COLLABORATION FOR ENVIRONMENTAL EVIDENCE

SYSTEMATIC REVIEW No. 66

WORKING TITLE: How do thinning and burning treatments in ponderosa pine forests in the United States affect wildlife density and population performance?

REVIEW PROTOCOL

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COVER SHEET

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Conflicts of interest	

1. BACKGROUND

After a century of fire suppression, grazing, and logging, ponderosa pine forests in the western United States have undergone a dramatic departure from conditions that existed prior to Euro American settlement (Covington and Moore 1994, Taylor and Skinner 1998, Fry and Stephens 2006). Many areas within this ecosystem are currently dominated by homogenous, dense stands of small-diameter trees characterized by low plant and wildlife diversity and susceptibility to stand-replacing crown fires (Cooper 1960, Fulé et al. 1997). These fires are different from the frequent, low-severity ones that used to occur, which would maintain forests by removing the understory and small diameter trees, resulting in a patchy structure of mostly mature trees and a meadow-like ground cover (Everett et al. 2000, Covington 2003). There is now an emphasis on implementing fuels reduction treatments in ponderosa pine forests, whereby fuel loads are reduced through both silvicultural treatments and controlled burns, decreasing the likelihood of crown fire.

Thinning and burning treatments expose wildlife species to short- and long-term alterations to their habitat. In the short-term, both mechanical harvesting of trees and prescribed fire are disturbance events that have immediate effects on the environment: removing or killing live trees, reducing shrub and herbaceous ground cover, altering structural components such as snags and downed woody material, and creating sites susceptible to colonization by invasive plant species (Chambers and Germaine 2003, Collins et al. 2007). In the long term, successful restoration treatments should create a forest with a decreased density of trees compared to today's conditions, but increased basal area due to the prevalence and growth of large, mature trees with a fairly open canopy; in addition, such treatments should increase understory plant cover and species diversity (Waltz et al. 2003, Metlen and Fiedler 2006). This increased spatial and temporal heterogeneity will diversify habitat available for wildlife. Thus, these "natural conditions" should, in turn, restore the native, diverse assemblage of animal species (Covington 2000, Allen et al. 2002).

Both thinning and burning treatments are being implemented across thousands of acres in the ponderosa pine forests of the western United States, with limited understanding of the implications to wildlife. Fuels reduction treatments have only been implemented in the last 10-20 years, and thus the corresponding studies on wildlife are relatively recent and limited in temporal and spatial scale. Individual species have been studied, but no review exists that quantitatively analyzes the existing literature across taxa. Existing reviews include summaries of the impacts of thinning and burning treatments on birds (Block and Finch 1997, Finch et al. 1997, Bock and Block 2005b;a), and qualitative reviews describe the effects of thinning and/or fire on all wildlife species (Lyon et al. 2000, Chambers and Germaine 2003, Pilliod and Bull 2006). However, none of these reviews quantitatively examine the effects of thinning and burning treatments on all wildlife species in a systematic review framework.

The objective of this review is to systematically review and evaluate the impacts of density-reducing treatments, including thinning and burning, on wildlife vertebrate species in ponderosa pine forests in the western United States. We will compare the treatments to controls, as well as to more severe forest treatments including highgrading, clearcutting, and high severity wildfire. Our objectives are to (1) determine which treatments had the greatest effect on wildlife, (2) determine which species were most and least sensitive to habitat manipulation, and (3) identify species or groups of species for which there was a paucity of field experimentation and data. This review will serve as a starting point for researchers and managers in understanding the comprehensive impacts on wildlife of fuels reduction treatments and determining future monitoring and research needs.

2. OBJECTIVE OF THE REVIEW

2.1 Primary question

How do thinning and burning treatments in ponderosa pine forests in the United States affect wildlife density and population performance?

2.2 Secondary questions

Which wildlife species are most vulnerable to habitat alteration? How do the impacts of fuels reduction treatments compare to those of highgrading, clearcutting, and wildfire?

