August 31, 2018

Via Certified Mail, Return Receipt Requested

Secretary Ryan Zinke
U.S. Department of the Interior
1849 C Street NW
Washington, D.C. 20240

Jim Kurth, Deputy Director
U.S. Fish and Wildlife Service
1849 C Street NW, Room 3331
Washington, D.C. 20240

Interim Chief Vicki Christiansen
U.S. Forest Service
1400 Independence Ave., SW
Washington, D.C. 20250

Supervisor Richard Periman
Mt. Hood National Forest
16400 Champion Way
Sandy, Oregon 97055

Sixty-Day Notice of Intent to Sue Under § 7 of the Endangered Species Act

Dear Secretary Zinke, Interim Chief Christiansen, Deputy Director Kurth, and Supervisor Periman:

In accordance with the sixty-day notice requirement of the Endangered Species Act (ESA), 16 U.S.C. § 1540(g), you are hereby notified that the following organizations intend to bring a civil action against the U.S. Forest Service and the officers and supervisors to whom this letter is directed (collectively, the Forest Service) for violating Section 7 of the ESA, 16 U.S.C. § 1536.

The name and address of the organizations giving Notice of Intent to Sue:

WildEarth Guardians
80 SE Madison St., Suite 210
Portland, OR 97214

Bark
P.O. Box 12065
Portland, OR 97212

Cascadia Wildlands
P.O. Box 10455
Eugene, OR 97440

Oregon Wild
5825 North Greeley
Portland, OR 97217

Counsel for the parties giving notice:

Brenna Bell, Staff Attorney
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As described herein, the Forest Service has violated the ESA by arbitrarily and capriciously relying on a flawed Biological Opinion from the U.S. Fish and Wildlife Service (FWS) in violation of Section 7 concerning the effects of Mt. Hood National Forest's Crystal Clear Restoration Project on listed species, thereby failing to ensure that its actions are not likely to jeopardize the continued existence of listed or candidate species, or result in the destruction or adverse modification of critical habitat. *See* 16 U.S.C. § 1536(a)(2).

We will file suit after the 60-day period has run unless the violations described in this notice are remedied.

Legal Background: Section 7 Consultation

Section 2(c) of the ESA establishes that it is "the policy of Congress that all Federal . . . agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of" the ESA. 16 U.S.C. § 1531(c)(1). The purpose of the ESA is to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered and threatened species . . . " 16 U.S.C. § 1531(b).

To implement this policy, Section 7(a)(2) of the ESA requires that each federal agency consult with FWS or NMFS to ensure that any action authorized, funded, or carried out by such agency is not likely to (1) jeopardize the continued existence of any threatened or endangered species or (2) result in the destruction or adverse modification of the critical habitat of such species. *See* 16 U.S.C. § 1536(a)(2). Federal agencies must use the best scientific and commercial data available to comply with their obligations under Section 7. *Id.* § 1536(b); *Res. Ltd., Inc. v. Robertson*, 35 F.3d 1300, 1304 (9th Cir. 1994).

The ESA's consultation requirement applies "to all actions in which there is discretionary Federal involvement or control." 50 C.F.R. § 402.03. Agency actions requiring consultation are broadly defined by regulation to mean "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies" and include "actions directly or indirectly causing modifications to the land, water, or air." 50 C.F.R. § 402.02.

If listed species may be present in the area of agency action, the action agency must prepare a Biological Assessment (BA) to determine whether the listed species may be affected by the proposed action. *See* 16 U.S.C. § 1536(c)(1); 50 C.F.R. § 402.12. If the agency determines that its proposed action "may affect" any listed species, the agency must engage in "formal consultation" with FWS or NMFS (collectively, the Services). 50 C.F.R. § 402.14; *see also Cal. ex rel. Lockyer v. U.S. Dep't of Agric.*, 575 F.3d 99, 1018 (9th Cir. 2009) ("any possible effect, whether beneficial, benign, adverse or of an undetermined character, triggers the requirement." (quoting 51 Fed. Reg. 19,926, 19,949 (June 3, 1986)).

The threshold for a "may affect" determination is very low, and ensures "actions that have any chance of affecting listed species or critical habitat—even if it is later determined that the actions are not likely to do so—require at least some consultation under the ESA." *Karuk Tribe of Cal. v. U.S. Forest Serv.*, 681 F.3d 1006, 1028 (9th Cir. 2012). Under the Fish and Wildlife Service Consultation handbook, the "may affect" threshold is met if "a proposed action may pose *any* effects on listed species or designated critical habitat." U.S. Fish and Wildlife Serv. & Nat'l Marine Fisheries Serv., *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act* at xvi (1998) (emphasis in original). The regulations implementing the ESA require an examination of both the direct effects of the action as well as the indirect effects of the action, which are defined as "those effects that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur." 50 C.F.R. § 402.02. Therefore, an agency must consult in every situation except when a proposed action will have "no effect" on a listed species or critical habitat.

If the action agency concludes in a BA that the activity is not likely to adversely affect the listed species or adversely modify its critical habitat, and the Services concur with that conclusion in a Letter of Concurrence, then the consultation is complete. 50 C.F.R. §§ 402.12, 402.14(b). If, however, the action agency determines that the activity is likely to adversely affect the listed species or its critical habitat, then the Services complete a "biological opinion" (BiOp) to determine whether the activity will jeopardize the species or result in destruction or adverse modification of critical habitat. *Id.* § 402.14. If the Services determine that an action will jeopardize the species or adversely modify critical habitat, they may propose reasonable and prudent alternative actions intended to avoid such results. 16 U.S.C. § 1536(b)(3)(A); 50 C.F.R. § 402.14(g)(5).

In addition to considering the direct effects of a proposed agency action, the Service must also consider the species' "environmental baseline," the "effect of actions," and the "cumulative effects upon a species." 50 C.F.R. § 402.14(g). An environmental baseline must include (1) the past and present impact on the species of all federal, state, or private actions; (2) the anticipated impacts of all federal projects in the action area that have already undergone section 7 consultation; and (3) the impact of state or private actions that are contemporaneous with the consultation in process. *Id.* § 402.02. Cumulative effects are defined as "those effects of future State or private activities not involving federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation." Thus, cumulative effects describe only *nonfederal* and *future* activities. Past and present impacts of nonfederal activity should be a part of the environmental baseline. *See, e.g., Nat'l Wildlife Fed'n v. Norton*, 332 F. Supp 2d 179 (D.D.C. 2004).

However, an agency's Section 7 duties do not end with the issuance of a BiOp. The action agency "cannot abrogate its responsibility to ensure that its actions will not jeopardize a listed species; its decision to rely on a FWS biological opinion must not have been arbitrary or capricious." *Pyramid Lake Paiute Tribe of Indians v. U.S. Dep't of Navy*, 898 F.2d 1410, 1415 (9th Cir. 1990). *See also Defenders of Wildlife v. EPA*, 420 F.3d 946, 976 (9th Cir. 2005) (rev'd on other grounds).

Further, once the consultation is complete, the agencies have a duty to ensure that it remains valid. To this end, an agency must re-initiate consultation if certain "triggers" occur. 50 C.F.R. § 402.16. The ESA's implementing regulations require the Forest Service to re-initiate consultation where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

> (a) If the amount or extent of taking specified in the incidental take statement is exceeded;
>
> (b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
>
> (c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or
>
> (d) If a new species is listed or critical habitat designated that may be affected by the identified action.

50 C.F.R. § 402.16.

After consultation is initiated or reinitiated, ESA Section 7(d) prohibits the agency or any permittee from "mak[ing] any irreversible or irretrievable commitment of resources" toward a project that would "foreclos[e] the formulation or implementation of any reasonable and prudent alternative measures . . . " 16 U.S.C. § 1536(d). The 7(d) prohibition "is in force during the consultation process and continues until the requirements of section 7(a)(2) are satisfied." 50 C.F.R. § 402.09.

Section 7(a)(4) of the ESA requires a Federal action agency to conference with the Services if the proposed action is likely to jeopardize a species proposed for listing or destroy or adversely modify proposed critical habitat. 16 U.S.C. § 1536(a)(4); 50 C.F.R. § 402.10(a). *See also* 50 C.F.R. § 402.02 (defining "[c]onference" as "a process which involves informal discussions between a Federal agency and the Service under section 7(a)(4) of the [ESA] regarding the impact of an action on proposed species or proposed critical habitat and recommendations to minimize or avoid the adverse effects."). The agencies must record any results of a conference. *Id.* at § 401.10(e) ("The conclusions reached during a conference and any recommendations shall be documented by the Service and provided to the Federal agency").

FACTUAL BACKGROUND

Crystal Clear Restoration Project, Mt. Hood National Forest

On June 27, 2018, Mt. Hood National Forest Barlow District Ranger Kameron Sam signed the final Decision Notice selecting the Proposed Action Alternative, as modified, for the Crystal Clear Restoration Project (hereafter, "Decision"). The modified Action Alternative includes logging approximately 11,742 acres within the project area, use of forest system roads[1] for log hauling (and pre-haul maintenance), plus building 35.8 miles of temporary roads for log hauling, decommissioning 0.7 miles of system road and closing 5.6 miles of system roads.

Threatened northern spotted owl and its critical habitat, Oregon spotted frog and its critical habitat, and endangered gray wolves occur within the Crystal project area on Mt. Hood National Forest. These species will be affected by the activities authorized under the Forest Service's Decision Notice, as described below. The Forest Service analyzed the effects of the Crystal project on listed species and critical habitat in a December, 2017 Biological Assessment (hereafter, "2017 Biological Assessment"). FWS issued a Biological Opinion on January 19, 2018 that found the Crystal project may affect and is likely to adversely affect the northern spotted owl and its critical habitat; may affect, but is not likely to adversely affect the Oregon spotted frog and its critical habitat; and may affect but is not likely to adversely affect the gray wolf.

<u>Northern spotted owl</u>

FWS listed the northern spotted owl as a threatened species in 1990. 55 Fed. Reg. 26,114 (June 26, 1990). The spotted owl population has continued to decline, especially in northern parts of its range where populations have declined as much as 80 percent since 1990. *See* 2017 Biological Assessment, page 26. In 2012, FWS designated revised critical habitat[2] for the northern spotted owl that includes critical habitat on Mt. Hood National Forest. 77 Fed. Reg. 71,876, 72,062 (Unit 6: West Cascades South, Subunits WCS 1 – WCS 6), 72,064 (Unit 7: East Cascades North, Subunits ECN 6 – ECN 9) (Dec. 4, 2012). The rule designating northern spotted owl critical habitat on Mt. Hood National Forest determined that all of the unoccupied and likely occupied areas in this subunit are essential for the conservation of the species to meet the recovery criterion. Past and current habitat loss, and competition from barred owls are the primary threats to spotted owl persistence. 76 Fed. Reg. 38,575, 38,576 (July 1, 2011). FWS recognized declining habitat as a severe or moderate threat to spotted owl throughout its range.

2011 Recovery Plan

The 2011 Recovery Plan for northern spotted owl prioritizes recovery tasks aimed at: (1) maintaining and managing for an adequate amount of spotted owl habitat across the species' range; (2) restoring natural processes in the dry forest landscape to minimize impacts of habitat loss through climate change; and (3) conducting large-scale experiments on the effects of barred owl removal where the two species co-occur. *See* 2011 Recovery Plan. *See*

[1] The Forest Service fails to disclose the number of miles of forest system roads it plans to use for haul of commercial materials. *See* Final EA at 84 (stating 165.20 miles of system roads exist within the project area); *id.* at 86 (explaining "[r]oad maintenance would occur on all roads used for haul of commercial materials (log and rock haul)" but omitting the number of road miles); *id.* at 86-88, Table 32 (listing system road treatments with road numbers, but omitting the number of road miles).

[2] *See* 2017 Biological Assessment (defining "critical habitat" as "[t]he specific areas within the geographic area, occupied by the spotted owl at the time it was listed, that contain the physical or biological features that are essential to the conservation of endangered and threatened species and that may need special management or protection").

also 76 Fed. Reg. at 38,576. The 2011 Recovery Plan identifies recovery actions as near-term recommendations to guide the activities needed to accomplish the recovery objectives and achieve the recovery criteria. Recovery Action 10 directs the Forest Service to conserve spotted owl sites and high value spotted owl habitat to provide additional demographic support to the spotted owl populations. 2011 Recovery Plan at III-43. Recovery Action 32 directs the Forest Service to maintain and restore well distributed, older and more structurally complex multi-layered conifer forests on Federal lands across its range. 2011 Recovery Plan at III-67. It explains that high-quality spotted owl habitat stands are characterized as having large diameter trees, high amounts of canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees. *Id.* The Recovery Plan recommends retaining more occupied spotted owl sites and unoccupied, high value spotted owl habitat on all lands. Final Wildlife Report for Crystal Clear Restoration project, page 3.

Northern Spotted Owl & Critical Habitat in Project Area

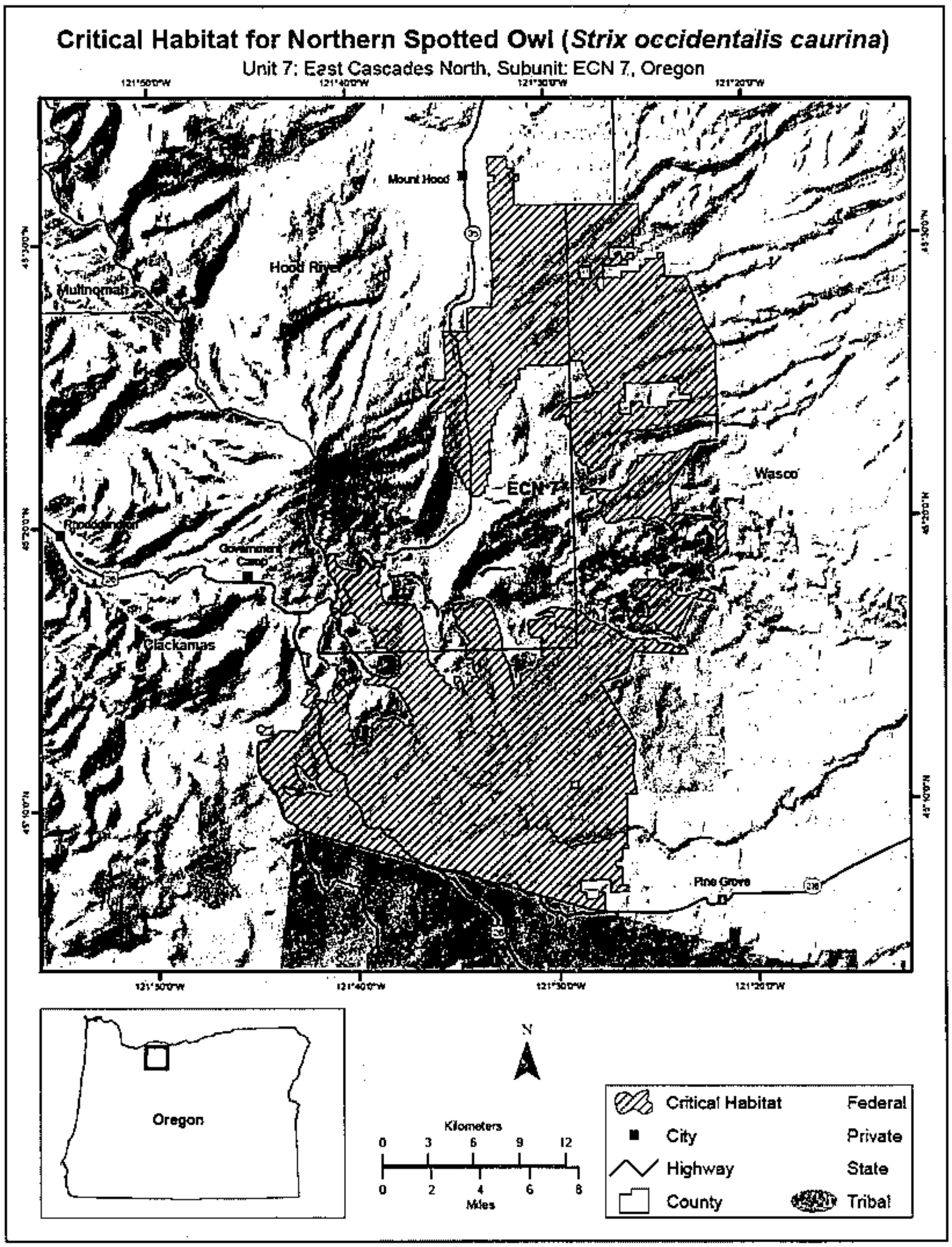
Spotted owls generally rely on older forested habitats that contain the structures and characteristics required for nesting, roosting, foraging, and dispersal. Final Wildlife Report for Crystal Clear Restoration, page 3. Generally, suitable habitat is 80 years or older, canopy exceeds 60% closure, is multi-storied, and has sufficient snags and down wood to provide opportunities for nesting, roosting, and foraging. *Id.* Dispersal habitat consists of mid-seral stage stands between 40 and 80 years of age with a canopy closure of 40 percent or greater and an average diameter of 11-inches. *Id.* Spotted owls use dispersal habitat to move between blocks of suitable habitat and juveniles use it to disperse from natal territories. *Id.*

The Crystal project area includes existing high-quality suitable habitat in the form of dense, mature forest. One known spotted owl site[3] (spotted owl site #3) occurs within the Crystal project area. 2017 Biological Assessment at 46. Spotted owl surveys that began in the spring of 2016 have not located spotted owls within the project area to date. *Id.* These surveys will continue until project implementation. *Id.* at 48. Of the 36,343-acre Crystal project area, 19,050 acres are functioning as suitable habitat and 8,771 acres are functioning as dispersal only habitat. *Id.* at 46. The Forest Service also identified seven potential sites in the project area that could support breeding spotted owl pairs. *Id.* at 46-47. All of the potentially 8 home ranges that overlap the project boundary are currently above the threshold of 50 percent suitable habitat in the core area and all of the territories, except 4 and 7, are above 40 percent suitable habitat in the home range. *Id.* at 48.

