*** Audubon Society of Portland * Bark * Cascadia Wildlands * Center for Biological Diversity * Coast Range Association * Conservation Congress * Environmental Protection Information Center * Geos Institute * John Muir Project * Klamath Forest Alliance* Olympic Park Associates * Soda Mountain Wilderness Council * Umpqua Watersheds * Wild Guardians**

January 20, 2017

Attention: Northwest Forest Plan Science Synthesis

Re: Comments on Chapter 1 (Synthesis of Science to Inform Land Management Within the Northwest Forest Plan Area) prepared by Dr. Dominick A. DellaSala (Chief Scientist, Geos Institute)

Dear Science Synthesis authors and peer reviewers:

Under separate cover, the above groups have submitted detailed comments for the public record on the Northwest Forest Plan (NWFP) science synthesis. Synthesis chapter authors designed the synthesis to inform managers of the underlying science on specific issues to be considered during the revision of management plans for 19 national forests within the range of the Northern Spotted Owl. The document is an impressive undertaking of over 1263 pages in 12 subject chapters.

The NFMA 2012 planning rule calls for use of best available science in agency forest planning[1]. The Forest Service also has decided that it will adhere to the Office of Management & Budget (OMB) guidelines on "highly influential scientific assessments." Based on our review of the entire synthesis and this chapter 1, we are concerned about some common themes that we see repeated throughout the synthesis that do not comport with best available science, including:

(1) Incomplete understanding of modern conservation biology approaches (i.e., GAP analysis, larger reserves, more reserves, climate refugia, "ecological stage");
(2) Lack of attention to landscape connectivity and, conversely habitat fragmentation, in climate adaptation strategies;
(3) Untested assumptions about fire-habitat losses to spotted owls;
(4) Overstating thinning as an adaptation/restoration strategy.

[1]"§ 219.3 Role of science in planning. The responsible official shall use the best available scientific information to inform the planning process required by this subpart. In doing so, the responsible official shall determine what information is the most accurate reliable, and relevant to the issues being considered. The responsible official shall document how the best available scientific information was used to inform the assessment, the plan decision, and the monitoring program as required in §§ 219.6(a)(3) and 219.14(a)(4). Such documentation must: Identify what information was determined to be the best available scientific information, explain the basis for that determination, and explain how the information was applied to the issues considered."

These concerns, described in greater detail below, prevent the science synthesis from achieving the standard of "best available science" under the 2012 forest planning rule and the standard set forth by the NWFP itself, "*scientifically sound and legally defensible*."

The science synthesis also failed to recognize that LSRs were expected to offer benefits not only to terrestrial but aquatic ecosystems. Those benefits will not be realized if active management is encouraged in reserves that depart from the standards and guidelines of the NWFP. The 1993 FEMAT report explicitly recognized the important role of LSRs in aquatic conservation. The reasons cited include LSRs that are "relatively undisturbed," aquatic refugia and standards and guidelines that "limit activity" (FEMAT V-32). Increasing active management in reserves, including but not limited to fuel reduction, will require roads, canopy reduction, and ground disturbance. These effects are incompatible with watershed protection as envisioned in the NWFP.

Here is the relevant quote from FEMAT, p V-32:

"Each of the options developed for managing federal lands within the range of the northern spotted owl (described in chapter 111), include a set of Late-Successional Reserves. Total area in Late-Successional Reserves varied from 5-9 million acres depending on the option (table V-4). While these reserves were not derived for the Aquatic Conservation Strategy, they are an important component. They confer two major benefits to fish habitat and aquatic ecosystems. First, the Standards and Guidelines under which Reserves are managed limit activity in these areas; providing increased protection for all stream types. Second, since these Reserves possess late-successional characteristics, they tend to be relatively undisturbed areas although some management may have taken place in them in the past. Some Reserves offer core areas of good stream habitat in predominantly degraded landscapes that will act as refugia and centers from which degraded areas can be recolonized as they recover. Streams in these Reserves may be particularly important for endemic or locally distributed fish species and stocks."

I. INCOMPLETE UNDERSTANDING OF MODERN CONSERVATION BIOLOGY APPROACHES (I.E., GAP ANALYSIS, LARGER RESERVES, MORE RESERVES, CLIMATE REFUGIA, ECOLOGICAL STAGE)

From Chapter 1 - "A growing body of scientific evidence recognizes that active management or restoration in reserves is often needed to promote habitat diversity and biodiversity conservation goals. Fixed reserves may not be effective for dynamic biotic communities, ecosystems and landscapes under climate change." (p. 3 lines 18-20).

This statement, while a summary of the synthesis chapters in general, reflects a narrow understanding of modern conservation biology approaches that have been rooted in disturbance dynamics for decades (e.g., Noss and Cooperrider 1994).

Because this bias is reflected in chapters 2, 3, 4, 6, 8, and 12, we repeat our comments for reviewers.

Importance of fixed reserves - Recognition of *in situ* conservation using fixed reserves has been widely accepted in conservation biology and ecosystem management approaches *as a* fundamental conservation approach (Watson et al. 2014), including the NWFP (Courtney et al. 2004, DellaSala et al. 2015b). In a recent global synthesis, Watson et al. (2014) indicate that for most of the time, well-managed protected areas reduce rates of habitat loss in both terrestrial and marine systems and that there is "**strong evidence that protected areas maintain species population levels (including threatened species) better than other management approaches**" (emphasis added). They further indicate that well-managed protected areas provide critical ecosystem services such as water, carbon, food security, protection of wild relatives of crops, and maintenance of wild stocks. And protected areas – particularly in carbon dense forests (Krankina et al. 2014) – are now seen as a critical component of global climate change mitigation efforts as protected intact forests store more carbon than logged forests (Mackey et al. 2014, Krankina et al. 2014). Thus, Watson et al. (2014) conclude that:

"Although there is strong global consensus within the conservation community that the principle role of protected areas is nature conservation, in practice they are expected to make much wider ecological, social and economic contributions to human society." We submit that the socio-economic contributions come largely from the ecosystem services values that protected forests provide for people and that needs to be properly evaluated in any socioeconomic discussion of protected areas given the ecosystem services losses associated with valuing one particular service – timber – over another.

The concept of large contiguous reserves interconnected at landscape and regional scales is fundamentally recognized in reserve design strategies (Noss and Cooperrider 1994, Noss et al. 2012, DellaSala et al. 2015b) that also incorporate non-reserve measures in the surroundings (Lindenmayer and Franklin 2008). For instance Noss et al. (2012) indicate:

"Although a well-managed landscape matrix may provide connectivity and other conservation benefits (Franklin and Lindenmayer 2009), it cannot be assumed to conserve biodiversity unless legally binding and enforced regulations keep land use compatible with conservation objectives. This is usually not the case."

Noss (2001) discusses robust forest conservation strategies in a changing climate that have relevance to the importance of NWFP reserves. Specifically, he concludes that the practices most likely to maintain forest biodiversity and ecological functions in a changing climate are:

(1) Representing forest types across environmental gradients in reserves.
(2) Protecting climatic refugia at multiple scales (also see Olson et al. 2012).
(3) Protecting primary forests (also see Mackey et al. 2014)
(4) Avoiding fragmentation and providing connectivity, especially parallel to climatic gradients (also see DellaSala et al. 2015b).
(5) Providing buffer zones for adjustment of reserve boundaries.
(6) Practicing low-intensity forestry and preventing conversion of natural forests to plantations.

(7) Maintaining natural fire regimes.
(8) Maintaining diverse gene pools
(9) Identifying and protecting functional groups and keystone species.

According to Noss (2001), "good forest management in a time of rapidly changing climate differs little from good forest management under more static conditions, but there is increased *emphasis on protecting climatic refugia and providing connectivity*.

Thus, because none of the chapters conducted a GAP analysis, connectivity analysis, or refugia analysis (i.e., standard approaches in conservation biology that you missed) it is premature to conclude that the status-quo reserve design has inherent failures in a dynamic landscape, particularly given that other complimentary approaches were not evaluated, including larger (>50,000 acres) reserves, refugia (e.g., north-facing slopes and older mesic forests, Olson et al. 2012), or eliminating matrix logging of older forests while holding reserves constant. The importance of corridors and functional landscape connectivity is also reinforced by global assessments (e.g., see discussion below).

Additionally, Noss (2007) in a treatise on "Climate Change in the Northwest" recommends some fundamental ways to help prepare natural systems for minimal loss of species and other components of biodiversity, including:

(1) Stop habitat fragmentation – enable movements latitudinal in range, dispersal from coastal to inland, upslope movements, and movements to refugia.
(2) Provide connectivity – maintain intact networks of protected lands, for example along the length of the Cascades (at all elevations), from the Olympics to the Cascades, and from the Cascades to the Rockies and northward.
(3) Maintain intact gradients (e.g., soil moisture, slope, elevation) – roads, clearcuts, and other developments impede wildlife movements (see Ibisch et al. 2017).
(4) Identify and protect refugia – cooler microclimates (e.g., valley bottoms, riparian areas, n-facing slopes, mesic older forests – Olson et al. 2012).

Noss (2007) concludes – "land conservation – the cornerstone of the conservation movement – is even more essential and urgent in a time of rapidly changing climate." The science synthesis is clearly lacking in this key recommendation as the chapter bias against fixed-reserves has policy implications that if implemented would be inconsistent with the large body of conservation biology literature that was not even addressed in the synthesis.

Management already allowed in NWFP reserves - Notably, in prior attempts by federal agencies to move from a fixed-reserve approach of the NWFP to "whole landscape approaches" have been widely criticized by the scientific community. In a 2012 open letter to decision makers, 229 scientists (Appendix A), including many who had published on forests and aquatic systems in the Pacific Northwest stated:

"The conservation foundation of the NWFP, which is rooted in fixed reserves, has been broadly supported in the scientific literature. This is largely because the reserve network

is the backbone to a regional conservation strategy for hundreds of species that depend on older forests that are relatively rare on surrounding nonfederal lands. The older forests and intact watersheds that these reserves protect, or seek to restore, also provide a myriad of related ecosystem benefits, including storing vast quantities of atmospheric carbon in live and dead trees and soils important in climate regulation, refugia and a relatively connected landscape for climate-forced migrations of wildlife in search of cool, moist conditions, and high quality water for aquatic organisms and people."

Thus, "whole-landscape approaches," shifting boundaries, and "reserveless" approaches with more active management (thinning) have been widely criticized by scientific experts, including scientific societies (The Wildlife Society, Society for Conservation Biology, American Ornithologists' Union) reviewing the 2008 Recovery Plan for the Northern Spotted Owl that included many of the same approaches you now advocate. Eliminating (or shifting boundaries without anchoring existing reserves) reserves currently governed by **measurable, enforceable standards and guidelines**, will place these areas at risk of managers that may seek to manage these lands down to their lowest value, degrading currently suitable owl habitat and other late-successional forest habitat. It must be remembered that one of the main listing factors for the spotted owl (in addition to habitat destruction) was inadequacy of regulatory mechanisms. Making reserves more open to logging (thinning) would remove enforceable standards currently in place to protect habitat.

Additionally, the discussion of reserves fails to mention how the BLM's western Oregon plan revisions are moving away from components of the NWFP reserves, particularly the Aquatic Conservation Strategy. How will that affect conservation outcomes in the broader context of the NWFP framework and reserve design? Why wasn't that evaluated? Chapter 8 (socioeconomics) discusses the legal framework of the NWFP including BLM O&C lands but the biology chapters of the synthesis (1, 2, 3, 4, 5, 6, 8, 12) are mostly silent on significance of BLM lands to the coordination and implementation of the NWFP as a framework for regional, integrated, and comprehensive conservation and ecosystem management (one of the main objectives of the NWFP). BLM lands in southwest Oregon, notably, exist in a highly fragmented landscape. Additional logging (federal and nonfederal) in this already highly fragmented landscape will contribute to cumulative effects to ecosystems and late-seral species that should be covered in this and related chapter syntheses.

