A Conservation Strategy for the Black-backed Woodpecker (*Picoides arcticus*) in California – Version 1.0

Male Black-backed Woodpecker foraging, Lassen National Forest. Photo by Joseph Leibrecht

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Executive Summary


Figure 1. Male Black-backed Woodpecker. Photo by Monica Bond

The Black-backed Woodpecker (*Picoides arcticus*) inhabits boreal and montane forests of northern North America, where it is strongly associated with burned forests. In California, the species is found at middle to higher elevations in inland mountains from the Oregon border to the southern Sierra Nevada, the southernmost extent of the species' range. The woodpecker occurs infrequently in most unburned forest types and is also found in beetle-killed forests, but reaches its greatest abundance in recently (1-8 year-old) burned forests with fire-killed trees, and is widely considered the North American bird species most strongly associated with burned forest. The Black-backed Woodpecker feeds primarily on wood-boring beetle larvae which become abundant after adult beetles lay their eggs on dying or recently dead trees. As the abundance of beetle larvae declines with time since fire occurrence, so too does the abundance of the Black-backed Woodpecker in the post-fire stand.

In California, the Black-backed Woodpecker's strong association with recently burned forest, a habitat that is ephemeral, spatially restricted, and often greatly modified by post-fire logging, as well as the species' relative rarity, may make the woodpecker vulnerable to declines in the state. Additionally, Black-backed Woodpeckers in California are affected by the management of unburned forests – both because pre-fire stand conditions affect the suitability of post-fire habitat for the species, and because a substantial proportion of California's Black-backed Woodpeckers nest and forage at a low population density in unburned forests. Conserving the Black-backed Woodpecker in California likely requires appropriate management and stewardship of the habitat where this species reaches its highest density – recently burned forest – as well as appropriate management of 'green' forests that have not burned recently. In both cases, existing science can provide decision-making support while research in California ecosystems is underway.

Interest in the conservation status of the Black-backed Woodpecker in California, the species' sensitivity to some post-fire forest management actions, and the lack of synthesized information from California for this species, spurred the development of this Conservation Strategy. The purpose of this Conservation Strategy is to provide a roadmap for conserving Black-backed Woodpeckers in California through informed management. It is our hope that state and federal agencies, as well as managers of private lands, will use the information and recommendations provided here to formulate policies and actions that will conserve Black-backed Woodpeckers. In this Conservation Strategy we try to facilitate Black-backed Woodpecker conservation by: (1) summarizing what is known about the taxonomy, distribution, population status, life history and ecology, and habitat requirements of the species in California and identifying potential threats; (2) recommending management approaches and specific actions to conserve the species in California; and (3) suggesting priorities for future research to help refine the recommended management actions. We identify overarching goals and recommend specific actions for achieving those goals in three broad areas: Habitat Management (4 goals, 16 recommended actions), Research and Monitoring (4 goals, 19 recommended actions), and Education and Outreach (1 goal, 5 recommended actions).

Introduction

Woodpeckers play a critical ecological role in forests throughout the world (Virkkala 2006). They are disproportionately important to their ecosystems in part because they are primary cavity excavators – essentially the only strong excavators capable of penetrating into hard wood – and nesting holes created by woodpeckers are later used by secondary cavity-nesters including owls, songbirds, ducks, mammals such as squirrels, martens, and fishers, and even some reptiles and amphibians (Martin et al. 2004). Woodpeckers also can regulate populations of bark and wood-boring beetles (Fayt et al. 2005), and are known to carry fungus that can aid in the decay of dead trees, termed "snags" (Farris et al. 2004). Because most woodpecker species are sensitive to changes in habitat, they can be useful indicators of biological diversity (Virkkala 2006).

Figure 2. Male Black-backed Woodpecker excavating a nest cavity in a fire-killed incense-cedar. Photo by Joseph Leibrecht

The Black-backed Woodpecker (*Picoides arcticus*) inhabits boreal and montane forests of northern North America, where it is strongly associated with burned forests. In California, the species is found at middle to higher elevations in inland mountains from the Oregon border to the southern Sierra Nevada, the southernmost extent of the species' range (Dixon and Saab 2000). The woodpecker occurs infrequently in most unburned forest types, but occurds in the greatest density in recently burned (1-8 years postfire) forests with fire-killed trees. This species is highly specialized to take advantage of post-fire conditions for nesting and foraging. The Black-backed Woodpecker feeds primarily on wood-boring beetle larvae which become abundant after adult beetles lay their eggs on dying or recently dead trees (Hutto 2008). In fact, Black-backed

Woodpeckers can drill into harder and thus more recently fire-killed snags than other woodpeckers. As the abundance of beetle larvae declines with time since fire, so too does the abundance of Black-backed Woodpeckers in the post-fire stand (Saab et al. 2007). Interest in the conservation status of the Black-backed Woodpecker in California, and the species' sensitivity to some post-fire forest management actions (Saab and Dudley 1998, Hutto and Gallo 2006, Saab et al. 2007, Koivula and Schmiegelow 2007, Hutto 2008, Hanson and North 2008, Cahall and Hayes 2009, Saab et al. 2009), as well as the relative paucity of data from California for this species, spurred the development of this Conservation Strategy.

Figure 3. Male Black-backed Woodpecker. Photo by Dayna Mauer

Although the Black-backed Woodpecker is found in unburned forest stands throughout its range, population densities in recently burned forest stands are substantially higher (Hutto 1995, Hoyt and Hannon 2002, Smucker et al. 2005, Hutto 2008, Fogg et al. 2012) and nest success apparently is higher as well (Bonnot et al. 2008). Hutto (2008 on p. 119) noted that "no other forest bird species appears to be as restricted to a single kind of forest type or condition as the Black-backed Woodpecker is to burned conifer forests." Hutto (2008) documented that 96% of all Black-backed Woodpecker detections from 16,465 independent sample points (including

3,128 in recently burned forests) over 14 years in 20 different vegetation types throughout northern Idaho and Montana were in burned forest stands. Furthermore, within the burn-severity spectrum, this woodpecker is most strongly associated with the most severely burned forests for nesting, particularly stands with higher densities of dead trees (Saab and Dudley 1998, Saab et al. 2002, Nappi et al. 2003, Hutto and Gallo 2006, Russell et al. 2007, Koivula and Schmiegelow 2007, Vierling et al. 2008, Hanson and North 2008, Nappi and Drapeau 2009, Saab et al. 2009, Forristal 2009, Seavy et al. in press). The species' strong association with dense, severely burned forests is a subject of ecological research throughout its range. One of the topics of particular interest is how the species persists in an area in the intervals between fires.