The Crystal project is within Unit 7: East Cascades North, subunit 7 of designated spotted owl critical habitat. 2017 Biological Assessment at 56. Special management protections are required in this subunit to address threats from current and past timber harvest, removal or modification of habitat, and competition with barred owls. *Id.* at 58 (listing eight special management considerations, including: (1) Conserve older stands that contain the conditions

[3] A "known spotted owl site" is a "site known to be occupied at some point between 1990 and the present by a pair of spotted owls or a resident single as defined by the Service's survey protocol." 2017 Biological Assessment, page 21 (explaining that "[t]he specific site location is determined by the unit biologist based on the best and/or most recent information. A site may be determined to be inactive only in accordance with the current survey protocol.").

to support spotted owl occupancy or high-value spotted owl habitat as described in Recovery Actions 10 and 32; (2) Emphasize vegetation management treatments outside of spotted owl territories or highly suitable habitat; (4) Retain and restore key structural components, including large and old trees, large snags, and downed logs; (7) Manage roads to address fire risk).

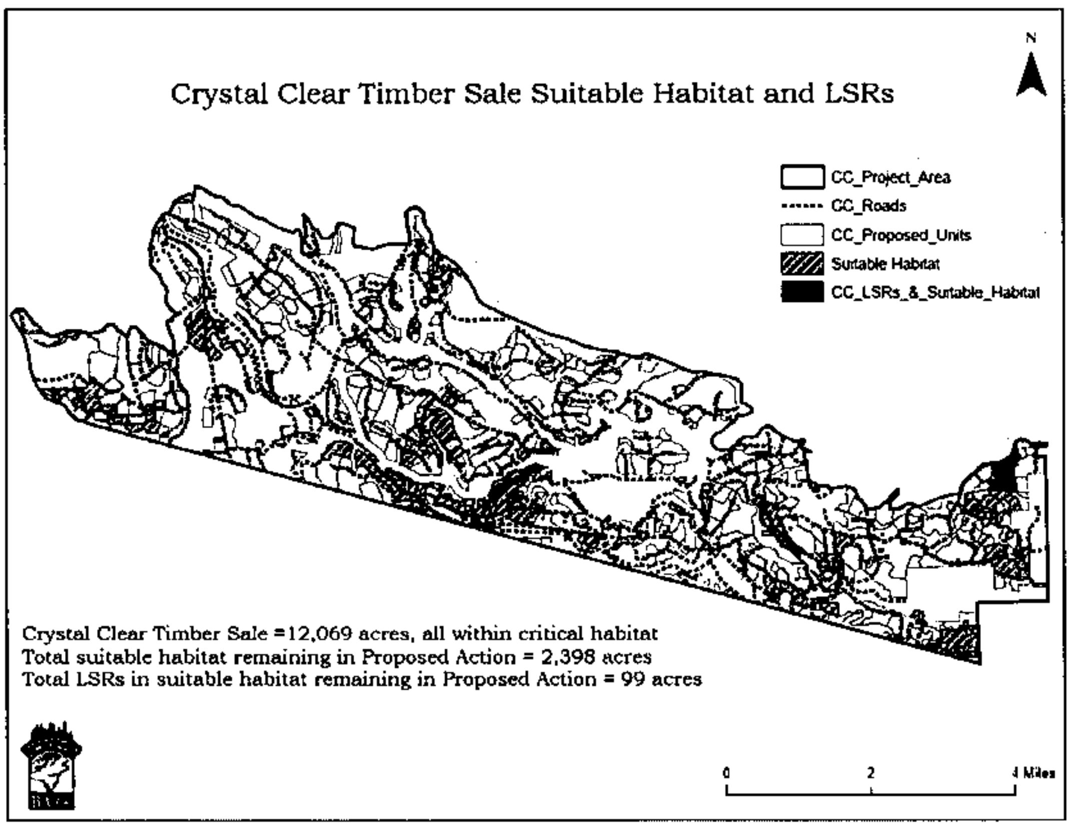


The Crystal project area provides an important north-south link for northern spotted owl. *Id.* at 56. The White River Watershed Analysis recommended maintaining existing northern spotted owl suitable and dispersal habitat in the Eastside Zone until increases in such habitat have been achieved in the Transition and Crest Zones. Bark Scoping comments at 6.

Impacts to Northern Spotted Owl

The Crystal project authorizes logging, road building, and log hauling activities that will adversely impact northern spotted owl and its critical habitat. The 2018 Biological Opinion largely defers to the Forest Service's 2017 Biological Assessment for an analysis of the direct and indirect effects of the proposed action on spotted owls and spotted owl critical habitat. 2018 Biological Opinion at 8-10.

The Forest Service's Decision authorizes logging 11,742 acres of northern spotted owl critical habitat. 2017 Biological Assessment at 56. Currently, about 2,148 acres are providing dispersal habitat and 1,946 acres are providing suitable habitat for spotted owls. 2017 Biological Assessment at 46. The authorized logging will remove 895 acres of dispersal habitat and downgrade 1,059 acres of suitable habitat to dispersal only habitat. Final EA at 126.



Data used to create the map above was included in Bark's 2017 FOIA of the CCTS project shapefiles, including calculations of remaining acres of habitat, which are not entirely consistent with the numbers given in the Final EA

The Forest Service's own analysis in its draft EA notes that:

> The removal of suitable habitat has an indirect effect on NSOs by reducing the amount of potential nesting, roosting or foraging habitat. These effects on local owl populations are greater when the amount of suitable habitat remaining post-harvest is limited in the area. The loss of nesting structure may reduce the number of breeding pairs if other nesting habitat is limited. The loss of roosting habitat reduces the number of stands that provide thermal protection, plus these stands usually also function as foraging habitat. The loss of foraging habitat could reduce the amount of food available to nearby adult and juvenile owls, which could affect their survival if other foraging options are limited. The removal of unoccupied suitable habitat could preclude future NSO occupancy for a period of time. It is estimated that these units would again provide quality suitable habitat in 75 to 100 years after treatments, depending on the site conditions.

Draft EA, page 215. *See also* Wildlife Report, page 3 (noting "[w]hile it is usually the alteration or removal of suitable habitat (nesting, roosting, and foraging) that may result[] in adverse impacts to a territorial pair of spotted owls, the loss or degradation of dispersal habitat may also result in short-term impacts"). While FWS has guidelines for how much removal of suitable habitat would result in take, it does not have guidelines for how much removal of dispersal habitat constitutes take. Wildlife Report at 3.

To maintain spotted owl suitable habitat adequate to provide for owl nesting, roosting, and foraging within the stand, the Forest Service must maintain a canopy cover of greater than 60% along with other habitat elements (e.g., snags, down wood, dominated by large overstory trees, tree-height class-diversity, and older hardwoods) post logging activities. 2017 Biological Assessment at 22. To maintain spotted owl dispersal habitat adequate to provide for owl dispersal within the stand, the Forest Service must maintain a canopy cover of greater than 40% along with other habitat elements (e.g., snags, down wood, dominated by large overstory trees, tree-height class-diversity, and older hardwoods) post logging activities. *Id.*

The Forest Service recognized that logging authorized by this Decision that downgrades suitable habitat will further reduce habitat for owl pairs 4 (9 acres) and 7 (147 acres) below threshold levels within the home range. Final Wildlife Report for Crystal Clear Restoration at 12. The authorized logging will reduce canopy closure from 70% to 50% in moist mixed conifer ecotype, and from 65% to 40% in dry mixed conifer ecotype. Draft EA at 148. The average canopy closure in the Late-Successional Reserve (LSR) units post-logging will be 35%, well below what is needed to provide suitable NSO habitat. *See* Final EA, Appendix 1. The decision also authorizes the removal of down wood, shrubs, and snags that provide important habitat for spotted own prey species. Removing this habitat will retard creation of these essential habitat elements for many years to come.

Best available science shows that northern spotted owls respond better to natural disturbances such as fire than they do to logging. Fire is an unpredictable force, and one that northern spotted owls are evolutionarily adapted to. A growing number of peer-reviewed studies indicate that owls are adapted to fire and preferentially utilize burned forests for foraging.[4] In contrast, logging is causing significant harm to owls and loss of mature forests needed for owl recovery.[5]

Bark's scoping comments detailed the findings of a study that concluded the long-term benefits of commercial thinning do not clearly outweigh adverse impacts, even if much more fire occurs in the future. *See* Odion, D., Hanson, C., DellaSala, D., Baker, W., & Bond, M., 2014, Effects of Fire and Commercial Thinning on Future Habitat of the Northern Spotted Owl, The Open Ecology Journal, 7, 37-51. The Forest Service failed to acknowledge this report or comment on its conclusion that the combination of thinning and maintenance reduced 6.7 times more late-successional forest that it increased.

The Forest Service's analysis in its 2017 Biological Assessment downplays how the project activities may increase barred owl competition, one of the primary threats to spotted owl. The Forest Service acknowledges the adverse impacts from increased barred owl competition in its draft EA, but – with no explanation – changes its analysis in the final EA. *Compare* Draft EA at 218 ("timber harvest activities may expand the range of barred owls; and silviculture treatments that thin forests and create early seral habitat, or create edge habitat, may favor barred owls over spotted owls.") *with* Final EA at 127 ("The silvicultural treatments proposed in the planning area would not be expected to expand the range of barred owls since they are already found throughout the planning area and treatments would not be expected to create habitat favored by barred owls over spotted owls").

Forest roads may directly impact spotted owl through direct mortality or changes in movement and habitat use patterns and may indirectly impact spotted owl by altering the adjacent habitat and interfering with predator-prey relationships.[6] Some of these impacts result from the presence of the road itself, and some result from uses on and around the roads, including log hauling. At the landscape level, roads fragment habitat blocks into smaller patches that may not be able to successfully support interior forest species. Ultimately, roads have been found to reduce the abundance and distribution of several forest species.[7]

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[4] *See, e.g.*, Lee, D.E., Spotted Owls and forest fire: a systematic review and meta-analysis of the evidence. Ecosphere 9(7):e02354. 10.1002/ecs2.2354 (2018) (Attachment 1).

[5] For example, one study reported that after logging for the Meadow Valley fuels treatment project on the Plumas National Forest conducted from 2006-2008, the number of territorial sites declined from 9 to 4 over a four-year period (2007-2011). *See* Keane, J.M., et al. Plumas Lassen Administrative Study, 2011 Annual Report: Spotted Owl Module, U.S. Forest Service, Pacific Southwest Region, Vallejo, CA (2012). This study was confirmed by a later study that found a 43% loss of northern spotted owl within a few years of mechanical thinning. *See* Stephens, S.L., et al. California Spotted Owl, songbird, and small mammal responses to landscape fuel treatments. BioScience (in press) (2014). The authors noted that while the region's overall population is declining, the steep rate of decline in the logging study area was of "a greater magnitude" than elsewhere on the landscape.

[6] Wisdom, et al. 2000. Source habitats for terrestrial vertebrates of focus in the interior Columbia basin: Broad-scale trends and management implications. Volume 1 – Overview. Gen. Tech. Rep. PNW-GTR-485. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; Trombulak, S., and C. Frissell. 2000. Review of the Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology 14(1):18-30.

[7] *See* Fahrig, L. and T. Rytwinski. 2009. Effects of roads on animal abundance: an empirical review and synthesis. Ecology and Society 14(1): 21; Benitez-Lopez, A., R. Alkemade, and P.A. Verweij. 2010. The impacts

The Forest Service's decision authorizes 3.7 miles of new temporary road construction[8] which would remove 7.3 acres of suitable northern spotted owl habitat. Final EA at 128. The Forest Service relies on information in Tempel and Gutierrez (2003, p. 700), Delaney et al. (1999, p. 69), and Kerns and Allwardt (1992, p.9) to state "we anticipate that spotted owls that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads." 2017 Biological Assessment at 25. Based on that conclusion, the Forest Service identifies only 0.25 mile disturbance distance from log hauling on open roads to spotted owl during the entire breeding season, and no buffer during the critical breeding period or latter breeding period. *Id. See also id.* at 59-61. This approach and these assumptions conflict with best available science showing northern spotted owl generally avoid forest roads, creating an avoidance buffer on average of 1,312 feet (437 yards) from the forestry roads with light traffic.[9]

At bottom, the logging and road-building authorized by the Forest Service's decision will downgrade suitable habitat may affect and is likely to adversely affect spotted owls.

2018 Biological Opinion is Arbitrary and Capricious

FWS concludes the Crystal project is not likely to jeopardize the continued existence of spotted owl, destroy or adversely modify spotted owl critical habitat, or result in take of spotted owls. 2018 Biological Opinion at 11-13. The 2018 Biological Opinion is unlawful, arbitrary, and capricious because it: (1) fails to accurately describe the actions authorized by the Crystal project; (2) ignores best available science; (3) fails to analyze or explain key aspects of the agency's jeopardy analysis; (4) relies on flawed assumptions regarding environmental baseline conditions and project impacts; (5) relies on uncertain mitigation measures; and (6) arbitrarily and capriciously determines the project is not likely to destroy or adversely modify spotted owl critical habitat. In turn, the Forest Service improperly relies on the faulty 2018 Biological Opinion and fails to ensure that its actions are not likely to jeopardize the continued existence of listed or candidate species, or result in the destruction or adverse modification of critical habitat.

The Biological Opinion fails to accurately describe the proposed action. It refers to the Crystal project as "a restoration project that will reduce the Project Area's fire risk" and "improve the Project Area's resilience to insect and disease related mortality." 2018 Biological Opinion at 2. It characterizes the entire project as a "dry forest restoration treatment." 2018 Biological Opinion at 11. In fact, the project area includes 5,646 acres of moist mixed conifer forest, 97% of which is in its natural fire return interval. Draft EA at 104. Of that, more than 1,200 acres of logging are planned for mature and old growth forest.

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of roads and other infrastructure on mammal and bird populations: a meta-analysis. Biological Conservation 143: 1307-1316.

[8] As noted above, the Forest Service fails to disclose the number of existing road miles that will be used for log hauling within the project area.

[9] *See* Wasser, S.K., K. Bevis, G. King, and E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology 11(4): 1019-1022.

The environmental baseline also does not account for other federal timber sales that affect the same critical habitat subunit. This is the fourth – and by far the largest – timber sale proposed by the Forest Service within critical habitat sub-unit ECN 7 in the past five years. Specifically, in the northern section of sub-unit ECN 7, the Dalles II project authorized logging that resulted in the loss or degradation of 785 acres of northern spotted owl dispersal habitat and 575 acres of suitable habitat, for a total loss of 1,360 acres. *See* Dalles II PA, pages 3-99. The Government Flats Complex Fire in 2013 and subsequent logging of the North Fork Mill Creek Timber sale (authorizing logging on over 380 acres and hauling on forest system roads) degraded an additional 365 acres of spotted owl habitat. Decision Notice and Finding of No Significant Impact, North Fork Mill Creek Revised (Jan. 16, 2015). The Polallie Cooper Hazardous Fuels Reduction – Phase I timber sale authorized logging 1,165 acres and hauling on forest roads. *See* Polallie Cooper Hazardous Fuels Reduction – Phase I, Final Decision Notice and Finding of No Significant Impact (Nov. 30, 2017). It includes logging on 902 acres of dispersal habitat, 168 acres of foraging habitat, and 4 acres of nesting and roosting habitat (total of 1,074 acres). *Id.* at 19.

None of these projects appear to have been considered in describing the environmental baseline in the Biological Assessment or Biological Opinion. An inaccurate identification of the environmental baseline and mis-characterization of the project itself results in a faulty analysis of the environmental impacts.

The Biological Opinion ignores best available science. As highlighted above, it fails to address best available science challenging the Forest Service's assumption that logging existing high-quality suitable habitat will benefit the northern spotted owl. As another example, it relies on the flawed assumption that northern spotted owls only need a 65-yard buffer from forest road construction activities, again, ignoring and failing to address best available science demonstrating owls will on average avoid roads at a buffer of 437 yards. The Forest Service's analysis of impacts in the Biological Assessment relies on 65 yards to measure disruption distance for spotted owls for forest road construction, and no buffer for impacts to spotted owls from log hauling on forest roads. 2017 Biological Assessment at 24-25.

The Biological Opinion fails to analyze or explain key aspects of the agency's jeopardy analysis. For example, FWS concludes cumulative impacts do not change the significance of its findings. 2018 Biological Opinion at 11. Based on the Forest Service's conclusion that the Crystal project is expected to improve affected areas' resilience to climate change, FWS concludes potential climate change interactions do not exacerbate the significance of its findings. 2018 Biological Opinion at 11. FWS fails to analyze or explain these conclusions. It fails to consider or explain relevant factors, including the project's impacts to the important north-south link for northern spotted owl, recommendations from the White River Watershed Analysis, cumulative impacts of habitat loss from other Forest Service timber sales within the same critical habitat unit, and increased stresses from competition with barred owls & climate change. And it fails to analyze or explain how log hauling on existing forest system roads will impact northern spotted owl or its critical habitat.

The Biological Opinion relies on flawed assumptions. For example, FWS concludes the Crystal project will conform to guidance set forth in the Final Recovery Plan for the spotted owl (including Recovery Actions 10 and 32) and is likely to contribute to the conservation needs of the spotted owl. 2018 Biological Opinion at 11-13. But the Forest Service's authorization to log 11,742 acres of designated critical habitat, 1,059 acres of which are suitable habitat and 895 acres of which are dispersal habitat, conflicts with Recovery Actions 10 and 32 of the 2011 Recovery Plan, which direct the Forest Service to protect high value spotted owl habitat.