Based on the above review of the importance of fixed reserves, we believe that chapter authors have not made a cogent scientific argument for moving to other reserve designs particularly absent GAP (representation) analysis, connectivity analysis, or any other comprehensive evaluation of the efficacy of alternative designs, including why larger reserves or "matrixless" management with fixed reserves in place would not achieve the goals of a resilient landscape. We summarily reject any attempt to shift boundaries without a guarantee that the existing reserves will not be eliminated or reduced in size (i.e., degazetted).

It should be noted that Courtney et al. (2004) concluded in their ten-year evaluation of the efficacy of NWFP reserves:

"We believe the persistence of the NWFP reserve system will be critical to maintaining owls and other old forest associated species."

In addition, it is important to note that current standards and guidelines, recommendations of FEMAT, and FEIS already allow for active management (including fire management) within reserves provided that it is compatible with the development of late-seral characteristics and older (>80 yr) trees are retained.

From the Standards and Guidelines, we highlight the following activities that can occur within reserves:

C-18:
In Late-Successional Reserves, a specific fire management plan will be prepared prior to any habitat manipulation activities. This plan, prepared during watershed analysis or as an element of province-level planning or a Late-Successional Reserve assessment, should specify how hazard reduction and other prescribed fire applications will meet the objectives of the Late-Successional Reserve. Until the plan is approved, proposed activities will be subject to review by the Regional Ecosystem Office. The Regional Ecosystem Office may develop additional guidelines that would exempt some activities from review. In all Late- Successional Reserves, watershed analysis will provide information to determine the amount of coarse woody debris to be retained when applying prescribed fire.

In Riparian and Late-Successional Reserves, the goal of wildfire suppression is to limit the size of all fires. When watershed analysis, province-level planning, or a Late-Successional Reserve assessment are completed, some natural fires may be allowed to burn under prescribed conditions. Rapidly extinguishing smoldering coarse woody debris and duff should be considered to preserve these ecosystem elements.

C-35:
Fire/Fuels Management

FM-1. Design fuel treatment and fire suppression strategies, practices, and activities to meet Aquatic Conservation Strategy objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuels management activities could be damaging to long-term ecosystem function (also see: Fire Management: C-17, C-35, C-44, C-48, D-8, D-11).

C-17:
Fire Suppression and Prevention - Each Late-Successional Reserve will be included in fire management planning as part of watershed analysis. Fuels management in Late-Successional Reserves will utilize minimum impact suppression methods in accordance with guidelines for reducing risks of large-scale disturbances. Plans for wildfire

suppression will emphasize maintaining late-successional habitat. During actual fire suppression activities, fire managers
will consult with resource specialists (e.g., botanists, fisheries and wildlife biologists, hydrologists) familiar with the area, these standards and guidelines, and their objectives, to assure that habitat damage is minimized. Until a fire management plan is completed for Late- Successional Reserves, suppress wildfire to avoid loss of habitat in order to maintain future management options.

FEIS 1994 B-43
In Late-Successional Reserves, standards and guidelines are designed to maintain late-successional forest ecosystems and protect them from loss due to large scale fire, insect and disease epidemics, and major human impacts. The intent is to maintain natural ecosystem processes such as gap dynamics, natural regeneration, pathogenic fungal activity, insect herbivory, and low intensity fire. In some alternatives, standards and guidelines encourage the use of silvicultural practices to accelerate the development of overstocked young plantations into stands with late-successional and old-growth forest characteristics, and to reduce the risk to Late-Successional Reserves from severe impacts resulting from large-scale disturbances and unacceptable loss of habitat.

Additionally, FEMAT anticipated and planned for the reserve network with disturbance in mind, particularly the concept of redundancy and well-distributed population centers and LS/OG throughout the range of the owl. We note:

FEMAT 1993 IV-21: Conservation areas are to be widely distributed throughout the range of the northern spotted owl to provide redundancy in the network.

FEIS 1994 G-8

The management for local populations within the metapopulation also should be designed to reduce the risk of local or widespread extirpation of owl populations due to catastrophic destruction of habitat. Such destruction could result from natural causes including windthrow, fire, flooding, insects, diseases, volcanic action, or climatic change. The risk to the overall population from large-scale disturbances is reduced by distributing local population centers throughout the species' range, and by providing redundancy of habitats. Additional security from catastrophic loss can be provided by reducing the risk within local population centers. The risk of catastrophic loss within a given population center can be influenced by the size, configuration, and management of that center. Larger areas are less susceptible to complete elimination from fire and windthrow. The likelihood of fire, and the likely impacts of fire, can be reduced through management of fuels within the population center and in the surrounding forest matrix. In some ecological conditions, the risk of serious insect and disease losses may be reduced through appropriate management.

The reserve network also was designed with resilience in mind and losses of late-seral forests from fire are within what was anticipated by FEMAT. From Courtney et al. (2004):

"The reserve system was predicated upon redundancy of individual reserves in order to spread risk across the entire reserve system."

"In general, models of differing structure and invoking various assumptions have been consistent in recommending sizeable patches of habitat to support largely self-sustaining local populations connected by frequent dispersal events. In addition, there needs to be substantial redundancy (i.e., many large patches widely distributed throughout the range of the owl) because of strong spatial autocorrelation in the climatic events that affect northern spotted owl populations."

We therefore see no reason to depart from the reserve design, permanent fixed-boundary reserves, or the large tree standard in dry forest reserves as implied in several of the chapter syntheses. If a more dynamic approach is warranted, then chapter authors should consider a fixed reserve design that instead includes eliminating matrix logging in favor of restoration activities compatible with conservation and ecosystem management approaches. The reserves needs to stay fixed until at least the LS/OG ecosystem has reached the goals of the NWFP (century). If federal managers wish to accelerate that timeline, then they should evaluate a "matrixless" design anchored by fixed reserves. Why wasn't this design included in your discussion?

Notably, an underlying assumption of the synthesis is that if more active management is not promoted in the reserves then the reserves will be prone to high severity fire. And while high severity fire has impacted the reserve network, actively managing the reserves for lower fire severities is no guarantee that high severity fire will be reduced. In fact, in a western US analysis of high severity fire in low-mid elevation pine and mixed conifer forests, Bradley et al. (2016) found that high severity amounts were greatest in actively managed forests compared to protected areas. Why wasn't this study included in the synthesis:

Abstract. There is a widespread view among land managers and others that the protected status of many forestlands in the western United States corresponds with higher fire severity levels due to historical restrictions on logging that contribute to greater amounts of biomass and fuel loading in less intensively managed areas, particularly after decades of fire suppression. This view has led to recent proposals—both administrative and legislative—to reduce or eliminate forest protections and increase some forms of logging based on the belief that restrictions on active management have increased fire severity. We investigated the relationship between protected status and fire severity using the Random Forests algorithm applied to 1500 fires affecting 9.5 million hectares between 1984 and 2014 in pine (Pinus ponderosa, Pinus jeffreyi) and mixed-conifer forests of western United States, accounting for key topographic and climate variables. We found forests with higher levels of protection had lower severity values even though they are generally identified as having the highest overall levels of biomass and fuel loading. Our results suggest a need to reconsider current overly simplistic assumptions about the relationship between forest protection and fire severity in fire management and policy. Ecosphere 7(10):e01492. 10.1002/ecs2.1492

II. LACK OF ATTENTION TO LANDSCAPE CONNECTIVITY IN RESERVE DESIGN AND CLIMATE ADAPTATION STRATEGIES

Connectivity - Landscape connectivity is a fundamental objective of conservation biology approaches involving reserves in dynamic landscapes. Connectivity is especially important in a changing climate as species move around (those that can) in search of suitable refugia (based on climate envelope theory). Chapter 1, like the synthesis in general, does not provide sufficient consideration of the importance of a *well-distributed and connected reserve network* that is fundamental to the restoration of a functional reserve system that is resilient to climate change (see DellaSala et al. 2015b). We summarize from our prior comments and an expansive literature review of Heller and Zavaleta (2009: Biodiversity management in the face of climate change: a review of 22 years of recommendations, Biological Conservation 142:14-32), particularly Fig. 1 and Table 1. Their global review of adaptation strategies included a review of hundreds of scholarly articles that repeatedly mentioned the importance of connectivity, larger reserves, more reserves, and climate refugia. Thus, to imply that these strategies are somehow no longer adequate in dynamic landscapes is unsupported by major reviews like this one.

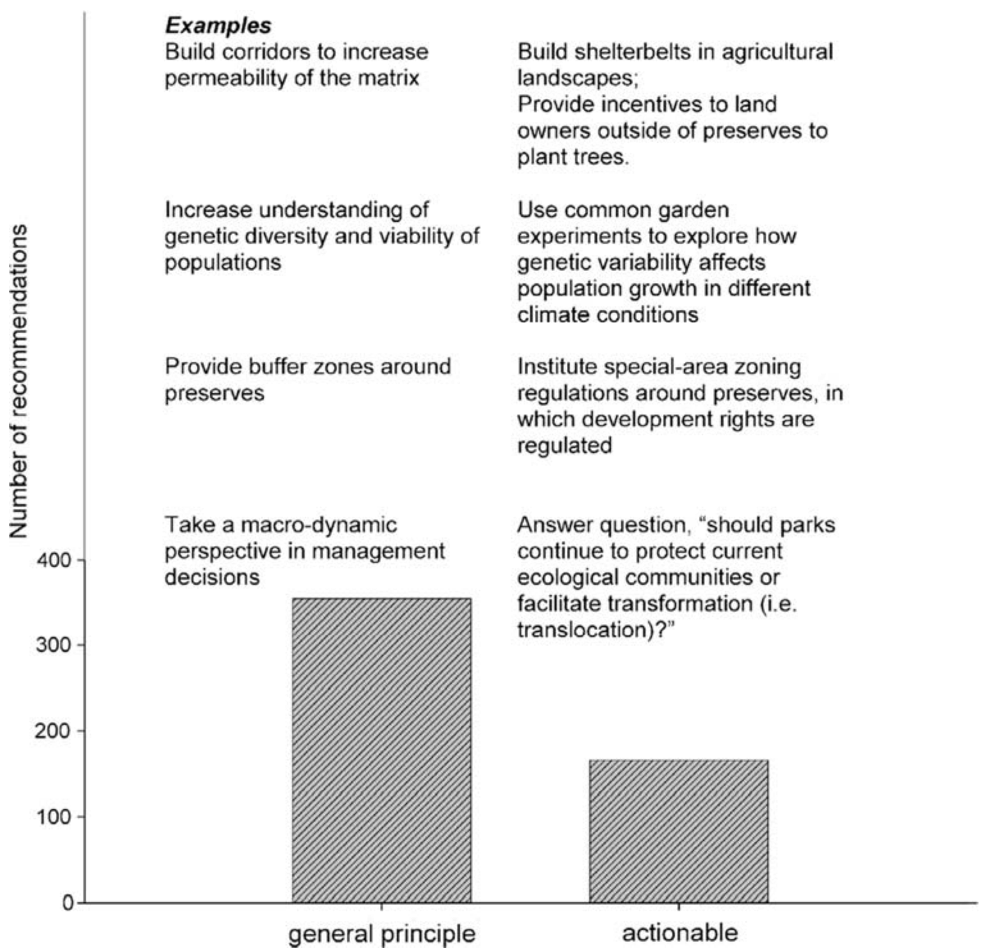


Figure 1. Recommendations classified as ‘‘general principle’’ and ‘‘actionable’’ for adaptation (from Heller and Zaveleta 2009).

