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UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NORTHERN CALIFORNIA
EUREKA DIVISION

ENVIRONMENTAL PROTECTION INFORMATION CENTER, CASCADIA WILDLANDS, CONSERVATION NORTHWEST, KLAMATH FOREST ALLIANCE, KLAMATH-SISKIYOU WILDLANDS CENTER, OREGON WILD, and AUDUBON SOCIETY OF PORTLAND, Plaintiffs, v. UNITED STATES FISH AND WILDLIFE SERVICE, an agency in the Department of Interior, Defendants.	Case No. _____ **COMPLAINT FOR DECLARATORY AND INJUNCTIVE RELIEF** (Endangered Species Act of 1973, 16 U.S.C. § 1531 *et seq.*)

INTRODUCTION

1. Plaintiffs Environmental Protection Information Center, Cascadia Wildlands, Conservation Northwest, Klamath Forest Alliance, Klamath-Siskiyou Wildlands Center, and Portland Audubon Society ("Plaintiffs") bring this action for declaratory and injunctive relief against the above-named Defendant ("FWS") for failure to meet mandatory statutory deadlines under 16 U.S.C. § 1533(c)(2) and 16 U.S.C. § 1533(b)(3)(B) of the Endangered Species Act ("ESA").

2. The ESA mandates deadlines for certain agency actions regarding threatened and endangered species. The northern spotted owl is a species that has been listed as threatened since 1990.

3. FWS has failed to complete a five-year review for the northern spotted owl as required by 16 U.S.C. § 1533(c)(2). FWS has also failed to complete a 12-month finding for the northern spotted owl as required by 16 U.S.C. § 1533(b)(3)(B).

JURISDICTION AND VENUE

4. This court has jurisdiction pursuant to 16 U.S.C. § 1540(g)(1) (ESA) and 28 U.S.C. § 1331 (Federal Question).

5. Plaintiffs provided defendants with 60 days' written notice of intent to sue on January 31, 2020, as required by 16 U.S.C. § 1540(g)(2).

6. The relief sought is authorized by 16 U.S.C. § 1540(g) (ESA), 28 U.S.C. § 2201 (Declaratory Judgment), and 28 U.S.C. § 2202 (Injunctive Relief).

7. Venue is proper in this District pursuant to 28 U.S.C. § 1391(e) because a substantial part of the ESA violations alleged in this complaint occurred in this District and a significant portion of the remaining northern spotted owl population impacted by the FWS's unlawful conduct are located in this District.

INTRADISTRICT ASSIGNMENT

8. This case is properly assigned to the Eureka Division under Civil L.R. 3-2(c) because

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several of the Plaintiffs and their members are located in counties within that district. Plaintiffs EPIC and Klamath Forest Alliance both have offices in Humboldt County, California. The habitat of the northern spotted owl, the species at issue in this dispute, is located on lands in Del Norte, Humboldt, Lake, and Mendocino Counties, California. FWS's failure to act, as alleged in this complaint, has impacted northern spotted owl populations in those counties.

PARTIES

9. Plaintiff ENVIRONMENTAL PROTECTION INFORMATION CENTER ("EPIC") is a nonprofit public benefit corporation organized under the laws of California. Since 1977, EPIC has defended the wildlife and wild places of the Klamath Mountains and North Coast Range. EPIC's mission is the science-based protection and restoration of northwest California's forests and seeks to ensure that a connected landscape exists for species survival and climate adaption. EPIC's advocacy utilizes community organizing, public education, collaboration, and litigation and submits substantive comments on projects that would negatively impact public and private forestlands. EPIC maintains an office in Arcata, California. Most of EPIC's 15,000 members and supporters live in northern California. EPIC's members and staff use, enjoy, and recreate on public lands within the range of the northern spotted owl.

10. Ken Hoffman is a member of plaintiff organization EPIC. Mr. Hoffman began working in northern spotted owl habitat for the Forest Service in 1980 as a timber sale planner on the Orleans Ranger District of the Six Rivers National Forest in California. Between 1982 and 1988, Mr. Hoffman was responsible for planning timber sales that clearcut millions of board feet of old-growth Douglas fir, prime northern spotted owl habitat. In 1989, because the northern spotted owl was under consideration for listing under the Endangered Species Act, the Forest Service began to survey for owls on the Six Rivers National Forest. That year, Mr. Hoffman began surveying for spotted owls as part of his timber sale planning duties, and saw his first northern spotted owl in the summer of 1989. Before that experience, he viewed trees in terms of timber volume, but afterwards, saw trees as habitat, and was stunned to realize that he was part

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of a timber sale program that had no plans to either protect any of this habitat or to allow it to regrow.

11. In 1994, Mr. Hoffman took a position with the U.S. Fish and Wildlife Service to work with the Forest Service on implementation of the Northwest Forest Plan. As a Fish and Wildlife Service employee and as part of his duties, Mr. Hoffman utilized survey data, demographic studies, and reports that showed that there were fewer owls and less owl habitat every year. This deeply alarms Mr. Hoffman, because demographic trends indicate that the owl is likely to go extinct within the lifetime of his children unless additional habitat and management actions are not taken to conserve the northern spotted owl. Mr. Hoffman retired from the Fish and Wildlife Service in 2010, but remains interested and committed to furthering northern spotted owl conservation and recovery as well as helping private landowners to sustainably manage their forests in a way that would benefit owl recovery. He regularly visits forests that are home to the northern spotted owl, in the hopes of catching sight of one of these disappearing birds. His last sighting was a few years ago in the City of Arcata's Community Forest; although they have become much more rare, Mr. Hoffman derives great joy knowing that they are likely out there, even when he does not see them.

12. Mr. Hoffman is harmed by FWS' failure to perform its 5-year review and consider uplisting the northern spotted owl. Since 1994, when he first began familiar with demographic studies of the owl, he has been aware that the owl's population is in sharp decline, and has spent countless hours working to help prevent the extinction of the northern spotted owl. That the federal defendant has failed to uphold its obligation to conduct a five-year status review and respond to the uplisting petition harms Mr. Hoffman because it demonstrates that the federal defendant is not trying to prevent the extinction of the owl. His work to protect the owl is directly threatened by federal defendant's refusal to comply with its statutory duties.

13. Plaintiff CASCADIA WILDLANDS is an Oregon non-profit organization based in Eugene, Oregon and with additional offices in Roseburg, Oregon and Cordova, Alaska.

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Representing over 6,000 members and supporters, Cascadia Wildlands is devoted to the conservation of the Cascadia Bioregion, which extends from northern California to southeastern Alaska. Cascadia Wildlands uses a combination of education, organizing, outreach, litigation, advocacy, and collaboration to defend wild places and promote sustainable, restoration-based forestry. Cascadia Wildlands' members use the range of the northern spotted owl for a variety of professional and personal pursuits including viewing threatened and endangered species.

14. Rebecca White, a member of Cascadia Wildlands, is a resident of Oregon and has served as a biological science technician on the Klamath National Forest. She supports Cascadia Wildlands in part because of its advocacy for strong protection for the northern spotted owl. Ms. White carried out northern spotted owl surveys on the Goosenest District and the Happy Camp/Oak Knoll Ranger District of the Klamath National Forest in 2005. Ms. White vividly remembers when she first saw a northern spotted owl in the wild, which was a life-altering interaction for her. A northern spotted owl responded to her survey call and then took a bait mouse to his partner on their nest. The stand of old-growth trees where the nest was located had sheltered generations of owl pairs across several decades, but to Ms. White's understanding, has since been destroyed by wildfires. When Ms. White was working on the Klamath National Forest, she was told that surveyors had begun noting an increase in barred owl appearances and a decrease in northern spotted owl appearances.

15. Ms. White enjoys exploring the native forests of the Northwest and has hiked the backcountry of northwestern California, the Klamath-Siskiyou Crest, the Coast Range, the Olympic Peninsula, and the Cascade Range in Oregon and Washington. She values those areas because of their mature and old-growth forests which the northern spotted owl calls home and depends on for survival. Ms. White has concrete future plans to backpack and hike throughout the range of the northern spotted owl, particularly in mature and old-growth forests that are well-suited owl habitat, as soon as she is able given social distancing requirements related to the global pandemic. It is her hope that she will encounter a northern spotted owl during one of those

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future visits. However, Ms. White has not observed a northern spotted owl in the wild since 2005. She has seen several barred owls. To Ms. White, the northern spotted owl is a symbol of untamed wilderness, spiritual renewal, and a livable planet. Ms. White believes that the continued decline and possible extinction of the northern spotted owl would be an incalculable loss to her personally and to the planet as a whole, and believes that federal defendant has shirked its legal obligation to ensure against the extinction of the species.

16. Plaintiff CONSERVATION NORTHWEST is a non-profit regional conservation organization founded in 1989, based in Seattle, Washington, with a mission to protect and connect habitat, and restore imperiled wildlife from the Pacific Coast to the Canadian Rockies. Conservation Northwest has over 17,000 members and supporters, and engages in science-based advocacy through collaboration on projects that protect wildlife habitat and restore forest and watershed ecological resilience. Conservation Northwest is an active voice strongly advocating for imperiled species such as the northern spotted owl, marbled murrelet, Canada lynx, grizzly bear, wolf, wolverine, sage grouse, pygmy rabbit, and woodland caribou. Conservation Northwest and its members use, enjoy, recreate and other pursuits on public lands within the range of the northern spotted owl.

17. Plaintiff KLAMATH FOREST ALLIANCE ("KFA") is a non-profit community organization founded in 1989, based in Orleans, California. Its mission is to promote sustainable ecosystems and sustainable communities of the Klamath-Siskiyou Mountain region. KFA participates in forest planning through agency engagement, substantive comments and collaboration and uses law, science, place-based knowledge and conservation advocacy to defend the biodiversity, wildlife, waters and mature forests of the Klamath-Siskiyou bioregion. KFA's members and staff use, enjoy, and recreate on public lands within the range of the northern spotted owl.

18. Kimberly Baker is the Executive Director of KFA and is also a member. In the twenty-two years of working with the organization, Ms. Baker has commented on and monitored nearly

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every timber sale on the Klamath and Six Rivers National Forests, and for the past thirteen years on the Shasta-Trinity and Mendocino National Forests. Because of her years of research and on-the-ground monitoring, Ms. Baker has an intimate place-based knowledge of specific northern spotted owls, their nest sites, and their preferred habitat throughout Northern California. Ms. Baker has personally witnessed and reported on the "take" of spotted owls by the United States Forest Service, as authorized by the defendant. Further, Ms. Baker has witnessed thousands of acres of habitat removal and degradation and the abandonment of nests due to logging, wildfire, post-fire logging, and barred owl encroachment. Ms. Baker's interests are harmed by federal defendant's failure to comply with its statutory obligations to conserve and recover the northern spotted owl.

19. Plaintiff KLAMATH-SISKIYOU WILDLANDS CENTER ("KS Wild") is a domestic non-profit corporation organized and existing under the laws of the State of Oregon. KS Wild's main offices are in Ashland, Oregon. KS Wild has over 3,500 members and supporters in more than 10 states, with most members concentrated in southern Oregon and northern California. On behalf of its members, KS Wild advocates for the forests, wildlife, and waters of the Rogue and Klamath Basins and works to protect and restore the extraordinary biological diversity of the Klamath-Siskiyou region of southwest Oregon and northwest California. KS Wild uses environmental law, science, education, and collaboration to help build healthy ecosystems and sustainable communities. Through its campaign work, KS Wild strives to protect the last wild areas and vital biological diversity of the Klamath region. KS Wild is a leader in protecting public lands and routinely participates in commenting, monitoring, and litigation affecting public lands and the natural resources located there. KS Wild's members and staff use, enjoy, and recreate on public lands within the range of the northern spotted owl.

20. Plaintiff OREGON WILD is a non-profit corporation with approximately 7,000 members and supporters throughout the state of Oregon and the Pacific Northwest. Oregon Wild and its members are dedicated to protecting and restoring Oregon's lands, wildlife, and waters as an

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enduring legacy. Oregon Wild members use the range of the northern spotted owl for hiking, recreation, bird watching, nature appreciation, and other recreational and professional pursuits.

21. Plaintiff AUDUBON SOCIETY OF PORTLAND ("Audubon") is a non-profit organization founded in 1902 based in Portland, Oregon, with 17,000 members in Oregon, sanctuaries in Portland, near Mt. Hood, and in the Oregon Coast Range. Audubon's mission is to inspire all people to love and protect birds, wildlife, and the natural environment upon which life depends. Audubon works to protect northern spotted owls and other native wildlife through science-based advocacy and environmental education, Audubon has a long history of working to protect northern spotted owls including serving as petitioner on the original August 1987 petition to list the northern spotted owl under the Endangered Species Act. For more than three decades, Audubon has remained actively involved in conservation and recovery of the northern spotted owl, serving on multiple advisory committees, advocating for stronger protections, engaging and educating the public on issues related to northern spotted owls, rehabilitating northern spotted owls at our Wildlife Care Center, and periodically housing non-releasable northern spotted owls for use as federally licensed educational animals. Audubon members regularly use the range of the northern spotted owl for a variety of professional and personal pursuits including viewing threatened and endangered species.

22. Robert Sallinger is a "life" member of Audubon, and has worked at Portland Audubon since 1992, currently serving as the Conservation Director. Mr. Sallinger has previously held the positions of Wildlife Care Center Director and Urban Conservation Director within the organization. He has a BA in biology from Reed College and a JD from Lewis and Clark Law School. Mr. Sallinger has personally been involved with spotted owls in a variety of personal and professional capacities, and consider the opportunity to see, and work with and on behalf of northern spotted owls among his most treasured experiences. As a lifelong birder, he considers the opportunities that he has had to see northern spotted owls in the wild as among his most valued birding experiences, and consider them to be too few and far in-between. Mr. Sallinger

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also highly values the ancient forest habitat of the northern spotted owl, and regularly camps, hikes, and birds in old growth forest habitat in Oregon and Washington that is home to spotted owls.

23. In his roles as a wildlife rehabilitator, Wildlife Care Center Staffer, and Conservation Director for Portland Audubon, Mr. Sallinger has both directly and indirectly overseen the rehabilitation for release back to the wild of several northern spotted owls at Audubon's Wildlife Care Center under permits issues by the federal defendant and Oregon Department of Fish and Wildlife. He has also worked with non-releasable educational northern spotted owls held at Audubon, also under permits issued by the federal defendant. In particular, Mr. Sallinger worked with a northern spotted owl named Hazel who was held at Audubon from 2004-2016. Hazel was found on Mt. Hood with non-repairable injuries to her wing and eye, and was an incredible bird that allowed thousands of families to see a bird up close that they might never see in the wild and educate them about the challenges facing spotted owls. Currently, Mr. Sallinger is working with a non-releasable spotted owl that Audubon intends to transfer to a spotted owl breeding facility (for reintroduction to the wild) in British Columbia. As soon as permits are authorized by the federal defendant, Mr. Sallinger will drive this owl to the United States-Canadian border in order to place the bird into the breeding program in time for the spring 2021 breeding season.