The woodpecker's strong association with burned forests, and its sensitivity to post-fire salvage logging, has garnered the species increasing attention from the conservation community in recent years. The Black-backed Woodpecker was chosen as a Focal Species in the 2002 California Partners in Flight Draft Coniferous Forest Bird Conservation Plan (California Partners in Flight 2002), but little information on habitat requirements was provided for the account. In 2007 the Forest Service designated Black-backed Woodpecker as a Management Indicator Species for snags in burned forests for 10 National Forests of the Sierra Nevada (Eldorado, Inyo, Lassen, Modoc, Plumas, Sequoia, Sierra, Stanislaus, and Tahoe National Forests, and the Lake Tahoe Basin Management Unit). Management Indicator Species are selected because their population changes may indicate the effects of land-management activities (USDA Forest Service 2007a). Otherwise, the Black-backed Woodpecker has no special status in California. However, in December 2011, the California Fish and Game Commission accepted for consideration a petition submitted by the John Muir Project and the Center for Biological Diversity (Hanson and Cummings 2010) to list the Black-backed Woodpecker (*Picoides arcticus*) as threatened or endangered under the California Endangered Species Act. The Commission's December 15, 2011, action conferred on the species the interim designation of "candidate for listing", effective January 6, 2012, and gave the California Department of Fish and Game 12 months from that date to review the petition, evaluate the available information, and report back to the Commission whether or not the petitioned action is warranted. Even more recently (May 2012), a consortium of environmental groups including the John Muir Project, the Center for Biological Diversity, the Blue Mountains Biodiversity Project, and the Biodiversity Conservation Alliance filed a petition (Hanson et al. 2012) to list the Oregon/California and Black Hills (South Dakota) populations of the Black-backed Woodpecker as threatened or endangered under the federal Endangered Species Act. The U.S. Fish and Wildlife Service is preparing a 90-day finding as to whether there is 'substantial information' indicating that the petitioned action may be warranted. If this preliminary finding is positive, a status review would be conducted to make a 12-month finding as to whether the listing is warranted.

Neither survival rates nor, for that matter, population trends of Black-backed Woodpecker populations based on capture-mark-recapture or occupancy rates, have been quantified in any habitat type anywhere in the range of the species. Such analyses are especially difficult for this species due to the ephemeral nature of the woodpecker's burned habitat and its tendency not to re-use nesting cavities in subsequent years. Additional topics about which little or nothing is known include habitat use and movements of Black-backed Woodpeckers during the winter, degree of reliance on bark beetle infestations in unburned montane forest, adult and juvenile dispersal, ecology and life history of Black-backed Woodpeckers utilizing forest that has not burned recently, habitat use in green forests surrounding burned forests with time since fire, and population genetics of the species in California. Particularly useful for Black-backed Woodpecker management in California would be habitat suitability models and estimates of home-range size in burned and unburned forests that are based on data from California habitats, as well as better information on the effects of different post-fire management activities that remove snags, as well as pre-fire thinning treatments in the near- and long-term, on occupancy rates, nesting success, and foraging ecology.

The purpose of this Conservation Strategy is to provide a roadmap for conserving Black-backed Woodpeckers in California through informed management. Our specific objectives are to: (1) summarize what is known about the taxonomy, distribution, population status, life history and ecology, and habitat requirements of the species in California and identify potential threats; (2) recommend management approaches and specific actions to conserve the species in California; and (3) suggest priorities for future research to help refine the recommended management actions. We also have developed an annotated catalog of scientific literature that can be expanded as new studies are conducted. We hope to continually update this Conservation Strategy as new information becomes available.

Information Sources

We reviewed and summarized the published and unpublished scientific literature to develop this Conservation Strategy for the Black-backed Woodpecker in California. We gave precedence to studies from California, but, given the relative paucity of data from the state, we also report results from other studies throughout the woodpecker's range. We recognize that habitat comparisons are dependent upon typical characteristics of the different tree species and forest types in each region, but nevertheless, studies from other regions often represent the best available science and provide important information for developing and testing hypotheses about the Black-backed Woodpecker in California. We summarize and build upon information presented at a Black-backed Woodpecker Technical Workshop co-convened by The Institute for Bird Populations and the USDA Forest Service in Sacramento, California, on November 18-19, 2010 (see Appendix A). Because multiple data sets and research projects on Black-backed Woodpecker in California have not yet been published or are currently underway, we consulted with researchers working in the state, and invited them to provide summaries of unpublished results or ongoing research (Appendix B). We included a discussion of different methodologies used to estimate population size, presented in Appendix C. Finally, in addition to the literature citations in this Strategy, we provide an annotated catalog of relevant scientific literature in Appendix D.

Much new information on the ecology and conservation of the Black-backed Woodpecker in California is likely to be developed in the coming months and years, and we hope to incorporate it into future versions of this document. Even as we were finalizing this version, important new sources of information (e.g., Tarbill 2010, Manley et al. 2012) became available to us too late to be incorporated. Readers aware of new or additional information relevant to this Conservation Strategy are invited to contact the editors.

Recommended Conservation Actions

Actions needed to conserve the Black-backed Woodpecker in California can be classified into three categories:

- habitat management
- research and monitoring
- education and outreach

Below we provide general goals and specific recommendations within each category of action. The goals and recommendations are abased on information presented in the subsequent sections of the Conservation Strategy. These goals and recommended actions, like this entire Conservation Strategy, should be modified over time in an adaptive framework as new information becomes available. In particular, new information derived from ongoing or future research may suggest new or refined habitat management recommendations.