Table 1 (Heller and Zaveleta 2009):

Table 1 – List of recommendations for climate change adaptation strategies for biodiversity management assembled from 112 scholarly articles. 524 records were condensed into 113 recommendation categories and are ranked by frequency of times cited in different articles.

Rank	Recommendation	No. articles	References
1	Increase connectivity (design corridors, remove barriers for dispersal, locate reserves close to each other, reforestation	24	Beatley (1991), Chambers et al. (2005), Collingham and Huntley (2000), Da Fonseca et al. (2005), de Dios et al. (2007), Dixon et al. (1999), Eeley et al. (1999), Franklin et al. (1992), Guo (2000), Halpin (1997), Hulme (2005), Lovejoy (2005), Millar et al. (2007), Morecroft et al. (2002), Noss (2001), Opdam and Wascher (2004), Rogers and McCarty (2000), Schwartz et al. (2001), Scott et al. (2002), Shafer (1999), Welch (2005), Wilby and Perry (2006) and Williams (2000)
2	Integrate climate change into planning exercises (reserve, pest outbreaks, harvest schedules, grazing limits, incentive programs	19	Araujo et al. (2004), Chambers et al. (2005), Christensen et al. (2004), Dale and Rauscher (1994), Donald and Evans (2006), Dyer (1994), Erasmus et al. (2002), Hulme (2005), LeHouerou (1999), McCarty (2001), Millar and Brubaker (2006), Peters and Darling (1985), Rounsevell et al. (2006), Scott and Lemieux (2005), Scott et al. (2002), Soto (2001), Staple and Wall (1999), Suffling and Scott (2002) and Welch (2005)
3	Mitigate other threats, i.e. invasive species, fragmentation, pollution	17	Bush (1999), Chambers et al. (2005), Chornesky et al. (2005), Da Fonseca et al. (2005), de Dios et al. (2007), Dixon et al. (1999), Halpin (1997), Hulme (2005), McCarty (2001), Noss (2001), Opdam and Wascher (2004), Peters and Darling (1985), Rogers and McCarty (2000), Shafer (1999), Soto (2001), Welch (2005) and Williams (2000)
4	Study response of species to climate change physiological, behavioral, demographic	15	Alongi (2002), Chambers et al. (2005), Crozier and Zabel (2006), Dyer (1994), Erasmus et al. (2002), Fukami and Wardle (2005), Gillson and Willis (2004), Honnay et al. (2002), Hulme (2005), Kappelle et al. (1999), McCarty (2001), Mulholland et al. (1997), Noss (2001), Peters and Darling (1985) and Swetnam et al. (1999)
	Practice intensive management to secure populations	15	Bartlein et al. (1997), Buckland et al. (2001), Chambers et al. (2005), Chornesky et al. (2005), Crozier and Zabel (2006), Dixon et al. (1999), Dyer (1994), Franklin et al. (1992), Hulme (2005), Morecroft et al. (2002), Peters and Darling (1985), Soto (2001), Thomas et al. (1999), Williams (2000) and Williams et al. (2005)
	Translocate species	15	Bartlein et al. (1997), Beatley (1991), Chambers et al. (2005), de Dios et al. (2007), Halpin (1997), Harris et al. (2006), Honnay et al. (2002), Hulme (2005), Millar et al. (2007), Morecroft et al. (2002), Pearson and Dawson (2005), Peters and Darling (1985), Rogers and McCarty (2000), Schwartz et al. (2001), Shafer (1999) and Williams et al. (2005)
5	Increase number of reserves	13	Burton et al. (1992), Dixon et al. (1999), Hannah et al. (2007), Hughes et al. 2003, LeHouerou (1999), Lovejoy (2005), Peters and Darling (1985), Pyke and Fischer (2005), Scott and Lemieux (2005) (2007), van Rensburg et al. (2004), Wilby and Perry (2006) and Williams et al. (2005)
6	Address scale problems match modeling, management, and experimental spatial scales for improved predictive capacity	12	Chornesky et al. (2005), Da Fonseca et al. (2005), Dale and Rauscher (1994), Ferrier and Guisan (2006), Guisan and Thuiller (2005), Huang (1997), Hughes et al. (2003), Kueppers et al. (2004), Kueppers et al. (2005), Mulholland et al. (1997), Noss (2001), Root and Schneider (1995) and Root and Schneider (2006)
	Improve inter-agency, regional coordination	12	Bartlein et al. (1997), Cumming and Spiesman (2006), Da Fonseca et al. (2005), Grumbine (1991), Hannah et al. (2002), Lemieux and Scott (2005), Rounsevell et al. (2006), Scott and Lemieux (2005), Soto (2001), Suffling and Scott (2002), Tompkins and Adger (2004) and Welch (2005)
7	Increase and maintain basic monitoring programs	11	Chambers et al. (2005), Cohen (1999), Huang (1997), Rogers and McCarty (2000), Root and Schneider (1995), Schwartz et al. (2001), Shafer (1999), Staple and Wall (1999), Suffling and Scott (2002), Wilby and Perry (2006) and Williams (2000)
	Practice adaptive management	11	Allison et al. (1998), Chambers et al. (2005), Hulme (2005), Lasch et al. (2002), Maciver and Wheaton (2005), Millar et al. (2007), Scott and Lemieux (2005), Staple and Wall (1999), Suffling and Scott (2002), Tompkins and Adger (2004) and Welch (2005)
	Protect large areas, increase reserve size	11	Beatley (1991), Bellwood and Hughes (2001), Burton et al. (1992), Bush (1999), Halpin (1997), Hulme (2005), Morecroft et al. (2002), Peters and Darling (1985), Shafer (1999), Soto (2001) and Watson (2005)

Rank	Recommendation	No. articles	References
Table 1 – continued			
8	Create and manage buffer zones around reserves	10	Bush (1999), de Dios et al. (2007), Halpin (1997), Hannah et al. (2002), Hartig et al. (1997), Hughes et al. (2003), Millar et al. (2007), Noss (2001), Shafer (1999) and van Rensburg et al. (2004)
9	Create ecological reserve networks large reserves, connected by small reserves, stepping stones	8	Allison et al. (1998), Collingham and Huntley (2000), de Dios et al. (2007), Gaston et al. (2006), Opdam et al. (2006), Opdam and Wascher (2004), Shafer (1999) and Welch (2005)
	Develop improved modeling and analysis capacity i.e. more effective software, integration with GIS, integrate greater complexity	8	Chornesky et al. (2005), Ferrier and Guisan (2006), Guisan and Thuiller (2005), Guo (2000), Huang et al. 1998, Mulholland et al. (1997), Peters and Darling (1985) and Rounsevell et al. (2006)
	Do integrated study of multiple global change drivers	8	Dale and Rauscher (1994), Desanker and Justice (2001), Donald and Evans (2006), Halpin (1997), Hannah et al. (2002), McCarty (2001), Watson (2005) and Williams (2000)
	Improve techniques for and do more restoration wetlands, rivers, matrix	8	Da Fonseca et al. (2005), de Dios et al. (2007), Dyer (1994), Hartig et al. (1997), Lovejoy (2005), Millar et al. (2007), Mulholland et al. (1997) and Shafer (1999)
	Increase interdisciplinary collaboration	8	Gillson and Willis (2004), Guisan and Thuiller (2005), Hannah et al. (2002), Hulme (2005), Kappelle et al. (1999), Root and Schneider 1995, Soto (2001) and Williams (2000)
	Promote conservation policies that engage local users and promote healthy human communities	8	Chapin et al. (2006), Desanker and Justice (2001), Eeley et al. (1999), Lovejoy (2005), Opdam and Wascher (2004), Ramakrishnan (1998), Tompkins and Adger (2004) and McClanahan et al. (2008)
	Protect full range of bioclimatic variation	8	Bush (1999), Eeley et al. (1999), McCarty (2001), Noss (2001), Pyke et al. (2005), Pyke and Fischer (2005), Shafer (1999) and Thomas et al. (1999)
	Soften landuse practices in the matrix	8	Beatley (1991), Burton et al. (1992), Da Fonseca et al. (2005), Franklin et al. (1992), Hannah et al. (2002), Noss (2001), Williams (2000) and Woodwell (1991)
10	Adopt long-term and regional perspective in planning, modeling, and management	7	Eeley et al. (1999), Ferrier and Guisan (2006), Franklin et al. (1992), Guo (2000), Lovejoy (2005), Millar and Brubaker (2006), Opdam and Wascher (2004), Peters and Darling (1985), Peterson et al. (1997), Scott et al. (2002) and Welch (2005)
	Re-asses conservation goals (i.e. move away from concepts of natural, embrace processes over patterns	7	Franklin et al. (1992), Hulme (2005), Millar et al. (2007), Scott and Lemieux (2005) (2007), Scott et al. (2002) and Suffling and Scott (2002)
	Study species dispersal across landuse boundaries, gene flow, migration rates, historic flux	7	Guo (2000), Halpin (1997), Hughes et al. (2003), Kappelle et al. (1999), Lovejoy (2005), Opdam and Wascher (2004) and Rice and Emery (2003)
	Study species distributions current and historic	7	Da Fonseca et al. (2005), Eeley et al. (1999), Erasmus et al. (2002), Guo (2000), Hannah et al. (2002), Kappelle et al. (1999) and Millar and Brubaker (2006)
11	Broaden genetic and species diversity in restoration and forestry	6	Burton et al. (1992), de Dios et al. (2007), Harris et al. (2006), Maciver and Wheaton (2005), McCarty (2001), Millar et al. (2007), Rice and Emery (2003) and Staple and Wall (1999)
	Develop adaptation strategies now; early adaptation is encouraged	6	Huang et al. (1998), Hulme (2005), Lemieux and Scott (2005), Scott and Lemieux (2005) (2007) and Welch (2005)
	Do not implement CO_2 emission mitigation projects that negatively impact biodiversity	6	Chambers et al. (2005), Klooster and Masera (2000), Koziell and Swingland (2002), Kueppers et al. (2004) and Streck and Scholz (2006), Welch (2005)
	Manage for flexibility, use of portfolio of approaches, maintain options	6	Eeley et al. (1999), Hulme (2005), Kappelle et al. (1999), Lovejoy (2005), Millar et al. (2007) and Welch (2005)
	Validate model results with empirical data	6	Dale and Rauscher (1994), Guisan and Thuiller (2005), Hulme (2005), Malcom et al. (2006), Opdam and Wascher (2004) and Watson (2005)
12	Do regional impact assessments	5	Cohen (1999), Desanker and Justice (2001), Lasch et al. (2002), Lindner et al. (1997) and Suffling and Scott (2002)
	Identify indicator species	5	Chambers et al. (2005), Hulme (2005), Noss (2001), Underwood and Fisher (2006) and Welch (2005)
	Initiate long-term studies of species responses to climate	5	Mulholland et al. (1997), Noss (2001), Opdam and Wascher (2004), Peters and Darling (1985) and Root and Schneider (2006)
	Model species ranges in the future	5	Allison et al. (1998), Da Fonseca et al. (2005), Hannah et al. (2002), Kerr and Packer (1998) and Kriticos et al. (2003)
	Protect refugia current and predicted future	5	Bush (1999), Chambers et al. (2005), Eeley et al. (1999), Noss (2001) and Scott et al. (2002)
	Study adaptive genetic variation	5	Harris et al. (2006), Hughes et al. (2003), Jump and Penuelas (2005), Kappelle et al. (1999) and Rice and Emery (2003)