24. Mr. Sallinger's interests, and those of Audubon, are irreparably harmed by the federal defendant's failure to timely consider and respond to the petition to uplist the northern spotted owl from threatened to endangered under the Endangered Species Act. He believes the best available science clearly demonstrates that the northern spotted owl warrants uplisting under the Endangered Species Act and that the failure of federal defendant to meet mandatory statutory deadlines puts the northern spotted owl at risk of extinction in Oregon.

25. Plaintiffs' members and staff derive esthetic, educational, conservation, recreational, educational, and scientific benefits from the northern spotted owl's continued existence and preservation in the wild. Observing the owl in the wild and being aware of its presence there as

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well as the health of its habitat offers benefits to Plaintiffs' members and staff. Plaintiffs' members and staff have visited northern spotted owl habitat across the Northwest to witness the owl and the forests where it lives. The failure to complete actions mandated by the ESA has caused direct injury to Plaintiffs' members and staff. Those injuries would be redressed by the relief requested in this complaint.

26. Defendant, UNITED STATES Fish and Wildlife Service ("FWS") is a federal agency within the Department of the Interior. FWS is responsible for administering the ESA with respect to wildlife and is responsible for completing 12-month findings and five-year status reviews of listed species like the northern spotted owl.

BACKGROUND

The Endangered Species Act

27. The ESA was enacted in 1973 based on Congressional findings that fish, wildlife, and plants provide "esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people," that various species had already gone extinct due to "economic growth and development untempered by adequate concern and conservation," and that other species' numbers had dropped so low that they were "in danger of or threatened with extinction." 16 U.S.C. § 1531(a). Congress's intent in enacting the ESA was to "halt and reverse the trend toward species extinction, whatever the cost." Tennessee Valley Auth. v. Hill, 437 U.S. 153, 184 (1978).

28. The purpose of the ESA is to "provide a program for the conservation of…endangered species and threatened species" and to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." 16 U.S.C. § 1531(b).

29. As part of its conservation program, the ESA provides a method for a species to be listed as either endangered or threatened. A list of all endangered species and a second list of all threatened species must be kept and published in the Federal Register. 16 U.S.C. § 1533(c)(1).

30. The ESA defines an endangered species as "any species which is in danger of extinction

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throughout all or a significant portion of its range." 16 U.S.C. § 1532(6).

31. The ESA defines a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1532(20).

32. A species listed as endangered receives greater protection (for the species itself as well as its habitat) than one listed as threatened, since it is closer to completely disappearing.

33. Once a species is listed as endangered or threatened, the ESA sets mandatory deadlines for certain federal agency actions. One of those deadlines requires a status review of all listed species "at least once every five years." 16 U.S.C. § 1533(c)(2). The review is used to determine "whether any such species should (i) be removed from such list; (ii) be changed in status from an endangered species to a threatened species; or (iii) be changed in status from a threatened species to an endangered species." Id. That periodic review is also reflected in the ESA's implementing regulations at 50 C.F.R. § 424.21.

34. The ESA permits interested parties to petition to add, remove, or reclassify a species from listing as either endangered or threatened. 16 U.S.C. § 1533(b)(3)(A). The requirements and procedures for petitions are described in the ESA's implementing regulations at 50 C.F.R. § 424.14.

35. The ESA and its implementing regulations mandate that, upon a finding that a petition presents "substantial information indicating that the petitioned action may be warranted," the Secretary of the Interior shall make a 12-month finding determining whether the action is warranted. 16 U.S.C. § 1533(b)(3)(B); 50 C.F.R. §§ 424.14(f), (h). If the action is warranted, the Secretary must also publish a "proposed regulation to implement such action" or an explanation as to why a timely regulation is precluded along with "a description and evaluation of the reasons and data on which the finding is based." 16 U.S.C. § 1533(b)(3)(B).

36. The ESA also provides that federal courts "shall have jurisdiction…to order the Secretary to perform" acts or duties mandated by the ESA. 16 U.S.C. § 1540(g)(1)(C).

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The Northern Spotted Owl (*Strix occidentalis caurina*)

37. The northern spotted owl is a medium-sized brown owl with dark eyes and whitish spots on its head, neck, and breast. The owl inhabits structurally complex forests in the Pacific Northwest, from Washington State to Marin County, California. The owl prefers old-growth forests, which contain large trees that take at least 150 years to mature, and a multi-layered, high forest canopy. Because of their sensitivity and need for a particular type of habitat, northern spotted owls are referred to as an indicator species. Within an old-growth forest ecosystem, the presence of spotted owls is an indicator that the forest ecosystem is healthy.

38. The owl prefers to occupy forest stands that have many large trees with cavities and platforms for nesting. Adult owls reach maturity at two years of age. If two northern spotted owls form a mating pair, they remain paired for life. Owl pairs do not nest every year. When they do, the female adult lays an average of two eggs. The owl invests significant time into caring for its young. The male owl hunts and forages and brings the female food while she primarily cares for the young owlets.

39. Nesting pairs require large amounts of land for hunting and nesting. The owl is primarily nocturnal, subsisting on a diet mostly consisting of small mammals.

40. In the past, researchers have noted that northern spotted owls are relatively unafraid of humans. This lack of fear is due to the owl's limited exposure to humans, since it lives deep in dense forests, far from human activity. Northern spotted owls are known to respond to humans mimicking or playing recordings of their calls by coming down from the canopy to get a closer look at forest visitors. This has occurred less frequently over time, likely due to the increasing presence of the competing barred owl and the continued decrease in northern spotted owl populations.

41. There has been widespread loss of spotted owl habitat across its range as a result of timber harvesting in the Northwest. Endangered and Threatened Wildlife and Plants; Designation of Rev. Critical Habitat for the Northern Spotted Owl, 77 Fed. Reg. 71,875 (Dec. 4, 2012). Loss

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of habitat continues to be exacerbated by past logging, climate change, and its effects on wildfires, insect predation, and disease. Id.

42. Those factors and others, like the increasingly frequent presence of the barred owl in the northern spotted owl's habitat, have led to sharp decreases in total population and increasingly isolated population segments, which are more vulnerable.

43. In 1990, FWS listed the northern spotted owl as threatened throughout its range under the ESA "due to loss and adverse modification of spotted owl habitat as a result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms." Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Northern Spotted Owl, 55 Fed. Reg. 26,114 (June 26, 1990).

44. The listing notice stated that the owl faced low and declining populations, limited and declining habitat, inadequate habitat and population distribution, isolated populations, predation and competition, lack of adequate conservation and regulatory measures, and vulnerability to natural disturbance. Id.

45. Even after its listing, northern spotted owl populations have continued to decline. While the level of timber harvest has been reduced since the time of the owl's listing, timber harvest continues to occur on public and private land that constitutes suitable northern spotted owl habitat.

46. Despite the continued decline of suitable northern spotted owl habitat, in August 2020 FWS initiated a rulemaking to revise the owl's critical habitat by newly excluding over 200,000 acres of its habitat in Washington and Oregon from protection. Endangered and Threatened Wildlife and Plants; Rev. Designation of Critical Habitat for the Northern Spotted Owl, 85 Fed. Reg. 48,487 (Aug. 11, 2020). The rulemaking was prompted by a settlement agreement with the timber industry. Stipulated Settlement Agreement and [Proposed Order], Carpenters Industrial Council v. Bernhardt, No. 13-cv-00361-RJL (D.D.C. Apr. 13, 2020) ECF No. 126; Order on Stipulated Settlement Agreement, Carpenters Industrial Council (D.D.C. Apr. 26, 2020), ECF

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No. 127.

47. An increase of wildfires in both frequency and intensity also continues to cause habitat loss and is a direct threat to the owl's survival.

48. In addition to habitat loss, there is also a second major threat to the northern spotted owl's continued survival: barred owls. Barred owls are not native to the Pacific Northwest but began arriving from the eastern United States approximately 70 years ago.

49. More recently, barred owls have increasingly displaced spotted owls, disrupting their nesting, and competing with the smaller spotted owl for food. Barred owls are larger, more aggressive, and have a more varied diet than the northern spotted owl, making them more adaptable. Researchers have also witnessed barred owls killing spotted owls. Barred owls have had a severe detrimental effect on the northern spotted owl population, now outnumbering the northern spotted owl throughout its range. Barred owls' increasing presence in northern spotted owl habitat has led to the species' further decline.

Plaintiffs' Petition to Reclassify the Northern Spotted Owl's Listing to Endangered

50. On August 21, 2012, FWS received a petition from Plaintiffs requesting that the northern spotted owl's listing status be reclassified from threatened to endangered, pursuant to the ESA and its implementing regulations. Plaintiffs' petition detailed the reasons this reclassification was warranted, including the owl population's continued and steep decline across its range, the increase in that rate of decline, the owl's historic and ongoing loss of habitat, and the invasion of barred owls into its territory.

51. On April 10, 2015, FWS announced it had made a 90-day finding on Plaintiffs' petition. FWS found that the Plaintiffs' petition to uplist the northern spotted owl as endangered presented "substantial scientific or commercial information indicating that the petitioned [action was] warranted." Endangered and Threatened Wildlife and Plants; 90-Day Findings on 10 Petitions, 80 Fed. Reg. 19,259 (Apr. 10, 2015).

52. In the 90-day finding, FWS stated that it was "initiating review of the status" of the

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northern spotted owl, and that, based on the review, it would issue a 12-month finding which would address "whether the petitioned action is warranted, as provided in section 4(b)(3)(B) of the [ESA]." Id. Additionally, FWS stated that the owl's status review would also serve as a five-year review for the species. Id.; 16 U.S.C. § 1533(c)(2).

53. On January 31, 2020, Plaintiffs sent FWS a 60 day notice of intent to sue for violations of the ESA, specifically FWS' failure to take appropriate timely action on Plaintiffs' petition to uplist the northern spotted owl to endangered, and to conduct a 5 year status review of the species.

54. Plaintiffs' 60 day notice is attached as Exhibit A to this Complaint.

55. On March 25, 2020, FWS responded to Plaintiffs' 60 day notice, stating "we are close to completing the 12-month finding on the petition, and we currently expect to send the finding to the Federal Register in summer 2020. The 12-month finding will also serve as a 5-year review for the northern spotted owl."

56. As of the date of the filing of this Complaint, FWS has neither published any finding in the Federal Register nor otherwise taken the requisite actions required by law.

57. It has been five and a half years since FWS issued a 90-day finding that uplisting the northern spotted owl was warranted, triggering the 12-month finding process in April 2015.

58. FWS has failed to complete a 12-month finding mandated by the ESA at 16 U.S.C. § 1533(b)(3)(B) for the northern spotted owl.

59. It has been over nine years since FWS completed a five-year review for the northern spotted owl. In its March 25, 2020 letter, FWS also affirmed its prior statement that the 12-month finding would also serve as a five-year status review for the owl.

60. FWS has failed to complete the five-year review mandated by the ESA at 16 U.S.C. § 1533(c)(2) for the northern spotted owl.

61. The northern spotted owl population has continued to decline as FWS fails to act and is in grave danger of extinction.

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CLAIMS FOR RELIEF
FIRST CLAIM FOR RELIEF
Violation of the Endangered Species Act (16 U.S.C. § 1533(c)(2)): Failure to Complete Five Year Status Review

62. Plaintiffs incorporate by reference all preceding paragraphs.

63. FWS is required to complete a five year review of all species listed as endangered and threatened under 16 USC § 1533(c)(2) of the ESA and 50 C.F.R. § 424.21 of the Act's implementing regulations.

64. FWS last completed a status review for the northern spotted owl in 2011. FWS has failed to complete a statutorily mandated five-year review of the owl and has not completed a status review in the past nine years, thus violating the ESA. 16 U.S.C. 1533(c)(2); 50 C.F.R. § 424.21.

SECOND CLAIM FOR RELIEF
Violation of the Endangered Species Act (16 U.S.C. § 1533 (b)(3)(B)): Failure to Complete 12-Month Finding

65. Plaintiffs incorporate by reference all preceding paragraphs.

66. Upon a finding that a petition submitted under the ESA may be warranted, FWS is required to complete a 12-month finding under 16 U.S.C. § 1533(b)(3)(B) of the ESA and 50 C.F.R. § 424.14 of the Act's implementing regulations.

67. In August 2012, Plaintiffs petitioned FWS to change the owl's listing status to endangered. In April 2015, the FWS found that reclassifying the owl to endangered may be warranted, thereby triggering the 12-month review and finding mandated by 16 U.S.C. § 1533(b)(3)(B) of the ESA. Endangered and Threatened Wildlife and Plants; 90-Day Findings on 10 Petitions, 80 Fed. Reg. 19,259 (Apr. 10, 2015).

68. FWS has failed to complete the statutorily-mandated 12-month review and finding after concluding that elevation of the northern spotted owl's listing from threatened to endangered may be warranted, and is therefore in violation of the ESA. 16 U.S.C. § 1533(b)(3)(B); 50 C.F.R. § 424.14.

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PRAYER FOR RELIEF

THEREFORE, Plaintiffs respectfully request that the Court:

1. Enter a declaratory judgment that FWS' failure to complete a five-year review and to complete a 12-month finding for the northern spotted owl violates the ESA;

2. Order FWS to complete a five-year review and publish the findings by a date certain to be set at the earliest possible time;

3. Order FWS to complete a 12-month finding and publish the findings by a date certain to be set at the earliest possible time;

4. Enjoin FWS from authorizing actions that are likely to adversely affect or result in incidental take of northern spotted owls until FWS has completed a five-year review and 12-month finding;

5. Grant Plaintiffs such further and additional relief as the Court may deem just and proper; and

6. Award Plaintiffs their reasonable fees, costs, and expenses, including attorney's fees, associated with this litigation.

DATED this 8th day of December, 2020.