Habitat Management

Effective conservation of Black-backed Woodpeckers in California requires that recently burned conifer forest, as well as suitable unburned forest, be maintained across the species' range in the state. The woodpecker's habitat requirements in both burned and unburned forests need to be better understood so that appropriate areas can be managed to promote Black-backed Woodpecker habitat suitability. Prior to the last few years, relatively little research on Black-backed Woodpecker had been conducted within California, but recent and ongoing efforts are rapidly addressing many information needs, and a substantial body of scientific information has been developed from studies in burned and unburned forests elsewhere in the species' range. Existing science can inform and support management of recent fire areas in California to benefit Black-backed Woodpeckers, at least in the interim while information from California ecosystems is still being developed. Additionally, Black-backed Woodpeckers in California are likely affected by the management of unburned forests – both because pre-fire stand conditions affect the suitability of post-fire habitat for the species, and because a substantial proportion of California's Black-backed Woodpeckers nest and forage at a low population density in unburned forests. Here, too, existing science can provide decision-making support while research in California ecosystems is underway.

Goal 1 – Manage recent fire areas on public and private lands to preserve and promote habitat for Black-backed Woodpeckers and other fire-associated species.

Note: Information on responses of Black-backed Woodpeckers to specific post-fire management actions that involve removal of some portion of snags in a post-fire area is still under development. Although we provide below some preliminary recommendations for making such *actions as compatible with Black-backed Woodpecker occupancy and reproduction as they can be, we emphasize that more information is needed. Wherever possible, we urge land managers implementing post-fire treatments that alter Black-backed Woodpecker habitat to monitor the effects of those treatments on Black-backed Woodpeckers. We invite managers to contact the editors of this Conservation Strategy for specific advice on how to design and implement such monitoring. Experimental tests of the suggestions in Recommendations 1.1, 1.3, 1.4, 2.1, and 2.2 would be especially valuable.*

Recommendation 1.1. Within the range of the Black-backed Woodpecker, ensure that postfire management occurring in new fires that burn 50 or more ha of conifer forest at moderate- to high-severity consider snag retention and other burned-forest habitat needs of the species. Where feasible, Black-backed Woodpeckers will likely benefit most from large patches of burned forest being retained in unharvested condition.

Data are not yet available to provide specific guidelines on the density of retained snags necessary to support Black-backed Woodpecker occupancy and reproduction. One study (Siegel et al. 2012c) reported an average snag basal area of 22 m^2/ha [96 ft^2/acre] (range = 6–34 m^2/ha [26-148 ft^2/acre]) within home ranges of 9 radio-tracked Black-backed Woodpeckers on Lassen NF, although home ranges within this landscape were quite large, perhaps indicating suboptimal habitat. Additionally, stands selected by the woodpeckers for nesting within this landscape generally had much higher snag densities.

Where post-fire snag removal is to occur, patches retained to support Black-backed Woodpeckers should incorporate areas with the highest densities of the largest snags to provide foraging opportunities (see Siegel et al. 2012b) as well as high density patches of medium- and small-diameter snags (see Seavy et al. in press) in the interior of the fire area to support higher nesting success in the early postfire years (see Saab et al. 2011). Researchers working in different forest types have defined tree size classes in various ways, but as a general guideline, large snags indicative of preferred foraging habitat roughly correspond to California Wildlife Habitat Relationships (CWHR; Mayer and Laudenslayer 1988) size class 5 (dbh >24”) and medium- and small-diameter snags typical of nesting habitat roughly correspond to CWHR size class 4 (dbh = 11-24”) or occasionally 3 (dbh = 6-11”).

Recommendation 1.2. Within burned forest, focus on retaining large patches of predominately prey-rich trees as evidenced by wood-boring beetle holes on trunks, or by using another appropriate index (see Recommendation 6.2). Where snag removal is proposed to meet other objectives, Black-backed Woodpeckers would likely benefit from targeting areas with relatively prey-poor snags, and retaining patches of snags that are relatively prey-rich. Because insect colonization varies among sites, identification of prey-poor and prey-rich areas is best informed by site-specific information on prey distribution (see Powell 2000, Bonnot et al. 2009). Where such data are not available, managers should focus on retaining as many snags as possible within the larger size classes available. Note that Black-backed Woodpeckers regularly forage on partially or completely charred snags – charred bark does not imply that the snag has been burned too severely to serve as foraging substrate.

Recommendation 1.3. If post-fire management is intended to be compatible with Black-backed Woodpecker conservation, area of post-fire clear-cut patches (where all the snags in an area are removed) should not exceed 2.5 ha [6.18 acres](see Schwab et al. 2006), at least until relevant findings from California ecosystems are available.

Recommendation 1.4. Retain high tree density in the unburned forest periphery around fire areas, to provide foraging habitat in the later post-fire years (see Saab et al. 2011).

Recommendation 1.5. Avoid harvesting fire-killed forest stands during the nesting season (generally May 1 through July 31). This management recommendation will protect dozens of other nesting bird species associated with burned forests in addition to the Black-backed Woodpecker. After about 8 years postfire, such stands are unlikely to contain many nesting Black-backed Woodpeckers, but many other bird species will nevertheless still be nesting in snags during this period.

Recommendation 1.6. Where managing for Black-backed Woodpeckers is a priority, avoid cutting standing snags for fuelwood in recent fire areas (≤8 years postfire) during the nesting season (generally May 1 through July 31). Harvesting of a portion of the available downed trees is an alternative that will not jeopardize Black-backed Woodpecker nests.

Recommendation 1.7. Consider the ecological importance of moderate- and high-severity burned forest[1] in Land and Resource Management Plan updates. Incorporate post-fire management strategies designed to retain high-quality Black-backed Woodpecker habitat in the planning area, and emphasize the use of prescribed fire and wildland fire.