(*continued on next page*)

Table 1 – continued			
Rank	Recommendation	No. articles	References
16	Action plans must be time-bound and measurable	1	Welch (2005)
	Adjust park boundaries to capture anticipated movement of critical habitats	1	Welch (2005)
	Create institutional flexibility	1	Millar et al. (2007)
	Create linear reserves oriented longitudinally	1	Pearson and Dawson (2005)
	Establish cross-national collaboration	1	Desanker and Justice (2001)
	Establish neo-native forests plant species where they were in the past, but are not found currently	1	Millar et al. (2007)
	Experiment with refugia	1	Millar et al. (2007)
	Focus protection on sensitive biomes	1	Scott et al. (2002)
	Focus on annual plants rather than perennials near climate boundaries	1	Buckland et al. (2001)
	Increase wetland protection	1	Hartig et al. (1997)
	Institutional capacity enhancement to address climate change	1	Lemieux and Scott (2005)
	Institute reform to improve support for interdisciplinary, multi-institutional research	1	Root and Schneider (1995)
	Locate reserves so major vegetation transitions are in core	1	Halpin (1997)
	Locate reserves at core of ranges	1	Araujo et al. (2004)
	Manage for landscape asynchrony	1	Millar et al. (2007)
	Manage human-wildlife conflict as change occurs	1	Wilby and Perry (2006)
	Manage populations to reduce temporal fluctuations in population sizes	1	Rice and Emery (2003)
	Develop guidelines for climate sensitive restoration and infrastructure development	1	Welch (2005)
	Need to increase social acceptance of shared resilience goals	1	Tompkins and Adger (2004)
	Promote personal action plans among employees to reduce emissions	1	Welch (2005)
	Protect endangered species ex situ	1	Noss (2001)
	Protect functional groups and keystone species	1	Noss (2001)
	Protect mountains	1	Peterson et al. (1997)
	Protect primary forests	1	Noss (2001)
	Protect urban green space	1	Wilby and Perry (2006)
	Quantify environmental susceptibility versus adaptive capacity to inform conservation planning	1	McClanahan et al. (2008)
	Schedule dam releases to protect stream temperatures	1	Rogers and McCarty (2000)
	Study changes in populations at rear of range rather than only range fronts	1	Willis and Birks (2006)
	Study response of undisturbed areas to climate change	1	Mulholland et al. (1997)
	Study social agency and human decision making	1	Desanker and Justice (2001)
	Study time-series data on species dynamics	1	Erasmus et al. (2002)
	Substitute space for time to study the responses of species to climate change	1	Millar and Brubaker (2006)
	Train more taxonomists	1	Huber and Langor (2004)
	Use caution in predictive modeling because the responses of some species are not well predicted	1	Willis and Birks (2006)
	Use simple decision rules for reserve planning	1	Meir et al. (2004)
	Use social networks for education about climate change	1	Huang (1997)
	Use triage in short-term to prioritize action	1	Millar et al. (2007)

Fragmentation - Habitat fragmentation can be thought of as the inverse of intactness. Chapter authors need to discuss the difference in habitat quality (or ecosystem integrity), disturbance rates (spatio-temporal), and affects on fragmentation sensitive species from natural heterogeneity vs. habitat fragmentation. The issue of fragmentation is dealt with mainly for spotted owls and marbled murrelets in relevant chapters; however, the NWFP is about a community of species associated with late-seral conditions and intactness.

Notably, in a global analysis of climate adaptation strategies and ecosystem vulnerabilities, Watson et al. (2013)[2] concluded:

"As biodiversity disruption and loss increase along with intensified climate-change

[2]Watson, J.E.M. T. Iwamura, and N. Butt. 2013. Mapping vulnerability and conservation adaptation strategies under climate change. Nature Climate Change 3:989-994.

impacts, conservation planners need to move beyond focusing on the long-term future and only on elements of exposure to climate change. Within the context of conservation practice, *vegetation intactness* is *more significant than climate stability* for ecosystem vulnerability: in terms of ecosystem degradation or species extinctions, *reduction in vegetation intactness is a greater threat than climate change at present*, and is likely to be in future, especially in tropical regions."

It is clear from the global literature on climate adaptation and vulnerability strategies that vegetation intactness is critically important to adaptation strategies, yet there is no analysis or mention of this fundamental approach in the synthesis. Instead chapter authors seem to have a single-minded purpose related to thinning as the main way to achieve adaptation with little attention to land-use stressors and vegetation intactness. Lack of attention to the literature on conservation biology approaches to adaptation is a serious omission of this chapter and the entire synthesis writ-large.

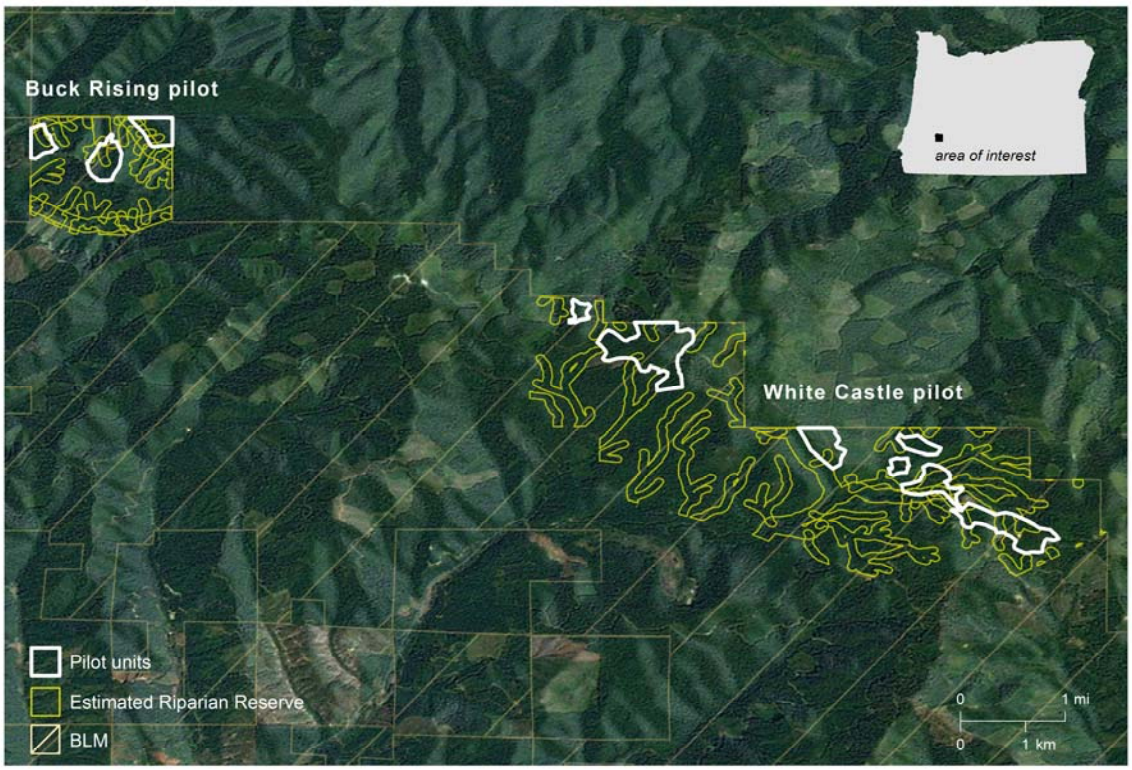
Chapter 1 therefore, like all of the synthesis chapters, fails to address recent publications on habitat fragmentation as the biggest contributor to global declines in biodiversity (http://onlinelibrary.wiley.com/doi/10.1111/ecog.2017.v40.i1/issuetoc). The science chapter offers no predictive models of consequences of habitat loss and fragmentation on biodiversity even though the literature is extensive on this topic and has been recently reviewed (http://onlinelibrary.wiley.com/doi/10.1111/ecog.02974/full).

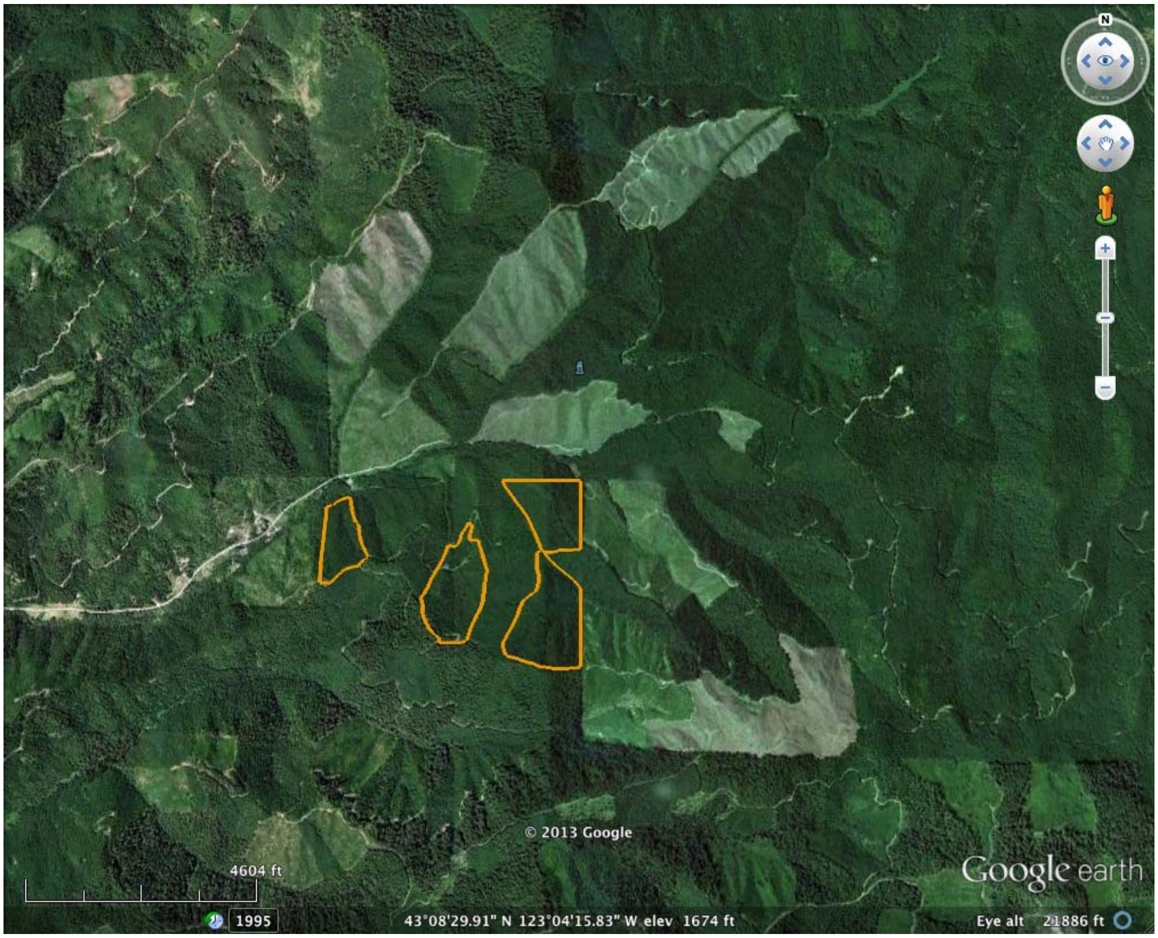
Therefore, the science synthesis represents a departure from the best available science underlying the NWFP, which included a reserve system based on viability outcomes for some 1,000 species associated with late-seral forests and not just spotted owls and murrelets. Habitat fragmentation in combination with other cumulative land-use stressors (see Paine et al. 1999) and climate change is likely to affect evolutionary potential of species by limiting dispersal capabilities in a changing climate (see http://onlinelibrary.wiley.com/doi/10.1111/ecog.02538/full). It is also likely to alter microclimates that otherwise could function as refugia for wildlife displaced by climate change (http://onlinelibrary.wiley.com/doi/10.1111/ecog.02551/full). This issue needs to be discussed in relation to how the NWFP currently provides a reserve network for late-seral associated species and could be supplemented (enhanced) with the addition of climate refugia (e.g., the ecological stage – see Beier and Brost 2010, Conservation Biology 24:701-710) and increased connectivity to address fragmentation problems.