Respectfully submitted,

Thomas Wheeler

_____

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EXHIBIT A

Sent via Email and U.S. Mail

January 31, 2020

The Honorable David Bernhardt
Secretary of the Interior
1849 C Street NW
WDC 20240
officeofthesecretary@ios.doi.gov

Director Aurelia Skipwith
U.S. Fish and Wildlife Service
1849 C Street, NW
Washington, DC 20240
Aurelia_skipwith@ios.doi.gov

Re: Notice of Violations of the Endangered Species Act and its Regulations Regarding the Northern Spotted Owl

Dear Secretary Bernhardt and Director Skipwith,

On behalf of the Environmental Protection Information Center, Klamath-Siskiyou Wildlands Center, Western Environmental Law Center, American Bird Conservancy, Cascadia Wildlands, Oregon Wild, Pilchuck Audubon Society, Northcoast Environmental Center, Safe Alternatives for our Forest Environment, Forest Issues Group, Lassen Forest Preservation Group, Sierra Foothills Audubon Society, and South Umpqua Rural Community Partnership, we hereby provide notice, pursuant to Section 11(g) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1540(g), that the U.S. Fish and Wildlife Service (Service or USFWS) is in violation of Sections 4(c)(2) and 4(b)(3)(B), 16 U.S.C. §§ 1533(c)(2) and 1533(b)(3)(B) because of its failure to take legally-mandated actions that may affect the protections afforded to the northern spotted owl. Failure to take corrective actions may result in legal action. If legal action is pursued, we will seek to recover attorney fees and other costs of the litigation.

The northern spotted owl (*Strix occidentalis caurina*) is a medium-sized brown owl that inhabits structurally complex forests from Washington[1] to Marin County, California. In 1990, the Service listed the species as "threatened" because of widespread loss of spotted owl habitat across the spotted owl's range and the inadequacy of existing regulatory mechanisms to conserve the spotted owl.

The northern spotted owl is in steep decline across its range and that rate of decline is increasing. Dugger et al. (2016). If left unchecked, in the near future, the northern spotted owl could be absent from large portions of its habitat, if not functionally extinct. Dunk et al. (2019). The

[1] The owl once inhabited British Columbia but the species is now functionally extinct there and a captive breeding program is underway.

reasons for the owls declines are multi-causal, but are primarily caused by two prime stressors: historic and ongoing habitat loss and competition with barred owls.

In response to new information, the Environmental Protection Information Center petitioned the Service to reclassify or "uplist" the owl to "endangered" in August 2012. In April 2015, the Service found that reclassification as endangered may be warranted, thereby triggering a 12-month review. After that announcement, no action has been taken to either review the status of the species or to complete the listing process as required by law.

Failure to Complete Updated Status Review

The Service is mandated to maintain a list of species determined to be endangered and threatened, and "at least once every five years," conduct a review of all species to determine whether any species should be removed, changed in status from endangered to threatened, or changed in status from threatened to endangered. 16 U.S.C. § 1533(c)(2). These five-year reviews are commonly referred to as "status reviews." The most recent status review for the northern spotted owl was completed in 2011.

To avoid litigation, the Service must begin a status review process for the northern spotted owl and provide a date-certain by which the review will be complete. In conducting the status review, the Service is obligated to make its determination "solely on the basis of the best scientific and commercial data available." 16 U.S.C. § 1533(b)(1)(A). To aid the Service, EPIC has compiled a non-exhaustive summary of science published on the owl between 2011 reclassification petition and present. (Attached here as "Attachment A.")

Failure to Complete 12-Month Finding

Upon a finding that a petition submitted under the ESA may be warranted, the Service must complete a 12-month finding, as described in 16 U.S.C. 1533(b)(3)(B). The Service has failed to complete a 12-month finding as required by law and is, indeed, over 36 months behind.

On April 10, 2015, the Service announced that reclassification may be warranted. 80 FR 19259. This action started the 12-month clock, with a finding required by April 2016. In a separate "Frequently Asked Questions" document published by the Service to accompany the decision, the Service stated that it would complete an updated five-year status review and that this status review would "also serve as a 12-month finding." USFWS (2015).

To avoid litigation, the Service must provide a date certain by which it will complete a 12-month finding.

Conclusion

For the above stated reasons, U.S. Fish and Wildlife Service has violated and remains in ongoing violation of Sections 4(c)(2) and 4(b)(3)(B) of the ESA, 16 U.S.C. §§ 1533(c)(2). If these violations of law are not cured within sixty days, we intend to file suit for declaratory and injunctive relief, as well as attorney fees and costs. 16 U.S.C. § 1540(g). If you believe that any of

the foregoing is inaccurate or otherwise would like to discuss this notice letter, please contact Tom Wheeler of the Environmental Protection Information Center at (707) 822-7711 or tom@wildcalifornia.org and Susan Jane Brown of the Western Environmental Law Center at 503-914-1323 or brown@westernlaw.org.

Sincerely,

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cc:

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Citations

Dugger, Katie M., et al. "The effects of habitat, climate, and Barred Owls on long-term demography of Northern Spotted Owls." *The Condor: Ornithological Applications* 118.1 (2015): 57-116.

Dunk, Jeffrey R., et al. "Conservation planning for species recovery under the Endangered Species Act: A case study with the Northern Spotted Owl." *PloS one* 14.1 (2019): e0210643.

U.S. Fish and Wildlife Service. "Frequently Asked Questions: U.S. Fish & Wildlife Service Status Review of Northern Spotted Owl." (2015). Available at https://www.fws.gov/oregonfwo/Species/Data/NorthernSpottedOwl/Documents/FAQ90-dayPetition4-7-15.pdf.

Attachment A

Northern Spotted Owl:

Baker, W. L. (2015). Historical northern spotted owl habitat and old-growth dry forests maintained by mixed-severity wildfires. *Landscape Ecology, 30*(4), 655-666. doi:http://dx.doi.org/10.1007/s10980-014-0144-6

> Reconstructing historical habitat could help reverse declining animal populations, but detailed, spatially comprehensive data are rare. For example, habitat for the federally threatened Northern spotted owl (NSO; Strix occidentalis caurina) was thought historically rare because low-severity fires kept forests open and habitat restricted to fire refugia, but spatial historical data are lacking. Here I use public land-surveys to spatially reconstruct NSO habitat and old-growth forests in dry forests in Oregon's Eastern Cascades in the late-1800s. I used reconstructions of forest structure across about 280,000 ha, including 9,605 tree records and 2,180 section-line descriptions. I was able to reconstruct likely NSO nest trees, nest stands, and foraging and roosting habitat, based on modern NSO habitat studies. Historical nest stands, including sufficient nest trees, were predicted across 22-39 % and foraging and roosting habitat across 11-68 % of the study area, thus neither were rare. More habitat than expected occurred in forests with preceding mixed-severity fires. Early post-fire succession produced foraging and roosting habitat. Mid- to late-succession produced nesting habitat. Late-succession after high-severity fires can also provide NSO habitat. Old-growth forests, covering 76 % of study-area forests, also likely link to preceding mixed-severity fires. Mixed- and high-severity fires strongly shaped historical dry forests and produced important components of historical NSO habitat. Focus on short-term loss of nest sites and territories to these fires is mis-directed. Fuel treatments to reduce these natural fires, if successful, would reduce future habitat of the NSO in dry forests.

Brown, S. J., & Beckett, J. (2016). A Case Study for the Implementation of Recovery Plans to Conserve Listed Species. *Natural Resources & Environment, 30`3*. Retrieved August 8, 2019, from http://eds.a.ebscohost.com.ezproxy.humboldt.edu/ehost/detail/detail?vid=1&sid=d579ea04-3af7-4653-bd25-e1937145d8f3@sdc-v-sessmgr02&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ==#db=8gh&AN=114649693

> *The article focuses on a case study related to conservation of listed species by implementation of different recovery plans. Topics include reconciliation of the 2013 Douglas Fire Complex Project as a Northern spotted owl (NSO) habitat, association of the U.S. Fish and Wildlife Service (FWS) in recovery plan development, description of arguments of the U.S. Ninth Circuit of Court of Appeals for recovery plan implementation and utilization of science and technology for spotted owl conservation.*

Clark, D. A., Anthony, R. G., & Andrews, L. S. (2013). Relationship between wildfire, salvage logging, and occupancy of nesting territories by northern spotted owls. *The Journal of Wildlife Management, 77*(4), 672-688. Retrieved July 25, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/jwmg.523.

The northern spotted owl (Strix occidentalis caurina) is one of the most intensively studied raptors in the world; however, little is known about the impacts of wildfire on the subspecies and how they use recently burned areas. Three large-scale wildfires in southwest Oregon provided an opportunity to investigate the short-term impacts of wildfire and salvage logging on site occupancy of spotted owls. We used Program MARK to develop single-species, multiple-season models of site occupancy using data collected during demographic surveys of spotted owl territories. In our first analysis, we compared occupancy dynamics of spotted owl nesting territories before (1992–2002) and after the Timbered Rock burn (2003–2006) to a reference area in the south Cascade Mountains that was not affected recently by wildfire. We found that the South Cascades had greater colonization probabilities than Timbered Rock before and after wildfire (^b . 1:31, 95% CI . 0.60–2.03), and colonization probabilities declined over time at both areas (^b . 0:06, 95% CI . 0.12 to 0.00). Extinction probabilities were greater at South Cascades than at Timbered Rock prior to the burn (^b . 0:69, 95% CI . 0.23–2.62); however, Timbered Rock had greater extinction probabilities following wildfire (^b . 1:46, 95% CI. 0.29–2.62). The Timbered Rock and South Cascades study areas had similar patterns in site occupancy prior to the Timbered Rock burn (1992–2001). Furthermore, Timbered Rock had a 64% reduction in site occupancy following wildfire (2003–2006) in contrast to a 25% reduction in site occupancy at South Cascades during the same time period. This suggested that the combined effects of habitat disturbances due to wildfire and subsequent salvage logging on private lands negatively affected site occupancy by spotted owls. In our second analysis, we investigated the relationship between wildfire, salvage logging, and occupancy of spotted owl territories at the Biscuit, Quartz, and Timbered Rock burns from 2003 to 2006. Extinction probabilities increased as the combined area of early seral forests, high severity burn, and salvage logging increased within the core nesting areas (^b . 1:88, 95% CI . 0.10–3.66). We were unable to identify any relationships between initial occupancy or colonization probabilities and the habitat covariates that we considered in our analysis where the b coefficient did not overlap zero. We concluded that site occupancy of spotted owl nesting territories declined in the short term following wildfire, and habitat modification and loss due to past timber harvest, high severity fire, and salvage logging jointly contributed to declines in site occupancy.

Comfort, E. J., Clark, D. A., Anthony, R. G., Bailey, J., & Betts, M. G. (2016). Quantifying edges as gradients at multiple scales improves habitat selection models for northern spotted owl. *Landscape Ecology, 31*(6), 1227-1240. Retrieved July 25, 2019, from https://link-springer-com.ezproxy.humboldt.edu/article/10.1007/s10980-015-0330-1.

Context: Testing the influence of edges on animal distributions depends on our capacity to quantify 'edge', particularly in heterogeneous landscapes. Habitat quality is likely to differ in instances where edges are abrupt and anthropogenic in origin, versus diffuse, disturbance-created edges.
Objectives: We tested whether or not structurally distinct edge types influence northern spotted owl habitat selection and whether the relationship between edge type and use varied across spatial scales relevant to owl foraging (\3 ha) and home range selection (50–800 ha).

Methods: We used remotely sensed disturbance severity data to define two distinct edge types, 'hard' and 'diffuse', following a 11,000 ha fire and subsequent salvage logging in southern Oregon. The approach quantifies the steepness of gradients directly by measuring the 'slope' of change in disturbance severity. We tested the degree to which 23 radio-collared spotted owls responded to edge characteristics caused by fire and logging. Results: Spotted owls showed a strong negative association with hard edge, even after accounting for habitat suitability and other confounding variables. However, this negative relationship was highly scale-dependent; spotted owls were resilient to hard edges at broad scales, but avoided the same feature at fine scales. On the other hand, spotted owls showed a positive association with diffuse edge, especially at broader scales.
Conclusions: Differential use of edge types indicates that owls favor disturbances that create diffuse edge habitat (e.g. low and mixed-severity fire) and rather than abrupt boundaries created by high severity disturbance.

Davis, R. J., Hollen, B., Hobson, J., Gower, J. E., & Keenum, D. (2016). Status and Trends of Northern Spotted Owl Habitats. *Northwest Forest Plan*. Retrieved from https://www.fs.fed.us/pnw/pubs/pnw_gtr929.pdf.

This is the third in a series of periodic monitoring reports on northern spotted owl (Strix occidentalis caurina) habitat status and trends on federally administered lands since implementation of the Northwest Forest Plan (NWFP) in 1994. The objective of this monitoring is to determine if the NWFP is providing for conservation and management of northern spotted owl (NSO) habitat as anticipated. This report focused on the amount, distribution, and spatial arrangement of NSO habitats across the NWFP area; and how these have changed as a result of disturbance and ingrowth starting with the year of the NWFP analyses in 1993. Results showed a net decrease from 9,089,700 ac to 8,954,000 ac (-1.5 percent) of nesting/roosting habitat on NWFP federal lands. This occurred despite gross losses from wildfire of 5.2 percent (474,300 ac), 1.3 percent from timber harvest (116,100 ac), and 0.7 percent from insects or other causes (59,800 ac), indicating that processes of forest succession have compensated for some of the losses resulting from disturbance. Dispersal habitat on NWFP federal lands increased by 2.2 percent (net change), but dispersal-capable landscapes experienced a 5 percent net decrease owing to habitat losses on the surrounding nonfederal lands. Large wildfires continue to be the leading cause for loss of NSO habitat on federal lands. Most of these losses occurred within the network of large reserves designed for NSO conservation.

DellaSala, D. A., Baker, R., Heiken, D., Frissell, C. A., Karr, J. R., Nelson, S. K., . . . Strittholt, J. (2015). Building on Two Decades of Ecosystem Management and Biodiversity Conservation under the Northwest Forest Plan, USA. *Forests, 6*(9), 3326-3352. Retrieved July 25, 2019, from https://www.mdpi.com/1999-4907/6/9/3326.

The 1994 Northwest Forest Plan (NWFP) shifted federal lands management from a focus on timber production to ecosystem management and biodiversity conservation. The plan established a network of conservation reserves and an ecosystem management strategy on ~10 million hectares from northern California to Washington State, USA, within the

range of the federally threatened northern spotted owl (Strix occidentalis caurina). Several subsequent assessments—and 20 years of data from monitoring programs established under the plan—have demonstrated the effectiveness of this reserve network and ecosystem management approach in making progress toward attaining many of the plan's conservation and ecosystem management goals. This paper (1) showcases the fundamental conservation biology and ecosystem management principles underpinning the NWFP as a case study for managers interested in large-landscape conservation; and (2) recommends improvements to the plan's strategy in response to unprecedented climate change and land-use threats. Twenty years into plan implementation, however, the U.S. Forest Service and Bureau of Land Management, under pressure for increased timber harvest, are retreating from conservation measures. We believe that federal agencies should instead build on the NWFP to ensure continuing success in the Pacific Northwest. We urge federal land managers to (1) protect all remaining late-successional/old-growth forests; (2) identify climate refugia for at-risk species; (3) maintain or increase stream buffers and landscape connectivity; (4) decommission and repair failing roads to improve water quality; (5) reduce fire risk in fire-prone tree plantations; and (6) prevent logging after fires in areas of high conservation value. In many respects, the NWFP is instructive for managers considering similar large-scale conservation efforts.