Recommendation 1.8. If no other legal or administrative protection for the Black-backed Woodpecker is adopted, consider designating the Black-backed Woodpecker as a Species of Conservation Concern or Sensitive in USDA. Forest Service Region 5 if emerging data support such a designation.

Recommendation 1.9. Work with the California Department of Forestry and Fire Protection (Cal-Fire) to address the needs of Black-backed Woodpeckers on private lands by modifying the guidelines regarding burned-forest management.

Goal 2 – Use prescribed fire and wildland fire to create primary habitat that is well-dispersed across the landscape.

Recommendation 2.1. Consider implementing prescribed fire in the unburned periphery of recent fire areas 5 to 6 years after fire to create additional Black-backed Woodpecker habitat as the habitat suitability of the original fire area begins to wane.

[1] Moderate Severity: stands with a mixture of effects on the structurally dominant vegetation. High Severity: stands where the dominant vegetation has experienced high- to complete-mortality.

Recommendation 2.2. Use prescribed fire, especially with mixed-severity effects, to create Black-backed Woodpecker habitat that is well-distributed across the landscape, especially in areas that have not experience wildfire recently; additional research should provide specific guidance regarding optimal spatial distribution of prescribed burns (see Russell et al. 2009a) and which habitat types to prioritize for prescribed burning to maximize benefit to Black-backed Woodpeckers (see Recommendation 6.5). Note that some degree of tree mortality resulting from prescribed burns is likely to be beneficial to Black-backed Woodpeckers.

Recommendation 2.3. Where feasible and compatible with other management objectives, allow naturally ignited fires to burn and create optimal Black-backed Woodpecker habitat in forested areas outside the wildland-urban interface (WUI).

Goal 3 – Manage unburned forest to promote suitable post-fire habitat for Black-backed Woodpeckers after future fires.

Recommendation 3.1. Where feasible, manage unburned forest to promote recruitment of large trees and patches of high tree density, to improve habitat quality after fire occurs.

Goal 4 – Manage 'green' forest, particularly stands dominated by lodgepole pine and red fir, in a manner that promotes Black-backed Woodpecker occupancy.

Recommendation 4.1. Manage unburned forests to retain and recruit medium- to large-sized (i.e., roughly corresponding to CWHR size class 4 and 5) dying trees and recently dead snags in the earliest stages of decay (*large trees*: Setterington et al. 2000, *early decay stages*: Tremblay et al. 2009). In areas managed specifically for Black-backed Woodpecker, manage for and retain even higher densities of medium to large, early-stage snags. Snag retention guidelines in green forests could be established based on information gleaned from studies on habitat requirements, home-range size, and food sources in unburned forests in California (see Recommendation 6.6).

Recommendation 4.2. In areas where Black-backed Woodpecker conservation is a priority, avoid fuelwood cutting (or issuing fuelwood cutting permits) within stands of lodgepole pine during the nesting season (generally May 1 through July 31), or conduct broadcast surveys (Saracco et al. 2011) to identify unoccupied stands where fuelwood cutting during the nesting period may not pose any risk to Black-backed Woodpecker nests. Harvesting of a portion of the available downed trees is an alternative that will not jeopardize Black-backed Woodpecker nests.

Recommendation 4.3. In the absence of data from California regarding the importance of aggregations of beetle-killed trees to Black-backed Woodpeckers, assume stands that experience mortality due to beetle outbreaks provide Black-backed Woodpecker habitat (see Goggans et al. 1989, Bonnot et al. 2009). In areas with aggregations of recent (<8 years) beetle-killed trees managed for Black-backed Woodpeckers, avoid harvesting snags. Ultimately, retention targets for beetle-killed trees should be based on empirical research findings (see Recommendation 6.5).

Research and Monitoring

Ongoing research and monitoring efforts in California need to be sustained and built upon to assess the population size and trend of the Black-backed Woodpecker in California, to test and refine management recommendations that are based on information from elsewhere in the species' range, and to develop and test new management recommendations developed from studies of the species in California ecosystems.

Goal 5 – Estimate the population size and trend of California's population of Black-backed Woodpeckers.

Recommendation 5.1. Sustain ongoing efforts (e.g., Siegel et al. 2010) to monitor trends in the amount of burned forest on national forests in California that is occupied by Black-backed Woodpeckers. Support efforts to assess and monitor site occupancy in California.

Recommendation 5.2. Continue research to estimate home-range size of Black-backed Woodpeckers in recent fire areas and degree of overlap among adjacent home ranges; use this information in efforts to estimate population size in burned forests.

Recommendation 5.3. Build on recent efforts to estimate the population size of Black-backed Woodpeckers in California (see Appendix C), including burned and unburned forests on public and private lands.

Recommendation 5.4. Conduct broadcast surveys to estimate how many Black-backed Woodpeckers occur in national parks in California.

Recommendation 5.5. Consider initiating demographic studies of Black-backed Woodpeckers to estimate and compare adult and juvenile survival and reproductive rates in different-aged fire areas, as well as 'green' forests.

Goal 6 – Develop and refine information on Black-backed Woodpecker habitat needs in California.

Recommendation 6.1. Continue ongoing research to characterize Black-backed Woodpecker nesting habitat and assess foraging habitat selection in recent (1–10 year old) fire areas.

Recommendation 6.2. Conduct prey studies to determine criteria for selecting post-fire stands and tree species for retention. Determine wood-boring beetle habitat selection in burned forests. Ascertain whether individual tree species, diameters, and levels of scorch can be used as an index for abundance of wood-boring beetle larvae. This information can be used in determining burned-forest patches to retain in areas where snag removal is to occur.

Recommendation 6.3. Assess how different intensities and spatial configurations of salvage logging and other postfire activities requiring snag removal affect Black-backed Woodpecker nesting, foraging, and occupancy rates.

Recommendation 6.4. Develop spatially explicit models to predict high-quality Black-backed Woodpecker nesting habitat following fires in California to help guide post-fire management.