Fragmentation also is a scale issue. While it is often thought of as occurring over large landscapes, fragmentation can occur at the stand level. For instance, "thinning" older forests down to 40% canopy cover (often practiced by the BLM and Forest Service) degrades spotted owl habitat by fragmenting intact blocks and introducing edge effects (DellaSala et al. 2013). Thus, fragmentation not only involves clearcutting intact areas at landscape scales but also occurs when the continuity of an intact forest is disrupted functionally and structurally.

As an example of landscape scale fragmentation, DellaSala et al. (2013) presented Google Earth images (below) of highly fragmented BLM lands in southwest Oregon where "ecoforestry" pilots were being proposed to log older forests for "early seral habitat" even though there is clearly a preponderance of low-quality early seral plantations in the surroundings. Notably, the chapter synthesis recommends ecoforestry and this is one example of how agencies are applying it in the region.

Landsat views of BLM pilots in southwest Oregon showing a highly fragmented landscape with BLM cut units (white polygons) in variable retention harvests and adjoining Riparian Reserve (linear polygons) in "density management" within a surrounding landscape of mostly early seral forest created by logging. Northwest units (3) are the Buck Rising pilot; other units are in the White Castle pilot. Data sources: Esri, Bureau of Land Management, US Department of Agriculture, i-cubed (DellaSala et al. 2013).





III. PROBLEMS WITH UNTESTED ASSUMPTIONS ABOUT FIRE

The spotted owl synthesis chapter to which Chapter 1 refers builds on prior assumptions carried over largely from the owl recovery plan and other assumptions regarding owls and fires, particularly high-severity patches, which are assumed to be a loss of habitat. The chapter authors have not presented compelling evidence that high-severity fire is a major threat to spotted owl populations and there are numerous places in the document that present unsupported conclusions about fire.

While we agree that "too much" high-severity fire at the scale of owl territories can cause nest site abandonment as evidenced by available published studies, no data are provided on what particular high-severity patch sizes (thresholds) result in nest or territory abandonment for northern spotted owls. Additionally, since most owl territories are "salvage" logged after severe burns, it is most important to distinguish whether logging (pre- or post-fire) or fire itself is the cause of territory abandonment. This was clearly problematic in studies conducted by Clark et al. (2011, 2013- cited in the synthesis) in southwest Oregon.

Notably, research on California Spotted Owls in the Sierra Nevada and southern California documented owls using mixed-severity mosaics that include patches of high severity as foraging habitat (Bond et al. 2009, Lee et al. 2012, Lee et al. 2013, Lee and Bond 2015a, b, Bond et al. 2016). This is consistent with Northern Spotted Owl habitat use in the southern range (e.g., Franklin et al. 2000, Dugger et al. 2005, Olson et al. 2005, Comfort et al. 2016 cited in the synthesis).

Roberts et al. (2011) included fires up to 15 years old. Lee et al. (2012) examined occupancy up to 7 years post-fire, and Lee et al. (2012)/Lee and Bond 2015b (SoCal) examined occupancy up to 8 years post fire. **Lee and Bond (2015a, b) found that even large amounts of high-severity patches within California Spotted Owl core areas (200-ha) did not adversely affect occupancy of consistently reproductive sites (So Cal) or sites with pairs (Rim Fire) (this should be cited).**

Thus, it cannot be assumed that high-severity fire patches represents a loss of habitat for owls without knowing specifics on patch size thresholds at the scale of owl territories. In fact, the available evidence from studies of California Spotted Owls indicates that high-severity patches provide important foraging habitat within a mixed-severity fire mosaic (Bond et al. 2009, 2016) and owls appear to be quite resilient to these fires (Bond et al. 2009, 2016). These findings underscore the need for caution in interpreting large-scale modeling that is limited only to owl nesting/roosting habitat (Chapter 4, Figure 4, p. 14) and does not include foraging habitat. We suggest that in addition to modeling nesting/roosting habitat, foraging habitat should also be modeled independently from dispersal and floater habitat and as critical for survival and persistence of Northern Spotted Owl populations.

Habitat loss and recruitment modeling used in this chapter synthesis, while an important advancement in classifying nesting/roosting habitat, misses the importance of un(salvage)logged, high-severity patches for owl foraging. Without foraging habitat included in these models, the models overestimate amount of habitat loss to owls from fire and seriously undervalue foraging habitat that is important to owl fitness (e.g., Franklin et al. 2000). **This omission has resulted in overestimates of fire losses in the chapter on spotted owls**.

Mis-classifying fire as a habitat loss – without determining high-severity patch sizes in owl territories and whether abandonment was caused by fire or logging – has resulted in extensive post-fire logging in owl territories and LSRs treated as no longer owl habitat by federal managers (examples include Biscuit fire, Klamath Westside fire, Rim fire, King fire, and several other fires where large post-fire logging operations in owl territories have caused owl site abandonment). This serious omission needs to be corrected so that high-severity patches are included in owl surveys and foraging habitat afforded the protections of nesting/roosting habitat.

Baker (2014) used public land-surveys to spatially reconstruct Northern Spotted Owl habitat and old-growth forests in dry forests of Oregon's eastern Cascades in the 1800s. His reconstructions were extensive, including ~280,000 ha, 9,605 tree records, and 2,180 section-line descriptions. Baker's work included nesting/roosting and foraging habitat maintained by mixed-severity fires that also included a high-severity component. Baker concluded:

"Mixed- and high-severity fires strongly shaped historical dry forests and produced important components of historical NSO habitat. Focus on short-term loss of nest sites and territories to these fires is mis-directed. Fuel treatments to reduce these natural fires, if successful, would reduce future habitat of NSO in dry forests."

With regard to habitat loss vs. recruitment, the chapter synthesis did not cite a simulation study by Odion et al. (2014a: The Open Ecology Journal 7:37-51) that specifically tested whether high-severity fire represented a bigger habitat loss compared to proposed thinning (owl recovery plan, Johnson and Franklin 2013) over a four-decade period for dry forests within the range of the Northern Spotted Owl. There is no mention of the one study that actually tested recruitment rates in the context of fire and thinning. Why wasn't the Odion et al. 2014a study included in this chapter discussion?

We include the abstract here for inclusion in the synthesis:

Abstract: The Northern Spotted Owl (*Strix occidentalis caurina*) is an emblematic, threatened raptor associated with dense, late-successional forests in the Pacific Northwest, USA. Concerns over high-severity fire and reduced timber harvesting have led to programs to commercially thin forests, and this may occur within habitat designated as "critical" for spotted owls. However, thinning is only allowed under the U.S. Government spotted owl guidelines if the long-term benefits clearly outweigh adverse impacts. This possibility remains uncertain. Adverse impacts from commercial thinning may be caused by removal of key habitat elements and creation of forests that are more open than those likely to be occupied by spotted owls. Benefits of thinning may accrue through reduction in high-severity fire, yet whether the fire reduction benefits accrue faster than the adverse impacts of reduced late-successional habitat from thinning remains an untested hypothesis. We found that rotations of severe fire (the time required for high-severity fire to burn an area equal to the area of interest once) in spotted owl habitat since 1996, the earliest date we could use, were 362 and 913 years for the two regions of interest: the Klamath and dry Cascades. Using empirical data, we calculated the future amount of spotted owl habitat that may be maintained with these rates of high-severity fire and ongoing forest regrowth rates with and without commercial thinning. Over 40 years, habitat loss would be far greater than with no thinning because, under a "best case" scenario, thinning reduced 3.4 and 6.0 times more dense, late-successional forest than it prevented from burning in high-severity fire in the Klamath and dry Cascades, respectively. Even if rates of fire increase substantially, the requirement that the long-term benefits of commercial thinning clearly outweigh adverse impacts is not attainable with commercial thinning in spotted owl habitat. It is also becoming increasingly recognized that exclusion of high-severity fire may not benefit spotted owls in areas where owls evolved with reoccurring fires in the landscape.

Overestimation of fire risks in the Northern Spotted Owl recovery plan was also critiqued by Hanson et al. 2009, which was not cited in the synthesis as well. Here is the abstract:

Abstract: The U.S. Fish and Wildlife Service's recent recovery plan for one of the most carefully watched threatened species worldwide, the Northern Spotted Owl (Strix occidentalis caurina), recommended a major departure in conservation strategies in the northwestern United States. Due to concern about fire, the plan would switch from a reserve to a no-reserve strategy in up to 52% of the owl's range. Fuel treatments (e.g., thinning) at regular intervals also would occur on up to 65–70% of dry forests in this area. Estimations of fire risk, however, were based on less than a decade of data and an anecdotal assessment of a single, large fire. We found that decadal data are inherently too short, given infrequent large fires, to accurately predict fire risk and trends. Rates of high-severity fire, based on remote-sensing data, are far lower than reported in the plan and in comparison with the rate of old-forest recruitment. In addition, over a 22-year period, there has been no increase in the proportion of high-severity fire. Our findings refute the key conclusions of the plan that are the basis for major changes in conservation strategies for the Spotted Owl. The best available science is needed to address these strategies in an adaptive-management framework. From the standpoint of fire risk, there appears to be ample time for research on fire and proposed treatment effects on Spotted Owls before designing extensive management actions or eliminating reserves. Conservation Biology 23:1314-1319

Finally, the spotted owl chapter authors concluded, without providing a single citation, that "subsequent to restrictions on harvest of old forest, high severity wildfire has become the leading cause of loss of suitable habitat for spotted owls on federal lands" (p. 27, line 1-4).

This statement not only conflicts with the literature on owl use of burned landscapes (above), it contradicts the chapter authors own definition of habitat as provided on p. 8 (line 3-4):

"Habitat for a species is an area that encompasses the necessary combination of resources and environmental conditions that promotes occupancy, survival, and reproduction"(from Chapter 4).

Basic owl biology (foraging habitat) is neglected in assumptions about fire and then transferred into habitat models that are used by managers to assume high-severity patches do not count as owl habitat. This is also reflected in the lumping of foraging habitat into "marginal" or "unsuitable" categories, whose language gives the erroneous impression that foraging habitat is somehow unimportant to northern spotted owls. This synthesis does not describe in-depth what might be suitable foraging habitat.

In one study of California Spotted Owls (Bond et al. 2009), high-severity burned, non-salvage-logged forests was used much higher than expected by chance based on availability, therefore according to the definition provided by the NWFP synthesis authors on p. 10 lines 17-18, this habitat type (also known as complex early seral forest), should be considered as highly suitable. The lack of consideration of severely burned forests as potentially suitable if not highly suitable habitat, and the assumption that each acre burned is an acre lost, are fundamental flaws in all the fire assumptions of this synthesis and related chapters that need to be corrected to adhere to the best available science (also see our comments on Chapter 2, 3, 4, 6 and 12).

