Comments On: Draft Conservation Strategy for the California Spotted Owl, Version 1.0

September 2, 2018

TO: Rodney Siegel, The Institute for Bird Populations
RE: Comments on the Draft Conservation Strategy for the California Spotted Owl Version 1.0

Thank you for the opportunity to review this important document. I will first offer some general comments on the Strategy (with a focus on goals and objectives, Section 3) and then focus more specifically on Sections 7 and 8.

<u>General Comments on the Necessity for Forest Restoration</u>:
I believe the authors convincingly argue that active forest management is needed to improve the resistance and resilience of Sierra Nevada forests in the face of current forest conditions, rapid climate change and increasing disturbances (frequency, extent and severity). In addition, the authors have articulated the reality that forest restoration towards historic conditions (structure and composition) is foundational to the long-term persistence of the California spotted owl. Finally, the authors have presented a document that is grounded in our best, current scientific understanding of how these forest deviate from historic conditions, what has caused these deviations, and what actions are needed to restore them. Overall, I give the Conservation Strategy high marks.

Despite my overall favorable impression of the authors' work, I have some concerns and suggestions for them to consider. Section 3 justifies the stated goals and objectives by highlighting "… the importance of active forest restoration to benefit the spotted owl by moving landscapes closer to the conditions in which the spotted owl evolved and that are likely to persist in the future." I agree with the stated goals and objectives (G&O). What I found a bit surprising, however, is that G&Os were stated primarily in qualitative terms which precludes their measurement and makes assessment of the degree to which the G&Os have been achieved almost impossible.

One example is the concept of resilience, defined as the amount of stress that can be absorbed by an ecosystem prior to a major state change (sometimes called "resistance" in the literature). The concept also includes the ability of the ecosystem to return to the undisturbed state following disturbance. The concept is vague because, among other factors, the bounds of ecosystems are usually not discrete and therefore cannot be easily mapped. In addition, it is important to attempt to define the dimensions of an ecosystem in terms of a small number of independent state variables (admittedly a difficult task but one that may be necessary to make the concept understandable to managers and decision makers). The set of state variables should bound the full domain of the ecosystem, and should be collectively complementary and comprehensive.

I acknowledge that the CSO conservation strategy may not the place to articulate the details of forest restoration in terms of quantitative metrics. However, key metrics (state variables) have been identified (e.g., fire frequency, fire size, # trees > 30" dbh/ha, canopy closure, average size of canopy gaps, etc.) and are discussed in Haugo et. al. (2015), North et. al. (2017), and Safford and Stevens (2017), for example. In order to measure departure from historic or reference conditions, environmental state variables must be identified, methods for their measurement need to be developed, and the magnitude of change that is ecologically relevant needs to be stated (see Manly et al. 1995).

I think there is a need to better integrate Sections 1-5 with Sections 6-8. One way to better link the sections of the document addressing current forest conditions and the need for restoration efforts with Section 7 (CSO conservation measures), is to identify the state variables that best characterize forest "condition" AND are also elements of the set of key CSO habitat attributes. Presenting these details, by broad forest type (yellow pine and mixed conifer), and evaluating their overlap with the structure and composition of nesting/roosting habitat, for example, would be a useful exercise. Finally, the lack of quantitative criteria in the discussion of forest restoration goals is in strong contrast to the details of habitat elements needed to sustain the CSO (Section 7).

Anchoring the discussion of forest restoration around the concept of NRV (or HRV) is useful, and appropriate, but again largely qualitative. I like the definition from Haugo et al. (2015): "NRV is defined as a frequency distribution of ecosystem characteristics, including the appropriate spatial and temporal scales for those distributions and a reference period, typically prior to European settlement." Several aspects of this definition are relevant. First, the use of the phrase "ecosystem characteristics" implies measurable attributes of forest structure and composition—that is, state variables that are quantitative and expressed in terms of their measurement units. Second is the idea of a frequency or probability distribution (pdf) for the state variables. This clearly communicates that even within the bounds of a NRV, all ecosystem state values are not equally probable. In addition, the pdf concept can be directly extended into a cumulative distribution function to communicate to managers the proportion of sample units (e.g., habitat patches, landscapes) that are less than (greater than) a given condition index. Third, is the scale-dependence of the concept. This latter point is thoroughly discussed by the authors.

Implicit in most NRV definitions is the concept of system stationarity—that is, the NRV is a stationary, stochastic process that does not change in distribution over space or time. Local random perturbations may occur, but the long-term sequence of changes are predictable after disturbance. The result is that the bounds of this distribution define the NRV. The authors recognize that, in the context of ongoing and accelerating climate change, we can no longer assume ecosystem stationarity.

It may be useful to present a typology of disturbances in order to discriminate those expected under an assumed stationarity system from those of a non-stationary system. I like the following typology developed for stationary systems:

Characteristics of Disturbance Processes

- Frequency (# occurrences/unit time)
- Ratio of the disturbance interval : recovery interval (can recovery occur before the next disturbance)
- Extent (area affected)
- Magnitude
    - Intensity (degree of effect on select state variables)
    - Duration (length of disturbance; chronic or acute)
- Selectivity (specific state variables affected by the disturbance)

I believe this typology could be directly integrated into your discussion of "variability across spatial scales" (table on page 35). The authors' explicit discussion of scale dependency in CSO demography and in forest structure and composition is a strong point of the document. Given this typology, is it useful to apply it to non-stationary climate drivers, specifically acknowledging the extent and duration of climate change. The urgency of forest restoration, and how this goal is consistent with the goal of sustaining CSO populations, could perhaps be made more strongly.