Recommendation 6.5. Assess the degree to which forest stands that undergo prescribed fire are subsequently used by Black-backed Woodpeckers; determine what post-fire stand characteristics make use by Black-backed Woodpeckers more or less likely.

Recommendation 6.6. Determine occupancy, habitat requirements, home-range size, food sources, and nest success of Black-backed Woodpeckers associated with unburned forest stands that contain patches of trees recently killed by beetles.

Recommendation 6.7. Assess the degree to which small patches of beetle-killed trees may explain the distribution of Black-backed Woodpeckers in unburned areas; Aerial Detection Survey data from the U. S. Forest Service Forest Health Monitoring program may be useful in answering this question.

Recommendation 6.8. Particularly if occurrence patterns of beetle-killed trees do not explain patterns in Black-backed Woodpecker occupancy of unburned forests (see Recommendation 6.7), assess other factors that may have explanatory power, and determine occupancy, habitat requirements, home-range size, food sources, and nest success of Black-backed Woodpeckers in unburned forests in California.

Recommendation 6.9. Assess Black-backed Woodpecker use of unburned subalpine forest in California.

Recommendation 6.10. Study and describe dispersal and colonization dynamics of Black-backed Woodpeckers occupying fire areas and surrounding unburned forests in California. Important questions include:

- What factors (e.g., tree density, wood-boring beetle population, proximity to other occupied fires) predict whether a new fire area will be colonized?
- Are new fire areas colonized by first-year birds or older birds, or both?
- Do birds recruit into new fire areas from other fire areas (are there distance thresholds?) or from nearby unburned forest, or both?

- Where do Black-backed Woodpeckers disperse to from fire areas, as time since fire increases?
- What is the desirable spatial distribution and heterogeneity (in terms of fire severity) of prescribed fires for maintaining connectivity of Black-backed Woodpecker populations between burned patches and maintaining gene flow?
- How do populations persist in the time between fires within a given area?

Recommendation 6.11. Assess historic range of variability in fire frequency, size, and severity within the range of the Black-backed Woodpecker in California.

Recommendation 6.12. Assess winter ecology and potential seasonal migratory movements in California.

Goal 7 – Conduct population viability analyses to inform forest management strategies for conservation of Black-backed Woodpeckers in California

Recommendation 7.1. Utilize data collected to meet Goals 5 and 6, to conduct population viability analyses for the Black-backed Woodpecker under varying environmental and management scenarios.

Goal 8 – Assess genetic distinctness of Black-backed Woodpeckers in California, and genetic variation within California.

Recommendation 8.1. Collect and analyze Black-backed Woodpecker genetic samples from multiple locations across the species' California range to determine the degree of isolation from birds elsewhere in the species' range, and to assess whether there is substantial genetic population structure within California.

Education and Outreach

Burned forests are often perceived by the general public, and even some land managers, as barren, lifeless landscapes. Black-backed Woodpecker conservation, monitoring, and research efforts likely would be bolstered by increased efforts to inform land managers, land owners, and the general public about the ecological value of recent fire areas to Black-backed Woodpeckers and other fire-associated species, as well as the critical role that Black-backed and other woodpeckers play in creating habitat for cavity-nesting species.

Goal 9 – Expand efforts to educate land managers and the general public about the value of burned forests to Black-backed Woodpeckers and other fire-associated species.

Recommendation 9.1. Incorporate "Recently Burned Forest" as a distinct habitat type in the California Department of Fish and Game's California Wildlife Habitat Relationships (CWHR) system and future conservation planning efforts conducted through California Partners in Flight.

Recommendation 9.2. Develop a web portal that can serve as a clearinghouse for information, survey results, and links to publications and other online resources that may help land managers better manage Black-backed Woodpecker populations and habitats.

Recommendation 9.3. Produce multi-media materials demonstrating the ecological value of burned forests to Black-backed Woodpeckers and other fire-associated species. Materials should target a variety of audiences, including land managers, private landowners, and general public, including users of national forest lands.

Recommendation 9.4. Conduct workshops to teach land managers about Black-backed Woodpecker biology and habitat needs and provide instruction on conducting surveys for Black-backed Woodpeckers.

Recommendation 9.5. Produce and distribute pamphlets or other materials asking woodcutters to avoid cutting snags that have nest cavities made by woodpeckers.

Species Description and Genetic Population Structure

Summary Points

- **Black-backed Woodpeckers have a solid black back, white underparts, heavily barred sides, and three toes; males have a solid yellow cap.**

- **The California population is likely genetically distinct from the northern boreal and Black Hills, South Dakota, populations; it is unknown whether it is genetically distinct from the much more proximal Oregon Cascade population, or how much genetic differentiation may occur within California.**

The Black-backed Woodpecker is a medium-sized, three-toed woodpecker with a solid black back, white underparts, and heavily barred sides; males have a solid yellow cap. Black dorsal feathers provide particularly good camouflage for the species when it forages against the charred bark of burned trees (Murphy and Lehnhausen 1998, Dixon and Saab 2000).

Figure 4. Male Black-backed Woodpecker wing plumage. Photo by Joseph Leibrecht

The species is found in montane and boreal conifer forests of North America (Dixon and Saab 2000). Using DNA analysis, Pierson et al. (2010) identified at least three genetically distinct groups of Black-backed Woodpeckers: a large, continuous population throughout the northern boreal forest to the Rocky Mountains (from DNA samples collected in Idaho, Montana, Alberta, and Quebec); a second small, isolated population in the Black Hills of South Dakota; and a third population in the Cascade region of Oregon. Pierson et al (2010) concluded that female Black-backed Woodpeckers do not cross large gaps in forested habitat and that large gaps of non-forested areas act as a higher-resistance landscape to long-distance dispersal for males.

