*. at 718 (relevant question is "whether any additional amount of precursor emissions should be considered significant in light of the serious nature of the ozone problems in this air basin").

A specific example of a baseline issue is the current amount of late seral forest left in California. The historical loss of late seral trees and habitat, the consequent present condition of such habitat (*i.e.*, the lack thereof), and the importance of such habitat to wildlife (*e.g.*, marbled murrelet, Pacific fisher, pine marten, Vaux's swift, coho salmon), has made that which remains exceedingly critical, and its further loss is therefore a cumulatively significant impact. In other words, given the existing situation in California regarding late seral trees and habitat, all additional loss should be treated as significant.

THPs, however, sometimes assume that a THP can log late-seral trees, especially that which is less than 20 acres, and not have a significant impact. A good solution would be to develop more definitive guidance that explains why THPs must acknowledge and account for the fact that loss of any single late-seral tree is by definition significant given the current baseline of such trees in California. This will help better "alert the public and its responsible officials to environmental changes before they have reached ecological points of no return." *Sierra Club v. State Bd. of Forestry* (1994) 7 Cal. 4th 1215, 1229.

Similarly, THPs should be explicitly required to disclose all late-seral trees within a THP area, "even in those situations involving a single tree or small stand of trees less than 20 acres in size."[1] Currently, it is sometimes the case that only during a PHI is it discovered that such "situations" actually do exist in the THP area. That should never be the case, especially since both Cal Fire and DFG are less and less conducting PHIs due to budget cuts. The public and decision-makers should always be able to clearly tell from a THP document whether any late-seral tree will be cut or otherwise harmed. And while the March 2, 2005, Cal Fire memo on this subject is helpful, more explicit guidance is still necessary in light of the fact that THPs still rely heavily on the "20 acres in size" aspect of the definition of "Late Succession Forest Stands" to assert that a) late seral forest does not exist in the THP and/or b) that there will not be significant impacts to late seral habitat.

A solution is to have a required section in the THP that maps and discusses any and all large, old trees in a THP area. That is the best way to ensure informed decision-making. *See San Joaquin Raptor/Wildlife Rescue Ctr. v. County of Stanislaus* (1994) 27 Cal. App.

[1] *See* March 2, 2005, Department of Forestry and Fire Protection Memorandum Re Disclosure, evaluation and protection of large old trees.

4th 713, 723 ("Knowledge of the regional setting is critical to the assessment of environmental impacts. Special emphasis should be placed on environmental resources that are rare or unique to that region and would be affected by the project."); *Cadiz Land Co. v. Rail Cycle* (2000) 83 Cal. App. 4th 74, 94 ("Because the EIR must be certified or rejected by public officials, it is a document of accountability. If CEQA is scrupulously followed, the public will know the basis on which its responsible officials either approve or reject environmentally significant action, and the public, being duly informed, can respond accordingly to action with which it disagrees."); 14 CCR 897 ("The information in [THPs] shall also be sufficiently clear and detailed to permit adequate and effective review by responsible agencies and input by the public to assure that; significant adverse individual and cumulative impacts are avoided or reduced to insignificance."); *San Joaquin Raptor/Wildlife Rescue Ctr.*, 27 Cal. App. 4th at 721-22 ("The ultimate decision of whether to approve a project, be that decision right or wrong, is a nullity if based upon an EIR that does not provide the decision-makers, and the public, with the information about the project that is required by CEQA.")

One other major area where questions exist on interpretation of the regulatory standards regarding cumulative impacts is water quality. As stated in Dunne 2001:[2]