Chapter authors also have overstated fire losses to late-successional forests, like that to spotted owls. We note that the chapter 1 authors concluded "overall late-successional and old-growth habitat area has decreased 3 percent on federal lands, with the biggest losses due to wildfires. However, *this rate of loss was in line with expectations outlined in the Forest Ecosystem Management Assessment Team's report during the design of option 9*. Therefore, if losses are in line with expectations then the reserve network is not a problem and concepts like *well-distributed and redundant reserve locations* must be working within expectations. Climate change losses can be dealt with as noted above by building on the reserve network rather than subtracting from it or adding even more active management that conflicts with the standards and guidelines of the NWFP.

IV. THINNING IS OVERSTATED AS AN ADAPTATION/RESTORATION STRATEGY

The adaptation discussion in the science synthesis presents a very biased review of the efficacy of thinning to contain insect infestations and reduce fire severity citing only studies that have shown a remedial effect in the relevant synthesis chapters.

For instance, based on a comprehensive literature review of bark beetle outbreaks in lodgepole pine and spruce-fir forests of western US in relation to effects of management before, during, and after such outbreaks, Black et al. (2013) concluded that thinning may reduce susceptibility to small outbreaks but is unlikely to reduce susceptibility to large, landscape-scale epidemics. Once beetle outbreaks reach epidemic levels, silvicultural strategies aimed at stopping them are not likely to reduce forest susceptibility and could instead have substantial, unintended short- and long-term ecological consequences with road access and overall degradation of natural areas the main stressors. This study should be cited to balance out the discussion of thinning and insects and to include the effects of roads, post-fire logging, and other forest management activities on resilience and adaptation to insects and fire.

As to fire, thinning may reduce fire intensity under certain conditions such as through removal of small trees and during "average" fire weather (Kalies and Kent 2016). However it does little to moderate fire effects in extreme fire weather when most large fires are burning (see Rhodes and Baker 2008, Lydersen et al. 2014, Moritz et al. 2014, Carey et al. 2012). The efficacy of thinning in fire-intensity reduction depends on:

(1) The very low probability that a fire will intersect a treated area within the period of lowest fuel levels (usually within 10-20 years depending on site productivity) – this probability has been assessed using computer simulations as around 5-8% (Rhodes and Baker 2008).
(2) The type of fuels removed and extent of bulk crown reductions – too much

thinning can increase wind speeds and fire spread (DellaSala and Frost 2001).

(3) Whether fuels are left on site or removed via prescribed fire or other means (Brown et al. 2004).

Thinning also has tradeoffs to close-canopy species, requires an extensive roads-network for access, and therefore may act in concert with climate change in a way that increases land-use stressors in time and space, which would be a maladaptive strategy when applied at large spatial scales (see DellaSala et al. 2013). Given the large management footprint necessary to affect fire behavior, thinning also increases emissions relative to forest fires (e.g., see Law et al. 2004, Mitchell et al. 2009-although this citation is mentioned on p. 30 line 21, Law et al. 2013, Law and Waring 2015, Mitchell 2015) and would like compromise on the net carbon sink that the NWFP is currently providing to the region (Krankina et al. 2012).

CONCLUSIONS

We are greatly concerned that the science synthesis has underlying policy implications that could lead to removal of reserves, shifting reserve boundaries that present additional land-use stressors to vulnerable species, and relies mainly on an increasingly large "active management" footprint that in addition to other stressors (e.g., livestock grazing – Beschta et al. 2012; mining, ORVs, biomass utilization, roads, invasives) and non-federal lands logging and other developments outside the NWFP area will result in an unprecedented combination of cumulative impacts during a changing climate. The chapter authors do not present a rigorous reserve design alternative that is even comparable to that proposed by FEMAT. Instead they dismiss fixed reserves as now being inadequate in a dynamic landscape without regard for the resilience properties built into the reserve network using concepts such as *well-distributed, redundant, and connected reserves* and have ignored a large body of conservation science literature on reserve design. Clearly, a GAP analysis would identify the need for additional reserves (see Staus et al. 2010, Carroll et al. 2012, Olson et al. 2012) not currently within the fixed reserve system that, if added, would provide for a more robust conservation strategy. The over-reliance on thinning without sufficient regard for impacts to spotted owls or closed-canopy dependent species and omission of literature on conservation biology approaches in dynamic landscapes creates unacceptable risks to the biodiversity provisions upon which the NWFP was formulated. Assumptions about fire and spotted owls are carried forward without empirical evidence and used to justify large-scale thinning approaches as "resilience" or restoration when, in fact, those approaches may result in novel ecosystems (DellaSala et al. 2013) and result in larger losses to spotted owl habitat than fire losses (Odion et al. 2014). For these reasons, we request that reviewers ask for broader coverage of the conservation biology literature at a minimum, including GAP analysis, refugia analysis, ecological stage analysis, and connectivity analysis and a more balanced coverage of the literature.

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OPEN LETTER FROM 229 SCIENTISTS IN SUPPORT OF THE NORTHWEST FOREST PLAN AS A GLOBAL AND REGIONAL MODEL FOR CONSERVATION AND ECOSYSTEM MANAGEMENT

June 14, 2012

As scientists with backgrounds in natural resource management and ecology, we wish to express our full support for the Northwest Forest Plan (NWFP), a global model in ecosystem management and biodiversity conservation[1]. The protective provisions of the late-successional reserve (LSR) network and the Aquatic Conservation Strategy (ACS) are fundamental to the plan's objectives and recent science confirms that these designations along with other elements of the NWFP are at least as vital today as they were when originally conceived by the plan's architects[2]. We are writing at this time, because we are concerned that the first forest-plan revision in the Pacific Northwest calls for dismantling key conservation biology principles of the NWFP by eliminating the LSR network and weakening the ACS.

The proposed draft revised forest plan for the Okanogan-Wenatchee forest, located on the east slopes of the Cascade Range in Washington, proposes changing the LSR designation to "Restoration Areas" within which vague active management practices will take place and moving away from the more protective standards and guidelines of the ACS. The Forest Service cites climate-related predictions that call for a doubling or tripling of fire by century's end in the Washington Cascades, and the agency claims that this, along with elevated insect and disease risks, is justification for eliminating reserve categories and weakening the ACS. However, even if such disturbances were to increase as a result of climate change, this is not cause for drastic measures that eliminate the region's underlying conservation strategy, particularly given the NWFP is a robust conservation strategy that allows for restorative actions in its current land-use configurations.

Under the NWFP, ~30% (7.4 million acres) of federal lands in the Pacific Northwest that were traditionally managed for timber production were designated as LSRs to provide habitat for hundreds of wildlife species associated with older forests that have been greatly depleted by logging across the landscape. These reserves are not inviolate and allow for some forms of logging – thinning in young forests to accelerate late-successional development and fuel reduction for fire concerns – provided they comply with the plan's standards and guidelines. The ACS, through its various components, including establishing Riparian Reserves and identification and protection of Key Watersheds, also was designed to restore and maintain

[1]DellaSala, D. A, & J. Williams. 2006. Northwest Plan Ten Years Later – how far have we come and where are we going. *Conservation Biology* 20:274-276.
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ecological processes for aquatic and riparian areas. These areas have shown measurable improvements in watershed conditions since the plan's inception[3].

The architects of the NWFP envisioned the LSR network as a regional and robust conservation strategy of sufficient redundancy in late-successional forest types, so that disturbance-related reductions in any given type would not affect the overall conservation strategy for that type. The reserves also were designed to be an interconnected ecosystem to accommodate wildlife shifts from recently disturbed to undisturbed areas. Protected reserves like those in the NWFP remain the cornerstone of scientifically sound conservation strategies globally, especially as threats to fundamental ecosystem services accelerate from climate change and land-use stressors. However, in the Pacific Northwest there have been attempts by federal agencies at weakening reserve protections or eliminating them entirely in favor of untested non-reserve, active management approaches as reflected by elements of earlier (2006, 2008) drafts of the northern spotted owl recovery plan. The Wildlife Society, Society for Conservation Biology, and American Ornithologists Union summarily rejected these approaches in peer review as being scientifically incredulous[4].

The conservation foundation of the NWFP, which is rooted in fixed reserves, has been broadly supported in the scientific literature[5]. This is largely because the reserve network is the backbone to a regional conservation strategy for hundreds of species that depend on older forests that are relatively rare on surrounding nonfederal lands. The older forests and intact watersheds that these reserves protect, or seek to restore, also provide a myriad of related ecosystem benefits, including storing vast quantities of atmospheric carbon in live and dead trees and soils important in climate regulation, refugia and a relatively connected landscape for climate-forced migrations of wildlife in search of cool, moist conditions, and high quality water for aquatic organisms and people. Notably, in a five-year status review of the northern spotted owl, scientists[6] concluded that there was no reason to depart from the NWFP and that the situation for the owl would be bleaker today if not for the NWFP[7]. In addition, the U.S. Fish and Wildlife Service in its 2011 revised critical habitat proposal for the owl stated that "results from the first decade of monitoring do not provide any reason to depart from the objective of habitat maintenance and restoration as described in the Northwest Forest Plan." Recent science on

[3]Reeves, G. Ibid.
[4]http://www.fws.gov/oregonfwo/Species/Data/NorthernSpottedOwl/Recovery/Plan/
[5]Courtney, S.P. et al. 2004. Ibid. Lint, J. 2005. Population status and trends. Pages 7–19 *in* J. Lint, technical coordinator. Northwest Forest Plan—the first 10 years (1994–2003): status and trends of northern spotted owl populations and habitat. U.S. Forest Service General Technical Report PNW-GTR-648, Pacific Northwest Research Station, Portland, Oregon. DellaSala, D. A., & J. Williams. Ibid
[6]Courtney et al 2004. Ibid.
[7]Anthony, R.G. et al. 2006. Status and trends in demography of northern spotted owls, 1985–2003. Wildlife Monograph No. 163.

climate change refugia also documents the importance of protecting old forests in reserves as climatic refugia.[8]

The Okanagan dry forest ecoregion was identified by the World Wildlife Fund as nationally significant but critically endangered due to extensive logging, grazing, mining, road building, fire suppression and other land-use disturbances[9]. Over half of the region's old forests have been logged and few intact areas remain.[10] The onset of climate change combined with ongoing land-use stressors pose unprecedented threats to key ecosystem services such as high quality water, carbon stored in old-forest ecosystems and wetlands, and fish and wildlife habitat. The continuation of the reserve network that includes both the LSRs and ACS among other land designations is even more fundamental today precisely because of climate change -- reducing these protections is neither consistent with conservation nor science-based climate adaptation or mitigation strategies.