The Crystal project is also inconsistent with the 2011 Recovery Plan direction, requiring long-term benefits to northern spotted owls from forest thinning treatments must be based on best available science and clearly outweigh adverse impacts from commercial logging. FWS relies on the Forest Service's assumption that logging high quality suitable habitat is beneficial to the northern spotted owl, ignoring and failing to address best available science to the contrary. And, long-term benefits to northern spotted owls from logging do not clearly outweigh adverse impacts. Given the owls' precipitous decline, short-term losses are not acceptable in exchange for unproven long-term benefits. The known adverse impacts of logging, road building, and log hauling in northern spotted owl critical habitat are much greater than the unlikely future benefits of possibly reducing the severity of a potential fire.

The Biological Opinion concludes, without justification and contrary to best available science, that the life history needs for foraging and dispersing would still be met in the logged units. Not only is this contrary to fact, it conflicts with the Forest Service's own earlier analysis in its Draft EA. Draft EA at 215. At base, the Forest Service fails to provide an ecological justification to log in suitable and dispersal northern spotted owl critical habitat, and FWS does not provide its own independent analysis of impact.

The Biological Opinion is arbitrary and capricious because the mitigation measures are ineffective or too uncertain. The Forest Service relies on Project Design Criteria as mitigation measures to minimize effects to listed wildlife species. 2017 Biological Assessment at 14. For example, the Forest Service states that "[i]n the event that a new spotted owl activity center is located during the period of the contract, any spotted owl nest sites would be protected through the implementation of seasonal operating restrictions." *Id. See also* Final EA at 46 (imposing restrictions on "timber harvest activities, mechanical fuel treatments, or temporary road construction within 65 yards of a Northern Spotted Owl nest patch from March 1 to July 15"); *id.* ("No burnings may take place within 0.25 mile of a Northern Spotted Owl nest patch between March 1 and September 30."); 2017 Biological Assessment at 14 (same, to minimize sound disturbance). But as explained above, restrictions on activities within 65 yards of a spotted owl nest are insufficient and contrary to best available science showing buffers of over 400 yards are needed to protect spotted owls.

What's more, the limited seasonal restrictions on activities like removal of suitable habitat, logging, or temporary road construction during the spring months only are insufficient to mitigate or otherwise protect spotted owls. For example, the Forest Service states "[n]o suitable habitat (unmanaged stands) removal would take place between March 1 and July 15." Final EA at 46. These dates are insufficient, given the breeding period for spotted owls is March 1 through September 30. 2017 Biological Assessment at 23. *See also id.* at 28 ("The potential for effects is mainly associated with breeding behavior at an active nest site.").

The Biological Opinion is arbitrary and capricious in its determination that the Crystal project "is not likely to destroy or adversely modify spotted owl critical habitat." 2018 Biological Opinion at 12. The Forest Service's decision authorizes logging of 11,742 acres of designated critical habitat, including dispersal habitat and suitable habitat. The reductions in canopy closure identified above will also adversely modify essential owl habitat. The Forest Service's decision removes and degrades existing high-quality northern spotted owl critical habitat before a natural disturbance might. The authorized logging could possibly be effective at altering fire behavior for 10-20 years, but it will definitely remove northern spotted owl habitat for 75-100 years. *Compare* Draft EA at 121 *with* 215.

FWS reasons the Crystal project is likely to affect only one territory (site 7) and the conservation needs of spotted owl will not be significantly impacted at the sub-unit, unit and range-wide scales. *Id.* It also notes that, because no critical habitat is designated for non-federal lands in Subunit 7 of Unit 7 (East Cascades North), cumulative impacts do not change its significance findings. *Id.* However, as noted above, it fails to consider relevant factors including the cumulative impacts from climate change, the importance of this area as a north-south link for spotted owl, and increased stresses from barred owl competition that are likely to result from the project activities. What's more, to the extent the Forest Service fails to consider the impacts of other timber sales on National Forest system lands within the same critical habitat sub-unit in the environmental baseline (explained above), omitting these projects from its cumulative impacts assessment is unreasonable, arbitrary and capricious.

Oregon spotted frog

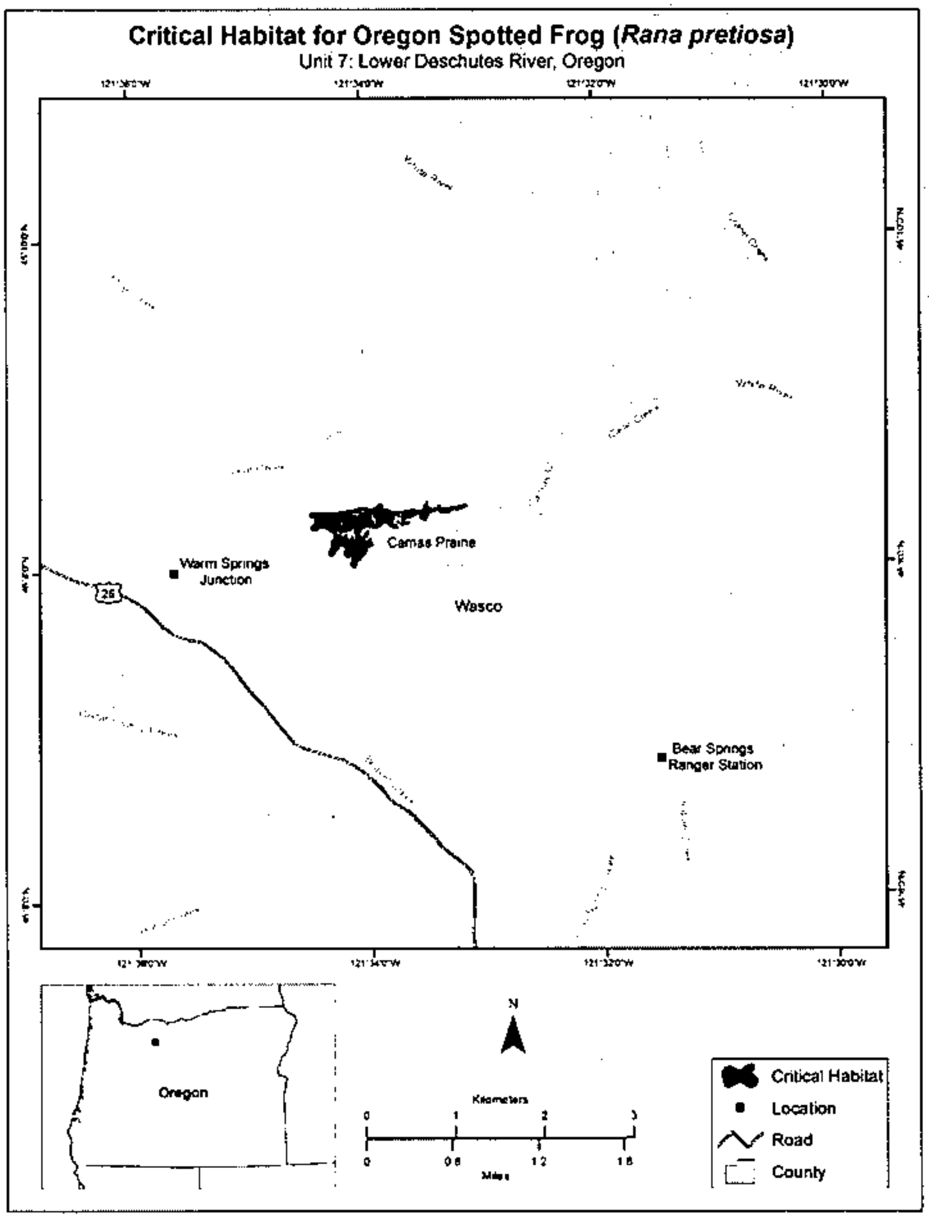
In 2014, FWS listed the Oregon spotted frog as threatened under the ESA. 79 Fed. Reg. 51,658 (Aug. 29, 2014). In 2016, FWS designated critical habitat for the Oregon spotted frog. 81 Fed. Reg. 29,336 (May 11, 2016). Primary threats include loss of wetland habitat and riverine disturbance processes due to human activities. *Id.* at 51,667. Natural processes that historically created emergent wetlands favorable to Oregon spotted frog have been greatly reduced, impaired, or permanently altered due to human activities including stream bank, channel, and wetland modifications; operation of water control structures; beaver removal; and fire suppression. *Id.* Of the 61 historical localities where Oregon spotted frog's previous existence can be verified, only 13 were confirmed as occupied in studies in the 1990s. 79 Fed. Reg. at 51,663.

Oregon spotted frog have specific habitat requirements. The frog is found in or near perennial bodies of water, such as springs, ponds, lakes, sluggish streams, irrigation canals, and roadside ditches. 81 Fed. Reg. at 29,351. Critical aspects of Oregon spotted frog habitat include suitable egg-laying and nursery sites, refuges from predation or unfavorable environmental conditions, and suitable temperatures necessary for egg laying, growth, and development. 79 Fed. Reg. at 51,668.

Oregon Spotted Frog & Critical Habitat in Project Area

A single extant population of Oregon spotted frog occurs at Camas Prairie, an 82-acre marsh along Camas Creek in the White River watershed of the Lower Deschutes River sub-basin.

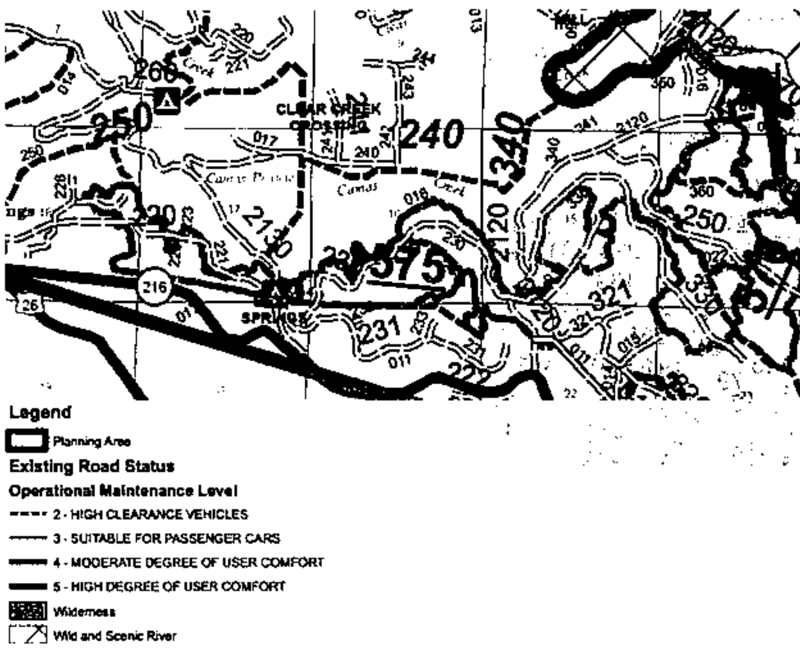
79 Fed. Reg. at 51,665. This population of Oregon spotted frog is the most geographically isolated, carries several alleles that are absent or rare in other sites, and has the lowest genetic diversity of Oregon spotted frogs range-wide. *Id.* The population appears to be the only remaining representatives of a major genetic group that is now almost extinct. *Id.* The population trend at this location has been positive between 2004 and 2012, but the number of individuals in the population remains low. *Id.* Critical Habitat Unit 7 (Lower Deschutes River) includes Camas Prairie and Camas Creek, a tributary to the White River that flows into Clear Creek. 81 Fed. Reg. at 29,358. Camas Prairie and Camas Creek fall entirely within the Crystal project area:



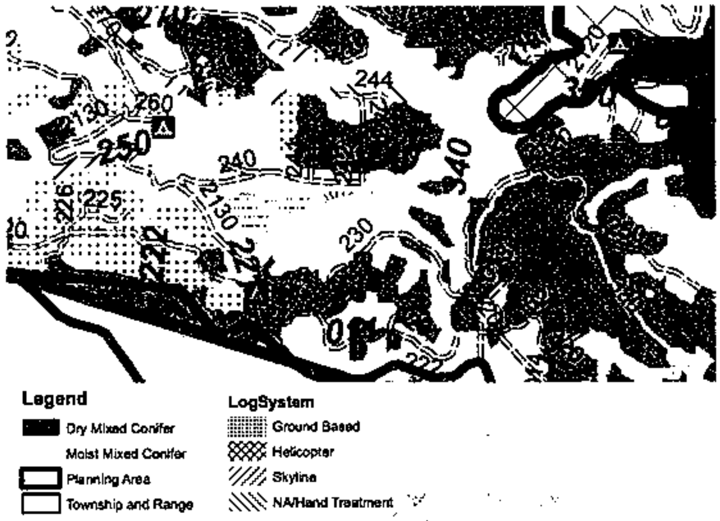
81 Fed. Reg. at 29,384.

Impacts to Oregon Spotted Frog

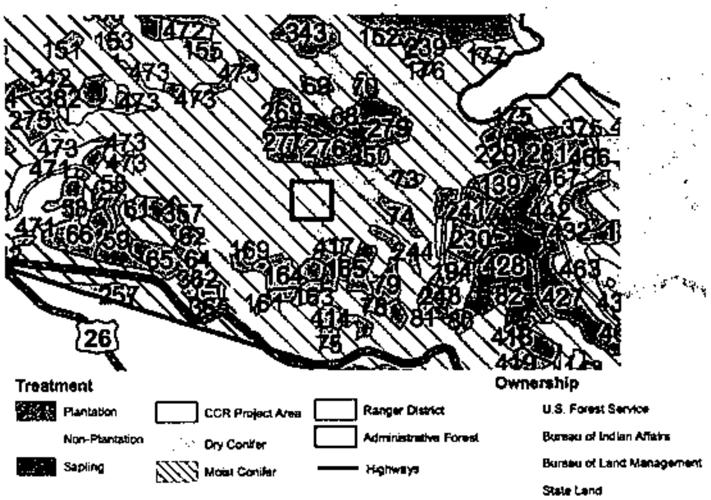
The Forest Service states there are no activities directly adjacent to Camas Prairie, and no proposed treatments that would remove vegetation and increase water temperature, or increase the amount of sediment reaching the meadow. 2017 Biological Assessment at 19. It notes that Watershed Impact Analysis percentage for flows entering Camas Prairie would increase slightly by 0.5%. *Id.* The Forest Service assumes that because the species is aquatic and all life stages are found in or near perennial bodies of water, individuals of this species would not be found within or directly adjacent to any of the treatment units. 2017 Biological Assessment at 19. This does not accurately describe the proposed action, because forest roads proposed for log hauling under the Crystal project run directly adjacent to Camas Prairie and the Oregon spotted frog's designated critical habitat.



Forest Service Preliminary EA Map, "Area Map."



Forest Service Preliminary EA Map, "Logging Systems."

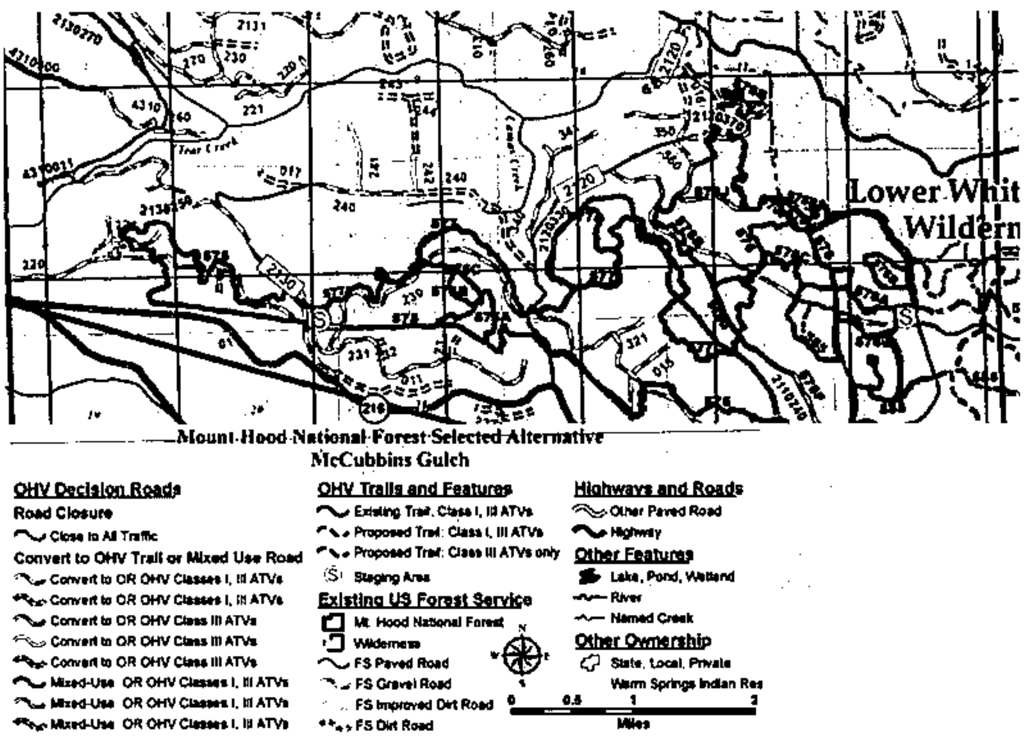


Final EA, "Fig. 4: Proposed treatment areas by vegetation treatment type."

Based on these maps provided as attachments to the Draft and Final EA, it appears that vegetation units 58, 61, 62, 64, 73, 74, 164, 165, 169, 244, 276, 277, 350, 357, and 417 are adjacent to or near Camas Prairie or Camas Creek. At least some or all of forest system roads 2130-000 (Frog Creek Road), 2130-230, 2130-240, 2130-241, and 2130-242 are necessary to access these vegetation units, and these forest system roads run adjacent to Camas Prairie or Camas Creek.

The Forest Service identifies various reconstruction and maintenance activities for these roads. On 4.5 miles of forest road 2130-000, the Forest Service proposes road reconstruction. *See* Final EA at 37 (listing plans to recondition one pipe inlet and replace four 18"x40' corrugated metal pipes). It proposes various road maintenance activities for road 2130-000. *Id.* at 87 (listing asphalt leveling course, roadside clearing and ditch reconditioning, recondition one pipe inlet, and replace four culverts). And it recommends "pre-treatment" for invasive species occur before any harvest activities are implemented along road 2130. *Id.* at 47. For forest road 2130-230, it lists roadside clearing and ditch reconditioning as road maintenance. Final EA at 87.