> [We] have been told explicitly by some RPFs that, in preparing a THP, they would never conclude that a CWE is likely because of the unnecessary regulatory burden that such an admission would bring. Denials of the likelihood of CWEs are repeated regularly by applicants and reviewers, despite the widespread recognition among environmental scientists that, in the aggregate, timber harvest in coastal California has resulted and continues to result in radical alterations of water quality, habitat conditions, and perhaps flood risk.
>
> [W]idespread experience in most types of terrain and land uses (forestry, agriculture, urbanization, mining, etc.) has proven that mitigation by on-site BMPs is usually imperfect, and much of the induced perturbation (say of runoff or sediment) "escapes" or "leaks" from the impoundment device or from the surface protection, and accumulates downstream, though at a reduced level. It is because of the limited effectiveness of on-site mitigation that CWEs have been identified widely by environmental scientists.
>
> Watershed impacts that have been shown to result from timber harvest (and other land–cover manipulations) include effects on: sediment, water temperature, in-channel volumes of organic debris, chemical contamination, the amount and physical nature of aquatic habitat, and increases in peak discharges during storm runoff. However, determination of the significance of these effects for some aspect of water quality or biodiversity requires taking into account biological populations, ecological functions, and the role of the above-mentioned physical and chemical characteristics in determining the quality of habitat.

[2] Dunne, et al. 2001. A Scientific Basis for the Prediction of Cumulative Watershed Effects. University of California Wildland Resource Center Report No. 46

At one level, therefore, there appears to be a considerable number of detailed measures with which to define the absence or presence of Cumulative Watershed Effects. Given the widespread nature of the watershed effects of timber harvest listed above in many disturbed landscapes, one would expect frequent identification of Cumulative Watershed Effects, --- even if the ecological significance of some effects could be debated. In practice, however, virtually no one filing a THP admits to the presence of *any* CWE, and CDF and resource agencies in other states have been unable to promulgate any defensible methodology for defining the presence and source of any CWE, even when they have consulted the scientific community. Thus, there is little effective technical basis for enforcement of available regulations designed to protect aquatic resources. There is an escape from every rule.

Despite the difficulties of identifying CWEs, the field evidence of environmental change in timberlands has led successive groups of scientists (e.g. Beschta et al. 1995; Bunte and MacDonald 1999) to document the widespread occurrence of cumulative watershed effects. Although there is often no steady-state, extant or foreseeable condition against which one can measure or predict in a deterministic, exact way the effects of land management, some changes due to land use are so radical and widespread that they are widely acknowledged, even by land managers as well as resource management scientists. In some cases, there are easily recognized metrics for land-use impact (e.g. the extent of old-growth forest and, by implication, its attendant biota). In other cases (such as turbidity or other measures of streamwater quality) the measures are obvious but the available data are sparse. And in yet other cases it has proven less easy to develop a useful metric (e.g. the grain size and extent of spawning gravels, large woody debris, and other aspects of channel-habitat complexity).

Given that many watersheds being logged are already “threatened or impaired” (*e.g.*, have waterways not in compliance with their WQSs or TMDLs), and given that there is little consensus regarding how to acknowledge or address CWEs, it is imperative that the Board of Forestry, Cal Fire, DFG, Water Boards, and the scientific community begin to address this problem by developing detailed guidance documents on the subject.

2. **<u>Issues encountered in achieving compliance with the regulatory standard of rules, including potential solutions</u>**

a. The issues discussed above apply here as well. Better guidance regarding baseline issues will aid in complying with rules regarding cumulative impacts.

b. To achieve compliance with the rules requiring cumulative impact analyses, it is important from both a resource protection as well as a public information perspective, to explain the impacts of, and the differences between and within, various silvicultural techniques. For instance, thus far, there has not been an adequate analysis of the cumulative impacts of widespread clearcutting in California. It is one thing to clearcut 100 acres; it is a much different thing to clearcut thousands of acres, which is what is currently happening in California. Until the cumulative impacts of widespread clearcutting are addressed, then we will not achieve compliance with the law because we will have failed to properly assess the watershed and/or landscape scale impacts that are occurring (such as habitat fragmentation), as well as stand level impacts (such as retaining high levels of structural, functional and compositional diversity in California forests). This is especially so given the current baseline in California in regard to late-seral trees and their associated habitat (i.e., the severe lack of such habitat).