Sincerely,

** Affiliations are listed for identification purposes only.*

Lead Signatories:

Dominick A. DellaSala, Ph.D.
President and Chief Scientist
Geos Institute
Ashland, Oregon

Robert G. Anthony, Ph.D.
Professor of Wildlife Ecology
Oregon State University
Corvallis, Oregon

E. Charles Meslow
USGS (retired)
Corvallis, Oregon

James Karr, Ph.D.
Professor Emeritus
University of Washington
Sequim, Washington

Thomas Michael Power, Ph.D.
Research Professor
University of Montana
Missoula, Montana

Jack E. Williams, Ph.D.
Senior Scientist
Trout Unlimited
Medford, Oregon

---

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Additional Signatories:

Paul Alaback, Ph.D.
Professor Emeritus of Ecology
University of Montana
Missoula, Montana

John Alcock, Ph.D.
Emeritus Professor
Arizona State University
Tempe, Arizona

Peter Alpert, Ph.D.
Professor
University of Massachusetts
Amherst, Massachusetts

Kayce Anderson, Ph.D.
Colorado State University
Glenwood Springs, Colorado

Steven C. Anderson, Ph.D.
Professor Emeritus
University of the Pacific
California Academy of Sciences
Stockton, California

William D. Anderson, Jr., Ph.D.
Professor Emeritus
College of Charleston
Charleston, South Carolina

Greg H. Aplet, Ph.D.
Senior Forest Scientist
The Wilderness Society
Denver, Colorado

William L. Baker, Ph.D.
Professor
University of Wyoming
Laramie, Wyoming

Jesse R. Barber, Ph.D.
Assistant Professor
Boise State University
Boise, Idaho

Linda Sue Barnes, Ph. D.
Professor of Biology (Emeritus)
Methodist University
Wade, North Carolina

Roger G. Barry, M.Sc., Ph.D.
Distinguished Professor Emeritus
National Snow & Ice Data Center
Boulder, Colorado

Andrew M. Barton, Ph.D.
Professor of Biology
University of Maine, Farmington
Farmington, Maine

Peter B. Bayley, Ph.D.
Courtesy Faculty
Oregon State University
Corvallis, Oregon

Constance Dustin Becker, Ph.D.
International Conservation Projects Coordinator
Life Net Nature
Wilcox, Arizona

Craig W. Benkman, Ph.D.
Professor
University of Wyoming
Laramie, Wyoming

Michael V. L. Bennett, D.Phil.
Professor
Albert Einstein College of Medicine
Bronx, New York

Robert L. Beschta, Ph.D.
Emeritus Professor
Oregon State University
Corvallis, Oregon

Del Blackburn, M.S.
Clark College (retired)
Worley, Idaho

Jim Boone, Ph.D.
Ecologist
Desert Wildlife Consultants, LLC
Las Vegas, Nevada

Richard Bradley, Ph.D.
Associate Professor
Ohio State University
Delaware, Ohio

Bill Bridgeland, Ph.D.
Refuge Biologist
USFWS
Bandon, Oregon

James H. Brown, Ph.D.
Distinguished Professor of Biology
University of New Mexico
Albuquerque, New Mexico

Daniel R. Brumbaugh, Ph.D.
University of California, Santa Cruz
Santa Cruz, California

Peter F. Brussard, Ph.D.
Professor Emeritus
University of Nevada, Reno
Reno, Nevada

Thomas Buckley, Ph.D.
Assistant Professor
Sonoma State University
Rohnert Park, California

Harold L. Burstyn, Ph.D., J.D.
Adjunct Professor
Syracuse University
Syracuse, New York

David Byman, Ph.D.
Assistant Professor of Biology
Penn State University
Clarks Summit, Pennsylvania

Alan B. Cady, Ph.D.
Professor of Zoology
American Arachnological Society
Oxford, Ohio

Philip Cafaro, Ph.D.
Professor of Philosophy
Colorado State University
Fort Collins, Colorado

John Cairns, Jr., Ph.D.
University Distinguished Professor
Virginia Tech
Blacksburg, Virginia

John R. Cannon, Ph.D.
Senior Scientist
Conservation Biology
Front Royal, Virginia

Ken Carloni, Ph.D.
Associate Professor of Biology
Umpqua Community College
Roseburg, Oregon

Ron Carroll, Ph.D.
Director of River Basin Center
University of Georgia
Athens, Georgia

Donna Cassidy-Hanley, Ph.D.
Freeville, New York

Norman L. Christensen, Ph.D.
Research Professor and Founding Dean
Duke Univ., Nicholas School of the Env.
Durham, North Carolina

John A. Cigliano, Ph.D.
Associate Professor of Biology,
Cedar Crest College
Allentown, Pennsylvania

Neil S. Cobb, Ph.D.
Director
N. Arizona Univ. Center for Env. Research
Flagstaff, Arizona

Phyllis D. Coley, Ph.D.
Distinguished Professor
University of Utah
Salt Lake City, Utah

Liza Comita, Ph.D.
Columbus, Ohio

Joseph A. Cook, Ph.D.
Professor of Biology
University of New Mexico
Albuquerque, New Mexico

Ian M. Cooke, Ph.D.
Professor Emeritus of Zoology
University of Hawaii
Honolulu, Hawaii

Paul Corogin, M.S.
Gainesville, Florida

Frank Lance Craighead, Ph.D.
Director
Craighead Institute
Bozeman, Montana

David A. Culver, Ph.D.
Professor Emeritus
Ohio State University
Columbus, Ohio

Luise K. Davis, Ph.D. (retired)
Society of Wetland Scientists
Pittsburgh, Pennsylvania

Paul Dayton, Ph.D.
Professor
Scripps Institution of Oceanography
La Jolla, California

James E. Deacon, Ph.D.
Distiguished Professor Emeritus
University of Nevada, Las Vegas
Henderson, Nevada

Amy L. Denton, Ph.D.
Associate Professor and Chair of Biology
California State Univ., Channel Islands
Camarillo, California

Alan Dickman, Ph.D.
Director, Environmental Studies Program
University of Oregon
Eugene, Oregon

Brett G. Dickson, Ph.D.
Assistant Research Professor
Northern Arizona University
Flagstaff, Arizona

Alex Doetsch, Ph.D.
Professor
College of Southern Idaho
Twin Falls, Idaho

Dana Dolsen, M.Sc.
Scientist
University of Alberta alumnus
Salt Lake City, Utah

Craig C. Downer, M.S.
President
Andean Tapir Fund; IUCN SSC
Minden, Nevada

R. Scot Duncan, Ph.D.
Assistant Professor
Birmingham-Southern College
Birmingham, Alabama

Greg Eaton, Ph.D.
Professor
Lynchburg College
Lynchburg, Virginia

William Edelglass, Ph.D.
Professor of Philosophy and
Environmental Studies
Marlboro College
Marlboro, Vermont

Norman Ellstrand, Ph.D.
Professor
Riverside, California

Tracy S. Feldman, Ph.D.
Assistant Professor
University of Wisconsin, Stevens Point
Stevens Point, Wisconsin

Doug Fischer, Ph.D.
Assistant Researcher
University of California, Santa Barbara
Santa Barbara, California

Thomas L. Fleischner, Ph.D.
Professor of Environmental Studies
Prescott College
Prescott, Arizona

Michael W. Fox, Ph.D., D.Sc.
Minneapolis, Minnesota

Christopher A. Frissell, Ph.D.
Research Aquatic Ecologist
Polson, Montana

Jed Fuhrman, Ph.D.
Professor
University of Southern California
Los Angeles, California

Michael M. Fuller, Ph.D.
Adjunct Professor of Biology
University of New Mexico
Albuquerque, New Mexico

Stephen W. Fuller, Ph.D.
Professor of Biological Sciences
University of Mary Washington
Fredericksburg, Virginia

Daniel Gavin, Ph.D.
Associate Professor
University of Oregon
Eugene, Oregon

Donald Geiger, Ph.D.
Professor Emeritus
University of Dayton
Dayton, Ohio

Wynne Geikenjoyner, Ph.D.
Flagstaff, Arizona

T. Luke George, Ph.D.
Emeritus Professor
Humboldt State University
Fort Collins, Colorado

Jennifer Gervais, Ph.D.
Wildlife Ecologist
Oregon Wildlife Institute
Corvallis, Oregon

John H. Gibbons, Ph.D.
National Academy of Engineering
The Plains, Virginia

Allen G. Gibbs, Ph.D.
University of Nevada
Las Vegas, Nevada

Phil Gibson, Ph.D.
Director, Kessler Atmospheric and
Ecological Field Station
Associate Professor of Biology
University of Oklahoma
Norman, Oklahoma

Thomas W. Giesen, M.S.
University of Oregon
Eugene, Oregon

Scott Goetz, Ph.D.
Senior Scientist
Woods Hole Research Center
Falmouth, Massachusetts

Enrique Gomezdelcampo, Ph.D.
Associate Professor
Bowling Green State University
Bowling Green, Ohio

Robert D. Good, D.V.M., M.S.
USDA/APHIS (retired)
Chester, Maryland

Steven Green, Ph.D.
Professor
University of Miami
Coral Gables, Florida

David Griffith, Ph.D.
Visiting Professor of Biology
Ferris State University
Big Rapids, Michigan

Gary D. Grossman, Ph.D.
Professor
University of Georgia
Athens, Georgia

Michael Hadjiargyrou, Ph.D.
Associate Professor
Stony Brook University
Coram, New York

John E. Hall, Ph.D.
Professor Emeritus
West Virginia University
Morgantown, West Virginia

Richard W. Halsey
Director, California Chaparral Institute
Escondido, California

Steven W. Hamilton, Ph.D.
Professor and Director
Austin Peay State, Center for Field Biology
Clarksville, Tennessee

Chad Hanson, Ph.D.
Director and Staff Scientist
John Muir Project of Earth Island Institute
Cedar Ridge, California

Cheryl F. Harding, Ph.D.
Professor
New York, New York

Leanna R. Heffner, Ph.D. Candidate
University of Rhode Island
Narragansett, Rhode Island

Ken Helms, Ph.D.
Research Assistant Professor
University of Vermont
Burlington, Vermont

Bill Hilton Jr., M.S., M.A.T.
Hilton Pond Center for Piedmont
Natural History
York, South Carolina

Karen Holl, Ph.D.
Professor and Chair
University of California, Santa Cruz
Santa Cruz, California

John R. Holloway, Ph.D.
Research Professor
Arizona State University
Ashland, Oregon

Richard T. Holmes, Ph.D.
Professor Emeritus of Biology
Dartmouth College
Hanover, New Hampshire

Emi Ito, Ph.D.
Professor
University of Minnesota
Minneapolis, Minnesota

David P. Janos, Ph.D.
Professor of Biology
University of Miami
Coral Gables, Florida

Charles H. Janson, Ph.D.
Associate Dean
University of Montana
Missoula, Montana

Daniel H. Janzen, Ph.D.
Professor of Conservation Biology
University of Pennsylvania
National Academy of Sciences
Philadelphia, Pennsylvania

Robert L. Jarvis, Ph.D.
Emeritus Professor
Oregon State University
Astoria, Oregon

Mitchell M. Johns, Ph.D.
Professor of Soils
California State University
Chico, California

Alan R. P. Journet, Ph.D.
Prof. Emeritus of Biology & Env. Science
Southeast Missouri State University
Ashland, Oregon

Jacob Kann, Ph.D.
Aquatic Ecologist
Ashland, Oregon

Sterling C. Keeley, Ph.D.
Professor of Botany
University of Hawaii, Manoa
Honolulu, Hawaii

John G. Kie, Ph.D.
Research Professor
Idaho State University
Pocatello, Idaho

Walter D. Koenig, Ph.D.
Senior Scientist
Cornell University
Ithaca, New York

Jason A. Koontz, Ph.D.
Associate Professor
Augustana College
Rock Island, Illinois

Marni Koopman, Ph.D.
Climate Change Scientist
Geos Institute
Ashland, Oregon

Andrew Kramer, Ph.D.
Athens, Georgia

Dana Krempels, Ph.D.
Senior Lecturer
University of Miami
Miami, Florida

Rebecca S. Lamb, Ph.D.
Assistant Professor
Ohio State University
Columbus, Ohio

Marc Lapin, Ph.D.
Middlebury College
Middlebury, Vermont

Beverly Law, Ph.D.
Prof. of Global Change Forest Science
Oregon State University
Corvallis, Oregon

Paul A. Lefebvre, Ph.D.
Professor
University of Minnesota
St. Paul, Minnesota

John Lill, Ph.D.
Associate Professor of Biology
George Washington University
Washington, DC