Farber, S. L., & Kroll, A. J. (2012). Site occupancy dynamics of northern spotted owls in managed interior Douglas fir forests, California, USA, 1995–2009. *The Journal of Wildlife Management, 76*(6), 1145-1152. Retrieved July 25, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/jwmg.368.

Northern spotted owls (Strix occidentalis caurina) have received intense research and management interest since their listing as a threatened species by the United States Fish and Wildlife Service in 1990. For example, public and private forest managers in the Pacific Northwest, USA, conduct surveys to determine presence or absence of spotted owls prior to timber harvest operations. However, although recently developed statistical methods have been applied to presence–absence data collected during research surveys, the effectiveness of operational surveys for detecting spotted owls and evaluating site occupancy dynamics is not known. We used spotted owl survey data collected from 1995 to 2009 on a study area in interior northern California, USA, to evaluate competing occupancy models from Program PRESENCE using Akaike's Information Criterion (AIC). During 1,282 individual surveys, we recorded 480 spotted owl detections (37.4%) and 13 barred owl (1.0%) detections. Average per visit detection probability (85% CL) for single and paired spotted owls was 0.93 (0.90–0.96) for informed daytime, stand-based searches and 0.47 (0.43–0.51) for nighttime, station-based surveys (estimated from the best model); the average per visit detection probability from the null model was 0.67 (0.64–0.70). Average pair-only detection probabilities were 0.86 (0.81–0.90) for informed daytime, stand-based searches and 0.23 (0.18–0.29) for nighttime, station-based surveys; the average per visit detection probability from the null model was 0.63 (0.58–0.68). Site occupancy for any owl declined from 0.81 (0.59–0.93) in 1995 to 0.50 (0.39–0.60) in 2009; pair occupancy declined from 0.75 (0.56–0.87) to 0.46 (0.31–0.61). Our results suggest that a combination of 1 informed stand and 2 station-based

operational surveys can support determinations of spotted owl site status (either a single or a pair) at desired levels of confidence. However, our information was collected in an area where barred owls were rarely detected. Surveys conducted in areas that support well-established barred owl populations are likely to be less effective for determining presence or absence of spotted owls and may require more surveys and/or different survey methods to determine site status with confidence.

Gaines, W. L., Lehmkuhl, J. F., Buchanan, J. B., & Halupka, K. (2015). Northern spotted owl issues and objectives. *USFWS General Technical Report*. Retrieved July 25, 2019, from https://www.researchgate.net/publication/282846875_Northern_spotted_owl_issues_and_objectives.

The integration of disturbance ecology and spotted owl habitat objectives is a significant issue in the fire-prone forests in eastern Oregon and Washington. To progress in our scientific understanding, we presented a summary of spotted owl habitat use, including interactions with barred owls; reiterated the importance of establishing a landscape context for where and how much habitat to retain, and where and how restoration treatment should occur; and we summarized key standlevel spotted owl habitat objectives to consider in the design of treatments and to use as working hypotheses in adaptive management. This provides a consistent set of habitat objectives so that treatment effects on spotted owl habitat structure and prey species, fuels and fire behavior, and vegetation structure and composition can be compared across ecological provinces. The design of specific monitoring or management studies based on the implementation of these treatments follows in chapter 5.

Glenn, E. M., Lesmeister, D. B., Davis, R. J., Hollen, B., & Poopatanapong, A. (2017). Estimating density of a territorial species in a dynamic landscape. *Landscape Ecology, 32*(3), 563-579. Retrieved July 25, 2019, from https://link-springer-com.ezproxy.humboldt.edu/article/10.1007/s10980-016-0467-6.

Context: Conservation planning for at-risk species requires understanding of where species are likely to occur, how many individuals are likely to be supported on a given landscape, and the ability to monitor those changes through time.
Objectives: We developed a distribution model for northern spotted owls that incorporates both habitat suitability and probability of territory occupancy while accounting for interspecies competition.
Methods: We developed range-wide habitat suitability maps for two time periods (1993 and 2012) for northern spotted owls that accounted for regional differences in habitat use and home range size. We used these maps for a long-term demographic monitoring study area to assess habitat change and estimate the number of potential territories based on available habitat for both time periods. We adjusted the number of potential territories using known occupancy rates to estimate owl densities for both time periods. We evaluated our range-wide habitat suitability model using independent survey data.
Results: Our range-wide habitat maps predicted areas suitable for territorial spotted owl presence well. On the demographic study area, the amount of habitat declined 19.7% between 1993 and 2012, while our estimate of the habitat-based carrying capacity

declined from 150 to 146 territories. Estimated number of occupied territories declined from 94 to 57.
Conclusions: Conservation and recovery of at-risk species depends on understanding how habitat changes over time in response to factors such as wildfire, climate change, biological invasions, and interspecies competition, and how these changes influence species distribution. We demonstrate a model-based approach that provides an effective planning tool.

Hagmann, R. K., Johnson, D. L., & Johnson, K. N. (2017). Historical and current forest conditions in the range of the Northern Spotted Owl in south central Oregon, USA. *Forest Ecology and Management, 389*, 374-385. Retrieved July 18, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0378112716312919.

Restoration to increase resilience to current and projected drought and fire in historically open-canopy forests in fire-prone environments may be constrained by concern for species that favor dense forest conditions. To assist the recovery of a threatened species, the Northern Spotted Owl (NSO), in dry forest environments, the US Fish & Wildlife Service (USFWS) recommends embedding NSO conservation and recovery in restoration efforts that enable ecosystem recovery from past management actions and increase resilience to changing climate. In this study, we assessed changes between historical and current (1) forest structure and composition and (2) extent of NSO nesting and roosting (NR) or foraging (F) forest cover on 39,000 ha at the eastern edge of the current designation of the range of the NSO. Historical records depict a predominantly open-canopy landscape dominated by large ponderosa pine. Current conditions include more than a 600% increase in trees 15–53 cm dbh, substantial decline in trees ⩾81 cm dbh, loss of the widespread distribution of trees ⩾53 cm dbh, and loss of the dominance of ponderosa pine on mixed conifer sites. NSO habitat assessment involves a suite of attributes including: landscape context; species composition; canopy cover; basal area; average tree diameter; diameter diversity; and abundance of large trees, snags, canopy layers, coarse woody debris, and mistletoe. We tested for the presence of forest that met USFWS threshold values for two of these variables, canopy cover and basal area. Historically none of the area met the 60% canopy cover threshold for NR or F forest cover and almost none meets it currently. However, several NSO nesting pairs and individual birds have been observed in the study area over the last 20 years, and studies in other frequent-fire forests show that canopy cover as low as 50% may be functional for NSO. To assess the implications of lower threshold values, we tested for NR or F forest cover presence at half the recommended thresholds, considerably below published estimates. Only five percent of the area exceeded 30% canopy cover historically; much of the current forest exceeds it today. Increase in canopy cover comes at the expense of increasing vulnerability to fire and drought and loss of historical functions and processes. Conflicting objectives of forest restoration and maintenance of spotted owl habitat on this site – isolated habitat in the dry margin of the range of the NSO – raises questions about how to achieve forest restoration in altered landscapes where existing, novel conditions favor at-risk species.

Irwin, L. L., Rock, D. F., & Rock, S. C. (2012). Habitat selection by northern spotted owls in mixed-coniferous forests. *The Journal of Wildlife Management, 76*(1), 200-213. Retrieved July 25, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/jwmg.218.

> *Conservation planning for the federally threatened northern spotted owl (Strix occidentalis caurina) requires an ability to predict their responses to existing and future habitat conditions. To inform such planning we modeled habitat selection by northern spotted owls based upon fine-scale (approx. 1.0 ha) characteristics within stands comprised primarily of mixed-aged, mixed coniferous forests of southwestern Oregon and north-central California. We sampled nocturnal (i.e., primarily foraging) habitat use by 71 radio-tagged spotted owls over 5 yr in 3 study areas and sampled vegetative and physical environmental conditions at inventory plots within 95% utilization distributions of each bird. We compared conditions at available forest patches, represented by the inventory plots, with those at patches used by owls using discrete-choice regressions, the coefficients from which were used to construct exponential resource selection functions (RSFs) for each study area and for all 3 areas combined. Cross-validation testing indicated that the combined RSF was reasonably robust to local variation in habitat availability. The relative probability that a fine-scale patch was selected decreased nonlinearly with distances from nests and streams; varied unimodally with increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir (Pseudotsuga menziesii) trees; increased linearly with increasing basal areas of sugar pine (Pinus lambertiana) and hardwood trees and with increasing density of understory shrubs. Large-diameter trees (>66 cm) appeared important <400 m from nest sites. The RSF can support comparative risk assessments of the short- versus long-term effects of silvicultural alternatives designed to integrate forest ecosystem restoration and habitat improvement for northern spotted owls. Results suggest fine-scale factors may influence population fitness among spotted owls.*

Irwin, L. L., Rock, D. F., & Rock, S. C. (2013). Do northern spotted owls use harvested areas? *Forest Ecology and Management, 310*, 1029-1035. Retrieved July 18, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0378112713002065.

> *The 2011 Revised Recovery Plan for the northern spotted owl (Strix occidentalis caurina) declared that active forest management is compatible and consistent with recovery goals. The plan indicated that ecologically motivated silvicultural treatments should improve stand conditions, promote forest resiliency, and develop late-successional structural complexity over the long term. Yet most biologists believe that intensive, even-aged silvicultural systems (i.e., clearcut, seed-tree, or shelterwood regeneration methods) degrade habitat for northern spotted owls. Only for the coastal redwood forests of California is it broadly accepted that small-patch clearcut harvest units interspersed within a landscape containing significant large stands of large, old trees can provide adequate habitat. Spotted owls prey upon ground-dwelling prey, such as dusky-footed woodrats (Neotoma fuscipes), in these situations, primarily along edges of 6–30 year old clearcuts that contain dense patches of shrubs and hardwoods as well as woody debris. Demographic pressures presumably cause surplus prey to emigrate into adjacent older*

stands with sparse understories, where they may be more vulnerable to predation by spotted owls. During 5 radio-telemetry studies in both the Klamath and Coastal Redwood Physiographic Provinces, we detected and observed northern spotted owls foraging as far as 600 m from forests within harvest-created hardwood/shrub patches that contained scattered conifers and snags. Preferential use of such areas occurred in winter, especially in patches with conifer basal area of 9–18 m2/ha that were outside of dense nesting areas. In areas where ground-dwelling small mammals comprise a significant proportion of the owl's prey base, we hypothesize that use of young harvest units with retained conifers may contribute to spotted owl conservation. Such treatments may promote greater prey biomass, which could assist females to attain a high plane of nutrition prior to nesting. This hypothesis should be tested and refined via adaptive management experiments.

Kroll, A. J., Jones, J. E., Stringer, A. B., & Meekins, D. J. (2016). Multistate models reveal long-term trends of northern spotted owls in the absence of a novel competitor. *PLoS One, 11*(4) doi:http://dx.doi.org/10.1371/journal.pone.0152888

Quantifying spatial and temporal variability in population trends is a critical aspect of successful management of imperiled species. We evaluated territory occupancy dynamics of northern spotted owls (Strix occidentalis caurina), California, USA, 1990–2014. The study area possessed two unique aspects. First, timber management has occurred for over 100 years, resulting in dramatically different forest successional and structural conditions compared to other areas. Second, the barred owl (Strix varia), an exotic congener known to exert significant negative effects on spotted owls, has not colonized the study area. We used a Bayesian dynamic multistate model to evaluate if territory occupancy of reproductive spotted owls has declined as in other study areas. The state-space approach for dynamic multistate modeling imputes the number of territories for each nesting state and allows for the estimation of longer-term trends in occupied or reproductive territories from longitudinal studies. The multistate approach accounts for different detection probabilities by nesting state (to account for either inherent differences in detection or for the use of different survey methods for different occupancy states) and reduces bias in state assignment. Estimated linear trends in the number of reproductive territories suggested an average loss of approximately one half territory per year (-0.55, 90% CRI: -0.76, -0.33), in one management block and a loss of 0.15 per year (-0.15, 90% CRI: -0.24, -0.07), in another management block during the 25 year observation period. Estimated trends in the third management block were also negative, but substantial uncertainty existed in the estimate (-0.09, 90% CRI: -0.35, 0.17). Our results indicate that the number of territories occupied by northern spotted owl pairs remained relatively constant over a 25 year period (-0.07, 90% CRI: -0.20, 0.05; -0.01, 90% CRI: -0.19, 0.16; -0.16, 90% CRI: -0.40, 0.06). However, we cannot exclude small-to-moderate declines or increases in paired territory numbers due to uncertainty in our estimates. Collectively, we conclude spotted owl pair populations on this landscape managed for commercial timber production appear to be more stable and do not show sharp year-over-year declines seen in both managed and unmanaged landscapes with substantial barred owl colonization and persistence. Continued monitoring of reproductive territories can determine whether recent declines continue or whether

trends reverse as they have on four previous occasions. Experimental investigations to evaluate changes to spotted owl occupancy dynamics when barred owl populations are reduced or removed entirely can confirm the generality of this conclusion.

Lehmkuhl, John; Gaines, William; Peterson, Dave W.; Bailey, John; Youngblood, Andrew, tech. eds. 2015. Silviculture and monitoring guidelines for integrating restoration of dry mixed-conifer forest and spotted owl habitat management in the eastern Cascade Range. Gen. Tech. Rep. PNW-GTR-915. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 158 p.

This report addresses the need for developing consistent regional guidelines for stand-level management that integrates goals and objectives for dry forest restoration and habitat management for the northern spotted owl. It is an outcome of a focused 3-day workshop attended by 25 scientists, managers, and regulators in Hood River, Oregon, September 5–7, 2012. The workshop's goals were to (1) develop novel and feasible stand-level silvicultural prescriptions that integrate dry forest restoration and conservation of the northern spotted owl, among other ecological values; and (2) develop options for monitoring such prescriptions in an adaptive management framework, ideally in a coordinated network of management studies. We review background issues, objectives, and information for forest restoration (chapter 2), northern spotted owl habitat management (chapter 3), and monitoring and adaptive management (chapter 5). The core of this report is chapter 4, which reviews guidelines for developing new silvicultural prescriptions that address these issues. Finally, we discuss some relevant social, economic, and organizational issues affecting successful implementation of such a program of work (chapter 6).