A good background regarding the ecological issues associated with various silvicultural techniques practiced in California is provided in Franklin et al 2002:[3]

> Traditional clearcutting leaves little or no above-ground structural legacy in contrast to most natural disturbances.
>
> Simplistic structural classifications can lead managers to believe that they can easily replicate examples of natural forests through silviculture (Scientific Panel on Ecosystem Based Forest Management, 2000; Aber et al., 2000).
>
> [S]ilviculturists managing forests for a mixture of ecological and economic goals need a comprehensive understanding of natural stand development, including the role of natural disturbances. Silviculture based on modern models of natural stand development are being increasingly adopted . . . . Generic approaches include: (1) structural retention at the time of harvest (Franklin et al., 1997); (2) use of longer rotations (Curtis, 1997); and (3) active creation of structural complexity including structures and spatial heterogeneity, in managed stands (Carey et al., 1996, 1999; Carey and Curtis, 1996; Carey, 2000). Biological legacies are central to development of silvicultural systems that emulate natural models. Creating and leaving biological legacies maintains critical structural elements as components of managed stands thereby sustaining many organisms and ecological processes dependent upon these structures (Franklin et al., 1997, 2000). Structural retention silviculture is modeled on the legacy concept and is one approach and sometimes the only feasible option for maintaining large-diameter snags, logs, and old decadent trees as a part of managed stands. Silvicultural prescriptions can be tailored to specific management goals by identifying the types, numbers and spatial distribution of necessary structures. Specific management actions can create missing structures, such as by killing living trees to create snags. Where there are issues with worker safety and survival of structures, reservation of small islands of vegetation around these structures (aggregates) can be used. Silvicultural planning can even utilize multiple rotations to create structures of sizes and conditions that cannot be created in a single rotation. It may be easiest to model silvicultural practices on natural disturbance regimes in forest types and regions that are (or were) characterized by frequent low- to moderate-intensity disturbance regimes. In such areas disturbances created and maintained a fine-scale mosaic of structural patches. Harvesting by group selection can produce stands that closely approximate those generated by the natural

[3] Franklin, Jerry F., et al. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. *Forest Ecology and Management* 155:399–423

disturbance regime, such as the structural mosaics characteristic of lenga forests in Tierra del Fuego (Rebertus et al., 1997) or many pine forests in western North America (Franklin and Fites-Kaufmann, 1996) (Fig. 8a and b). Harvest patch sizes under group selection should approximate those in the natural stand. Silviculturalists tend to prescribe larger patches than those characteristic of the natural mosaic for such reasons as increased growth of the regenerated stand (Knight, 1997), overall ease of application, and even short-term profits. The structural match between harvesting by group selection and natural stands can be improved further by retaining some individual structures within the harvested patches (Fig. 9) and permanently reserving some patches in the stand from logging. Shelterwood harvesting of forest types characterized by fine-scale mosaics ultimately produces stand structures that contrast with those of the natural stands. The shelterwood system is designed to spatially homogenize the treated forest, creating an even-aged stand, rather than maintaining a high level of spatial heterogeneity in a natural multi- or uneven-aged stand. Designing silvicultural systems based upon natural disturbance models is much more challenging for forest types characterized by large-scale catastrophic disturbances. Traditional clearcutting has little in common with most natural catastrophic disturbances except for creating a light environment suitable for regeneration of a shade-intolerant tree species. Similarly, plantations created on clearcut sites are much simpler than young stands developed after natural disturbances. Structural retention at the time of forest harvest is clearly essential in modeling silviculture on catastrophic disturbance regimes (Franklin et al., 1997) (Fig. 10a and b). Structural legacies sustain species and processes that provide young natural stands with functional and compositional diversity characteristic of more successionally advanced forests (see, e.g. Ruggiero et al., 1991). The major challenge in writing the silvicultural prescriptions is determining the kinds, numbers, and spatial patterns of retained structures required to achieve defined management objectives. Difficult issues include trade-offs among environmental and economic objectives and operational and safety issues. Rotation lengths (Curtis, 1997) and active management of stands to create specific structures and structural patterns (Carey et al., 1996; Carey and Curtis, 1996) are also essential elements of silvicultural systems that purport to incorporate processes and structures characteristic of natural stands. It is clear from recent research that structural development of natural forest stands is more complex than foresters have traditionally believed. Some general conclusions are that: there are many relevant structural features in addition to live trees; there are numerous developmental processes contributing to stand development and many of these operate throughout the sere; disturbances and the biological legacies from preceding ecosystems are significant aspects of stand development that have been largely ignored; spatial patterns of structures (horizontal and vertical) are significant aspects of forest stands that have not been fully appreciated; structural development involving ecologically significant processes and structures may continue for many centuries in forests of long-lived species; sequences of forest development (seres) almost always end in structurally diverse forests, regardless of whether the dominant disturbance regimes are catastrophic or chronic. Traditional even-aged harvest practices (clearcut, seed tree, and shelterwood) are not based upon natural models of disturbance and stand development, as they are currently understood.