Harvey B. Lillywhite, Ph.D.
Professor
University of Florida
Gainesville, Florida

Joshua M. Linder, Ph.D.
Assistant Professor
James Madison University
Harrisonburg, Virginia

Steven R. Manchester, Ph.D.
Curator of Paleobotany
Florida Museum of Natural History
Gainesville, Florida

Janet Marsden, M.S., M.P.S.
Syracuse, New York

Patrick Martin, Ph.D.
Associate Professor
Colorado State University
Fort Collins, Colorado

Glenn R Matlack, Ph.D.
Associate Professor
Ohio University
Athens, Ohio

Michael Mazurkiewicz, Ph.D.
Professor of Biological Sciences
University of Southern Maine
Portland, Maine

John McLaughlin, Ph.D.
Associate Professor
Western Washington University
Bellingham, Washington

Gary K. Meffe, Ph.D.
Adjunct Professor, University of Florida
Gainesville, Florida

Brian T. Miller, Ph.D.
Professor of Biology
Middle Tennessee State University
Murfreesboro, Tennessee

Kailen Mooney, Ph.D.
Professor
University of California, Irvine
Irvine, California

Kara Moore, Ph.D.
Research Ecologist
University of California, Davis
Davis, California

Vicki Moore, M.S.
Tempe, Arizona

Peter B. Moyle, Ph.D.
Professor of Fish Biology
University of California, Davis
Davis, California

Rob Mrowka, M.S.
Ecologist
Center for Biological Diversity
North Las Vegas, Nevada

Peter G. Murphy, Ph.D.
Prof. Emeritus, Distinguished Faculty
Michigan State University
East Lansing, Michigan

K. Greg Murray, Ph.D.
Professor of Biology
Hope College
Holland, Michigan

Philip Myers, Ph.D.
Professor
University of Michigan
Ann Arbor, Michigan

Knute Nadellhoffer, Ph.D.
Professor
University of Michigan
Ann Arbor, Michigan

Wolf Naegeli, Ph.D.
Senior Research Scientist Emeritus
University of Tennessee, Knoxville
Knoxville, Tennessee

Charles R. Neal, B.S.
Ecologist
U.S. Dept. of Interior (retired)
Cody, Wyoming

Jay A. Nelson, Ph.D.
Professor, Towson University
Towson, Maryland

John C. Nemeth, Ph.D.
President, CGJC Enterprises
Christiansburg, Virginia

Barry R. Noon, Ph.D.
Professor of Wildlife Ecology
Colorado State University
Fort Collins, Colorado

Elliott A. Norse, Ph.D.
President
Marine Conservation Institute
Bellvue, Washington

Gretchen North, Ph.D.
Professor
Occidental College
Los Angeles, California

Alison Nurok, Ph.D.
Middlebury, Vermont

Dennis Odion, Ph.D.
Department of Environmental Studies
Southern Oregon University
Ashland, Oregon

Charles Olmsted, Ph.D.
Professor Emeritus
University of Northern Colorado
Greeley, Colorado

Theodore J. Papenfuss, Ph D.
Research Scientist
University of California, Berkeley
Berkeley, California

Michael S. Parker, Ph.D.
Professor of Biology
Southern Oregon University
Ashland, Oregon

Gustav Paulay, Ph.D.
Professor & Curator
University of Florida
Gainesville, Florida

Barbara L. Peckarsky, Ph.D.
Honorary Fellow and Adjunct Professor
University of Wisconsin, Madison
Madison, Wisconsin

David A. Perry, Ph.D.
Professor Emeritus
Oregon State University
Taos, New Mexico

Steven Phillips, Ph.D.
Research Scientist
AT&T
New York, New York

Anna Pidgeon, Ph.D.
Assistant Professor
Univ. of Wisconsin, Madison
Madison, Wisconsin

Stuart Pimm, Ph.D.
Doris Duke Professor of Conservation
Duke University
Durham, North Carolina

Tony Povilitis, Ph.D.
Director
Life Net Nature
Willcox, Arizona

Jessica D. Pratt, M.S.
University of California, Irvine
Costa Mesa, California

James J. Provenzano, M.A., C.Ph.
President
Clean Air Now
Los Angeles, California

Robert Michael Pyle, Ph.D.
Founder
Xerces Society
Gray's River, Washington

Ted K. Raab, Ph.D.
Senior Investigator
Carnegie Institution of Washington
Stanford, California

Gurcharan S. Rahi, Ph.D.
Associate Professor
Fayetteville State University
Fayetteville, North Carolina

John T. Ratti, M.S., Ph.D.
Research Professor (retired)
University of Idaho
New Meadows, Idaho

Michael Reed, Ph.D.
Tufts University
Medford, Massachusetts

Marcel Rejmanek, Ph.D.
Professor
University of California, Davis
Davis, California

Michael S. Rentz, Ph.D.
Duluth, Minnesota

Tina Rhea, M.S.
Greenbelt, Maryland

Fred M. Rhoades, Ph.D.
Research Associate
Instructor of Biology(retired)
Western Washington University
Bellingham, Washington

Ann F. Rhoads, Ph.D.
Senior Botanist
Morris Arboretum, Univ. of Pennsyvania
Philadelphia, Pennsylvania

David W. Roberts, Ph.D.
Professor
Montana State University
Bozeman, Montana

Dina Roberts, Ph.D.
Conservation Biologist
Vancouver, Washington

Javier A. Rodriguez, Ph.D.
Associate Professor
University of Nevada, Las Vegas
Las Vegas, Nevada

Gary W. Roemer, Ph.D.
Associate Professor
New Mexico State University
Las Cruces, New Mexico

Garry Rogers, Ph.D.
President
Agua Fria Open Space Alliance
Humboldt, Arizona

Thomas Rooney, Ph.D.
Associate Professor
Wright State University
Dayton, Ohio

Terry L. Root, Ph.D.
Senior Fellow
Stanford University
Stanford, California

Jon Rosales, Ph.D.
Associate Professor
St. Lawrence University
Canton, New York

Robert K. Rose, Ph.D.
Professor Emeritus
Old Dominion University
Norfolk, Virginia

Amy Y. Rossman, Ph.D.
Research Leader
Mycological Society of America
Beltsville, Maryland

Eric J. Routman, Ph.D.
Professor of Biology
San Francisco State University
San Francisco, California

Matthew Rubino, M.S.
Research Associate
North Carolina State University
Raleigh, North Carolina

Scott D Russell, Ph.D.
George Lynn Cross Research Professor
University of Oklahoma
Norman, Oklahoma

Robin S. Salter, Ph.D.
Associate Professor of Biology
Oberlin College
Oberlin, Ohio

D. Scott Samuels, Ph.D.
Professor of Biological Sciences
University of Montana
Missoula, Montana

Melissa Savage, Ph.D.
Director, Four Corners Institute
University of California, Los Angeles
Santa Fe, New Mexico

Paul Schaeffer, Ph.D.
Assistant Professor
Miami University
Oxford, Ohio

Ruth G. Shaw, Ph.D.
Professor
University of Minnesota
St. Paul, Minnesota

Thomas W. Sherry, Ph.D.
Professor
Ecological Society of America
American Ornithologists Union
New Orleans, Louisiana

Jack W. Sites, Jr., Ph.D.
Maeser Professor and Curator
Brigham Young University
Provo, Utah

William R. Skinner, Ph.D.
Professor of Geology (retired)
Oberlin College
Oberlin, Ohio

Douglas P. Smith, Ph.D.
Professor
California State University, Monterey Bay
Seaside, California

Nicholas J. Smith-Sebasto, Ph.D.
Executive Director
Kean University Center for Sustainability
Union, New Jersey

John Sovell, M.S.
Senior Researcher
Colorado State University
Fort Collins, Colorado

Georgeanne Spates, M.S.
Wildlife Refuge Manager (retired)
Quogue Wildlife Refuge
Southold, New York

Timothy P. Spira, Ph.D.
Professor
Clemson University
Clemson, South Carolina

Richard Steiner, M.Sc.
Conservation Biologist
University of Alaska (retired)
Anchorage, Alaska

Alan Stemler, Ph.D.
Professor Emeritus
University of California, Davis
Davis, California

Glenn R. Stewart, Ph.D.
Professor Emeritus of Biological Sciences
Ca. State Polytechnic University, Pomona
Pomona, California

Christopher Still, Ph.D.
Associate Professor
University of California, Santa Barbara
Santa Barbara, California

Stephen F. Stringham, Ph.D.
President, WildWatch LLC
University of Alaska
Soldotna, Alaska

James R. Strittholt, Ph.D.
President/ Executive Director
Conservation Biology Institute
Corvallis, Oregon

C. F. Sturm, M.D., M.S.
Research Associate
Murrysville, Pennsylvania

John D. Styrsky, Ph.D.
Associate Professor of Biology
Lynchburg College
Lynchburg, Virginia

Steven Swartz, Ph.D.
Senior Scientist
Cetacean Research Associates
Darnestown, Maryland

John W. Terborgh, Ph.D.
Research Professor
Duke University
Durham, North Carolina

Stephen T. Tettelbach, Ph.D.
Professor of Biology
Long Island University
Brookville, New York

Edward Thornton, Ph.D.
Professor of Chemistry
University of Pennsylvania
Swarthmore, Pennsylvania

Phil Tonne
Senior Collection Manager
University of New Mexico Herbarium
Albuquerque, New Mexico

Paul F. Torrence, Ph.D.
Emeritus Prof. of Chemistry & Biochemistry
Northern Arizona University
Flagstaff, Arizona

Vicki Tripoli, Ph.D.
Ashland, Oregon

Rick Van de Poll, Ph.D.
Principal
Ecosystem Management Consultants, LLC
Center Sandwich, New Hampshire

Mike Vandeman, Ph.D.
San Ramon, California

David R. Vann, Ph.D.
University of Pennsylvania
Philadelphia, Pennsylvania

Mark D. Varien, Ph.D.
Research and Education Chair
Crow Canyon Archaeological Center
Cortez, Colorado

Scott Veirs, Ph.D.
President
Beam Reach Marine Science School
Seattle, Washington

Eric von Wettberg, Ph.D.
Assistant Professor
Florida International University
Miami, Florida

Faith M. Walker, Ph.D.
Research Fellow
Northern Arizona University
Flagstaff, Arizona

Gregory P. Walker, Ph.D.
Professor
University of California, Riverside
Riverside, California

Don Waller, Ph.D.
Professor of Botany
University of Wisconsin
Madison, Wisconsin

David O. Wallin, Ph.D.
Professor
Western Washington University
Bellingham, Washington

Richard T. Ward, Ph.D.
Emeritus Professor
Colorado State Univesity
Fort Collins, Colorado

Gerald J. Wasserburg, Ph.D.
Prof. of Geology & Geophysics Emeritus
California Inst. of Technology
Florence, Oregon

Vicki Watson, Ph.D.
Professor, University of Montana
Missoula, Montana

Kenneth Weiss, Ph.D.
Evan Pugh Professor Genetics
Penn State University
University Park, Pennsylvania

Orion Z. Weldon, Ph.D. Candidate
Rutgers University
New Brunswick, New Jersey

David F. Whitacre, Ph.D.
Instructor
Treasure Valley Math and Science Center
Boise, Idaho

Norris H. Williams, Ph.D.
Curator
Gainesville, Florida

Mark A. Wilson, Ph.D.
Professor of Geology
College of Wooster
Wooster, Ohio

Shaye Wolf, Ph.D.
Kensington, California

Steven Yanoff, M.S.
Ecologist
White Oaks, New Mexico