The legend for the "Area Map" from the Draft EA does not identify what the brown dashed lines demonstrate, including one dashed brown line that cuts through Camas Prairie and runs along Camas Creek. However, the following map shows McCubbin's Gulch Off-Highway Vehicle Use Area, and identifies many of the same routes as blue lines. The legend explains these routes are existing trails for Class I and III ATVs:



See Mt. Hood National Forest, McCubbin's Gulch Off-Highway Vehicle Use Area, *available at* https://www.fs.usda.gov/detail/mthood/recreation/?cid=stelprd3823141 (last accessed August 28, 2018).

2017 Biological Assessment & FWS Concurrence are Arbitrary and Capricious

The Forest Service's 2017 Biological Assessment ignores best available science, including how forest roads will adversely impact Oregon spotted frog and its critical habitat. For example, the Forest Service states that no treatments are in any habitat that provides for cover, shelter, breeding, or rearing for Oregon spotted frogs. 2017 Biological Assessment at 19. But it fails to consider the harmful impacts of log hauling, road reconstruction and maintenance, and culvert replacement on forest roads adjacent to or upstream from the frog's critical habitat. This is especially concerning, given that the frog may be found in or near roadside ditches. 81 Fed. Reg. at 29,351.

Development of roads adjacent to wetlands with Oregon spotted frogs introduces new impervious surfaces, which increase the amplitude and frequencies of peak highs and lows in water levels. 79 Fed. Reg. at 51,670. This has been shown to reduce amphibian species diversity in wetlands *Id.* Manmade barriers such as culverts on roads that intersect streams, rivers, or wetlands that disconnect or increase the amplitude of flow may prevent or impede Oregon spotted frog movements between breeding areas and other habitats. *Id.*

The Forest Service fails to analyze or explain key aspects of its analysis, and relies on flawed assumptions. For example, it states that none of the proposed treatments would remove vegetation and increase water temperature, or increase the amount of sediment reaching the meadow. 2017 Biological Assessment at 19. There is no analysis in the 2017 Biological Assessment regarding how the proposed logging, road reconstruction, road maintenance, culvert replacement, or log hauling on forest roads might impact temperature, sediment, or flow of water into the neighboring Camas Prairie and Camas Creek. The Forest Service references, but does not disclose, a temperature, sediment, and flow analysis.

Completely missing from the analysis in the 2017 Biological Assessment is an assessment of impacts from the Crystal project activities to Oregon spotted frog critical habitat. The Forest Service relies on implementation of "appropriate buffers" and best management practices (BMPs) to mitigate impacts. *Id.* But there is no analysis regarding the effectiveness or certainty of these mitigation measures.

The Forest Service determined in its 2017 Biological Assessment, and FWS concurred in its 2018 Biological Opinion, that the Crystal project is not likely to adversely affect Oregon spotted frog or Oregon spotted frog critical habitat. *See* 2017 Biological Assessment at 19; 2018 Biological Opinion at 2. The 2017 Biological Assessment and FWS's concurrence letter are arbitrary and capricious because they: (1) Fail to accurately describe the proposed action; (2) Ignore best available science; (3) Fail to analyze or explain key aspects of the agencies' analysis; (4) Rely on flawed assumptions; and (5) Rely on mitigation measures that are too uncertain.

Gray wolf

FWS first listed a subspecies of the gray wolf as endangered under the ESA in 1974,[10] and then generally listed the gray wolf as endangered in 1978.[11] Following FWS's delisting of the Northern Rockies Distinct Population Segment (DPS) of the gray wolf in 2011,[12] wolves that are "east of Highway 395 and Highway 78 north of Burns Junction and that portion of Oregon east of Highway 95 south of Burns Junction" are part of the Northern Rockies DPS and not protected under the ESA. Gray wolves on the western side of the DPS boundary in Oregon, however, retain protections as an endangered species under the ESA.

Primary threats to the gray wolf include widespread habitat destruction and human persecution. 43 Fed. Reg. at 9607. Wolves were once common throughout Oregon, as in much of the western United States. The species now occupies only a small part of its original range. *Id.* Gray wolves frequently live in defined packs, and pack territory averages in size

[10] 39 Fed. Reg. 1171, 1175 (Jan. 4, 1975).
[11] 43 Fed. Reg. 9607 (Mar. 9, 1978).
[12] 76 Fed. Reg. 25590 (May 5, 2011).

between 200 to 500 square miles. To establish new territories, young wolves will disperse from their packs and sometimes travel significant distances to find a mate and establish a new pack.

The Oregon Department of Fish and Wildlife (ODFW) monitors the gray wolf population in Oregon. For 2016, ODFW estimated the Oregon minimum wolf population to be 112 wolves.[13] However, by the end of 2016, ODFW was only able to monitor nine radio-collared wolves (8% of the known population).[14] Even with less than 10% of the wolf population in Oregon wearing radio collars, the monitoring efforts of ODFW show the wide-ranging dispersal of the gray wolf across Oregon.

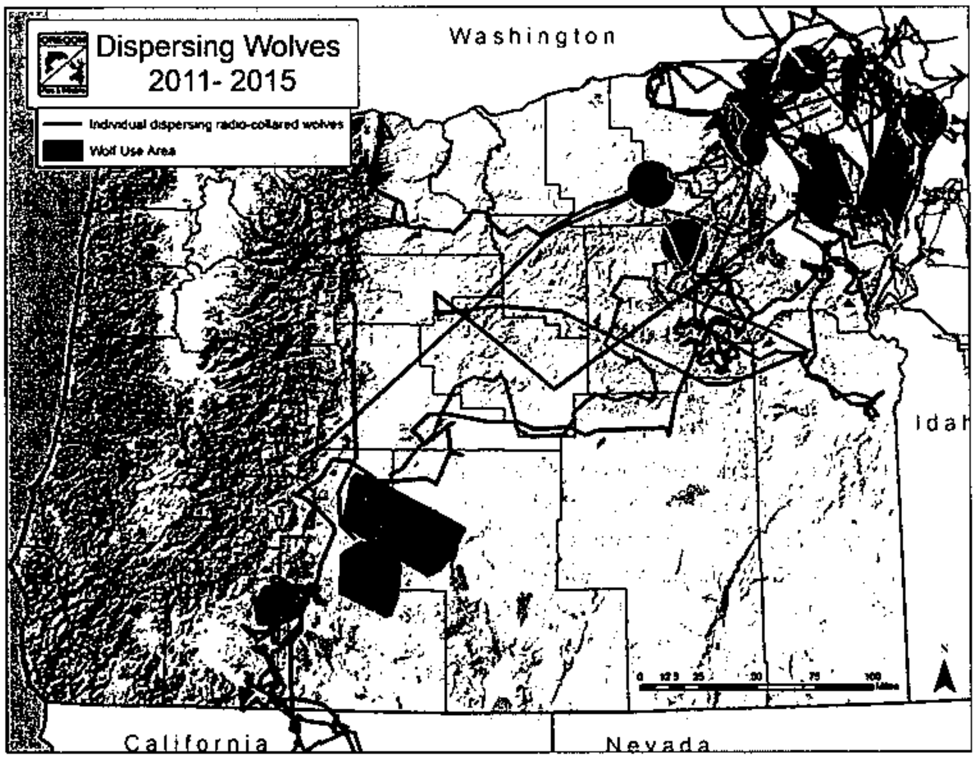


Figure 5. Approximate paths of dispersing wolves in Oregon (2011-2015)

Multiple radio-collared, and likely many other, wolves have dispersed from northeastern Oregon into the Cascades and will likely continue to disperse in the future.

Gray Wolves in Project Area

Gray wolves are likely to exist in the Crystal project area. Gray wolves within the Crystal project area are protected by the ESA. Wolf detections in and near the project area occurred in January 2018, after the close of the official public notice and comment period. In January

[13] Oregon Department of Fish and Wildlife. 2017. Oregon Wolf Conservation and Management 2016 Annual Report, page 2. Oregon Department of Fish and Wildlife, 4034 Fairview Industrial Drive SE. Salem, OR, 97302. (hereafter, "2016 Wolf Report").
[14] *Id.*

2018, ODFW confirmed at least two wolves are using an area in southern Wasco County.[15] In August 2018, ODFW confirmed a new pair of wolves in the White River Unit south of Mt. Hood produced at least two pups this year.[16]

The Forest Service's 2017 Biological Assessment and FWS's concurrence do not consider these sightings.

Impacts to Gray Wolves

Best available science shows that wolves are susceptible to harm from humans where access is provided into wolf habitat. Potential and favorable wolf habitat is defined by several elements such as low human population density, sufficient prey density, and low road density.[17]

The Forest Service relies on mitigation measures that are uncertain and not proven to be effective to mitigate essentially any impacts to gray wolves. *See* 2017 Biological Assessment at 16. It fails to discuss the effects of the proposed activities to gray wolves or gray wolf habitat. The project design criteria (PDC) that the Forest Service relies on to avoid impacts to gray wolves would restrict operations between April 1 and July 15, but only for activities within one mile of a den or rendezvous site. *See* 2017 Biological Assessment at 14. Wolf breeding takes place from January through March.[18] Pups are born in early to mid-April, and remain at the den site for 6 to 8 weeks. *Id.* In September, when pups are large enough to travel with the pack, rendezvous sites are abandoned and the pack moves as a single unit. *Id.*

Best available science shows gray wolves use the project area. There is no mention of whether the Forest Service has conducted surveys to monitor for wolf den or rendezvous sites in the project area despite recent confirmation of new pups being born in the area, and there is no mention of the 2018 wolf detections near the project area. Therefore, the single PDC relevant to gray wolves is not effective at preventing habitat alteration or disturbance beyond insignificant or discountable effects.

The 2017 Biological Assessment concludes, without providing any basis or best available science, that the proposed actions could indirectly benefit the gray wolf by increasing availability of prey in the project area. This is a flawed assumption that discounts very real, harmful impacts from logging, forest system road reconstruction, road maintenance, culvert replacement, log hauling on forest system roads, and construction and rock and log hauling on 39 miles of temporary roads in the project area over a five- to ten-year period.

The Forest Service fails to consider or explain key aspects of its analysis in the 2017 Biological Assessment. For example, it fails to consider the effects of the project on wolf

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[15] January 16, 2018 News Release from US Fish & Wildlife Service and ODFW (Attachment 2).

[16] *See* August 29, 2018 News Release from ODFW, Pups for White River Wolves (Attachment 3); August 30, 2018 Andrew Selsky, AP News, Wolf pups born in Oregon's Cascade Mountains (Attachment 4).

[17] *See, e.g.*, Mladenoff D.J., et. al. 1995. A Regional landscape analysis and prediction of favorable gray wolf habitat in the northern Great lakes Region. Cons. Biol.9:279-294.

[18] Fuller, T. K. 1989. Population dynamics of wolves in north-central Minnesota. Wildlife Monographs 105:1-41.

dispersal into the region. After denning in the early spring, the gray wolf generally reaches a period of peak dispersal in June and continues to disperse throughout the summer and fall in search of vacant habitat, a potential mate, or a new pack.[19] The Crystal project activities during peak dispersal season will likely prevent wolves from dispersing in the area and could potentially eliminate Mt. Hood National Forest as potential range for the gray wolf to occupy.

It also fails to consider impacts to gray wolf habitat, beyond known rendezvous or den sites. As part of a 2015 biological status review of gray wolves in Oregon, ODFW identified potential habitat for wolves based on four main predictors: (1) forested areas, (2) prey availability, (3) low human presence, and (4) low road density.[20] As the wolf population increases and areas occupied by wolves continue to expand, Mt. Hood National Forest and the Crystal project area within the Barlow Ranger District will become increasingly important as gray wolf habitat. The actions authorized under the Crystal project will decrease the quality of potential habitat for gray wolves by increasing human presence and disturbance from, *inter alia*, logging, road construction, and log hauling on forest roads. Because wolves are sensitive to human presence, the increased human presence and disturbance will likely eliminate potential habitat for gray wolves and risk future conservation and recovery of the species.

2017 Biological Assessment & FWS Concurrence are Arbitrary and Capricious

The Forest Service determined in its 2017 Biological Assessment, and FWS concurred, that the Crystal project is not likely to adversely affect gray wolves. *See* 2017 Biological Assessment at 16; 2018 Biological Opinion at 2. The 2017 Biological Assessment and FWS's concurrence letter are arbitrary and capricious because they: (1) Ignore best available science; (2) Fail to analyze or explain key aspects of the agencies' analysis; (3) Rely on flawed assumptions; and (4) Rely on mitigation measures that are too uncertain. Because the Crystal project may adversely affect gray wolves, the Forest Service must initiate formal consultation with FWS.

ESA VIOLATIONS

1. The FWS's 2018 Biological Opinion assessing impacts to northern spotted owl is arbitrary, capricious, and contrary to the ESA. 16 U.S.C. § 1536; 5 U.S.C. § 706(2)(A). The 2018 Biological Opinion is unlawful, arbitrary, and capricious because it: (1) fails to accurately describe the actions authorized under the Crystal project; (2) ignores best available science; (3) fails to analyze or explain key aspects of the agency's analysis; (4) relies on flawed assumptions; (5) relies on mitigation measures that are too uncertain; and (6) arbitrarily and capriciously determines the project is not likely to destroy or adversely modify spotted owl critical habitat.

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[19] Meaney C., and G.P. Beauvais. 2004. Species assessment for gray wolf (*Canis lupus*) in Wyoming. U.S. Department of Interior, Bureau of Land Management. Cheyenne, Wyoming.
[20] Oregon Department of Fish and Wildlife. 2015. Updated mapping potential gray wolf range in Oregon. Oregon Department of Fish and Wildlife, 4034 Fairview Industrial Drive SE. Salem, OR 97302.

2. The Forest Service's reliance on this legally flawed Biological Opinion violates the Forest Service's independent and continuing duty to insure that the authorization and implementation of the Crystal Clear Restoration Project is not likely to jeopardize the continued existence of northern spotted owl, or result in the destruction or adverse modification of its designated critical habitat, in violation of Section 7 of the ESA. 16 U.S.C. § 1536(a)(2).

3. The Forest Service's 2017 Biological Assessment and FWS's concurrence letter assessing impacts from the Crystal Clear Restoration Project to threatened Oregon spotted frog and its designated critical habitat are arbitrary, capricious, and contrary to the ESA because they: (1) fail to accurately describe the proposed action; (2) ignore best available science; (3) fail to analyze or explain key aspects of the agencies' analysis; (4) rely on flawed assumptions; and (5) rely on mitigation measures that are too uncertain.

4. The Forest Service's 2017 Biological Assessment and FWS's concurrence letter assessing impacts from the Crystal Clear Restoration Project to the endangered gray wolf are arbitrary, capricious, and contrary to the ESA because they: (1) ignore best available science; (2) fail to analyze or explain key aspects of the agencies' analysis; (3) rely on flawed assumptions; and (4) rely on mitigation measures that are too uncertain.

WildEarth Guardians, Bark, Cascadia Wildlands, and Oregon Wild will initiate litigation over the Forest Service's and FWS's ESA violations unless the Forest Service and FWS remedy the flaws in the ESA consultation documents identified above, and prevent any irreversible or irretrievable commitment of resources from occurring until consultation is completed.

For the above stated reasons, the Forest Service and FWS have violated and remain in ongoing violation of the ESA. The 60-day notice requirement is intended to provide you an opportunity to correct the actions that are in violation of the ESA.

Sincerely,

/s/ Brenna Bell
Staff Attorney, Bark

Jennifer Schwartz
Law Office of Jennifer R. Schwartz

cc: Jeff Sessions, U.S. Attorney General

Enclosures:

Attachment 1: Lee, D.E., Spotted Owls and forest fire: a systematic review and meta-analysis of the evidence. Ecosphere 9(7):e02354. 10.1002/ecs2.2354 (2018)).

Attachment 2: January 16, 2018 News Release from US Fish & Wildlife Service and ODFW).

Attachment 3: August 29, 2018 News Release from ODFW, Pups for White River Wolves.

Attachment 4: August 30, 2018 Andrew Selsky, AP News, Wolf pups born in Oregon's Cascade Mountains.

Attachment 1

Check for updates

esa

ECOSPHERE

SYNTHESIS & INTEGRATION

Spotted Owls and forest fire: a systematic review and meta-analysis of the evidence

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[1]Wild Nature Institute, 15 North Main Street #208, Concord, New Hampshire 03302 USA

Citation: Lee, D. E. 2018. Spotted Owls and forest fire: a systematic review and meta-analysis of the evidence. Ecosphere 9(7):e02354. 10.1002/ecs2.2354

Abstract. Forest and Spotted Owl management documents often state that severe wildfire is a cause of recent declines in populations of Spotted Owls and that mixed-severity fires (5–70% of burned area in high-severity patches with >75% mortality of dominant vegetation) pose a primary threat to Spotted Owl population viability. This systematic review and meta-analysis summarize all available scientific literature on the effects of wildfire on Spotted Owl demography and ecology from studies using empirical data to answer the question: How does fire, especially recent mixed-severity fires with representative patches of high-severity burn within their home ranges, affect Spotted Owl foraging habitat selection, demography, and site occupancy parameters? Fifteen papers reported 50 effects from fire that could be differentiated from post-fire logging. Meta-analysis of mean standardized effects (Hedge's *d*) found only one parameter was significantly different from zero, a significant positive foraging habitat selection for low-severity burned forest. Multi-level mixed-effects meta-regressions (hierarchical models) of Hedge's *d* against percent of study area burned at high severity and time since fire found the following: a negative correlation of occupancy with time since fire; a positive effect on recruitment immediately after the fire, with the effect diminishing with time since fire; reproduction was positively correlated with the percent of high-severity fire in owl territories; and positive selection for foraging in low- and moderate-severity burned forest, with high-severity burned forest used in proportion to its availability, but not avoided. Meta-analysis of variation found significantly greater variation in parameters from burned sites relative to unburned, with specifically higher variation in estimates of occupancy, demography, and survival, and lower variation in estimates of selection probability for foraging habitat in low-severity burned forest. Spotted Owls were usually not significantly affected by mixed-severity fire, as 83% of all studies and 60% of all effects found no significant impact of fire on mean owl parameters. Contrary to current perceptions and recovery efforts for the Spotted Owl, mixed-severity fire does not appear to be a serious threat to owl populations; rather, wildfire has arguably more benefits than costs for Spotted Owls.