As did Franklin et al 2002, Lindenmayer and Franklin 2002[4] points out that practices such as clearcutting do not mimic natural forest events such as fire. As summarized in Lindenmayer and Franklin 2002, fire leaves abundant snags, logs are common, soil disturbance is low, understory plants are common, and fire results in a pulse of nitrogen and phosphorus release. Lindenmayer and Franklin 2002 found that clearcuts are very much unlike most natural disturbances, including fire.

The Attorney General's Office has explained that "the plain intent of the Legislature in enacting the [Forest Practice Act] was to require the Board to view the forests of the state as a complete working ecosystem, and not only as a producer of high quality timber, but also as forestlands valuable in their own right as a public resource."[5] Silvicultural techniques such as clearcutting and group selection, as they are currently practiced in California, are oftentimes not based on modern models of natural stand development, and are consequently contributing to cumulative ecosystem impacts at all scales (*e.g.*, stand, watershed, landscape),[6] and hence, not achieving compliance with cumulative impact law.

One example of a solution is to develop a guidance document regarding how silviculture choices impact ecosystem integrity. However, given that foresters are not trained as conservation biologists, and given that DFG has a legal obligation to protect California's wildlife/ecosystems,[7] it is imperative that DFG be given equal or greater power in developing such a document. In fact, the most appropriate road to take, given the political factors that often drive government agencies at the higher levels, is to allow independent conservation biologists to provide significant input to the Board of Forestry and Cal Fire regarding how to avoid the cumulative ecological impacts associated with various silvicultural practices, instead of only having Cal Fire or DFG address the problem.

Another solution is to greatly extend rotation lengths. Currently, the rotation ages for private forest land in California typically range from 50 to 80 years. Franklin et al. 1997 recommend increasing rotation length by 50 to 300 percent to allow the development of structural complexity associated with large old trees, snags, and down wood.[8] O'Hara 2004[9] found that

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[4] Lindenmayer, D. B. and Franklin, J. F. 2002. Conserving forest biodiversity: A comprehensive multiscaled approach. Island Press.

[5] *Advice Regarding Board of Forestry's Regulatory Authority to Provide for the Restoration of Resources* at 4 .

[6] Put succinctly, clearcutting and group selection can fail to retain the high levels of structural, functional and compositional diversity necessary to a healthy forest.

[7] *See, e.g.*, CFGC Section 711.7(a): "the fish and wildlife resources are held in trust for the people of the state by and through the department."

[8] Franklin, J. F., Berg, D. R., Thornburgh, D. A., and Tappeiner, J. C. 1997. Alternative silvicultural approaches to timber harvesting: Variable retention harvest systems. In: Kohm, K. A. and Franklin, J. F. (eds.) Creating a forestry for the 21st century: The Science of ecosystem management. Island Press.

[9] O'Hara, K. L. 2004. Forest Stand Structure and Development: Implications for Forest Management. Proceedings Sierra Nevada Science Symposium, October 7-10, 2002. USDA Forest Service Gen. Tech. Rep. PSW-GTR-193.

> "if longer rotations were widely adopted in the Sierra Nevada, this would lead to major changes in the distribution of stand structures over broad scales and an increase in the number of stands containing old forest features."

One more solution is to retain much greater structure at the time of harvest. Variable retention practices, wherein clumps of trees or scattered trees are retained throughout a clearcut, have been proposed to maintain or increase forest diversity for future stands (Franklin et al. 1997). While some companies do engage in a practice of retaining scattered or clumped trees within some clearcuts, this practice, as it is currently performed in California, falls well short of the requirements for variable retention and as such is recognized only as an alternative to clearcutting. Recent work by Aubry et al. 2009[10] indicates that high levels of retention (40%), and large retained areas (2.5 acres), are necessary to meet important ecological conditions compared to lower retention levels (15%).