3. METHODS

3.1 Search strategy

- Databases supported by Cline Library, Northern Arizona University, including
  - Academic Search Premier
  - Biological Sciences
  - BioOne
  - Environmental Science & Pollution Management
  - Plant Science
  - Springer Link
  - Wiley Interscience
  - Zoological Record
  - JSTOR
  - Forest Science Database
  - Dissertation and Theses Full Text
  - Cline Library
- ISI Web of Science
- Government and agency websites and libraries (US Forest Service TreeSearch, Ecological Restoration Institute library, Arizona Game and Fish website and library, US Fish & Wildlife Service website)
- Search terms to include: All combinations of the following:
  - Wildlife, birds, reptiles, amphibians, mammals AND
  - Western forest, ponderosa pine AND
  - Restoration, thinning, prescribed burn, fuels reduction, fire, logging, clearcut, harvest, treatment

3.2 Study inclusion criteria

- **Relevant subject(s):** Vertebrate species that live in ponderosa pine forests in the United States, including
  - Birds
  - Mammals
  - Reptiles
  - Amphibians
- **Types of intervention:**
  - Thin (removal of small diameter trees)
  - Burn (low severity prescribed fire)
  - Thin and burn
  - Harvesting (highgrading)
  - Clearcut
  - Wildfire (high severity fire)
- **Types of comparator:**
  - Experiments with controls (dense forest) and treatments (thinned/burned forest), either control-impact (C-I) or before-after (BACI)
  - Treatments will be compared against one another (using their mean effect sizes) to assess relative effects, for example thin vs clearcut
- **Types of outcome:**
  - Density
  - Reproductive output, as defined by number of successful nests, number of offspring, and/or survival rates of offspring
- **Types of study:**

Primary/peer-reviewed studies, grey literature, observational studies and expert opinion as appropriate.

- **Potential reasons for heterogeneity:**

There is heterogeneity in the distribution of species across different forest types, elevation, and topography in ponderosa forests in the western US. There is also variation in the application of thinning and burning treatments, including intensity, spatial extent, and duration. This variability will be addressed using multiple predictor variables (see Section 3.5).

3.3 Study quality assessment

In wildlife studies, the standard deviation between replicate means is often not (1) reported, (2) available because sample size is one, or (3) meaningful because the size of a replicate varies dramatically from study to study. We will use a biologically meaningful weighting scheme using the natural log of the area sampled, similar to Mosquera et al. (2000). Study bias will be assessed by examining normal quantile plots (Wang and Bushman 1998).

3.4 Data extraction strategy

The two primary reviewers will conduct the initial database searches, and eliminate irrelevant papers based on title. The resulting list will be examined by each primary reviewer, who will eliminate irrelevant articles based on abstracts. Agreement between reviewers will be evaluated by Kappa test. The reviewers will then check the reference lists of the remaining papers to find additional material, and contact authors and experts as necessary for additional information. A second party (Arizona Game & Fish) will also be involved at this stage to ensure objectivity.

3.5 Data synthesis

We will conduct a meta analysis if there are sufficient data. We will calculate effect sizes using the response ratio metric: ln(treatment mean/control mean) (Hedges et al. 1999). We will build generalized linear models, weighted using the area sampled (see Section 3.3), to predict effect size based on covariates including: treatment, forest type, time since treatment, species, study type (BACI or C-I), density estimation method (with or without detection probability), replication, quality of study, reference (study of origin, since some studies have multiple observations). We will develop *a priori* the models we think best predict effect size, and use a model selection approach to identify the most parsimonious model (Burnham and Anderson 2002). This will allow us to address non-independence of data, as the "reference" effect will be assessed relative to the other covariates. Each covariate in the best-fitting model will be examined via Forrest plots (using Metawin software v.2), by calculating mean effect sizes with bootstrapped confidence intervals (Adams et al. 1997, Rosenberg et al. 2000). We can thus characterize the relative impact of the various treatments on wildlife, the response of individual species to the treatments, as well as any other covariate that predicts effect size. We will use qualitative methods such as vote counting to incorporate the results of studies that can not be incorporated into the meta analysis.

4. POTENTIAL CONFLICTS OF INTEREST AND SOURCES OF SUPPORT

The review is led by the Ecological Restoration Institute, which has funded and published studies on impacts of forest treatments on some wildlife species. We will address the possibility of conflict of interest by including scientists from Arizona Game and Fish Department in the development of the systematic review, as well as using independent scientists and agency personnel on the review panel for the completed document. Another independent check is the review process through CEBC which solicits additional reviews from scientists whom are not affiliated with the Ecological Restoration Institute or Northern Arizona University.

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