Miller, M. P., Haig, S. M., Forsman, E. D., Anthony, R. G., Diller, L., Dugger, K. M., . . . Sovern, S. G. (2018). Variation in inbreeding rates across the range of Northern Spotted Owls (Strix occidentalis caurina): Insights from over 30 years of monitoring data. *American Ornithological Society, 135*(4), 821-833. Retrieved July 18, 2019, from https://academic-oup-com.ezproxy.humboldt.edu/auk/article-abstract/135/4/821/5148968?redirectedFrom=fulltext.

Inbreeding has been difficult to quantify in wild populations because of incomplete parentage information. We applied and extended a recently developed framework for addressing this problem to infer inbreeding rates in Northern Spotted Owls (Strix occidentalis caurina) across the Pacific Northwest, USA. Using pedigrees from 14,187 Northern Spotted Owls, we inferred inbreeding rates for 14 types of matings among relatives that produce pedigree inbreeding coefficients of F = 0.25 or F = 0.125. Inbreeding was most common in the Washington Cascades, where an estimated 15% of individuals are inbred. Inbreeding was lowest in western Oregon (3.5%) and northern California (2.7%), and intermediate for the Olympic Peninsula of Washington (6.1%). Estimates from the Olympic Peninsula were likely underestimates because of small sample sizes and the presence of few pedigrees capable of resolving inbreeding events. Most inbreeding resulted from matings between full siblings or half siblings, although a high rate of inbreeding from mother–son pairs was identified in the Olympic Peninsula. Geographic variation in inbreeding rates may reflect population declines and bottlenecks

that have been detected in prior investigations. We show that there is strong selection against inbred birds. Only 3 of 44 inbred birds were later identified as parents (6.8%), whereas 2,823 of 10,380 birds that represented a comparable cross section of the data were later seen as reproducing parents (27.2%). Habitat loss and competition with Barred Owls (S. varia) remain primary threats to Northern Spotted Owls. However, given the negative consequences of inbreeding, Spotted Owl populations in Washington with suitable habitat and manageable numbers of Barred Owls may benefit from translocations of individuals from Oregon and California to introduce new genetic variation and reduce future inbreeding events.

Rockweit, J. T., Franklin, A. B., & Carlson, P. C. (2017). Differential impacts of wildfire on the population dynamics of an old-forest species. *Ecology, 98*(6), 1574-1582. Retrieved July 25, 2019, from https://esajournals-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/ecy.1805.

Ecological disturbances shape and maintain natural communities, but climate change and human land use can alter disturbance regimes and affect population persistence and vital rates in unpredictable ways. Species inhabiting landscapes shaped by wildfire have evolved mechanisms allowing them to persist under this dynamic disturbance type, which creates habitats of varying quality for these species. We utilized data from a 26-yr demographic study of northern spotted owls to analyze the influence of wildfire on apparent survival and recruitment rates. Wildfires occurred across different years and affected different spotted owl territories, which allowed us to implement a retrospective Before-After-Control-Impact (BACI) analysis and model the potential effect of wildfire extent and severity. Our results indicated that mixed-severity fires that burned at predominantly low-severity had little effect on survival and recruitment while fires characterized by more medium to high burn severities negatively affected spotted owl survival, with varying effects on recruitment. Reduced survival and increased recruitment rates on some territories affected by medium to high severity fires suggested that post-fire habitat quality was reduced resulting in territories that were marginally capable of supporting owls. We hypothesize these territories may have represented "sinks" that were supported by nearby "source" territories in a spatially heterogeneous landscape created by the mixed-severity fire regime of the region.

Schilling, J. W., Dugger, K. M., & Anthony, R. G. (2013). Survival and home-range size of northern spotted owls in Southwestern Oregon. *Ornithological Societies of North America, 47*(1), 1-14. Retrieved July 18, 2019, from https://bioone-org.ezproxy.humboldt.edu/journals/Journal-of-Raptor-Research/volume-47/issue-1/JRR-11-76.1/Survival-and-Home-range-Size-of-Northern-Spotted-Owls-in/10.3356/JRR-11-76.1.full.

In the Klamath province of southwestern Oregon, Northern Spotted Owls (Strix occidentalis caurina) occur in complex, productive forests that historically supported frequent fires of variable severity. However, little is known about the relationships between Spotted Owl survival and home-range size and the characteristics of fire-prone, mixed-conifer forests of the Klamath province. Thus, the objectives of this study were to estimate monthly survival rates and home-range size in relation to habitat characteristics

for Northern Spotted Owls in southwestern Oregon. Home-range size and survival of 15 Northern Spotted Owls was monitored using radiotelemetry in the Ashland Ranger District of the Rogue River–Siskiyou National Forest from September 2006 to October 2008 Habitat classes within Spotted Owl home ranges were characterized using a remote-sensed vegetation map of the study area. Estimates of monthly survival ranged from 0.89 to 1.0 and were positively correlated with the number of late-seral habitat patches and the amount of edge, and negatively correlated with the mean nearest neighbor distance between late-seral habitats. Annual home-range size varied from 189 to 894 ha (x 5 576; SE 5 75), with little difference between breeding and nonbreeding home ranges. Breeding-season home-range size increased with the amount of hard edge, and the amount of old and mature forest combined. Core area, annual and nonbreeding season home-range sizes all increased with increased amounts of hard edge, suggesting that increased fragmentation is associated with larger core and home-range sizes. Although no effect of the amount of late-seral stage forest on either survival or home-range size was detected, these results are the first to concurrently demonstrate increased forest fragmentation with decreased survival and increased home-range size of Northern Spotted Owls.

Schumaker, N. H., Brookes, A., Dunk, J. R., Woodbridge, B., Heinrichs, J. A., Lawler, J. J., . . . Laplante, D. (2014). Mapping sources, sinks, and connectivity using a simulation model of northern spotted owls. *Landscape Ecology, 29*(4), 579-592. doi:http://dx.doi.org/10.1007/s10980-014-0004-4

Source-sink dynamics are an emergent property of complex species-landscape interactions. A better understanding of how human activities affect source-sink dynamics has the potential to inform and improve the management of species of conservation concern. Here we use a study of the northern spotted owl (Strix occidentalis caurina) to introduce new methods for quantifying source-sink dynamics that simultaneously describe the population-wide consequences of changes to landscape connectivity. Our spotted owl model is mechanistic, spatially-explicit, individual-based, and incorporates competition with barred owls (Strix varia). Our observations of spotted owl source-sink dynamics could not have been inferred solely from habitat quality, and were sensitive to landscape connectivity and the spatial sampling schemes employed by the model. We conclude that a clear understanding of source-sink dynamics can best be obtained from sampling simultaneously at multiple spatial scales. Our methodology is general, can be readily adapted to other systems, and will work with population models ranging from simple and low-parameter to complex and data-intensive.

Sovern, S. G., Forsman, E. D., Dugger, K. M., & Taylor, M. (2015). Roosting habitat use and selection by northern spotted owls during natal dispersal. *The Journal of Wildlife Management,79*(2), 254-262. doi:10.1002/jwmg.834

We studied habitat selection by northern spotted owls (Strix occidentalis caurina) during natal dispersal in Washington State, USA, at both the roost site and landscape scales. We used logistic regression to obtain parameters for an exponential resource selection function based on vegetation attributes in roost and random plots in 76 forest stands that

were used for roosting. We used a similar analysis to evaluate selection of landscape habitat attributes based on 301 radio-telemetry relocations and random points within our study area. We found no evidence of within-stand selection for any of the variables examined, but 78% of roosts were in stands with at least some large (>50 cm dbh) trees. At the landscape scale, owls selected for stands with high canopy cover (>70%). Dispersing owls selected vegetation types that were more similar to habitat selected by adult owls than habitat that would result from following guidelines previously proposed to maintain dispersal habitat. Our analysis indicates that juvenile owls select stands for roosting that have greater canopy cover than is recommended in current agency guidelines.

Sovern, S. G., Lesmeister, D. B., Dugger, K. M., Pruett, M. S., Davis, R. J., & Jenkins, J. M. (2019). Activity center selection by northern spotted owls. *The Journal of Wildlife Management, 83*(3), 714-727. Retrieved August 8, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/jwmg.21632.

The federally threatened northern spotted owl (Strix occidentalis caurina) has been intensively studied across its range, and habitat needs for the species have influenced forest management in northwestern North America for decades. Dense forest canopies are often reported in the scientific literature and agency management plans as an important habitat attribute for spotted owls, though the means of measuring forest canopy and interpreting species requirements vary across studies and more importantly, among management plans. We used light detection and ranging (lidar) measurements of canopy cover, canopy surface heterogeneity, and upper canopy surface connectivity, and an index of the presence of a competitive invasive species, the barred owl (S. varia), in multinomial discrete choice models using a Bayesian framework to evaluate selection of forest cover types by spotted owls in Oregon, USA, 2008–2015. We designated yearly activity centers based on the most biologically significant observation during the nesting season (Mar–Aug), generally centered on the nest tree. Spotted owls selected activity centers with more canopy cover and higher heterogeneity of the canopy surface within 100 m than was available within their territories. The average proportion of canopy cover within 100 m of a spotted owl activity center was 0.79 ± 0.12 (SD; range = 0.34–0.99). The presence of barred owls did not explain variability in selection of spotted owl activity centers, but barred owls might not affect third-order habitat selection within territories, or our index was too spatially coarse to detect these effects on spotted owl resource selection. We demonstrate that lidar provides researchers and managers with a tool that can accurately measure forest canopies over large areas, and assist in mapping spotted owl habitat. Light detection and ranging (lidar) measurements of forest canopy showed spotted owls selected activity centers with greater canopy cover and canopy height heterogeneity compared to randomly selected areas within their territories. Lidar is a useful tool to accurately measure forest canopy at large scales and it will aid managers in assessing habitat utility for spotted owls and other species associated with old complex forests in the Pacific Northwest, USA.

Standiford, Richard B.; Weller, Theodore J.; Piirto, Douglas D.; Stuart, John D., tech. coords. 2012. Proceedings of the coast redwood forests in a changing California: a symposium for

scientists and managers. Gen. Tech. Rep. PSW-GTR-238. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 675 p. (p. 399-408) "Two Decades of Research and Monitoring of the Northern Spotted Owl on Private Timberlands in the Redwood Region: What do We Know and What Challenges Remain?"

> *Surveys for northern spotted owls on Green Diamond Resource Company's (formerly Simpson Timber Company) ownership in coastal northern California were initiated in 1989. The following year, a long-term demography study was initiated that has continued to the present time. A Habitat Conservation Plan was developed for the species in 1992 and numerous habitat studies followed. The extensive dataset generated was used to estimate the trend in owl numbers, develop resource selection functions for nighttime activity and nesting habitat, and analyze the factors influencing spotted owl survival, fecundity and habitat fitness (i.e., ability of the habitat to support a stable population of owls). Important conclusions generated to date include that habitat heterogeneity (i.e., juxtaposition of young and older stands) is critical to both survival and fecundity, as is precipitation during the early nesting season. A landscape projection of current and future habitat indicated an abundance of high quality habitat that has the potential to support an increasing population of owls. Demographic analysis found the owl population was stable from 1990 to 2001, but has declined in recent years. The decline coincided with an apparent increase in barred owls. Growing evidence including barred owl removal experiments indicate that the invasion of barred owls into northern California is responsible for the decline. Preliminary results of the recently initiated removal experiment suggest that control of barred owls is feasible, and that spotted owls respond rapidly and favorably where barred owls are removed.*

Wan, H. Y., Ganey, J. L., Vojta, C. D., & Cushman, S. A. (2018). Managing Emerging Threats to Spotted Owls. *The Journal of Wildlife Management, 82*(4), 682-697. Retrieved July 18, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/abs/10.1002/jwmg.21423.

> *The 3 spotted owl (Strix occidentalis) subspecies in North America (i.e., northern spotted owl [S. o. caurina], California spotted owl [S. o. occidentalis], Mexican spotted owl [S. o. lucida]) have all experienced population declines over the past century due to habitat loss and fragmentation from logging. Now, the emerging influences of climate change, high-severity fire, and barred owl (Strix varia) invasion also appear to be synergistically and differentially affecting population trends of each subspecies. Our objective was to review the existing literature on the spotted owl to describe historical and emerging threats and whether those threats have been adequately examined for each subspecies. Using 527 publications from a Web of Science search of the literature from 1900–2015, we statistically evaluated the emphasis placed on each subspecies regarding 4 influences: mechanical tree removal, fire, climate change, and barred owl invasion. There were 98 papers that explicitly examined the effects of ≥1 of these influences. Most of these papers were focused on the northern spotted owl, and for all 3 subspecies, most papers examined short-term effects only. We used our results to identify significant information gaps relative to historical and emerging threats. Commercial timber harvesting remains a potential threat for all 3 spotted owl subspecies, but effects from*

forest thinning may be increasing because of the heightened emphasis on fuels reduction and forest restoration treatments on public lands. Owl response to mechanical tree removal, especially forest thinning, remains understudied. Climate change also may threaten all 3 subspecies. Changes in climate likely affect survival and reproduction of spotted owls and their prey, and alter habitat availability by affecting disturbance regimes and vegetation composition and succession, but little empirical information is available describing specific responses to climate change. The literature on response to high-severity fire is sparse for some subspecies, primarily short-term in nature, and not consistent. Barred owl invasion is a major threat to the northern spotted owl and the California spotted owl but does not currently threaten the Mexican spotted owl. Rigorous research on the response of spotted owls to all factors influencing population change, particularly for the Mexican spotted owl, is needed. The most useful information for predicting owl response to these threats stems primarily from long-term studies of owl demography. The lack of such studies within the range of the Mexican spotted owl greatly limits our understanding of its population dynamics and our ability to predict the effects of various threats on Mexican spotted owl populations. For all 3 subspecies, we encourage long-term studies of their responses to threats, using uniquely marked owls across large spatial extents to account for spatiotemporal variability in ecological conditions within and among subspecies.