Some have also asserted that carbon sequestration and protecting forest diversity are at cross purposes. That is not true. From a carbon perspective, retaining structural diversity and large old trees makes sense in order to protect carbon stores, especially in the short term.

In sum, while clearcut logging practices are currently lawful under California's existing forest practice rules, to achieve compliance with the cumulative impacts aspects of the FPRs and CEQA, and to protect "the forests of the state as a complete working ecosystem," it is imperative that we reassess, and then provide better guidance regarding, how the various silvicutural techniques can be practiced in California. This is necessary in order to avoid the cumulative impacts that are caused when there is widespread use of silvicultural practices that do not promote natural stand development.

3. <u>Suggested regulatory modifications which would either 1) clarify existing rule language to better achieve the intended resource protection, or 2) which would reduce regulatory inefficiencies and maintain the same or better level of protection</u>.

a. Existing rule language states, at 14 CCR 1038, that:

> timber operations are exempt from the plan preparation and submission requirements (PRC § 4581) and from the completion report and stocking report requirements (PRC §§ 4585 and 4587) of the Act with the following exceptions and requirements . . .
>
> (b) Harvesting dead, dying or diseased trees of any size, fuelwood or split products in amounts less than 10 percent of the average volume per acre when the following conditions are met . . .
>
> (d) The limit of 10 percent of the volume per acre in subsection (b) above does not apply when harvesting dead trees which are unmerchantable as sawlog-size timber

[10] Aubry, K. B., Halpern, C. B., and Peterson, C. E. 2009. Variable-retention harvests in the Pacific Northwest: A review of short-term findings from the DEMO study. *Forest Ecology and Management* 258: 398–408.

> from substantially damaged timberlands, as defined in 14 CCR 895.1, and the following conditions are met . . .
>
> (5) The RPF shall also certify that no conditions were identified where operations, conducted in compliance with the rules of the Board, would reasonably result in significant adverse effects.

Two issues are important here. First, this rule allows post-fire timber operations to be "exempt from the plan preparation and submission requirements" which means that the public and decision-makers have little say in how this important forest resource (*i.e.*, post-fire habitat) is protected. Therefore, to better achieve protection of post-fire habitat, this exemption should end.

Second, because post-fire habitat has significant ecological value, there should be better guidance regarding what constitutes "significant adverse effects." Otherwise, we risk removing necessary habitat for species like cavity-nesting birds, as well as damaging soil (Beschta et al. 2004, [11] Lindenmayer et al. 2004[12]). Beschta et al. 2004 recommended, among other things, that post-fire timber operations retain at least 50% of snags in each size class, refrain from removing large snags, and avoid the most severely burned stands that tend to have the most fragile post-fire soil.

It is also important to clarify that while fire is a problem for human structures, fire is healthy and natural for California forest ecosystems. Snag forest habitat, which is created by high-intensity fire patches that have not been logged, is one of the most ecologically important and biodiverse forest habitat types in western U.S. conifer forests (Lindenmayer and Franklin 2002, Noss et al. 2006[13], Hutto 2008[14]), and is among the most underrepresented, and rarest, of forest habitat types. Noss et al. 2006 observed that "early-successional forests (naturally disturbed areas with a full array of legacies, i.e., not subject to post-fire logging) and forests experiencing natural regeneration (i.e., not seeded or replanted), are among the most scarce habitat conditions in many regions." Hutto 2006 likewise notes:

> Besides the growing body of evidence that large, infrequent events are ecologically significant and not out of the range of natural variation (Foster et al. 1998, Turner & Dale 1998), an evolutionary perspective also yields some insight into the 'naturalness' of severely burned forests . . . . The dramatic positive response of so

[11] Beschta, R.L., J.J. Rhodes, J.B. Kauffman, R.E. Gresswell, G.W. Minshall, J.R. Karr, D.A. Perry, F.R. Hauer, and C.A. Frissell. 2004. Postfire management on forested public lands of the western United States. *Conservation Biology* 18:957-967.