Key words: adaptive management; evidence-based decision making; meta-analysis; mixed-severity fire; Spotted Owls; *Strix occidentalis*; systematic review; wildfire.

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Introduction

Wildfires are major natural disturbances in forests of the western United States, and native plants and animals in this region have been coexisting with fire for thousands of years of their evolutionary history (Pierce et al. 2004, Power et al. 2008, Marlon et al. 2012). Western forest fires typically burn as mixed-severity fires with each fire resulting in a mosaic of different vegetation burn severities, including substantial patches (range, 5–70% of burned area; mean, 22%) of high-severity fire (Beaty and Taylor 2001, Hessburg et al. 2007, Whitlock et al. 2008, Williams and Baker 2012, Odion et al. 2014*a*, Baker 2015*a*). High-severity fire (high vegetation burn severity) kills most or all of the dominant vegetation in a stand (>75% mortality; Hanson et al. 2009, Baker 2015*a*, *b*) and creates complex early seral forests, where standing dead trees, fallen logs, shrubs, tree seedlings, and herbaceous plants comprise the structure (Swanson et al. 2011, DellaSala et al. 2014). Post-fire vegetation processes (i.e., succession) then commence according to the pre-fire vegetation, local wildfire processes, propagules from outside the disturbance, and the dynamic biotic and abiotic conditions at the site (Gutsell and Johnson 2006, Johnson and Miyanishi 2006, Mori 2011).

Spotted Owls (*Strix occidentalis*) occur in western U.S. forests and have been intensively studied since the 1970s (Fig. 1). The species is strongly associated with mature and old-growth (i.e., late-successional) conifer and mixed conifer–hardwood forests with thick overhead canopy and many large live and dead trees and fallen logs (Gutiérrez et al. 1995). Its association with older forests has made the Spotted Owl an important umbrella indicator species for public lands management (Noon and Franklin 2002). The scientific literature has established that the optimal habitat for Spotted Owl nesting, roosting, and foraging is provided by conifer and mixed conifer–hardwood forests dominated by medium (30–60 cm) and large (>61 cm) trees with medium (50–70%) to high (>70%) canopy cover (Gutiérrez et al. 1995). The populations of all three subspecies have declined due to widespread historical and ongoing habitat loss, primarily from logging mature and old-growth forests favored by the owls for nesting and roosting (Seamans et al. 2002, Forsman et al. 2011, USFWS 2011, 2012, Conner et al. 2013, Tempel and Gutiérrez 2013, Dugger et al. 2016).

Research on Spotted Owl in fire-affected landscapes did not begin until the early 2000s, and much of what scientists previously understood about habitat associations of Spotted Owl was derived from studies in forests that had generally not experienced recent fire, and where the nonsuitable owl habitat was a result of logging (Gutiérrez et al. 1992, Franklin et al. 2000, Seamans et al. 2002, Blakesley et al. 2005, Seamans and Gutiérrez 2007, Forsman et al. 2011, Tempel et al. 2014). Because Spotted Owls are associated with dense, late-successional forests, it has often been assumed that fires that burn at high severity are analogous to clear-cut logging and have a negative effect on population viability. It has become widely believed among wildlife management professionals that severe wildfire is a contributing cause of recent Spotted Owl population declines (USFWS 2011, 2012, 2017), and many land managers believe that forest fires currently pose the greatest risk to owl habitat and are a primary threat to population viability (Davis et al. 2016, Gutiérrez et al. 2017). These beliefs result in fuel-reduction logging projects in Spotted Owl habitat (USDA 2012, 2018) which the USDA Forest Service and US Fish and Wildlife Service state are actions consistent with Spotted Owl recovery (USDA 2012, 2018, Gutiérrez et al. 2017, USFWS 2017). Narrative literature reviews have attempted to summarize the effects of fire on Spotted Owl (Bond 2016, Gutiérrez et al. 2017), but evidence-based conservation decisions should be based upon systematic, transparent reviews of primary literature with quantitative meta-analysis of effects (Sutherland et al. 2004, Pullin and Stewart 2006, Pullin and Knight 2009, Koricheva et al. 2013).

The following systematic review and meta-analysis summarize all available published scientific literature on the effects of wildfire on aspects of Spotted Owl demography (survival, recruitment, and reproduction), site occupancy, and habitat selection, from studies using empirical data to answer the question: How does fire, especially mixed-severity fire with substantial patches of high-severity fire within their home ranges, affect Spotted Owl demography, site occupancy, and habitat selection in the first few post-fire years?

Methods

Literature search

I conducted a systematic review of the primary scientific literature and used meta-analyses and meta-regression to examine the evidence for the direct effects of wildfire on Spotted Owl demography, site occupancy, and habitat selection. My subject was Spotted Owls; the intervention was

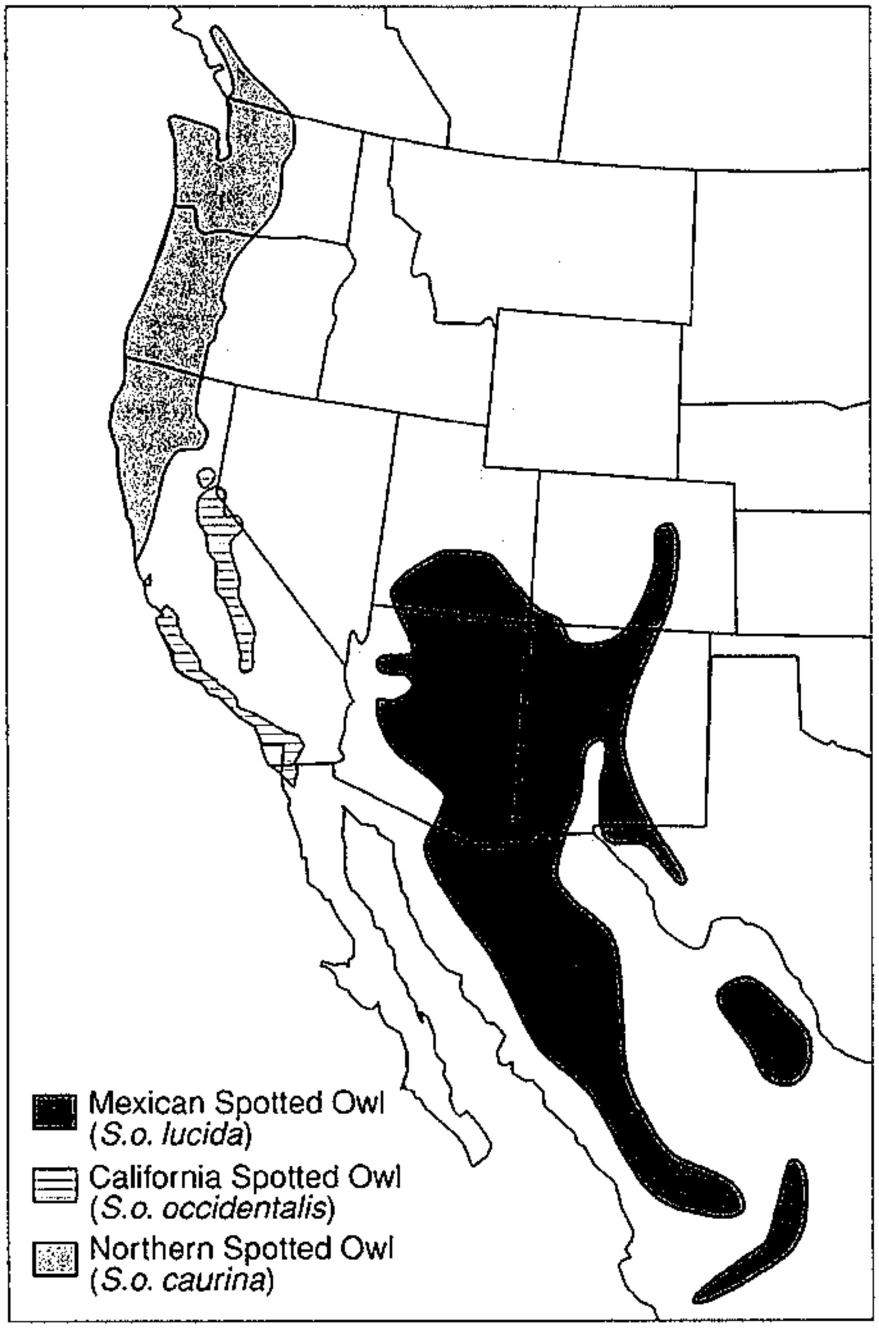

Fig. 1. Range map for the three subspecies of the Spotted Owl (*Strix occidentalis*).

wildfire; the outcomes were change or difference in estimates of demography, site occupancy, and habitat selection probabilities; and the comparator was pre-fire estimates or control estimates from unburned areas (Pullin and Stewart 2006). I searched the following electronic databases on 1 April 2018: Agricola, BIOSIS Previews, ISI Web of Science, and Google Scholar. Search terms were as follows: spotted AND owl AND *fire, Strix AND occidentalis AND *fire. My search included papers published in any year.

I used a threefold filtering process for accepting studies into the final systematic review. Initially, I filtered all articles by title and removed any obviously irrelevant material from the list of articles found in the search. Subsequently, I examined the abstracts of the remaining studies with regard to possible relevance to the systematic review question, using inclusion criteria based on the subject matter and the presentation of empirical data. I accepted articles for viewing at full text if I determined that they may contain information pertinent to the review question or if the abstract was ambiguous and did not allow inferences to be drawn about the content of the article. Finally, I read all remaining studies at full text and either rejected or accepted into the final review based upon subject matter (Pullin and Stewart 2006, Koricheva et al. 2013). Studies that only modeled effects of simulated fires on Spotted Owl habitat and demography were not considered here.

Because post-fire logging often occurred, I also recorded effects of this disturbance where they were reported. I believe all studies in the final review were generally comparable because time since fire and percent of high-severity burn were similar among studies (Tables 1, 2), and the high number of non-significant results reported indicates little to no publication bias exists in this topic (Tables 1, 2; Appendix S1: Fig. S1). I considered the basic sampling unit of all studies to be the central core of the owl breeding-season territory (~400 ha, or a circle with radius 1.1 km centered on the nest or roost stand) because this is the spatial and temporal scale for sampling used in almost all Spotted Owl studies. In contrast, Spotted Owl year-round home ranges vary according to latitude and dominant vegetation, but range from 300 to 11,000 ha, or circles with radius 1.0–5.9 km (Zabel et al. 1992). I considered forest fires to affect the landscape scale (~10,000 ha/decade), but that fires would affect numerous individual owl breeding-season territories (1200 ha) and year-round home ranges (300–19,000 ha) in various ways.

Meta-analyses and meta-regression

I evaluated all final review papers and included all papers where effects of fire were reported and could be differentiated from other disturbances such as post-fire logging. I extracted evidence by reading every paper and tabulating all quantified results from text, tables, and figures (Table 1). I noted the mean ($\bar{x}$) and variation (SD) of burned and unburned groups for all significant and non-significant parameters, the parameters being estimated, sample sizes (n = number of owl breeding sites in burned and unburned groups), amount of high-severity fire in the total fire perimeter and/or within the owl territory core areas examined, time since fire (years), amount of post-fire logging that occurred, subspecies (California = *Strix occidentalis occidentalis*, Mexican = *Strix occidentalis lucida*, or northern = *Strix occidentalis caurina*), and whether the result was statistically significant (as defined in each paper).

I conducted all analyses in R 3.3.1 (www.r-project.org). For meta-analysis, I noted or calculated the mean, variance (SD), and sample size for burned (treatment) and unburned (control) groups. I calculated raw effect sizes as mean differences ($\bar{x}_{\text{burned}} - \bar{x}_{\text{control}}$) and signs (positive or negative) for all reported effects, regardless of their statistical significance. Most papers reported effect sizes as probabilities (occupancy, survival, and foraging habitat selection) so raw effect sizes were scaled between negative and positive one with a mean of zero, making comparison among studies easy. When papers reported multiple effects (e.g., occupancy and reproduction, or survival and recruitment), I recorded each effect individually. Where papers did not report any effect size for a parameter determined to have no significant effects from fire, I included a zero to represent the presence of no significant effect and to avoid a significance bias in the meta-analysis. I stratified data by subspecies (California, Mexican, or northern) and parameter type according to whether the study estimated site occupancy, foraging habitat selection (substratified into selection for low-, moderate-, and high-severity burned forest), and demographic rates (substratified into survival, reproduction, and recruitment). I performed meta-analyses on parameters for which ≥4 estimates existed from ≥4 different fires.

I used three quantitative methods for evaluating the evidence (Koricheva et al. 2013): a random-effects meta-analysis of mean effect sizes as

Table 1. Summary of systematic review of studies examining effects of fire on Spotted Owls.

No.	Ref.	Sample size	HOD	Time since fire	Context	Fire effects (* = statistically significant, NS = non-significant)	Fire	Any effect	Signif. effect	Post-fire logging
1	Bond et al. (2002)	21 owls in 11 burned sites	OD	1 yr post-fire	No effect on survival, site fidelity, mate fidelity, or reproduction. 50% of territories burned 36–88% high severity, 50% burned mostly low–moderate severity, unknown amount of post-fire logging	No significant effects. (3% higher survival NS, 1% lower site fidelity [occupancy] NS, 26% higher repro NS)	0/+/–	+0.032 −0.013 +0.259	na	na
2	Jenness et al. (2004)	33 burned and 31 unburned breeding sites	OD	1-yr study, 1–4 yr post-fire	No effect on occupancy from fire or amount of high-severity fire. No effect on reproduction. 55% of burned territories area burned, 18% at high severity, unknown amount of post-fire logging	No significant effects from fire. (14% lower occupancy NS, 7% lower repro in burn NS)	0/–	−0.14 −0.07	na	na
3	Bond et al. (2009)	Seven radioed owls from four burned sites	H	1-yr study, 4 yr post-fire	Owls preferred burned forest for foraging, especially high-severity burned forest. Owls preferred roost sites burned at low severity and avoided unburned sites and sites burned at moderate and high severity. 69% of foraging area burned, 13% at high severity, <3% post-fire logging	Positive effect from fire on foraging habitat selection (+42%, +42% +33%*), negative and positive effect of fire on roosting nesting habitat selection (−29%, −13%, −28%*)	+/–	+0.33 +0.42 +0.42 +0.29 −0.13 −0.28	+0.33 +0.42 +0.42 +0.29 −0.13 −0.28	na
4	Bond et al. (2010)	Five radioed owls in occupied burned sites	H	1-yr study, 4 yr post-fire	Three of five owls occupied burned forest over winter	No significant effects, perhaps some positive effect	0/+	na	na	na
5	Clark et al. (2011)	11 radioed owls in burned and post-fire logged sites, 12 in unburned sites	D	2-yr study, 3–4 yr post logging	No effects on survival. Reduced survival in salvage-logged areas relative to owls in unburned forest. 14% high severity, 21% post-fire logged	Negative survival effect from combined effects of fire and post-fire logging (−0.07 NS)	?	na	na	−0.07
6	Roberts et al. (2011)	16 burned and 16 unburned survey areas	O	1-yr study, 2–14 yr post-fire	No effect of fire on survey area occupancy. 14% of survey area burned at high severity, little to no post-fire logging	No significant effect from fire. Possible negative effect from basal area and canopy cover model (−26% lower occupancy in burned survey area NS)	0/–	−0.260	na	na

(Table 1. *Continued*)

No.	Ref.	Sample size	HOD	Time since fire	Context	Fire effects (* = statistically significant, NS = non-significant)	Fire	Any effect	Signif. effect	Post-fire logging
7	Lee et al. (2012)	41 burned and 145 unburned breeding sites	O	11-yr study. 1–7 yr post-fire from six large fires	No effect on occupancy probability. 32% high severity. Unknown amount of post-fire logging	No significant effect from fire, perhaps a slightly positive effect (4% higher occupancy in burned sites NS)	0/+	+0.041	na	na
8	Bond et al. (2013)	Seven radioed owls	H	1-yr study. 4 yr post-fire	Owls in burned forest have same size or smaller home ranges than owls in unburned forest. 69% of foraging area burned, 13% at high severity, 3% post-fire logging	No significant effect from fire, possible positive effect (HR size 12% smaller in burned area NS)	0/+	+0.12	na	na
9	Clark et al. (2013)	40 burned and salvage-logged sites and 103 unburned sites	O	13-yr study, 1–4 yr post-fire	Lower site occupancy on salvage-logged sites relative to unburned sites. 11% high severity, 13% post-fire logged	Negative effect on occupancy from combined fire and post-fire logging (−0.39*)	?	na	na	−0.39
10	Lee et al. (2013)	71 burned and 97 unburned breeding sites, post-fire logging on 21 of the burned sites	O	8-yr study, 1–8 yr post-fire	No effects from fire or logging. Burned site occupancy 17% (10% for pairs) lower than unburned sites. Post-fire logged sites occupancy 5% lower than unlogged burned sites. 23% high severity in burned sites, 59% logged in post-fire logged sites	No significant effect from fire, negative effect (17% lower any occupancy, 10% lower pair occupancy in burn NS) Same data as ref. no. 14	0/−	−0.171 −0.107	na	−0.05
11	Ganey et al. (2014)	Four radioed owls	H	1-yr study, 4–6 yr post-fire	Owls moved to burned forest over winter. Burned wintering sites had 2–6 times more prey biomass relative to unburned core areas. 21% high severity, unknown amount of post-fire logged	Positive effect from fire	+	na	na	na
12	Tempel et al. (2014)	12 burned, 62 unburned sites	DO	20-yr study of survival and reproduction, 6-yr study of occupancy.	No effect on survival, reproduction, or site extinction. Reported a negative effect of fire on colonization rate, but colonization parameter was faulty due to low sample size and zero colonization events. Unknown amount of high-severity fire, unknown amount of post-fire logging	No significant effect from fire. Possible negative effect from fire (6% lower occupancy when fire frequency doubled in simulations that assumed zero post-fire colonizations)	0/−	0 0 −0.060	−0.060	na