The Black-backed Woodpecker occurs at the southernmost portion of its range in the Sierra Nevada of California, where birds are likely more closely related to the Oregon Cascade population than to the large, continuous central population in the northern boreal forest. Populations at geographic margins of their ranges may be particularly important for long-term persistence and evolution of species because disjunct or peripheral populations are likely to have diverged genetically from central populations due to either genetic drift or adaptation to local environments (Fraser 1999). Populations at geographic margins of their ranges can exhibit differences from larger, core populations in their habitat relationships, associations with competing species, and feeding and breeding behaviors (Restrepo and Gomez 1998, Lomolino et al. 2006). Current research in California should elucidate the extent to which the population of Black-backed Woodpeckers in California conform to the ecological patterns and habits observed in core populations in the northern boreal forest. The potential for adaptation to local environments makes conservation measures for Black-backed Woodpeckers in California particularly important.

***Additional Research Needed* – Genetic data are currently being gathered from California, but as yet the degree of genetic isolation or connectivity between birds in Oregon and California is unknown. It is also unknown whether substantial genetic variation and population structure exists within California. Research on genetics in California is underway by The Institute for Bird Populations and the U.S. Forest Service Rocky Mountain Research Station.**

Distribution, Population Size, and Population Trend in California

Summary Points

- **Black-backed Woodpeckers breed from 1,200-2,800 m elevation in the southern Cascades, Sierra Nevada, and Warner Mountains, although survey data are lacking for elevations higher than 2,800 m. They may also breed in the Siskiyou Mountains, but are much rarer there.**

- **Black-backed Woodpeckers are still distributed across their historical breeding range in California.**

- **Occupancy probability and densities of Black-backed Woodpeckers are greater in burned relative to unburned forests.**

  Occupancy probability of burned forests in California is greater in the north, at higher elevations, and in younger fires, with occupancy higher in fires <6 years old than in fires 7-10 years old.

- **Black-backed Woodpeckers occur at low densities in unburned forests, but because these areas are far more widespread than recently burned (≤10 year old) forests, woodpeckers in 'green' forest likely account for a substantial portion of the total population size.**

- **The number of Black-backed Woodpeckers occupying recent fire areas (fires that burned from years 2000 to 2010) in the Sierra Nevada appears not to exceed several hundred pairs. Population estimates in 'green' forests of the Sierra Nevada range from several hundred to several thousand pairs.**

- **Estimating demographic rates of Black-backed Woodpeckers among burned, beetle-killed, and 'green' forests is critical to understanding which habitats drive population growth rates, but no demographic studies have been conducted for this species.**

- **Black-backed Woodpecker occurrence data from the Breeding Bird Survey (BBS) are too sparse to make inferences about population trends in the Sierra Nevada.**

Distribution – The Black-backed Woodpecker occurs in boreal forests from south-central Alaska across Canada to Newfoundland and Nova Scotia, and south in the western United States into the northern Rocky Mountains and the Cascade and Sierra Nevada Mountains to east-central California (Dixon and Saab 2000). In California the Black-backed Woodpecker breeds in the southern Cascades, Sierra Nevada, and Warner Mountains, as well as the Siskiyou Mountains where it is much rarer. The species is very rare on the Shasta-Trinity and Klamath National Forests (Siegel and DeSante 1999; J. Alexander, personal communication 2011). The Sierra Nevada is the most southerly portion of the species' range (Dixon and Saab 2000).

Saracco et al. (2011) estimated detection probability while surveying for Black-backed Woodpeckers using 6-min broadcast surveys (in which the species' vocalizations and drumming are repeatedly broadcast to elicit a response) versus 5-min passive surveys (the method commonly used for multi-species birds surveys). The authors estimated detection probability using the broadcast method to be 0.705 versus just 0.231 using the passive method, suggesting that caution is needed in inferring occurrence patterns based on passive surveys.

Using primarily broadcast surveys, Saracco et al. (2011) detected Black-backed Woodpeckers at 169 survey stations placed in stands burned at moderate- to high-severity and distributed within 28 of 51 recent (≤10 years post-fire) fire areas throughout the species' range in the South Cascades, Sierra Nevada, and Warner Mountains in 2010 (see Fig. 5, right, for location of survey stations). The proportion of points surveyed that were estimated to be occupied by Black-backed Woodpeckers was 0.25 (Saracco et al. 2011). Occupied survey points occurred on both the west and east sides of the Sierra crest, and across nearly the full latitudinal range of the study area, including the most northerly fire area surveyed (the Fletcher fire area on the Modoc National Forest, which spans the California – Oregon border), and the third most southerly fire area surveyed (the Vista fire area on the Sequoia National Forest). These results suggest the Black-backed Woodpecker is still distributed across its historical breeding range in California. Probability of occupancy of a fire area was greater at higher elevations, more northerly latitudes, and in younger fires (with occupancy higher in fires <6 years old than in fires 7-10 years old) (Saracco et al. 2011). During subsequent years, the proportion of occupied survey points in the same study area was estimated to be 0.19 in 2010 and 0.21 in 2011 (Siegel et al. 2012b).

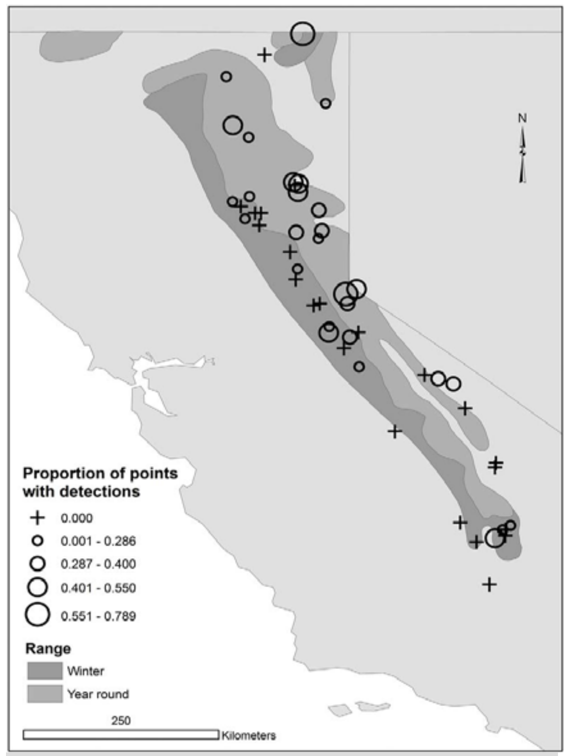

Figure 5. Distribution of 51 fires surveyed for Black-backed Woodpeckers on National Forests of the Sierra Nevada in 2009, and proportions of survey stations with detections. Gray shading is the range of the species in California, from California Department of Fish and Game (2005). Figure from Saracco et al. (2011).