[12] Lindenmayer, D.B., et al. 2004. Salvage Harvesting Policies After Natural Disturbance. *Science* 303:1303

[13] Noss, R.F., J.F. Franklin, W.L. Baker, T. Schoennagel, P.B. Moyle. 2006. Managing fire-prone forests in the western United States. *Frontiers in Ecology and Environment* 4:481-487.

[14] Hutto, R.L. 1995. Composition of bird communities following stand-replacement fires in northern Rocky Mountain (U.S.A.) conifer forests. *Conservation Biology* 9:1041-1058.

> many plant and animal species to severe fire and the absence of such responses to low-severity fire in conifer forests throughout the U.S. West argue strongly against the idea that severe fire is unnatural. The biological uniqueness associated with severe fires could emerge only from a long evolutionary history between a severe-fire environment and the organisms that have become relatively restricted in distribution to such fires. The retention of those unique qualities associated with severely burned forest should, therefore, be of highest importance in management circles.

In addition, Kotliar et al. 2007[15] observed that the results of their study "demonstrated that many species tolerate or capitalize on the ecological changes resulting from severe fires…", and concluded that: "Fire management that includes a broad range of natural variability (Allen et al. 2002), including areas of severe fire, is more likely to preserve a broad range of ecological functions than restoration objectives based on narrowly defined historic fire regimes (Schoennagel et al. 2004)." A broad discussion of post-fire forest issues is well developed in the recent book *Salvage Logging and Its Ecological Consequences* by David Lindenmayer, Philip Burton, and Jerry Franklin (Island Press, 2008). The authors conclude, "Salvage logging and other post-disturbance practices can have profound negative impacts on ecological processes and biodiversity."

The scientific literature demonstrates that there is strong consensus among ecologists that post-fire habitat, including high-intensity fire and its resulting habitat, is something that must be preserved and facilitated, not destroyed, and regulatory modifications are therefore necessary to achieve protection of that resource. Consequently, it is important that the Board and Cal Fire clarify the existing "significant adverse effects" language by developing stricter guidance regarding post-fire timber operations that ensures protection of the forest habitat created by fire. Moreover, given the importance of post-fire habitat, post fire timber operations should not be "exempt from the plan preparation and submission requirements."

b. GHG analysis:

The THP review process is intended to "demonstrate to an apprehensive citizenry that the agency has, in fact, analyzed and considered the ecological implications of its action" and to permit public "accountability and informed self-government." *See Joy Road Area Forest & Watershed Assn. v. California Dept. of Forestry & Fire Protection* (2006) 142 Cal. App. 4th 656, 670. Thus far, GHG analyses in THPs have been lacking in terms of providing, among other things, the following information; therefore, clarification is needed to better achieve resource protection and to provide for informed decision-making.

1) Temporal analysis

Timing is of great importance in regard to GHG emissions. Future sequestration is irrelevant if emissions in the short term have caused significant damage. In

[15] Kotliar, N.B., P.L. Kennedy, and K. Ferree. 2007. Avifaunal responses to fire in southwestern montane forests along a burn severity gradient. *Ecological Applications* 17:491-507.

other words, emissions occurring in the short term can not be explained away by pointing to future sequestration. A section of all GHG analyses should be required to explicitly address the temporal aspects of GHG emissions associated with logging. It is likewise necessary to address the temporal differences, in terms of GHG emissions, between the use of various silvicultural techniques.

2) In order to provide a comprehensive GHG analysis to the public and decision-makers, THPs, among other things, should address the following:

    i) Type of Forest Management

       Each silvicultural practice has different implications in terms of GHG emissions. THPs should provide enough information to assess the GHG emissions that would be associated with the chosen silvicultural technique as well as what would be the GHG emissions associate with a potentially less intensive alternative silvicultural technique

    ii) Ages and tree species of stands at issue

       This information is important for assessing the emissions associated with a THP because different species and different aged stands will have different GHG emissions associated with them

    iii) Store of carbon in soil and understory

       It is important to include an estimate of soil and understory emissions

    iv) Reduction of carbon stores v. rate of carbon uptake

Thank you for considering these comments.

Sincerely,

Justin Augustine

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Justin Augustine
Center for Biological Diversity