(Table 1. *Continued*)

No.	Ref.	Sample size	HOD	Time since fire	Context	Fire effects (* = statistically significant, NS = non-significant)	Fire	Any effect	Signif. effect	Post-fire logging
13	Lee and Bond (2015*a*)	45 burned breeding sites	O	Rim Fire, 1-yr study, 1 yr post-fire	Higher burned-site occupancy rates than any published unburned area. 100% high-severity fire in territory surrounding nest and roost sites reduced single owl occupancy probability 5% relative to sites with 0% high severity. Amount of high-severity fire did not affect occupancy by pairs of owls. In fire perimeter: 37% high severity, no post-fire logging	Positive (17% higher occupancy rates*). Small negative effect on site occupancy (3% lower occupancy in burn*). No significant effect on pair occupancy	+/0	+0.175 −0.04 0	−0.175	na
14	Lee and Bond (2015*b*)	71 burned and 97 unburned breeding sites, post-fire logging on 21 of the burned sites	OD	8-yr study, 1–8 yr post-fire	Occupancy of high-quality sites (previously reproductive) that burned was 2% lower than unburned sites. Occupancy of high-quality sites that were post-fire logged was 3% lower. Occupancy of low-quality sites (previously non-reproductive) was 19% lower in burned vs. unburned sites and 26% lower after post-fire logging. Fire did not affect reproduction. 23% high severity in burned sites, 59% logged in post-fire logged sites	Negative effect on site occupancy (2% and 19% lower*), No significant effect on reproduction	−/0	−0.02 −0.19 0	−0.02 −0.19	−0.03 −0.26
15	Bond et al. (2016)	Eight radioed owls in five sites	H	2-yr study, 3–4 yr post-fire	Owls used forests burned at all severities in proportion to their availability, with the exception of significant selection for moderately burned forest farther from core areas. 23% high severity, <5% post-fire logging	No significant effect from fire (3% lower probability of use in high-severity burn NS), some positive effect (15% higher probability of use of low-severity burn NS, 10% higher probability of use in moderate-severity burned forest NS, 3% higher probability of use of moderate severity away from the core*)	0/+	−0.03 +0.15 +0.10	+0.033	na

(Table 1. *Continued*)

No.	Ref.	Sample size	HOD	Time since fire	Context	Fire effects (* = statistically significant, NS = non-significant)	Fire	Any effect	Signif. effect	Post-fire logging
16	Comfort et al. (2016)	23 radioed owls in post-fire logged area	H	2-yr study, 3–4 yr post logging	Scale-dependent effects of logging (+/−). Owls selected a moderate amount of hard edges around logged stands. 14% high severity, 21% post-fire logged	Positive and negative effect from post-fire logging created edges	?	na	na	+/−
17	Jones et al. (2016)	30 burned sites, 15 unburned sites, nine radioed owls in seven sites	OH	23-yr study, 1 yr post-fire	Negative effects from high-severity fire. Positive effect of low- to moderate-severity fire. 64% high-severity burn, 2% post-fire logging	>50% high-severity burned sites had lower occupancy (−0.49*), <50% high-severity burned sites had higher occupancy (+0.07 NS). High-severity burned habitat was avoided (−0.307*), low-tomoderate-severity burn was preferred (+0.04 NS)	+/−	+0.070 −0.490 −0.307 −0.04	−0.490 −0.307 +0.04	na
18	Tempel et al. (2016)	43 burned sites and 232 unburned sites in four study areas	O	19-yr study, examined 3-yr post-fire effects	No effects of fire. One study area had positive effect of fire. Lower site extinction probability correlated with proportion of site where wildfire reduced canopy >10%. 1% of all territories burned, unknown amount of post-fire logging	No significant effect from fire, some positive effect (1% lower extinction rate in burned sites NS)	0/+	+0.003 0 0 0	na	na
19	Eyes et al. (2017)	13 radioed owls in eight sites (14 owl-year data sets)	H	3-yr study, 1–14 yr post-fire	No effect of fire on foraging habitat selection, owls foraged in all burn severities in proportion to their availability. 6% high severity, little to no post-fire logging	No significant effect from fire. Possibly negative effect (6% lower probability of use for highest burn severity NS; 3% lower use of moderate severity NS)	0/−	−0.06 −0.03	na	na
20	Rockweit et al. (2017)	193 burned and 386 unburned encounter histories from 28 burned (8, 2, 4, 14) and 70 unburned sites	D	26-yr study, 4–26 yr post-fire	Four fires had different effects. Generally, fires reduced survival and increased recruitment. 10%, 12%, 16%, and 48% high severity, no post-fire logging reported	Two fires had no significant effects on survival or recruitment. Two fires had reduced survival (−0.17 and −0.30*), one had increased recruitment (+0.22*)	0/+/−	−0.03 −0.10 −0.17 −0.30 +0.01 +0.02 +0.04 +0.22	−0.17 −0.30 +0.22	na

(Table 1. *Continued*)

No.	Ref.	Sample size	HOD	Time since fire	Context	Fire effects (* = statistically significant, NS = non-significant)	Fire	Any effect	Signif. effect	Post-fire logging
21	Hanson et al. (2018)	54 burned sites in eight fires that were occupied immediately before fire, before–after comparison	O	14-yr study, 1 yr post-fire	Eight large fires (4 included in Tempel et al. 2016). Four groups: 20–49% and 50–80% high-severity fire; and <5% and ≥5% post-fire logging within 1500 m of site center. Mean 63% high severity in core areas, mean 17% logged if ≥5% of core was post-fire logged Compared burned site occupancy with unburned occupancy from Tempel et al. (2016)	No significant effect from fire, significant negative effect of post-fire logging (3% reduction in occupancy if 50–80% of core burned high-severity fire NS, 52% reduction in occupancy from ≥5% post-fire logging*)	0/-	−0.017 −0.013	na	−0.52

Notes: HOD indicates habitat selection (H), occupancy (O), or demographic (D) parameters were estimated. A question mark (?) indicates confounded fire and post-fire logging effects, so fire effects could not be estimated.

the standardized difference in means (Hedge's *d*; Hedges and Olkin 1985); multi-level linear mixed-effects models (hierarchical models) meta-regression of time since fire and percent of high-severity fire in the study area as covariates to explain heterogeneity in mean effect sizes (Hedges and Vevea 1998, Nakagawa and Santos 2012); and a random-effects meta-analysis of variation to examine differences in parameter variances due to fire with effect sizes as the natural logarithm of the ratio between the coefficients of variation (lnCVR; Nakagawa et al. 2015). For analyses, I used the metafor package of R (Viechtbauer 2010) and used function metacont for random-effects meta-analyses, function rma.mv for multi-level linear mixed-effects model meta-regression, and function rma for random-effects meta-analysis of variation (Viechtbauer 2010). Study within geographic area was included as multi-level random effects to properly estimate study site- and region-specific variation and to account for repeated measurements (pseudo-replication) within a study or region. Regions were defined as Sierra Nevada, southern California, national parks, not California, and the Eldorado density study area (because several studies used data from there).

I used all three methods at three levels: on all parameters, on three main groups of parameters (occupancy, foraging habitat selection, and demography), and on subgroups of habitat selection (for low-, moderate-, and high-severity burned forest) and demography (survival, reproduction, and recruitment). In meta-analyses, I used *z* tests to determine if effects were significantly different from zero (95% confidence interval excluded zero). In meta-regression, *z* tests determined whether intercepts or slope coefficients were significantly different from zero. I quantified heterogeneity among effects as Cochran's *Q* (Hedges and Olkin 1985) and I^2 (Higgins and Thompson 2002). I used a funnel plot and the rank correlation test (Kendall's τ) to assess publication bias (Begg and Mazumdar 1994).

Results

Literature search

I found 21 papers reporting empirical evidence relevant to direct fire effects on owls (Table 1). Three papers presented data from a study area which was extensively logged post-fire and results did not discriminate between effects of fire and post-fire logging (Clark et al. 2011, 2013, Comfort et al. 2016), so these three papers were not included in meta-analyses with the meta-analysis set of papers that were not confounded

Table 2. Summary statistics for published effects of mixed-severity fire on Spotted Owls (*Strix occidentalis*) 1987–2018 used in meta-analysis.

Ref no.	Study	Subspecies	Region	Parameter	*n* burned	*n* unburned	Raw effect size (mean difference)	Significant (in study)	Time since fire (yr)	Percentage of high-severity fire in burned territories
1	Bond (2002)	CNM	NotCal	Occupancy	18	100	−0.013	na	1	30
1	Bond (2002)	CNM	NotCal	Reproduction	7	100	0.259	na	1	30
1	Bond (2002)	CNM	NotCal	Survival	21	100	0.032	na	1	30
2	Jenness (2004)	M	NotCal	Occupancy	33	31	−0.14	na	2.5	16
2	Jenness (2004)	M	NotCal	Reproduction	33	31	−0.07	na	2.5	16
3	Bond (2009)	C	SN	Foraging High	7	7†	0.42	0.42	4	13
3	Bond (2009)	C	SN	Foraging Low	7	7†	0.33	0.33	4	13
3	Bond (2009)	C	SN	Foraging Mod	7	7†	0.42	0.42	4	13
6	Roberts (2011)	C	NP	Occupancy	16	16	−0.26	na	8	12
7	Lee (2012)	C	SN	Occupancy	41	145	0.041	na	4	32
10	Lee (2013)	C	SoCal	Occupancy	71	97	−0.171	na	4.5	23
10	Lee (2013)	C	SoCal	Occupancy	71	97	−0.107	na	4.5	23
12	Tempel (2014)	C	Eldorado	Occupancy	12	62	−0.06	−0.06	3	23‡
12	Tempel (2014)	C	Eldorado	Reproduction	12	62	0	na	3	23‡
12	Tempel (2014)	C	Eldorado	Survival	12	62	0	na	3	23‡
13	Lee (2015*a*)	C	SN	Occupancy	45	45	−0.04	na	1	37
13	Lee (2015*a*)	C	SN	Occupancy	45	45	0	na	1	37
13	Lee (2015*a*)	C	SN	Occupancy	45	145	0.175	0.175	1	37
14	Lee (2015*b*)	C	SoCal	Occupancy	71	97	−0.19	−0.19	4.5	23
14	Lee (2015*b*)	C	SoCal	Occupancy	71	97	−0.02	−0.02	4.5	23
14	Lee (2015*b*)	C	SoCal	Reproduction	71	97	0	na	4.5	23
15	Bond (2016)	C	SoCal	Foraging High	8	8†	−0.093	na	3.5	15
15	Bond (2016)	C	SoCal	Foraging High	8	8†	−0.035	na	3.5	16
15	Bond (2016)	C	SoCal	Foraging High	8	8†	0.092	na	3.5	9
15	Bond (2016)	C	SoCal	Foraging Low	8	8†	0.115	na	3.5	15
15	Bond (2016)	C	SoCal	Foraging Low	8	8†	0.167	na	3.5	9
15	Bond (2016)	C	SoCal	Foraging Low	8	8†	0.169	na	3.5	16
15	Bond (2016)	C	SoCal	Foraging Mod	8	8†	−0.042	na	3.5	15
15	Bond (2016)	C	SoCal	Foraging Mod	8	8†	0.033	0.033	3.5	16
15	Bond (2016)	C	SoCal	Foraging Mod	8	8†	0.102	na	3.5	9
17	Jones (2016)	C	Eldorado	Foraging High	9	9†	−0.307	−0.307	1	19

(Table 2. *Continued*)

Ref no.	Study	Subspecies	Region	Parameter	*n* burned	*n* unburned	Raw effect size (mean difference)	Significant (in study)	Time since fire (yr)	Percentage of high-severity fire in burned territories
17	Jones (2016)	C	Eldorado	Foraging Mod	9	9†	0.04	+0.04	1	19
17	Jones (2016)	C	Eldorado	Occupancy	14	15	−0.490	−0.490	1	64
17	Jones (2016)	C	Eldorado	Occupancy	16	15	0.07	na	1	19
18	Tempel (2016)	C	SN	Occupancy	12	78	0	na	4	23‡
18	Tempel (2016)	C	Eldorado	Occupancy	14	60	0	na	4	23‡
18	Tempel (2016)	C	SN	Occupancy	3	63	0	na	4	23‡
18	Tempel (2016)	C	NP	Occupancy	14	31	0.003	0.003	4	23‡
19	Eyes (2017)	C	SN	Foraging High	13	13†	−0.06	−0.06	7	6
19	Eyes (2017)	C	SN	Foraging Mod	13	13†	−0.03	−0.03	7	6
20	Rockweit (2017)	N	NotCal	Recruitment	8	8	0.01	na	12.5	10
20	Rockweit (2017)	N	NotCal	Recruitment	2	2	0.02	na	6.5	16
20	Rockweit (2017)	N	NotCal	Recruitment	4	4	0.04	na	4	48
20	Rockweit (2017)	N	NotCal	Recruitment	14	14	0.22	0.22	2	12
20	Rockweit (2017)	N	NotCal	Survival	4	4	−0.30	−0.3	4	48
20	Rockweit (2017)	N	NotCal	Survival	14	14	−0.17	−0.17	2	12
20	Rockweit (2017)	N	NotCal	Survival	2	2	−0.10	na	6.5	16
20	Rockweit (2017)	N	NotCal	Survival	8	8	−0.03	na	12.5	10
21	Hanson (2018)	C	SN	Occupancy	13	201	−0.017	−0.017	1	63
21	Hanson (2018)	C	SN	Occupancy	15	201	0.013	0.013	1	35

Notes: Study indicates first author and year. Subspecies are C, California (*Strix occidentalis occidentalis*); N, northern (*Strix occidentalis caurina*); M, Mexican (*Strix occidentalis lucida*); CNM, study included all subspecies. Regions are SN, Sierra Nevada, California (except El Dorado study area and national parks); SoCal, southern California; Eldorado, El Dorado study area in Sierra Nevada, California; NotCal, not California Spotted Owl subspecies; NP, national parks. Parameters: habitat selection (foraging or roosting) in low-, moderate-, (mod) or high-severity burned forest; occupancy, recruitment, reproduction, and survival. Sample sizes (*n*) are number of breeding site territories burned and unburned. Raw mean effect size is $\bar{x}_{burned} - \bar{x}_{control}$, significant repeats effects that the individual study determined was statistically significant. Time since fire is the median number of years between the fire and the parameter estimate(s). Percent high-severity fire in burned study territories is the mean relevant to the estimate, or the grand mean if percentage of high severity was not reported (see ‡).

† Habitat selection occurred within territories that contained a mosaic of burn severities and unburned forest.

‡ Percent high-severity fire was not reported for burned territories only for all territories burned and unburned, so the grand mean of reported percentages was used.

by extensive post-fire logging (Table 2). All 21 papers are summarized in Appendix S1.

Fifteen of the 18 papers in the meta-analysis set reported evidence explicitly pertaining to mixed-severity wildfires that burned during the past few decades and which included proportions of high-severity burn characteristic of this fire regime, while three reported evidence from an undifferentiated mix of wildfire and prescribed fires. The studies reported varying amounts of high-severity fire, a defining feature of mixed-severity fires, and the burn severity type that is most responsible for vegetation changes in wildfires, with an overall mean percent of high-severity fire of 26% (standard error [SE] = 3.6, range 6–64) within the study area. Because almost all the studies in this review reported on effects from recent wildfires (all fires burned in the past 30 yr, mean time since fire = 4 yr, SE = 1.1, range 1–26), the reported effects are representative of natural mixed-severity fires as they burned through currently existing forest structure, fire regime, and climate conditions. Papers reported effects of fire on site occupancy (11), foraging habitat selection (4), reproduction (4), apparent survival (3), overwinter roosting habitat selection (2), site fidelity (1), mate fidelity (1), breeding-season nesting and roosting habitat selection (1), home-range size (1), and recruitment (1). Sample sizes measured as number of burned sites were variable among studies (demography CV = 122%, site occupancy CV = 56%, and habitat selection CV = 24%).

Meta-analyses

Meta-analysis of 50 reported effects on occupancy, foraging habitat selection, and demographic rates found effect sizes and signs were variable (Table 2 and Fig. 2), with high heterogeneity among effects ($Q = 1091$, df = 51, $P < 0.0001$; $I^2 = 95.3\%$). Funnel plot (Appendix S1: Fig. S1) and rank correlation test (Kendall's $\tau = 0.108$, $P = 0.27$) showed no publication bias or unusual heterogeneity. Sample sizes (n = number of reported effects) were variable among parameter types (Fig. 3). The number of reported effects were occupancy = 20; demography = 14; and foraging habitat selection = 16. The number of reported effects by demography subtype were survival = 6; reproduction = 4; and recruitment = 4. The number of reported effects by habitat selection subtype were low-severity burned forest = 4; moderate-severity burned forest = 6; and high-severity burned forest = 6.

The mixed-effects model meta-analysis of fire effects on Spotted Owl parameters grouped by type (occupancy, demography, and foraging habitat selection), and subtypes of demography (survival, reproduction, and recruitment) or foraging habitat selection (selection for low-, moderate-, and high-severity burned forest), found mixed-severity fire has generally no significant effect on Spotted Owls (Fig. 3a). Mean overall raw effect size was positive (+0.001), but weighted mean Hedge's d from the random-effects model was not significantly different from zero (Fig. 3a, 95% confidence interval included zero). Mean raw effect sizes were negative for occupancy (−0.060), demography (−0.006), and survival (−0.095), but no Hedge's d value for these three negative effects was significantly different from zero (Fig. 3a). Mean raw effect sizes were positive for reproduction (+0.047), recruitment (+0.073), foraging habitat selection (+0.083), selection of high-severity (+0.004), moderate-severity (+0.087), and low-severity burned forest (+0.195), but Hedge's d values were not significantly different from zero for any of these positive effects, except for significant selection of low-severity burned forest (Fig. 3a).