Waterhouse, F.L., I.A. Manley, A.S. Harestad, and P.K. Ott. 2012. Nest structures and habitats of the northern spotted owl in three ecological subregions of British Columbia. Prov. B.C., Victoria, B.C. Tech Rep 069. www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr069.htm

Fourteen nest sites of the endangered Northern Spotted Owl (Strix occidentalis caurina) in British Columbia were sampled in 2003 and 2004. Nests were located in three broad ecosystem types: the maritime (n =), submaritime (n = 6), and continental (n = 7) ecological subregions. Spotted Owls exhibited flexibility in their use of different types of nest structures across their broad ecological distribution. Most nests occurred in chimney top or side cavities of large diameter (average 98 cm dbh) trees and snags (79%) with fewer found on platform type structures (2%). Although a variety of tree species provided nest structures, the largest proportion were Douglas-fir (Pseudotsuga menziesii; 79%). There was little evidence that Spotted Owls selected for particular habitat attributes in the immediate area surrounding the nest (patch-level selectivity) within the nest stands, except for higher densities of small trees (< 0 cm dbh) and lower densities of mid-size snags (30–50 cm dbh). Older forest stands (> 40 years old) adjacent to the nest stand were defined as the local landscape. Stand-level selectivity within the local landscape was indicated because nest stands had significantly taller trees than adjacent stands. Nest stands were not uniformly distributed across available aspects (0–290°); most (92%) were on southerly and or eastern aspects, but the importance of aspect within the broader regional landscape is unknown. Findings from our study using a small sample of Northern Spotted Owl nest sites in British Columbia appear consistent with those from studies in the United States. The findings of our study support provisioning for nesting habitat over the long term, as undertaken in the current Spotted Owl Management Plan (SOMP2).

Wilk, R. J., Lesmeister, D. B., & Forsman, E. D. (2018). Nest trees of northern spotted owls (strix occidentalis caurina) in washington and oregon, USA. *PLoS One, 13*(5) doi:http://dx.doi.org/10.1371/journal.pone.0197887

> *The northern spotted owl (Strix occidentalis caurina) is a federally-threatened subspecies in the United States associated with late-successional forests. In mesic forests it nests primarily in tree cavities, but also uses various types of external platform nests in drier forests. We describe 1717 northern spotted owl nests in 16 different tree species in five study areas in Washington and Oregon in the Pacific Northwest, USA. The vast majority of nests (87%) were in Douglas-fir (Pseudotsuga menziesii) trees, except on the Olympic Peninsula, Washington, where nests were about equally abundant in Douglas-fir, western red cedar (Thuja plicata), and western hemlock (Tsuga heterophylla) trees. Distribution of nests was 57.9% in top cavities of trees with broken tops, 20.3% in side cavities of hollow tree trunks, and 21.8% on external platforms of trees. Platforms were most common in the two driest study areas in the Eastern Cascades Physiographic Province, Washington (89% of nests), and the Klamath Province, Oregon (32%). The vast majority (89%) of nests were in trees with intact or declining crowns. Nests in dead trees were most common on the Olympic Peninsula. Nest trees with top and side cavities were larger and much more prevalent in study areas where annual precipitation was highest (Olympic Peninsula, Oregon Coast Range). Large nest cavities and platforms used by northern spotted owls occur almost exclusively in old forest. Managing for the retention of such forests and for their replacement is a significant challenge for land managers, especially in the face of climate change and an increasing human population, but will likely be required for the persistence of viable populations of northern spotted owls.*

Yackulic, C. B., Bailey, L. L., Dugger, K. M., Davis, R. J., Franklin, A. B., Forsman, E. D., . . . Sovern, S. G. (2019). The past and future roles of competition and habitat in the range-wide occupancy dynamics of Northern Spotted Owls. *Ecological Applications, 29*(3), E01861. Retrieved July 25, 2019, from https://esajournals-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/eap.1861.

> *Slow ecological processes challenge conservation. Short-term variability can obscure the importance of slower processes that may ultimately determine the state of a system. Furthermore, management actions with slow responses can be hard to justify. One response to slow processes is to explicitly concentrate analysis on state dynamics. Here, we focus on identifying drivers of Northern Spotted Owl (Strix occidentalis caurina) territorial occupancy dynamics across 11 study areas spanning their geographic range and forecasting response to potential management actions. Competition with Barred Owls (Strix varia) has increased Spotted Owl territory extinction probabilities across all study areas and driven recent declines in Spotted Owl populations. Without management intervention, the Northern Spotted Owl subspecies will be extirpated from parts of its current range within decades. In the short term, Barred Owl removal can be effective. Over longer time spans, however, maintaining or improving habitat conditions can help promote the persistence of northern spotted owl populations. In most study areas, habitat effects on expected Northern Spotted Owl territorial occupancy are actually greater than the effects of competition from Barred Owls. This study suggests how intensive*

management actions (removal of a competitor) with rapid results can complement a slower management action (i.e., promoting forest succession).

Competition, Competitor Populations and Prey Populations of Northern Spotted Owls:

Diller, L. V., Hamm, K. A., Early, D. A., Lamphear, D. W., Dugger, K. M., Yackulic, C. B., . . . McDonald, T. L. (2016). Demographic response of northern spotted owls to barred owl removal. *The Journal of Wildlife Management, 80*(4), 691-707. Retrieved July 25, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/jwmg.1046.

> *Federally listed as threatened in 1990 primarily because of habitat loss, the northern spotted owl (Strix occidentalis caurina) has continued to decline despite conservation efforts resulting in forested habitat being reserved throughout its range. Recently, there is growing evidence the congeneric invasive barred owl (Strix varia) may be responsible for the continued decline primarily by excluding spotted owls from their preferred habitat. We used a long-term demographic study for spotted owls in coastal northern California as the basis for a pilot barred owl removal experiment. Our demography study used capture–recapture, reproductive output, and territory occupancy data collected from 1990 to 2013 to evaluate trends in vital rates and populations. We used a classic before-after-control-impact (BACI) experimental design to investigate the demographic response of northern spotted owls to the lethal removal of barred owls. According to the best 2-species dynamic occupancy model, there was no evidence of differences in barred or northern spotted owl occupancy prior to the initiation of the treatment (barred owl removal). After treatment, barred owl occupancy was lower in the treated relative to the untreated areas and spotted owl occupancy was higher relative to the untreated areas. Barred owl removal decreased spotted owl territory extinction rates but did not affect territory colonization rates. As a result, spotted owl occupancy increased in the treated area and continued to decline in the untreated areas. Prior to and after barred owl removal, there was no evidence that average fecundity differed on the 2 study areas. However, the greater number of occupied spotted owl sites on the treated areas resulted in greater productivity in the treated areas based on empirical counts of fledged young. Prior to removal, survival was declining at a rate of approximately 0.2% per year for treated and untreated areas. Following treatment, estimated survival was 0.859 for the treated areas and 0.822 for the untreated areas. Derived estimates of population change on both study areas showed the same general decline before removal with an estimated slope of –0.0036 per year. Following removal, the rate of population change on the treated areas increased to an average of 1.029 but decreased to an average of 0.870 on the untreated areas. The results from this first experiment demonstrated that lethal removal of barred owls allowed the recovery of northern spotted owl populations in the treated portions of our study area. If additional federally funded barred owl removal experiments provide similar results, this could be the foundation for development of a long-term conservation strategy for northern spotted owls.*

Dugger, K. M., Forsman, E. D., Franklin, A. B., Davis, R. J., White, G. C., Schwarz, C. J., . . . Sovern, S. G. (2015). The effects of habitat, climate, and barred owls on long-term demography of northern spotted owls. *Condor, 118*(1), 57-116. doi:http://dx.doi.org/10.1650/CONDOR-15-24.1

Estimates of species' vital rates and an understanding of the factors affecting those parameters over time and space can provide crucial information for management and conservation. We used mark-recapture, reproductive output, and territory occupancy data collected during 1985-2013 to evaluate population processes of Northern Spotted Owls (Strix occidentalis caurina) in 11 study areas in Washington, Oregon, and northern California, USA. We estimated apparent survival, fecundity, recruitment, rate of population change, and local extinction and colonization rates, and investigated relationships between these parameters and the amount of suitable habitat, local and regional variation in meteorological conditions, and competition with Barred Owls (Strix varia). Data were analyzed for each area separately and in a meta-analysis of all areas combined, following a strict protocol for data collection, preparation, and analysis. We used mixed effects linear models for analyses of fecundity, Cormack-Jolly-Seber open population models for analyses of apparent annual survival (Ï), and a reparameterization of the Jolly-Seber capture-recapture model (i.e. reverse Jolly-Seber; RJS) to estimate annual rates of population change (Î»RJS) and recruitment. We also modeled territory occupancy dynamics of Northern Spotted Owls and Barred Owls in each study area using 2-species occupancy models. Estimated mean annual rates of population change (Î») suggested that Spotted Owl populations declined from 1.2% to 8.4% per year depending on the study area. The weighted mean estimate of Î» for all study areas was 0.962 (± 0.019 SE; 95% CI: 0.925-0.999), indicating an estimated range-wide decline of 3.8% per year from 1985 to 2013. Variation in recruitment rates across the range of the Spotted Owl was best explained by an interaction between total winter precipitation and mean minimum winter temperature. Thus, recruitment rates were highest when both total precipitation (29 cm) and minimum winter temperature (-9.5°C) were lowest. Barred Owl presence was associated with increased local extinction rates of Spotted Owl pairs for all 11 study areas. Habitat covariates were related to extinction rates for Spotted Owl pairs in 8 of 11 study areas, and a greater amount of suitable owl habitat was generally associated with decreased extinction rates. We observed negative effects of Barred Owl presence on colonization rates of Spotted Owl pairs in 5 of 11 study areas. The total amount of suitable Spotted Owl habitat was positively associated with colonization rates in 5 areas, and more habitat disturbance was associated with lower colonization rates in 2 areas. We observed strong declines in derived estimates of occupancy in all study areas. Mean fecundity of females was highest for adults (0.309 ± 0.027 SE), intermediate for 2-yr-olds (0.179 ± 0.040 SE), and lowest for 1-yr-olds (0.065 ± 0.022 SE). The presence of Barred Owls and habitat covariates explained little of the temporal variation in fecundity in most study areas. Climate covariates occurred in competitive fecundity models in 8 of 11 study areas, but support for these relationships was generally weak. The fecundity meta-analysis resulted in 6 competitive models, all of which included the additive effects of geographic region and annual time variation. The 2 top-ranked models also weakly supported the additive negative effects of the amount of suitable core area habitat, Barred Owl presence, and the amount of edge habitat on fecundity. We found strong support for a negative effect of Barred Owl presence on apparent survival of Spotted Owls in 10 of 11 study areas, but found few strong effects of habitat on survival at the study area scale. Climate covariates occurred in top or competitive survival models for 10 of 11 study areas, and in most cases the relationships were as predicted; however, there was little consistency among areas regarding the relative importance of

specific climate covariates. In contrast, meta-analysis results suggested that Spotted Owl survival was higher across all study areas when the Pacific Decadal Oscillation (PDO) was in a warming phase and the Southern Oscillation Index (SOI) was negative, with a strongly negative SOI indicative of El Niño events. The best model that included the Barred Owl covariate (BO) was ranked 4áµÊ° and also included the PDO covariate, but the BO effect was strongly negative. Our results indicated that Northern Spotted Owl populations were declining throughout the range of the subspecies and that annual rates of decline were accelerating in many areas. We observed strong evidence that Barred Owls negatively affected Spotted Owl populations, primarily by decreasing apparent survival and increasing local territory extinction rates. However, the amount of suitable owl habitat, local weather, and regional climatic patterns also were related to survival, occupancy (via colonization rate), recruitment, and, to a lesser extent, fecundity, although there was inconsistency in regard to which covariates were important for particular demographic parameters or across study areas. In the study areas where habitat was an important source of variation for Spotted Owl demographics, vital rates were generally positively associated with a greater amount of suitable owl habitat. However, Barred Owl densities may now be high enough across the range of the Northern Spotted Owl that, despite the continued management and conservation of suitable owl habitat on federal lands, the long-term prognosis for the persistence of Northern Spotted Owls may be in question without additional management intervention. Based on our study, the removal of Barred Owls from the Green Diamond Resources (GDR) study area had rapid, positive effects on Northern Spotted Owl survival and the rate of population change, supporting the hypothesis that, along with habitat conservation and management, Barred Owl removal may be able to slow or reverse Northern Spotted Owl population declines on at least a localized scale.

Dunk, J. R., ×, B. W., Schumaker, N., Glenn, E. M., White, B., LaPlante, D. W., . . . Thrailkill, J. (2019). Conservation planning for species recovery under the endangered species act: A case study with the northern spotted owl. *PLoS One, 14*(1) doi:http://dx.doi.org/10.1371/journal.pone.0210643

The northern spotted owl (Strix occidentalis caurina) was listed as threatened under the U.S. Endangered Species Act (ESA) in 1990. We applied modern spatial conservation theory and models to evaluate several candidate critical habitat networks, and sought an efficient conservation solution that encompassed the highest value lands for spotted owl recovery rather than maximizing the total area of potential critical habitat. We created a map of relative habitat suitability, which served as input to the spatial conservation prioritization program Zonation. We used the spatially-explicit individual-based population model HexSim to estimate and compare simulated spotted owl population outcomes among a suite of candidate critical habitat networks that varied in size and spatial arrangement under alternative scenarios of future habitat suitability and barred owl (S. varia) effects. We evaluated simulated spotted owl population outcomes, including total population size, and extinction and quasi-extinction likelihoods for 108 combinations of candidate critical habitat networks by habitat change by barred owl scenarios, both range-wide and within 11 distinct portions of the owl's range. Barred owl encounter rates and the amount and suitability of habitat had substantial effects on

simulated spotted owl populations. When barred owl encounter rates were high, changes in the amount and suitability of habitat had minimal impacts on population performance. Under lowered barred owl encounter rates, candidate critical habitat networks that included most existing high suitability habitat supported a high likelihood of long-term population persistence. Barred owls are currently the primary driving force behind poor population performance of NSOs; however, our models demonstrated that a sufficient area of high suitability habitat remains essential for recovery when effects of barred owls can be reduced. The modeling approach we employed is sufficiently flexible to incorporate new information about spotted owls as it becomes available and could likely be applied to conservation planning for other species.

Holloway, G. L., Smith, W. P., Halpern, C. B., Gitzen, R. A., Maguire, C. C., & West, S. D. (2012). Influence of forest structure and experimental green-tree retention on northern flying squirrel (Glaucomys sabrinus) abundance. *Forest Ecology and Management, 285*, 187-194. Retrieved July 25, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0378112712005099?via=ihub.