Black-backed Woodpeckers were observed in low numbers, mostly in burned areas, in Yosemite National Park and Devils Postpile National Monument, but were not detected at Sequoia and Kings Canyon National Park, during spatially extensive, passive point count surveys of those parks by The Institute for Bird Populations in 1999–2000 (*Yosemite*; Siegel and DeSante 2002), 2003 (*Devils Postpile*; Siegel and Wilkerson 2004), and 2002–2003 (*Sequoia and Kings Canyon*; Siegel and Wilkerson 2005). Anecdotal detections of the species have been reported from all three parks in the past decade.

In unburned forests throughout the Sierra Nevada, Black-backed Woodpeckers were found in lodgepole pine, eastside pine, Jeffrey and ponderosa pine, white fir, red fir, mixed-conifer, and montane chaparral, but the birds selected for lodgepole pine and red fir forests (Fogg et al. 2012; see Figure 6, right, for location of survey sites). During passive point-count surveys conducted in 2009 and 2010 by PRBO Conservation Science in unburned forests throughout 10 National Forest units in the Sierra Nevada (the Modoc, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Inyo, Sierra, and Sequoia National Forests, and the Lake Tahoe Basin Management Unit), Black-backed Woodpeckers were encountered at 98 of 5,730 (1.7%) stations, on all but the Plumas, Stanislaus, and Sequoia National Forests (R. Burnett unpublished data). Using both passive and broadcast surveys in unburned forests in 2011, Fogg et al. (2012) detected Black-backed Woodpeckers on 40 of 472 ‘clusters’ of point count stations (each cluster = 4 point count stations at 250 m in the cardinal directions from a fifth point in the center). Estimated occupancy in the unburned forest at mean covariate values for the point count station sites was 0.05, and estimated occupancy at the point scale was 0.11. These results suggest that occupancy probability in moderately- to high-severity burned forests (mean covariate value = 0.097: Saracco et al. 2011) is twice that of unburned forests (mean covariate value = 0.05: Fogg et al. 2012). Research from other regions (e.g., *Montana*: Hutto 2008, *Idaho*: Russell et al. 2009b), further corroborate that that this species is uncommon in unburned forests.

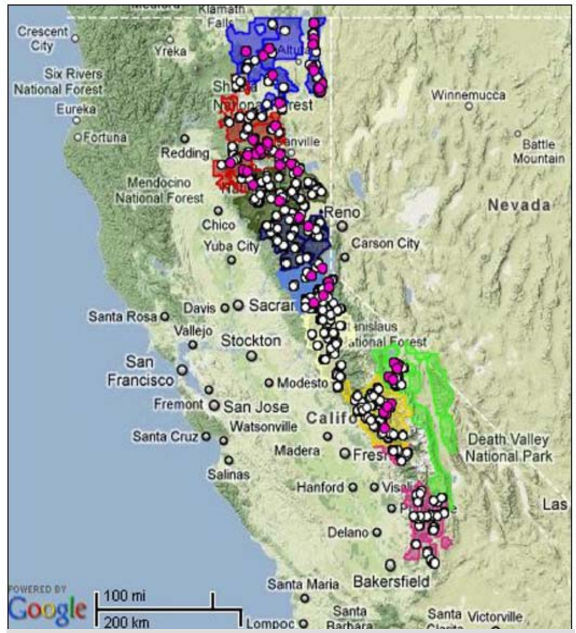

Figure 6. Location of Black-backed Woodpecker survey sites from 2009–2011 in the Sierra Nevada. Pink circles are point-count stations where Black-backed Woodpeckers were detected and white where they were not. Figure from Fogg et al. 2012.

The Breeding Bird Survey (BBS), which utilizes passive point counts, yields too few detections of Black-backed Woodpeckers in California for reliable statistical analysis (Sauer et al. 2011).

Between 1982 and 2011, an average of just 2.4 (SD = 2.5) individuals were detected each year on all of the state's BBS routes combined (Sauer et al. 2011).

Elevation Range in California – During broadcast surveys for Black-backed Woodpeckers in burned forests throughout the Sierra Nevada, southern Cascades, and Warner mountains in 2009 and 2010, 95% of detections were between 1,461 and 2,596 m above sea level, with a mean detection elevation of 1,997 m (SD = 379 m; R. Siegel unpublished data; see Figure 7, next page). It should be noted, however, that the surveys included no stations above 2,800 m, so the upper boundary of the range of detection elevations may not be meaningful. The study area spanned hundreds of miles between its southern and northern boundaries and the data suggest an interaction between elevation and latitude that is described in detail in Siegel et al. (2010) and Saracco et al. (2011); in essence, probability of occupancy of a fire area is greater at higher-elevation sites at more northerly latitudes. Additionally, all survey stations were located within the perimeters of recent (1-10 years post-burn) fires.

In unburned forests, Fogg et al. (2012) surveyed for Black-backed Woodpeckers at point-count stations ranging in elevation from 1,000 to 2,800 m. Black-backed Woodpeckers tended to occur on higher-elevation transects, especially for those transects not associated with fires (>2 km from a fire perimeter). Elevation of Black-backed Woodpecker detections in unburned forests averaged 2,494 m ± 29 (SE) in the central and southern Sierra (Eldorado, Inyo and Sierra National Forests) and 1,975 m ± 58 (SE) in the northern Sierra and southern Cascades (Modoc, Lassen, and Tahoe National Forests).