Variation was generally higher among parameter estimates from burned areas compared to estimates from unburned areas (mean $CV_{burned} - CV_{unburned} = 23\%$; range 4–57%). The mixed-effects meta-analysis of variation in fire effects on Spotted Owl parameters (lnCVR) found mixed-severity fire resulted in significantly higher variation in parameter estimates in all parameters and in occupancy, demography, and survival (Fig. 3b). There was significantly lower variation in estimates of foraging habitat selection probability for low-severity burned forest (Fig. 3b).

Meta-regression

Meta-regression of all standardized mean effects found significant effect of time since fire (Table 3), and a nearly significant effect of percent high-severity burn in territory cores (Table 3), so those effects were included in parameter-specific meta-regressions. Subspecies was not a significant factor (Table 3), so effects from different subspecies were pooled in subsequent parameter-specific analyses.

Meta-regression of occupancy probability found no significant immediate effect of fire on occupancy (intercept not significantly different from zero; Table 4). There was a significant negative effect of time since fire (Fig. 4, Table 4), but no effect of percent high-severity fire in study territories (Table 4). The negative effect of time since fire was sensitive to one study (Roberts et al. 2011), and when that study was omitted, the effect disappeared.

Meta-regression of demographic parameters found a significant positive effect on recruitment immediately after the fire (intercept significantly different from zero), but the effect diminished

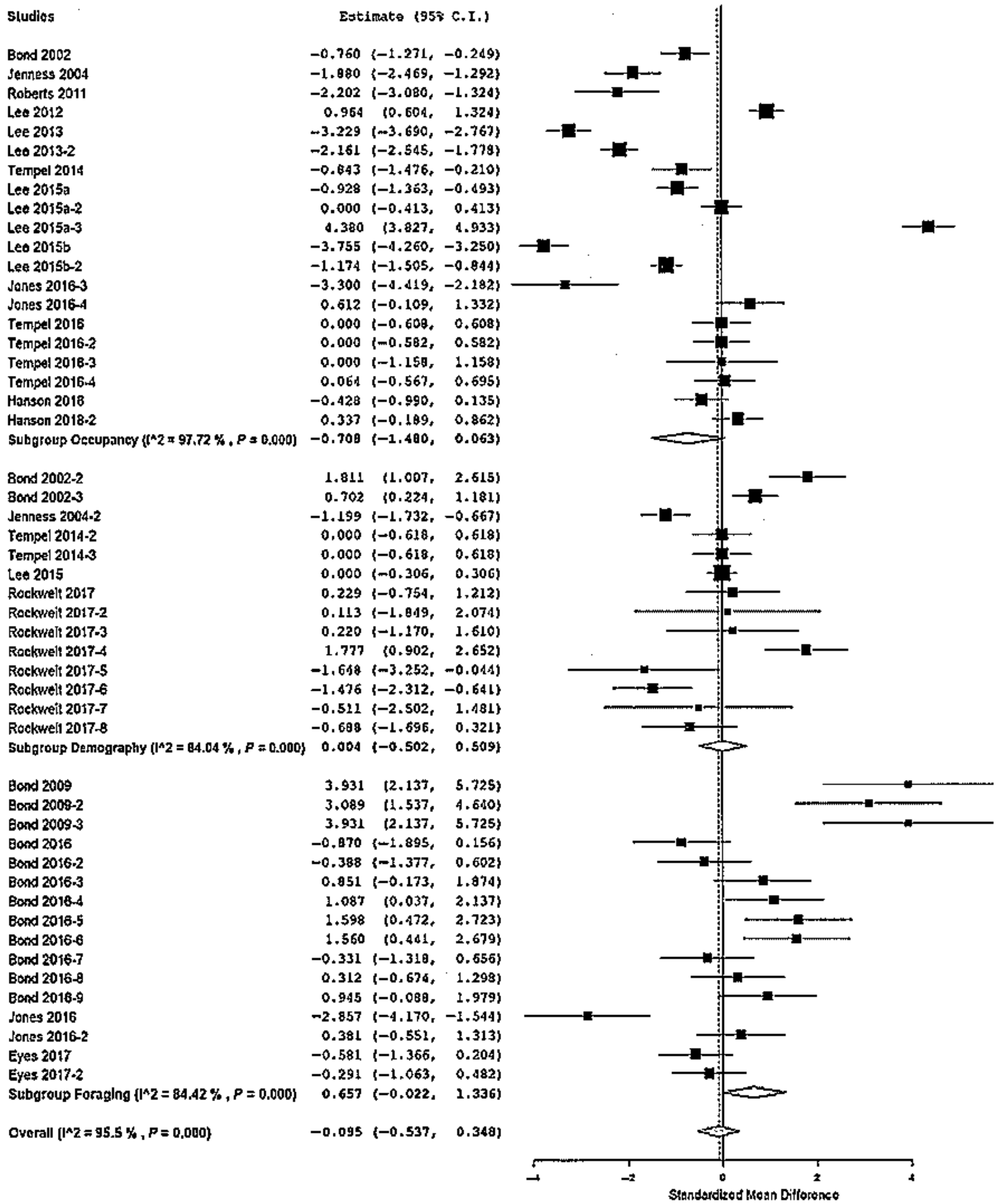

Fig. 2. Forest plot of effect sizes for 50 Spotted Owl (*Strix occidentalis*) parameters (grouped into occupancy, demography, and foraging habitat selection) affected by mixed-severity wildfire as standardized mean difference (Hedge's *d*) between burned and unburned samples. Studies and parameters are listed in Table 2.

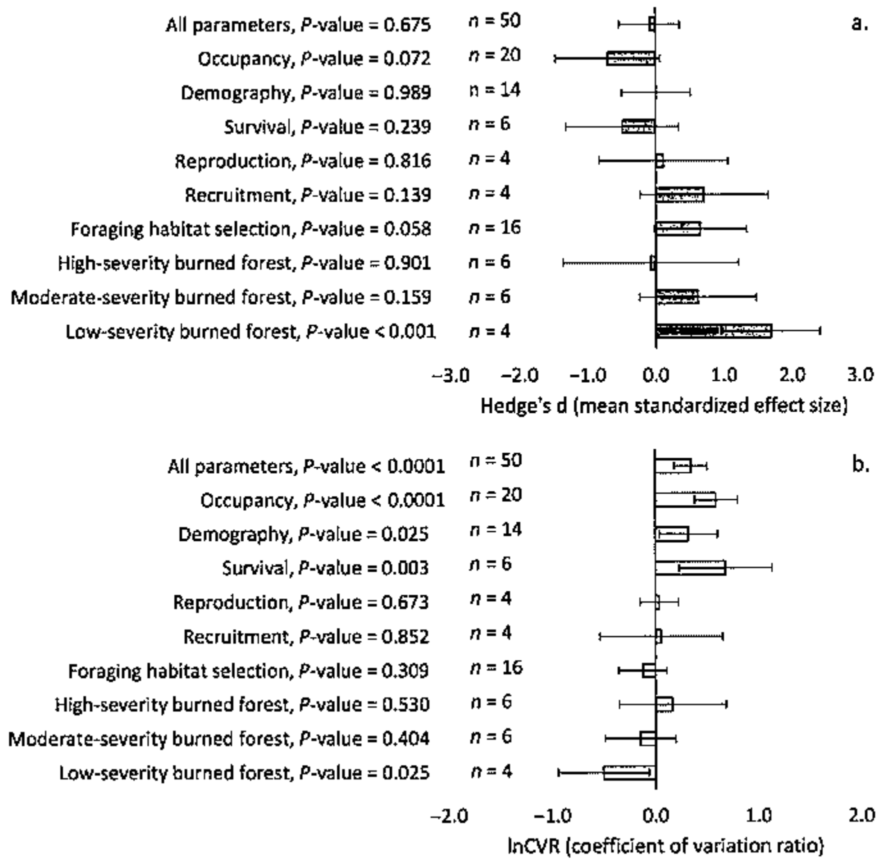

Fig. 3. Results of mixed-effects meta-analyses of mixed-severity fire effects (n = 50 effects from 21 studies) on Spotted Owl (*Strix occidentalis*) parameters grouped by type (occupancy, demography, and foraging habitat selection) and subtype of demography (survival, reproduction, and recruitment), or habitat selection (selection for low-, moderate-, and high-severity burned forest). (a) Hedge's d is standardized mean effect size, and error bars are 95% confidence intervals. The only significant effect (95% confidence intervals excluded zero) was a positive effect of habitat selection for low-severity burned forest. (b) lnCVR is the natural logarithm of the ratio between the coefficients of variation, a measure of differences in variation of parameter estimates between burned and unburned areas. Mixed-severity fire resulted in significantly higher variation in parameter estimates in all parameters, occupancy, demography, and survival, and significantly lower variation in habitat selection for low-severity burned forest.

with time since fire (Fig. 5, Table 4). Reproduction intercept was not significantly different from recruitment (Table 4), and not significantly different from zero ($z = -0.218$, $P = 0.86$), but reproduction was significantly positively correlated with the percent of high-severity fire in owl territories (Fig. 5, Table 4). Survival was significantly lower than recruitment (Table 4), but survival intercept was not significantly different from zero ($z = -0.052$, $P = 0.97$). There were no significant survival effects of time since fire or percent of high-severity fire (Table 4).

Meta-regression of foraging habitat selection parameters found a significant positive selection for low- and moderate-severity burned forest, with high-severity burned forest used in proportion to its availability, but not avoided (Fig. 5, Table 4). Time since fire did not affect foraging habitat selection during the period covered by the studies I examined (up to 7 yr), and the

Table 3. Results from multivariate mixed-effects meta-regression model of mixed-severity fire effects (n = 50 effects from 21 studies) on Spotted Owl (*Strix occidentalis*) parameters related to occupancy, demography, and foraging habitat selection.

Covariates	β	SE	z	P
Intercept (California subspecies)	1.601	1.070	1.497	0.134
Time since fire	−0.199	0.099	−2.017	**0.044**
Percentage of area high-severity fire in study territories	−0.044	0.023	−1.866	0.062
Mix of California, northern, Mexican subspecies	0.467	1.592	0.294	0.769
Mexican subspecies	−1.947	1.608	−1.211	0.226
Northern subspecies	0.360	1.571	0.229	0.819

Notes: SE, standard error. Time since fire was significant, and percent high-severity burn in territory cores was nearly significant, so those effects were included in parameter-specific meta-regressions. Subspecies was not a significant factor, so effects from different subspecies were pooled in subsequent parameter-specific analyses. Bold values are significant at alpha = 0.05.

amount of high-severity fire did not affect habitat selection overall (Table 4).

Post-fire logging had negative effects on Spotted Owls in 100% of the papers that examined this disturbance and where effects from fire and post-fire logging could be differentiated, with large effect sizes (−0.18 occupancy, −0.07 survival).

Discussion

This systematic review and summary of effects from the primary literature indicated Spotted Owls are usually not significantly affected by mixed-severity fire as 83% of all studies and 60% of all effects found no significant impact of fire on owl parameters. Meta-analysis of mean effects found no significant effects of fire on owls, except a positive effect on foraging habitat selection for low-severity burned forest. Meta-regression indicated significant positive effects in recruitment, reproduction, and foraging habitat selection for low- and moderate-severity burned forest. Meta-regression found a significant negative effect of time since fire on occupancy probability. Meta-analysis of variation found mixed-severity fire resulted in greater parameter variation overall, and specifically in occupancy, demography, and survival, and significantly less

Table 4. Table of model coefficients from multi-level linear mixed-effects model meta-regression for effects of mixed-severity fire on Spotted Owls 1987–2018.

Coefficient	β	SE	z	P
Occupancy				
Intercept	1.854	1.115	1.662	0.096
Time since fire	−0.512	0.216	−2.375	**0.018**
Percentage of area high-severity fire in study territories	−0.036	0.022	−1.645	0.100
Demography				
Intercept (Recruitment)	2.328	1.152	2.021	**0.043**
Time since fire (Recruitment)	−0.153	0.065	−2.347	**0.019**
Percentage of area high-severity fire in study territories	−0.032	0.022	−1.466	0.143
Reproduction	−6.479	3.337	−1.942	0.052
Survival	−2.558	1.206	−2.121	**0.034**
Time since fire (reproduction)	0.034	0.422	0.081	0.936
Time since fire (survival)	0.101	0.112	0.900	0.368
Percentage of area high-severity fire (reproduction)	0.234	0.109	2.142	**0.032**
Percentage of area high-severity fire (survival)	0.031	0.033	0.924	0.356
Foraging habitat selection				
Intercept (High severity)	1.167	2.926	0.399	0.690
Time since fire	−0.061	0.529	−0.115	0.908
Percentage of area high-severity fire in study territories	−0.084	0.068	−1.236	0.216
Low severity	1.936	0.732	2.644	**0.008**
Moderate severity	0.777	0.321	2.416	**0.016**

Note: SE, standard error. Bold values are significant at alpha = 0.05.

variation in foraging habitat selection for low-severity burned forest.

These results represent Spotted Owl responses to mixed-severity wildfires that burned within the past 30 yr with representative proportions of high-severity fire in a landscape mosaic. Additionally, because most of the studies in this review reported on effects from wildfire, rather than prescribed fire, the fires and their effects are representative of wildfires as they burned through currently existing forest structure, fire regime, and climate conditions. Several studies have reported that fires during the past few decades have been larger and more severe than the historical mean (Miller and Safford 2012, 2017, Mallek et al. 2013, Steel et al. 2015), but others have disputed this

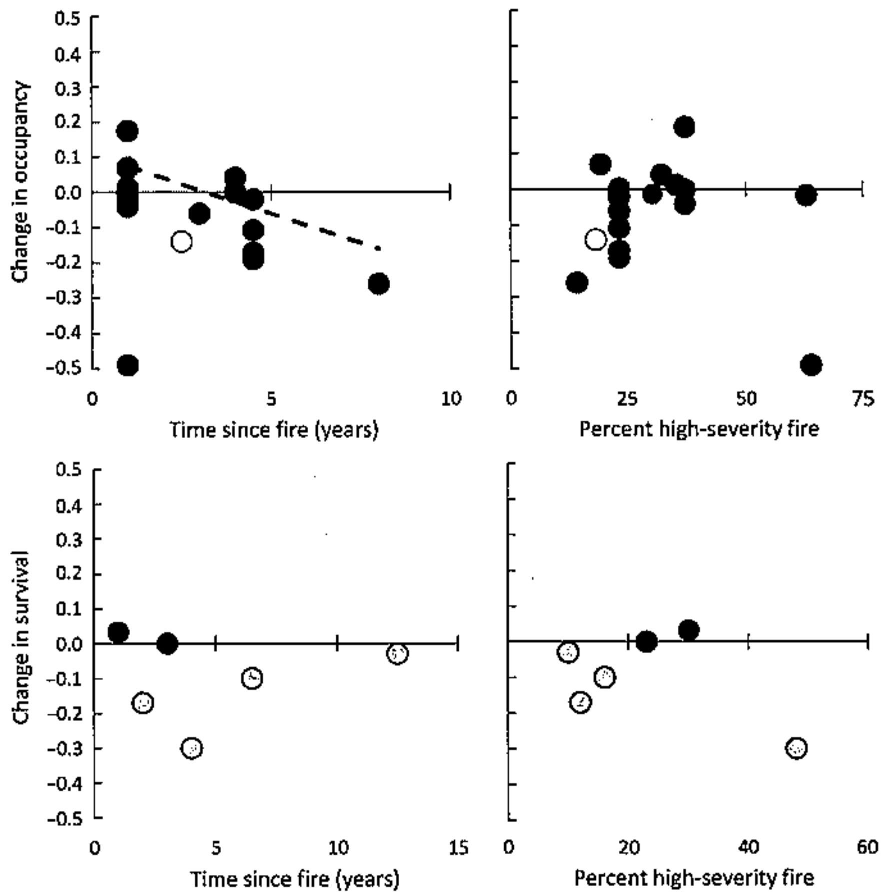

Fig. 4. Results of multi-level linear mixed-effects models (hierarchical models) meta-regression of time since fire and percent of high-severity fire in the study area as covariates to explain heterogeneity in effect sizes from mixed-severity fire on Spotted Owl (*Strix occidentalis*) parameters of breeding site occupancy and survival. The only significant effect was a reduction in occupancy with increasing time since fire, but the effect was sensitive to one study. Symbols indicate subspecies: filled black circles, California; white circles with black outline, Mexican; light gray circles with black outline, northern; and dark gray circles, all three subspecies.

point (Odion and Hanson 2006, Hanson et al. 2009, Odion et al. 2014*a*, Baker 2015*a*). Regardless of what is correct about trends in fire severity, Spotted Owls appear fairly resistant and/or resilient to effects from recent hot, large fires, wherever these fires fall in the long-term range of variability for size and amount of high-severity burn. This is corroborated by the meta-regressions that explicitly quantified the relationship between amount of high-severity fire and Spotted Owl parameters and found only a positive significant correlation (reproduction). My finding of no significant negative relationships between amount of high-severity fire and Spotted Owl parameters demonstrates that large high-severity fire patches, including territories that burn 100% at high severity as was seen in sites within several of the studies in this review, do not have unequivocally negative outcomes for Spotted Owls.