In many regions of the world, forest management has shifted from practices emphasizing timber production to more sustainable harvesting that integrates ecological values, including maintenance of biodiversity, wildlife habitat, and ecological goods and services. To this end, management strategies emphasize retention of stand structures that meet the needs of forest-obligate wildlife species and enhance connectivity across landscapes. However, little is known about the effects on arboreal rodents of varying the amount or spatial distribution of retained structures. We quantified the responses of northern flying squirrels (Glaucomys sabrinus) to retention harvests of varying levels (15%, 40%, 75%, and 100% of original basal area) and spatial patterns (trees uniformly dispersed vs. aggregated in 1-ha patches), using six experimental treatments replicated at three locations in southwestern Oregon and Washington. Relative abundance of northern flying squirrels decreased following harvest; minimum number of squirrels known alive (MNKA) in the control (100%) and 75% retention treatment was significantly higher than in the 15% or 40% treatments. In mixed-effects regression models, MNKA increased with treatment-unit basal area and amount of surrounding mature (>80-year-old) forest, suggesting that squirrel abundance was influenced by local structure and landscape-scale variables. However, only basal area contributed to best-fit models of reproductive female abundance. Our results suggest a threshold response of northern flying squirrels to green-tree retention somewhere between 40% and 75% that is likely to be influenced by the spatial pattern of retention and landscape context. This study underscores previous conclusions that northern flying squirrels are sensitive to logging at both local and larger landscape scales, and demonstrates the current minimum retention standard of 15% will not provide suitable habitat for this species. 2012 Elsevier B.V. All rights reserved.

Irwin, L. L., Rock, D. F., & Rock, S. C. (2018). Barred owl habitat selection in west coast forests. *The Journal of Wildlife Management, 82*(1), 202-216. doi:10.1002/jwmg.21339

The invasion of the Pacific Northwest, USA by northern barred owls (Strix varia) is a conservation conundrum because it contributes to lingering declines in populations of northern spotted owls (Strix occidentalis caurina). We evaluated factors influencing nocturnal (i.e., foraging) habitat selection by northern barred owls using a repeated-studies design and information-theoretic methods across 3 Pacific Northwest study areas, each containing a broad range of forest and environmental conditions. We constructed discrete-choice resource selection functions (RSF) based upon telemetry points linked to forest inventory plots and map-based physical environmental metrics within home ranges of radio-tagged barred owls at Chehalis, Washington (n = 16), Springfield, Oregon (n = 22), and Arcata, California (n = 15). A general RSF based upon pooling data across study areas suggested barred owls selectively hunted for prey in lower-slope positions on southerly aspects often near streams at low elevations, and often within red alder (Alnus rubra) dominated stands or in moderately dense patches of medium- and large-diameter coniferous trees close to patches containing nests. The relative probability of use decreased with increasing densities of small-diameter trees, suggesting barred owls avoided clearcuts and young plantations. These general patterns were modified by study-area variation in tree species composition and density. Study-area-specific factors that were associated positively with barred owl habitat selection included increasing basal area of western redcedar (Thuja plicata) and red alder at Chehalis and increasing densities of western redcedar and basal area of bigleaf maple (Acer macrophyllum) and western hemlock (Tsuga heterophylla) at Springfield. At Arcata, high densities of Douglas-fir (Pseudotsuga menziesii) trees and increasing basal area of tanoak (Notholithocarpus densiflorus) were negatively associated with barred owl habitat selection. Seasonal patterns of habitat selection did not differ dramatically although model coefficients suggested selection for specific tree species was weaker in the non-breeding season and barred owls did not seek topographic situations that provided thermo-regulatory benefits. The information may help inform conservation strategies for reducing competition between barred owls and northern spotted owls or perhaps in predicting colonization of new areas by barred owls.

Long, L. L., & Wolfe, J. D. (2019). Review of the effects of barred owls on spotted owls. *Journal of Wildlife Management, 83*(6), 1281-1296. doi:http://dx.doi.org/10.1002/jwmg.21715

Barred owls (Strix varia) are forest-dwelling owls, native to eastern North America, with populations that expanded westward into the range of the spotted owl (Strix occidentalis). Barred owls exert an overwhelmingly negative influence on spotted owls, thereby threatening spotted owl population viability where the species co-occur. In this review, we provide an overview of the barred owl's range expansion and detail and synthesize previously published literature on spotted and barred owls within the range of the spotted owl as related to potential future outcomes for the northern spotted owl (S. o. caurina). We include research on diet, habitat use and selection, effects of barred owls on spotted owl demography and behavior, hybridization with spotted owls, parasites, contemporary management, and future research needs for spotted owl populations given continued barred owl expansion throughout western North America. Our literature review and synthesis should provide managers with the information necessary to develop

strategies that mitigate deleterious effects of barred owls at local and landscape scales. © 2019 The Wildlife Society.

Manning, T., Hagar, J. C., & McComb, B. C. (2012). Thinning of young Douglas-fir forests decreases density of northern flying squirrels in the Oregon Cascades. *Forest Ecology and Management, 264*, 115-124. Retrieved July 25, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0378112711006025?via=ihub.

Large-scale commercial thinning of young forests in the Pacific Northwest is currently promoted on public lands to accelerate the development of late-seral forest structure for the benefit of wildlife species such as northern spotted owls (Strix occidentalis caurina) and their prey, including the northern flying squirrel (Glaucomys sabrinus). Attempts to measure the impact of commercial thinning on northern flying squirrels have mostly addressed short-term effects (2–5 years post-thinning) and the few published studies of longer-term results have been contradictory. We measured densities of northern flying squirrels 11–13 years after thinning of young (55–65 years) Douglas-fir forest stands in the Cascade Range of Oregon, as part of the Young Stand Thinning & Diversity Study. The study includes four replicate blocks, each consisting of an unthinned control stand and one stand each of the following thinning treatments: Heavy Thin; Light Thin; and Light Thin with Gaps. Thinning decreased density of northern flying squirrels, and squirrel densities were significantly lower in heavily thinned stands than in more lightly thinned stands. Regression analysis revealed a strong positive relationship of flying squirrel density with density of large (>30 cm diameter) standing dead trees and a negative relationship with percent cover of low understory shrubs. Maintaining sufficient area and connectivity of dense, closed canopy forest is recommended as a strategy to assure that long-term goals of promoting late-seral structure do not conflict with short-term habitat requirements of this important species.

Singleton, P. H. (2013). *Barred owls and northern spotted owls in the eastern cascade range, washington* (Order No. 3563096). Available from Agricultural & Environmental Science Collection. (1399186783). Retrieved from http://ezproxy.humboldt.edu/login?url=https://search.proquest.com/docview/1399186783?accountid=11532

Competitive interactions with barred owls (Strix varia) are an important factor contributing to the observed decline in the northern spotted owl (Strix occidentallis caurina) population in Washington. My goal was to develop an understanding of barred owl habitat associations at spatial scales corresponding to home ranges and larger landscapes, and to apply that understanding to evaluate potential patterns of population interaction between spotted owls and barred owls in the eastern Cascade Range, Washington. I found that during the breeding season, barred owls used portions of their home ranges characterized as complex-structure mixed grand fir (Abies grandis) forest more than open ponderosa pine (Pinus ponderosa) or simple-structure Douglas-fir (Pseudotsuga menziesii). At a landscape scale, barred owls were associated with a broader range of forest structure and species composition conditions than spotted owls, but barred owls were more strongly associated with gentle slopes in lower topographic

positions. Seventy-two percent of the areas used by spotted owls were located on slopes >16 degrees, and 72% of the areas used by barred owls were located on slopes <16 degrees. Overlap between barred owl and spotted owl habitat had a substantial effect on spotted owl pair site occupancy dynamics from 1989 to 2011. Site occupancy probability declined for all of the spotted owl pair sites, but it declined much less for sites with more good spotted owl habitat that overlapped with poor barred owl habitat within 500 ha of the spotted owl activity centers. Despite differences in space use and landscape associations displayed by the two species, displacement by barred owls had substantial detrimental impacts on spotted owl population performance in individual-based population modeling scenarios. The most plausible estimates of barred owl vital rates produced spotted owl population declines of approximately 60% to 80% relative to the spotted owl population estimate without barred owl displacement. Population simulations suggested that this landscape was capable of supporting at least twice as many barred owls as spotted owls, without considering the effects of inter-specific competition. When territorial displacement effects were incorporated, this landscape supported more than seven times as many barred owls as spotted owls.

Smith, M. J., Forbes, G. J., & Betts, M. G. (2013). Landscape configuration influences gap-crossing decisions of northern flying squirrel (Glaucomys sabrinus) Author links open overlay panel. *Biological Conservation, 168*, 176-183. Retrieved July 25, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0006320713003534?via=ihub.

Reduced movement across a landscape due to habitat loss and fragmentation is considered one of the primary reasons for species' population declines. Gliding mammals, such as the northern flying squirrel (Glaucomys sabrinus), are expected to be particularly sensitive to large non-forested gaps and therefore have been used as umbrella species in planning for landscape connectivity. We tested the gap-crossing decisions of the northern flying squirrel in a forested landscape in southern New Brunswick, Canada. We translocated 35 flying squirrels across non-forested gaps (50–960 m) with varying detour efficiency (distance to return home across the gap divided by the forested detour distance) and recorded the individual movement paths to return home. We found that 69% of flying squirrels took the forested route home and avoided crossing gaps. Detour efficiency was the only significant landscape predictor of gapcrossing; for every 1% increase in detour efficiency the odds of flying squirrels detouring were 15% higher. Northern flying squirrels were much more likely to take forested routes than to cross open canopy gaps, even when the direct distance was 6.8 times shorter. In addition, flying squirrels took substantially longer to return home if gaps in forest cover exceed a threshold of 335 m. Such threshold responses by flying squirrels could partly explain observed drops in flying squirrel occurrence in small, isolated patches of forest. Avoidance of gaps when detours are cheap suggests that there is a cost associated with crossing gaps. This provides support for the importance of maintaining functional connectivity in forested landscapes.

Sovern, S. G., Forsman, E. D., Olson, G. S., Biswell, B. L., Taylor, M., & Anthony, R. G. (2014). Barred owls and landscape attributes influence territory occupancy of northern spotted

owls. *The Journal of Wildlife Management, 78*(8), 1436-1443. Retrieved July 25, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/jwmg.793.

> *We used multi-season occupancy analyses to model 2 fates of northern spotted owl territories in relation to habitat amount, habitat fragmentation, and the presence of barred owls in Washington State, USA, 1989–2005. Local colonization is the probability a territory unoccupied by a spotted owl in year i would be occupied in year i + 1, and local extinction is the probability a territory that was occupied by a spotted owl in year i would be unoccupied in year i + 1. We found a negative relationship between local extinction probability and amount of late-seral forest edge. We found a negative relationship between colonization probability and the number of late-seral forest patches (higher fragmentation), and a negative relationship between colonization probability and the amount of non-habitat within 600 m of a spotted owl territory center (Akaike weight = 0.59). The presence of barred owls was positively related to extinction probability and negatively related to detection probability of spotted owls. The negative relationship between presence of barred owls and detectability of spotted owls indicated that spotted owls could be modifying their calling behavior in the presence of barred owls. The positive relationship between barred owl detections and local extinction probability suggests that because of competition with barred owls, spotted owls are being displaced.*

Trapp, S. E., Day, C. C., Flaherty, E. A., Zollner, P. A., & Smith, W. P. (2019). Modeling impacts of landscape connectivity on dispersal movements of northern flying squirrels (Glaucomys sabrinus griseifrons). Ecological Modelling, 394, 44-52. Retrieved July 25, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0304380018304368?via=ihub.

> *Landscape connectivity is a key component for successful dispersal of wildlife. Many approaches to quantify landscape connectivity utilize landscape characteristics and wildlife behavior in response to those characteristics, whereas other approaches focus on wildlife dispersal behavior. Combining landscape structure and wildlife behavior (e.g. movement, food acquisition, response to predation risk) provides critical information for conservation and management of many species. Individual-based models (IBM) are useful tools for evaluating the interaction between landscape characteristics and individual behaviors, thereby providing insights into management and conservation. Our objective was to evaluate the effect of reductions in landscape connectivity on northern flying squirrel dispersal movements under alternative timber management scenarios within the modeling framework of a spatially-explicit IBM. We simulated timber harvests of 6% and 9% of old-growth forest, the primary habitat for this species, distributed across 5, 10 or 15 harvest locations. We measured the influence of these scenarios upon landscape connectivity for flying squirrels. Landscapes with greater connectivity exhibited longer flying squirrel dispersal distances, more sinuous dispersal paths, and a greater total area of landscape utilization. However, connectivity was not directly correlated with habitat loss. The harvest scenario with 6% harvest of old growth distributed among 15 harvest locations had the lowest connectivity index value despite other scenarios modeling a greater percentage of old growth loss. The IBM demonstrated*

the importance of behaviors such as path tortuosity and movement rates in conjunction with landscape configuration in influencing the movement of dispersing individuals. The spatially explicit IBM provided a framework to evaluate connectivity from a fine-scale behavioral rather than structural perspective as well as to evaluate the distribution of new home range locations, which could be a useful management tool when evaluating the influence of landscape heterogeneity and stochastic behavior on wildlife movement and dispersal.

Wasser, S. K., Hayward, L. S., Hartman, J., Booth, R. K., Broms, K., Berg, J., . . . Smith, H. (2012). Using detection dogs to conduct simultaneous surveys of northern spotted (strix occidentalis caurina) and barred owls (strix varia). *PLoS One, 7*(8) doi:http://dx.doi.org/10.1371/journal.pone.0042892

State and federal actions to conserve northern spotted owl (Strix occidentalis caurina) habitat are largely initiated by establishing habitat occupancy. Northern spotted owl occupancy is typically assessed by eliciting their response to simulated conspecific vocalizations. However, proximity of barred owls (Strix varia)–a significant threat to northern spotted owls–can suppress northern spotted owl responsiveness to vocalization surveys and hence their probability of detection. We developed a survey method to simultaneously detect both species that does not require vocalization. Detection dogs (Canis familiaris) located owl pellets accumulated under roost sites, within search areas selected using habitat association maps. We compared success of detection dog surveys to vocalization surveys slightly modified from the U.S. Fish and Wildlife Service's Draft 2010 Survey Protocol. Seventeen 2 km ×2 km polygons were each surveyed multiple times in an area where northern spotted owls were known to nest prior to 1997 and barred owl density was thought to be low. Mitochondrial DNA was used to confirm species from pellets detected by dogs. Spotted owl and barred owl detection probabilities were significantly higher for dog than vocalization surveys. For spotted owls, this difference increased with number of site visits. Cumulative detection probabilities of northern spotted owls were 29% after session 1, 62% after session 2, and 87% after session 3 for dog surveys, compared to 25% after session 1, increasing to 59% by session 6 for vocalization surveys. Mean detection probability for barred owls was 20.1% for dog surveys and 7.3% for vocal surveys. Results suggest that detection dog surveys can complement vocalization surveys by providing a reliable method for establishing occupancy of both northern spotted and barred owl without requiring owl vocalization. This helps meet objectives of Recovery Actions 24 and 25 of the Revised Recovery Plan for the Northern Spotted Owl.