A final suggestion is to discuss possible temporal constraints to the successful conservation of the CSO. That is, do managers have enough time to restore forest structure and composition, particularly the large tree component, before CSO populations experience severe declines due to habitat limitations, displacement by barred owls, and synergistic effects of declines in habitat quality driven by drought and declining plant productivity?

Section 7. Conservation Measures

This section describes the heart of the conservation strategy. For the most part, I found this section to be comprehensive and sufficiently detailed as to allow an assessment of the degree to which conservation objectives were being achieved. The detailed prescriptions—allowable and constrained activities—in all parts of Section 7 were clear and unambiguous. Even though this section is the most important part of the document, it is difficult for me to comment on the "correctness" of all the details in this section given that I am no longer current on all the relevant literature.

The core of the conservation strategy is the system of protected activity centers (PAC). I support the goal of maintaining a dynamic system of PACs because it explicitly recognizes that PACs will undergo extinction and colonization dynamics over time as a function of CSO demography, habitat dynamics and climate variability. The goal of adding new PAC as they are discovered is also an important aspect of the strategy. Discovery of new, or previously unknown, PACs suggest that surveys will not be limited to the currently known PACs. Is this a stated aspect/requirement of the strategy?

I found the discussion of treatments within PACS (mechanical thinning, prescribed fire) to achieve restoration goals to be thoroughly described and the logic behind proposed practices and constraints to be easily understood.

One missing element in this section is a discussion of the targeted number of PACs, their spatial distribution, and how connectivity will be maintained in order to facilitate colonization of unoccupied PACs. The PAC system, and the occupancy model framework, are basically a type of metapopulation model. As such, the PAC system should have target goals for number of PACs, inter-PAC spacing, spatial distribution of PACs across forest types, and structure and composition of the landscape matrix in which PACs are embedded. Reviewing the reserve design criteria used for the northern spotted owl conservation strategy may prove useful (Murphy and Noon 1992, Ecological Applications).

Section 8. Monitoring and Adaptive Management

I believe this section would have benefitted from additional detail. I assume that the monitoring program will be based on a multistate occupancy survey design where occupancy state (single individual, pair, breeding pair, breeding pair with young) will be the monitoring state variable. The goal would be an assessment of the magnitude and direction of change in occupancy state over time (temporal trend) and how occupancy state and dynamics are associated with environmental covariates. I suggest that the design features of the monitoring program be explicitly stated in this section. At a minimum, clarify the survey design features and list the possible environmental covariates (explanatory variables) to be related to the observed spatial and temporal variation in occupancy state.

There are many other key monitoring design issues that are not discussed in this section. Perhaps a separate document is planned for the CSO monitoring program. If so, I believe there is a strong consensus in the scientific literature on the essential components of monitoring programs designed to assess status and trend. The key requirements are to:

1) Specify objectives in terms of measurable attributes
2) Identify the monitoring state variables (e.g., indicators) and why they were selected
3) State the spatial and temporal domain of the population of interest (i.e., the sample frame)
4) State the type of change to detect
5) Specify the magnitude of change to detect (effect size; essential for sample design decisions)
6) Following (5), specify desired precision for the trend estimate (requires pilot data and a components of variance analysis)
7) Generate estimates of uncertainty
8) Specify 'trigger point' (thresholds) that will lead to a management response
9) Specify the management action that will occur
10) Determine (monitor) the effects of the management actions
11) Update design as needed (adaptive monitoring)

Many (e.g., 1, 2, and 8), but not all, of these elements have already been addressed by the authors.

All of the above steps are important but program components cannot compensate for inadequate attention to design and analytical issues. Specifically, I believe the statistical model(s) to be used for analysis must be decided upon early in the process. Given specific monitoring state variables, sampling objectives such as desired statistical power, effect sizes, and statistical precision require a priori identification of specific statistical methods. Failure to do this makes it impossible to perform basic sample size calculations and to optimally allocate sampling effort across time and space. This also ensures that limited project funding is used in the most efficient way and is not wasted. Decisions on sample designs, methods of analysis, and variance components analysis go hand-in-hand and should occur before major data collection begins.

Some thoughts on adaptive management: It is a given that land management agencies will say they are practicing adaptive management, even when they fail to recognize its essential components. It may be worthwhile to emphasize in this section that AM: 1) is an approach to decision-making under conditions of high uncertainty about management outcomes; 2) is a process for making recurrent decisions to achieve management objectives in the context of dynamic environmental conditions; 3) uses the outcomes from management actions to learn about system response to management and reduce uncertainty associated with future decisions; and 4) is a process that requires feedback between management actions and assessment (i.e., monitoring data) where each influences the other. An addition issue, often ignored, is that AM decision and actions should generally not lead to irreversible changes to the system being managed. To do so, effectively constrains the ability to respond adaptively to future threats and stressors.