Contrary to current perceptions, recovery efforts, and forest management projects for the Spotted Owl (USFWS 2011, 2012, 2017, USDA 2012, 2018, Gutiérrez et al. 2017) mixed-severity fire as it has been burning in recent decades does not appear to be an immediate, dire threat to owl populations that require landscape-level fuel-reduction

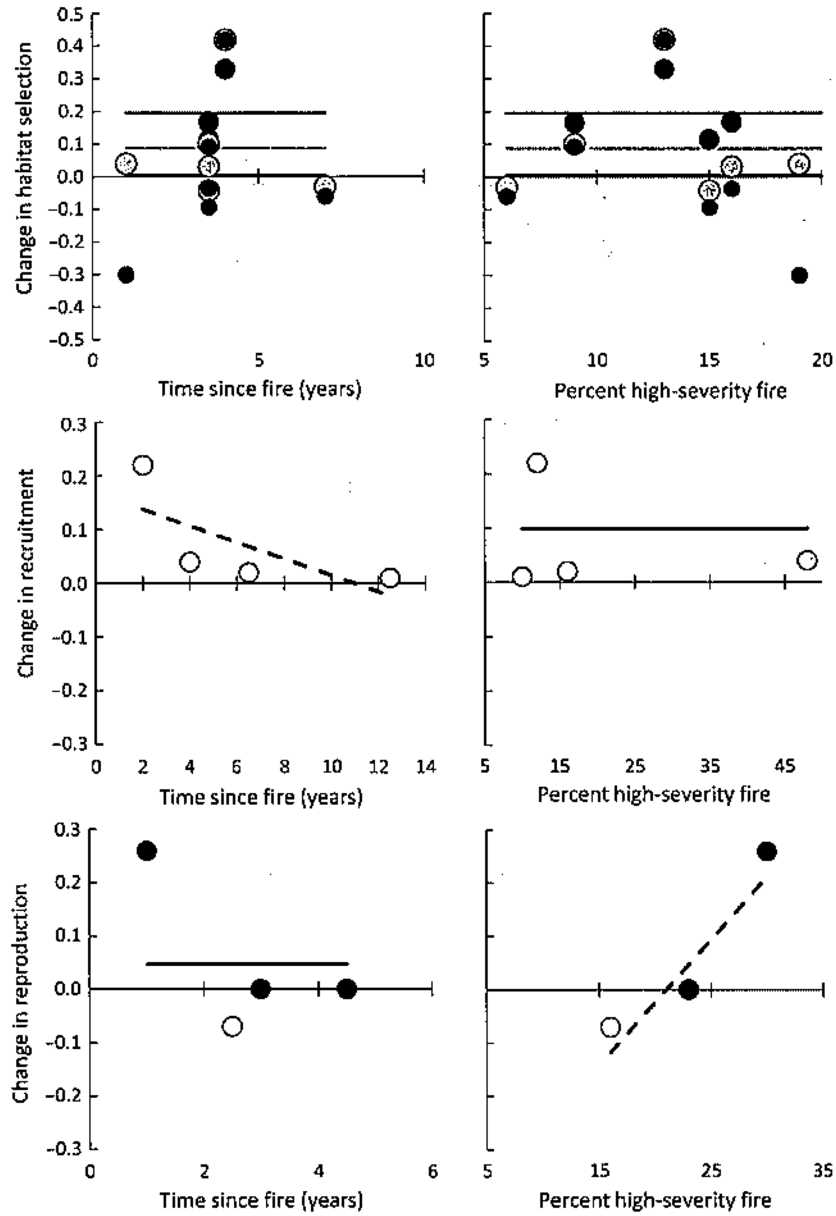

Fig. 5. Results of multi-level linear mixed-effects models (hierarchical models) meta-regression of time since fire and percent of high-severity fire in the study area as covariates to explain heterogeneity in effect sizes from mixed-severity fire on Spotted Owl (*Strix occidentalis*) parameters of foraging habitat selection, recruitment, and reproduction. Significant effects included positive selection for low- and moderate-severity burned forest for foraging, increased recruitment immediately post-fire that diminished with increasing time since fire, and increased reproduction with a positive correlation with amount of high-severity fire. In top two panels, all studies were California subspecies, and colors indicate forest in different burn severity categories: green, low severity; orange, moderate severity; red, high severity. In bottom four panels, symbols indicate subspecies: filled black circles, California; white circles with black outline, Mexican; light gray circles with black outline, northern; and dark gray circles, all three subspecies.

treatments to mitigate fire severity. Empirical studies reviewed here demonstrated that wildfires can generally have no significant effect, but effects can include improved foraging habitat, reduced site occupancy, and improved demographic rates. Most territories occupied by reproductive Spotted Owl pairs that burn remain occupied and reproductive at the same rates as sites that did not experience recent fire, regardless of the amount of high-severity fire in core nesting and roosting areas.

To place my results into perspective, mixed-severity fire typically affects (≥50% vegetation basal area mortality) a very small portion (0.02–0.50%) of Spotted Owl nesting and roosting habitat per year (Odion et al. 2014*b*, Baker 2015*b*, Stephens et al. 2016). Breeding sites that experienced a typical mixed-severity burn mosaic can be expected to have occupancy probability reduced by −0.06 on average. A 0.06 decline in occupancy is less than typical annual declines in occupancy rates observed in the Sierra Nevada in the absence of large fires (Jones et al. 2016: Fig. 3f). In comparison, post-fire logging caused a mean occupancy probability reduction of −0.18.

Post-fire logging is likely to be partially responsible for some of the negative effects attributed to high-severity fire in the studies reviewed here (Tempel et al. 2014, Jones et al. 2016, Rockweit et al. 2017, Hanson et al. 2018). Because Spotted Owl studies typically characterize territory vegetation only in the breeding core area within 1.1 km of the nest, these studies ignore habitat changes and alterations in the year-round home-range area that can extend up to 5.9 km from the nest (Zabel et al. 1992). Spotted Owl habitat protections have generally not included areas beyond 1 km from the nest, a management policy that has not contributed to population recovery.

Complex early seral forests created by fire differ from post-fire salvage-logged forests in that dead trees remain on-site, providing perching sites for hunting owls as well as food sources and shelter for numerous wildlife species (Hutto 2006, Swanson et al. 2011, DellaSala et al. 2014). Longitudinal studies also indicated that burned breeding sites where owls were not detected immediately after fire were often recolonized later (Lee et al. 2012, 2013, Tempel et al. 2016), and this review shows burned forest habitat is used for foraging, demonstrating the mistake of concluding severely burned sites or habitats are lost to Spotted Owls or require restoration (Davis et al. 2016). A recent global meta-analysis found post-fire logging is generally not consistent with ecological management objectives (Thorn et al. 2018).

This review on fire and Spotted Owls forms one portion of the evidence base for data-driven forest management. A recent systematic review of thinning and fire found 56 studies addressing fuel treatment effectiveness in real (not simulated) wildfires from eight states in the western United States (Kalies and Kent 2016). There was general agreement that thin + burn treatments (thinning immediately followed by burning) had some positive effects in terms of reducing fire severity, while treatments by burning or thinning alone were less effective or ineffective (Kalies and Kent 2016). There is also evidence that doing nothing can achieve many forest restoration goals related to age structure and fuels' density (Zachmann et al. 2018). Additional systematic reviews are needed to examine (1) the quantifiable risk of fire to Spotted Owl habitat, as there are disparate lines of evidence regarding whether fire is impeding the recovery of late-seral-stage forests; and (2) the impacts of fuel treatments on Spotted Owl demography and site occupancy. Thinning immediately followed by burning to reduce wildfire risk may or may not have adverse effects on Spotted Owls (Franklin et al. 2000, Dugger et al. 2005, Tempel et al. 2014, 2016, Odion et al. 2014*b*), but the evidence presented here indicates fire itself has arguably more benefits than costs to the species and thus suggests thinning is not necessary.

The results presented here should serve to guide management decisions, but also should be understood as limited by the available data. The sample sizes of number of estimated effects from mixed-severity fire on survival and recruitment were small and limited mainly to the northern subspecies. There were also very few studies from the Mexican subspecies. A few studies presented effect sizes that were influential on results, especially meta-regression results (Roberts et al. 2011), so studies examining longer times since fire are needed. We encourage future studies to increase sample sizes of each parameter and to provide a more balanced sample of studies from all subspecies, and over longer time frames.

Management Implications

The preponderance of evidence presented here shows mixed-severity forest fires, as they have burned through Spotted Owl habitat in recent decades under current forest structural, fire regime, and climate conditions, have no significant negative effects on Spotted Owl foraging habitat selection, or demography, and have significant positive effects on foraging habitat selection, recruitment, and reproduction. Forest fire does not appear to be a serious threat to owl populations and likely imparts more benefits than costs for Spotted Owls; therefore, fuel-reduction treatments intended to mitigate fire severity in Spotted Owl habitat are unnecessary. These findings should inform revisions to planning documents to consider burned forest, including large patches of high-severity burned forest, as useful habitat that imparts significant benefits to Spotted Owls. Forest and wildlife planning documents promote a diverse mosaic of heterogeneous tree densities and ages (USFWS 2017, USDA 2018), the very conditions created by mixed-severity wildfire, and it follows that heterogeneous post-fire structure would lead to greater variation in some Spotted Owl parameters, as was observed in the meta-analysis of variation. Planning documents (USFWS 2011, 2012, 2017, Gutiérrez et al. 2017, USDA 2018) claiming that forest fires currently pose the greatest risk to owl habitat and are a primary threat to population viability appear outdated in light of this review.

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Supporting Information

Additional Supporting Information may be found online at: http://onlinelibrary.wiley.com/doi/10.1002/ecs2.2354/full

The following press release is available on ODFW's website: http://www.dfw.state.or.us/Wolves/wolf_program_updates.asp (last accessed March 20, 2018).

January 16, 2018 – *News Release from US Fish & Wildlife Service and ODFW*

Wolves confirmed in northern portion of Cascades (Wasco County)

THE DALLES, Ore.—At least two wolves are using an area in southern Wasco County, marking the first time multiple wolves have been confirmed in the northern portion of Oregon's Cascade Mountains since they began returning to Oregon in the 2000s.

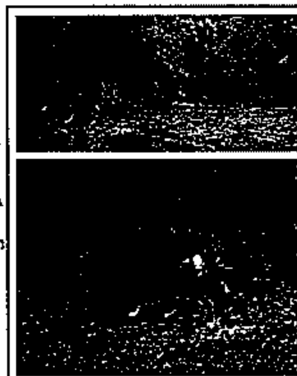
The wolves were documented on the White River Wildlife Area and Mt Hood National Forest and have also been observed on the Warm Springs Indian Reservation.

Several wolves are known to have dispersed through Wasco County in the past few years. A single wolf was documented in the White River Unit in December 2013. In May 2015, a wolf from the Imnaha pack travelled through the area as he dispersed to Klamath County. Later in 2015, a single wolf was documented in Wasco County.

Wolves in Wasco County and anywhere west of Hwys 395-78-95 are protected by the federal Endangered Species Act, so U.S. Fish and Wildlife Service is the lead management agency.

Additional information about Oregon's wolf population will be available in March, after ODFW completes its annual winter surveys and minimum population count.

Contact info.



Images of two wolves in the northern portion of Oregon's Cascade Mountains were captured on remote ODFW cameras on the Mt Hood National Forest. Photos taken Jan. 4, 2018.

UPDATE: At their meeting on Jan. 19 in Salem, Commissioners decided they want to conduct some additional facilitated outreach and postpone final Wolf Plan adoption in hopes of getting more consensus from stakeholders. So the Wolf Plan will not be considered for adoption at the April meeting in Astoria. ODFW will announce a new meeting date when it's scheduled.

Available at: https://dfw.state.or.us/Wolves/ (last accessed August 30, 2018)

Regulating harvest, health, and enhancement of wildlife populations

Wolves in Oregon

Wolf Program Updates

August 29, 2018

Pups for White River Wolves

Report wolf sightings online or call your nearest field office

A new pair of wolves in the White River Unit (southern Wasco County) south of Mt Hood has produced at least two pups this year.

A remote camera on the Warm Springs Indian Reservation first captured images of two pups on Aug. 10. This marks the first known reproduction by wolves in the northern portion of Oregon's Cascade Mountains since wolves began returning to the state in the 2000s.

Wolves in Wasco County and anywhere west of Hwys 395-78-95 are protected by the federal Endangered Species Act, and U.S. Fish and Wildlife Service is the lead management agency.

ODFW, U.S. Fish and Wildlife Service and the Confederated Tribes of Warm Springs are working together to monitor this group of wolves.

Photo shows the breeding male of White River wolves with two pups, taken Aug. 19 by remote camera on the Warm Springs Indian Reservation. Photo courtesy of Wildlife Department BNR-Confederated Tribes of Warm Springs. Click photo to enlarge

August 22, 2018

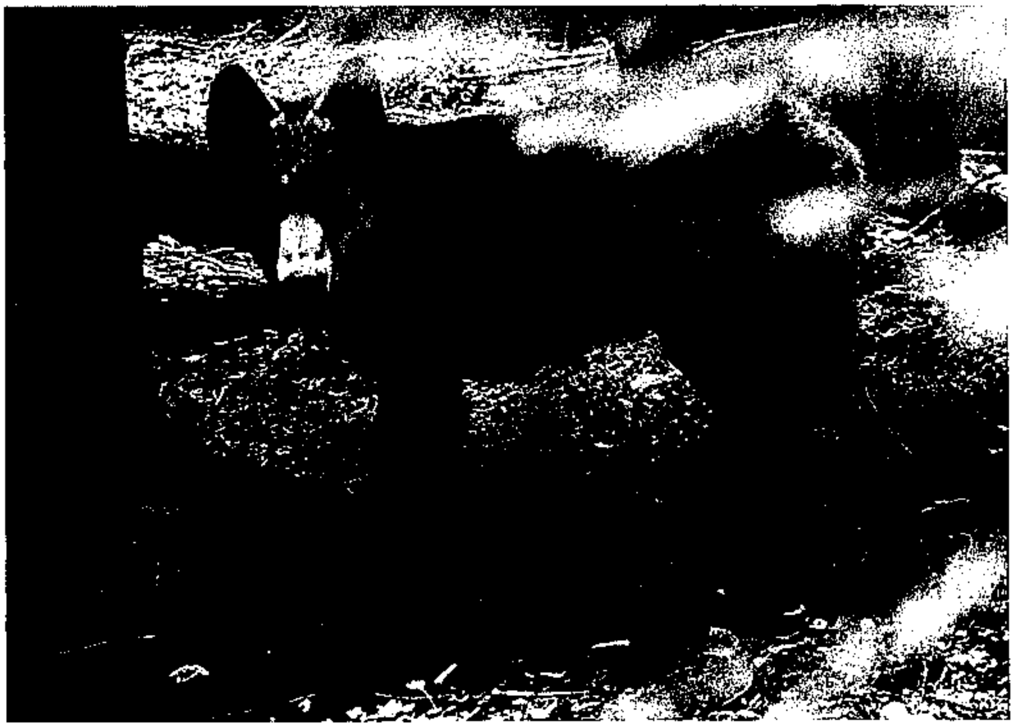
Facilitated meeting with Wolf Plan stakeholders Aug. 30 in The Dalles

SALEM, Ore.—ODFW will host a meeting with Wolf Plan stakeholders on Thursday, Aug. 30 from 9 a.m.-4 p.m. at The Dalles Screen Shop, 3561 Kindt Drive. Stakeholders deeply involved with the Wolf Plan update have been invited to attend.

The topic of the meeting will be the Wolf Plan, which has been undergoing a review and update. Earlier this year, Fish and Wildlife Commissioners decided to postpone final Wolf Plan adoption and conduct additional facilitated outreach in hopes of getting more consensus from stakeholders.

Available at: https://apnews.com/8582a35026ba4042b41e4ac1533a7b04/Wolf-pups-born-in-Oregon's-Cascade-Mountains (last accessed August 30, 2018).

Wolf pups born in Oregon's Cascade Mountains



SALEM, Ore. (AP) — Imagine camping in the forest near Oregon's towering Mount Hood, and hearing wolves howling.

That prospect became more real on Wednesday when state wildlife officials announced that two wolf pups were seen near the mountain for the first time since wolves were exterminated from the state nearly 70 years ago.

A remote camera on the Warm Springs Indian Reservation, whose boundary lies some 10 miles (16 kilometers) south of Oregon's highest mountain, captured images of two pups on Aug. 10, the Oregon Department of Fish and Wildlife announced Wednesday. The department's web site showed a photo taken Aug. 19 of a wolf sitting in grass, looking at two wolf pups whose coats are light brown. One of the pups is looking straight at the camera and seems to be sniffing at it.

Environmentalists celebrated the news.

"Today, we let out a huge howl knowing that a wolf pack is rightly back on the landscape around iconic Mt. Hood after the species was systematically exterminated decades ago," said Josh Laughlin, executive director of Cascadia Wildlands.

The images mark the first known reproduction by wolves in the northern part of the Cascade Mountains in Oregon since wolves began returning to the state in the past decade, said the state wildlife department, which is working with the U.S. Fish and Wildlife Service and the Confederated Tribes of Warm Springs to monitor the wolves.

Wolves in the western two-thirds of the state are protected by the federal Endangered Species Act, and the sighting falls within that area.

Cascadia Wildlands said the state needs to ensure strong state and federal protections remain in place for recovering wolves "so they can continue to re-occupy their historic territories across Oregon."

It said the Oregon Department of Fish and Wildlife is years overdue in revising its Wolf Plan, which guides recovery in the state. The environmental group said it will be present at a stakeholder meeting for the Wolf Plan revision, being held Thursday in the town of The Dalles.

The state wildlife department said Fish and Wildlife Commissioners decided earlier this year to postpone adopting a final Wolf Plan in hopes of getting consensus from stakeholders. Some ranchers in eastern Oregon have seen livestock being killed by wolves. There have been several instances of wolves being poached.

The state wildlife department has said it will reissue a "limited duration kill permit" to a rancher who recently lost a calf to wolves, the fourth depredations to his livestock in northeast Oregon since June. The new permit will allow the rancher or his agent to shoot one wolf on his public land allotment occupied by his livestock.

State wildlife biologists counted 124 wolves in Oregon this past winter, an 11 percent increase over the number counted last year.