Willson, T. M., & Forsman, E. D. (2013). Thinning effects on spotted owl prey and other forest-dwelling small mammals. *General Technical Report*. Retrieved July 25, 2019, from https://www.fs.fed.us/pnw/pubs/pnw_gtr880/pnw_gtr880_009.pdf.

Thinning has been promoted as a method for accelerating the development of late-seral habitat and improving the overall health and function of young forests in the Pacifi c Northwest. Population studies have shown early and positive responses to thinning by some small forest-floor mammals (primarily mice, terrestrial voles, and shrews).

However, thinning reduces the abundance of some tree-dwelling rodents, especially Northern Flying Squirrels (Glaucomys sabrinus) and Red Tree Voles (Arborimus longicaudus), that are important prey species for Northern Spotted Owls (Strix occidentalis caurina). Recent studies suggest that reductions in Northern Flying Squirrel abundance following thinning may be driven by increased susceptibility to predation created by removal of critical above-ground cover. Predation, lack of canopy connectivity, and reduction in suitable nest substrates may all contribute to reduced Red Tree Vole abundance following thinning. The long term benefits of some thinning treatments may be positive for both flying squirrels and Red Tree Voles, but may not be realized for several decades or more, as the development of a midstory layer of trees may be critical to the success of thinning in promoting habitat for these species. Additional research into the ecology of the two woodrat species (Neotoma fuscipes and N. cinerea) found in the Pacifi c Northwest is needed to provide a more complete understanding of the effects of forest management activities on spotted owls and their prey. It may be possible to design thinning prescriptions that lessen the short-term negative effects on arboreal rodents. Long-term goals should focus on creating more structurally and biologically complex forests across the landscape at scales and patterns compatible with the ecologies of spotted owl prey and other organisms. Joint research-management efforts to test new silvicultural prescriptions, expand current predictive models of high-quality prey habitat, and develop management strategies that consider the temporal effects of management on owl prey at the stand, landscape, and regional levels, could advance our understanding of owl prey ecology and help ensure that healthy populations of spotted owls and their prey persist on the landscape over the long term.

Yackulic, C. B., Reid, J., Davis, R., Hines, J. E., Nichols, J. D., & Forsman, E. (2012). Neighborhood and habitat effects on vital rates: Expansion of the Barred Owl in the Oregon Coast Ranges. *Ecology, 93*(8), 1953-1966. doi:10.1890/11-1709.1

In this paper, we modify dynamic occupancy models developed for detection-nondetection data to allow for the dependence of local vital rates on neighborhood occupancy, where neighborhood is defined very flexibly. Such dependence of occupancy dynamics on the status of a relevant neighborhood is pervasive, yet frequently ignored. Our framework permits joint inference about the importance of neighborhood effects and habitat covariates in determining colonization and extinction rates. Our specific motivation is the recent expansion of the Barred Owl (Strix varia) in western Oregon, USA, over the period 1990-2010. Because the focal period was one of dramatic range expansion and local population increase, the use of models that incorporate regional occupancy (sources of colonists) as determinants of dynamic rate parameters is especially appropriate. We began our analysis of 21 years of Barred Owl presence/nondetection data in the Tyee Density Study Area (TDSA) by testing a suite of six models that varied only in the covariates included in the modeling of detection probability. We then tested whether models that used regional occupancy as a covariate for colonization and extinction outperformed models with constant or year-specific colonization or extinction rates. Finally we tested whether habitat covariates improved the AIC of our models, focusing on which habitat covariates performed best, and whether the signs of habitat effects are consistent with a priori hypotheses. We conclude that all

covariates used to model detection probability lead to improved AIC, that regional occupancy influences colonization and extinction rates, and that habitat plays an important role in determining extinction and colonization rates. As occupancy increases from low levels toward equilibrium, colonization increases and extinction decreases, presumably because there are more and more dispersing juveniles. While both rates are affected, colonization increases more than extinction decreases. Colonization is higher and extinction is lower in survey polygons with more riparian forest. The effects of riparian forest on extinction rates are greater than on colonization rates. Model results have implications for management of the invading Barred Owl, both through habitat alteration and removal

Yackulic, C. B., Reid, J., Nichols, J. D., Hines, J. E., Davis, R., & Forsman, E. (2014). The roles of competition and habitat in the dynamics of populations and species distributions. *Ecology, 95*(2), 265-279. doi:10.1890/13-0012.1

The role of competition in structuring biotic communities at fine spatial scales is well known from detailed process-based studies. Our understanding of competition's importance at broader scales is less resolved and mainly based on static species distribution maps. Here, we bridge this gap by examining the joint occupancy dynamics of an invading species (Barred Owl, Strix varia) and a resident species (Northern Spotted Owl, Strix occidentalis caurina) in a 1000-km2 study area over a 22-year period. Past studies of these competitors have focused on the dynamics of one species at a time, hindering efforts to parse out the roles of habitat and competition and to forecast the future of the resident species. In addition, while these studies accounted for the imperfect detection of the focal species, no multi-season analysis of these species has accounted for the imperfect detection of the secondary species, potentially biasing inference. We analyzed survey data using models that combine the general multistate-multi-season occupancy modeling framework with autolo-gistic modeling, allowing us to account for important aspects of our study system. We found that local extinction probability increases for each species when the other is present; however, the effect of the invader on the resident is greater. Although the species prefer different habitats, these habitats are highly correlated at the patch scale, and the impacts of invader on the resident are greatest in patches that would otherwise be optimal. As a consequence, competition leads to a weaker relationship between habitat and Northern Spotted Owl occupancy. Colonization and extinction rates of the invader are closely related to neighborhood occupancy, and over the first half of the study the availability of colonists limited the rate of population growth. Competition is likely to exclude the resident species, both through its immediate effects on local extinction and by indirectly lowering colonization rates as Northern Spotted Owl occupancy declines. Our analysis suggests that dispersal limitation affects both the invasion dynamics and the scale at which the effects of competition are observed. We also provide predictions regarding the potential costs and benefits of managing Barred Owl populations at different target levels.

California Spotted Owl:

Burnett, R. D., & Roberts, L. J. (2015). A quantitative evaluation of the conservation umbrella of spotted owl management areas in the sierra nevada. *PLoS One, 10*(4) doi:http://dx.doi.org/10.1371/journal.pone.0123778

> *Whether by design or default, single species management often serves as an umbrella for species with similar habitat requirements. In recent decades the focus of National Forest management in the Sierra Nevada of California has shifted towards increasing closed canopy mature forest conditions through the protection of areas occupied by the California Spotted Owl (Strix occidentalis occidentalis). To evaluate the implications of these habitat changes and the potential umbrella resulting from a system of owl reserves on the broader avian community, we estimated occupancy of birds inside and outside of Spotted Owl Home Range Core Areas in northeastern California. We used point count data in a multi-species hierarchical Bayesian model incorporating the detection history of 81 species over a two-year time period (2005-2006). A small set of vegetation cover and topography covariates were included in the model to account for broad differences in habitat conditions, as well as a term identifying whether or not a site was within a Core Area. Seventeen species had a negative Core Area effect, seven had a positive effect, and the rest were not significant. Estimated species richness was significantly different with 23.1 species per 100 m radius circle outside Core Areas and 21.7 inside Core Areas. The majority of the species negatively associated with Core Areas are tied to early successional and other disturbance-dependent habitats. Conservation and climate vulnerability rankings were mixed. On average we found higher scores (greater risk) for the species positively associated with Core Areas, but a larger number of species with the highest scores were negatively associated with Core Areas. We discuss the implications for managing the Sierra Nevada ecosystem and illustrate the role of monitoring broader suites of species in guiding management of large complex ecosystems.*

Gallagher, C. V., Keane, J. J., Shaklee, P. A., Kramer, H. A., & Gerrard, R. (2019). Spotted owl foraging patterns following fuels treatments, Sierra Nevada, California. *The Journal of Wildlife Management, 83*(2), 487-501. Retrieved July 18, 2019, from https://wildlife-onlinelibrary-wiley-com.ezproxy.humboldt.edu/doi/full/10.1002/jwmg.21586.

> *Western dry conifer forests continue to experience increased severe, stand-replacing wildfire that is outside of historical precedent. Fuels treatments, landscape-scale modifications of forest fuels and structure, are likely to remain a management tool to modify fire behavior and restore ecological resilience. The impacts of fuels treatments to listed species such as spotted owls (Strix occidentalis) remain uncertain and are contested because of limited available information. To evaluate spotted owl foraging habitat selection in a landscape recently modified by forest fuels-reduction treatments, we radio-marked and tracked 10 California spotted owls (S. o. occidentalis) for 2 years immediately following fuels treatment installation in the northern Sierra Nevada, California, USA. We categorized fuels treatments into 3 types: mechanical thin, installed within the study area as landscape-scale fire breaks characterized by even tree spacing, open understory, and low canopy cover, or group selections; understory thin, a hand-*

removal of small trees and shrubs; and understory thin followed by underburn, a controlled surface-fuel burn that left the overstory intact. We described post-treatment habitat using forest structural metrics derived from a Light Detection and Ranging (LiDAR) dataset that was collected 1 year after fuels treatments were completed. We collected 436 spotted owl foraging locations during 2 breeding seasons and evaluated breeding season home range size and composition using a resource selection function. We assessed possible contributors to owl foraging patterns by comparing a priori hypotheses in an information-theoretic approach and using randomly generated points that estimated available habitat. Spotted owl breeding season home ranges contained fuels treatments in proportion to their availability on the landscape and averaged 17.1% treated area. Within the home range, owl foraging locations in the post-treatment landscape were best predicted by lower proportions of gaps than anticipated at random, steeper slopes, and minimized distance from the owl's site center. Our results suggest that moderate to high proportions of gaps, typically a feature of forest fuels reduction and restoration treatments, may reduce the probability of spotted owl foraging.

Irwin, L. L., Rock, D. F., Rock, S. C., Loehle, C., & Van Deusen, P. (2015). Forest ecosystem restoration: Initial response of spotted owls to partial harvesting. *Forest Ecology and Management, 354*, 232-242. Retrieved July 25, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0378112715003357?via=ihub.

Conservation planning for spotted owls (Strix occidentalis) hinges upon retaining late-successional and old-growth forests. This strategy is to be supplemented over time by creating structural conditions found in such forests using innovative silviculture in less well-developed forests. Recent research indicates that spotted owls often hunt for prey or may nest in relatively young or mid-seral forest stands that were thinned or partially harvested in previous decades, but little information has been available to evaluate short-term direct responses (<5 year) by spotted owls to such practices. We used selection ratios to compare the frequency of nocturnal use by radio-tagged northern spotted owls (S.o. caurina) and California spotted owls (S.o. occidentalis) 62 years before and 62 years after 150 forest stands were thinned or partially harvested within 1200 m of nest sites of 19 owl home ranges in 5 study areas in western Oregon and northern California. We used logistic regression to investigate habitat and environmental factors that distinguished between 89 stands that were used and 115 stands that were not found used by radio-tagged owls for up to 2 years after treatment via a broad range of partial-harvest or thinning prescriptions within 2400 m of nest sites. Before harvest, radio-tagged owls generally used stands scheduled for harvest treatment in proportions significantly less than availability. After harvesting, selection ratios increased (n = 4), remained the same (n = 4), or decreased (n = 2) among 10 owl pairs for which we acquired sufficient telemetry data both before and after harvesting. Across all owls and all post-harvest conditions, the overall selection ratio increased after harvesting, suggesting that many of the harvests were benign or may have resulted in improved habitat. The probability of use of thinned or partially-harvested stands increased with harvest-unit size, decreased with distance from nest sites, and varied with the intensity of harvest and among forest types as represented by study areas. We found only limited evidence for a positive effect of retained basal area of large trees (P66 cm diameter at

breast height [dbh]), probably because many treated stands contained no such large trees prior to harvest. We found a quadratic relationship with retained basal area of mid-story conifers (10–65 cm dbh), such that harvested stands that contained 25–35 m2 /ha basal area of such mid-story trees were more likely to be used, holding other factors constant at their means. We also found evidence for a positive influence of proximity to riparian zones on probability of use of harvested stands. Although we did not obtain information on prey abundance or foraging efficiency, our study suggests that judicious applications of partial-harvest forestry, primarily commercial thinning, have the potential to improve foraging habitats for spotted owls.

Tempel, D. J., Peery, M. Z., & Gutiérrez, R. J. (2014). Using integrated population models to improve conservation monitoring: California spotted owls as a case study. *Ecological Modelling,289*, 86-95. Retrieved July 18, 2019, from https://www-sciencedirect-com.ezproxy.humboldt.edu/science/article/pii/S0304380014003329.

Integrated population models (IPMs) constitute a relatively new approach for estimating population trends and demographic parameters that makes use of multiple, independent data sources (e.g.,count and mark-recapture data) within a unified statistical framework. In principle, IPMs offer several advantages over more conventional modeling approaches that rely on a single source of data, including greater precision in parameter estimates and the ability to estimate demographic parameters for which no explicit data are available. However, to date, the IPM literature has focused primarily on model development and evaluation, and few "real-world" applications have demonstrated that IPMscan strengthen inferences about population dynamics in a species of conservation concern. Here, we combined 23 years of count, occupancy, reproductive, and mark-recapture data into an IPM framework to estimate population trends and demographic rates in a population of California spotted owls(Strix occidentalis occidentalis). Using this framework, we observed a significant population decline, as evidenced by the geometric mean of the finite annual rate of population change (¯t= 0.969, 95% CRI0.957–0.980) and the resulting realized population change (proportion of the initial population present in 2012;2012= 0.501, 95% CRI 0.383–0.641). The estimated decline was considerably greater than the approximately 30% decline estimated using conventional mark-recapture and occupancy approaches(Tempel and Gutiérrez, 2013). The IPM likely yielded a greater decline because it allowed for the inclusion of three years of data from the beginning of the study that were omitted from previous analyses to meet the assumptions of mark-recapture models. The IPM may also have yielded a greater estimate of decline than occupancy models owing to an increase in the number of territories occupied by single owls over the study period. All demographic parameters (adult and juvenile apparent survival, reproductive rate,immigration rate) were positively correlated with, but immigration was fairly high (immt= 0.097,95% CRI 0.055–0.140) and contributed most to temporal variation in, suggesting that changes in owl abundance were influenced by processes occurring outside of our study area. More broadly, our results indicated that the IPM framework has the potential to strengthen inference in population monitoring and demographic studies, particularly for those involving long-lived species whose abundance maybe slowly declining. In our case, the

conservation implications from the results of the IPM suggested a decline in the population of owls that was steeper than previously thought.