Figure 7. Elevational distributions of broadcast survey stations in burned forests throughout the Black-backed Woodpecker's range in California where the species was (left of central vertical line) and was not (right of central vertical line) detected in 2009 and 2010 (R. Siegel et al. unpublished data). White tick marks represent survey stations; longer tick marks represent multiple stations at the same elevation. Dark shading indicates the density trace of the data for stations with detections, light shading for stations without detections. Black horizontal lines show mean elevation of survey stations where Black-backed Woodpeckers were detected (left of center) and not detected (right of center). The dashed line shows the mean elevation of all stations surveyed.

Population Size – Population size is an essential measure for identifying species with a high risk of extinction because small populations are considered more vulnerable than large ones (Pimm et al. 1988, Mace and Lande 1991), although even relatively large populations can suffer local extirpation from extreme environmental disturbances (Pimm et al. 1988).

Estimating overall population size for the Black-backed Woodpecker in California is challenging because of the ephemeral nature of its burned-forest habitat and the low density at which the species occurs in unburned forests. In general, Black-backed Woodpeckers reach their greatest densities and highest nest success rates in moderate- and high-severity burned forests, and occur at very low population densities in 'green' forests, but, because 'green' forests comprise a far greater area than recently burned (≤8 year old) moderate- and high-severity burned forest area, birds in green forests likely account for a substantial portion of the total population size. Three groups of researchers have aimed to provide estimates of population size in different habitats in California using various methods: Hanson and Cummings 2010, Siegel et al. 2010, and Fogg et al. 2012. Results suggest estimates of several hundred pairs in burned forests on public lands (Hanson and Cummings 2010, Siegel et al. 2010), and several hundred pairs (Hanson and Cummings 2010) to several thousand pairs (Fogg et al. 2012) in unburned forests on public lands; none of these estimates have yet been published in a peer-reviewed forum. A discussion of each of these unpublished estimates is provided in Appendix C.

***Additional Research Needs* – Estimating population size in various habitat types is essential for identifying risk of extinction. In addition, estimating and comparing demographic rates (adult and juvenile survival and reproductive rates) in burned areas versus 'green' forests would help elucidate which habitat types drive population growth rates.**

Population Trend – Population trend is another important parameter as population size for assessing population vulnerability. Species with decreasing population trends are generally at greater risk than species with flat or increasing trends; even for species without long-term deterministic population declines, estimating population trends is important because extinction risk is greater in populations that fluctuate substantially over time (Pimm et al. 1988)

Data on population trends of the Black-backed Woodpecker in California are lacking. The Breeding Bird Survey (BBS) cannot estimate population trends in the state due to low detection rates from passive point counts and the relatively low number of point count stations in general. Recent inclusion of Black-backed Woodpecker monitoring in the Forest Service's Management Indicator Species (MIS) program for 10 national forest units in California (USDA Forest Service 2007b) should yield trend information for the species in burned forests of the Sierra Nevada and southern Cascades (Siegel et al. 2010, 2011, 2012b; Saracco et al. 2011), and possibly for unburned forest in the region as well (Fogg et al. 2012).

The recent use of broadcast calling for Black-backed Woodpeckers should assist with detection probabilities. Probability of detection of Black-backed Woodpeckers using broadcast calling at point counts (0.178) was three times greater than with passive (0.065) point counts in burned forests (Saracco et al. 2011). Fogg et al. (2012) detected Black-backed Woodpeckers at 28 point-count clusters using passive counts but an additional 12 clusters using subsequent broadcast calling. The MIS program uses both passive and broadcast surveys, but is still too new to yield long-term trend information. Nevertheless, occupancy rates of burned forests during 2009–2011 suggest a relatively stable population at least during this time period (Siegel et al. 2012b).

***Additional Research Needed* – Reliability of population estimates within burned and unburned forest in California will improve as more is learned about home-range size, degree of overlap between adjacent home ranges, and habitat associations within burned and unburned forest stands in California. Reliable population trend estimates should be possible with more data from ongoing monitoring efforts.**

Life History and Ecology

Summary Points

- **Throughout their range, Black-backed Woodpeckers begin laying eggs as early as April and fledge young as late as July.**
- **Both sexes incubate and brood 2–6 young.**
- **Black-backed Woodpeckers usually excavate a new nest cavity every year.**
- **Predation is the major cause of nest failure.**
- **Nest densities and occupancy in burned forests begin to decrease around 5 years after fire and then continue to decrease throughout the following several years.**
- **Black-backed Woodpeckers primarily eat larvae of wood-boring beetles and sometimes bark beetles.**
- **Altitudinal migration or other seasonal movements of the Black-backed Woodpecker in California have not been examined.**
- **Research from across the species' range, but excluding California, indicates both males and females disperse, but males disperse at greater rates than females.**

Nesting – Black-backed Woodpeckers are primary cavity excavators, creating holes in trees in which to lay their eggs and raise their young. The birds usually excavate and occupy a new nest cavity every year, with little re-use of previous cavities. A study of 210 Black-backed Woodpecker nests in burned forests in Oregon documented only 3 cavities re-used in subsequent years (Forristal 2009). In two fires in western Idaho, no Black-backed Woodpeckers re-used nest cavities over a 13-year study period (*n* = 46 unique nests; Saab et al. 2009). Cavities made by strong excavators such as Black-backed Woodpeckers provide important nesting opportunities for other bird species that nest in cavities but have limited or

Figure 8. A Black-backed Woodpecker nestling investigating its surroundings. Photo by Stephen Shunk

no ability to excavate their own cavities ('secondary cavity nesters'); 27% of Black-backed Woodpecker cavities in Idaho were re-used by other bird species in subsequent years (Saab et al. 2004). Black-backed Woodpeckers in California have been observed to simultaneously excavate multiple cavities (up to 5 different cavities) prior to nesting, only one of which was used for nesting (R. Siegel unpublished data). Thus, the importance of Black-backed Woodpeckers to secondary cavity-nesters may be even greater than population densities would otherwise indicate.

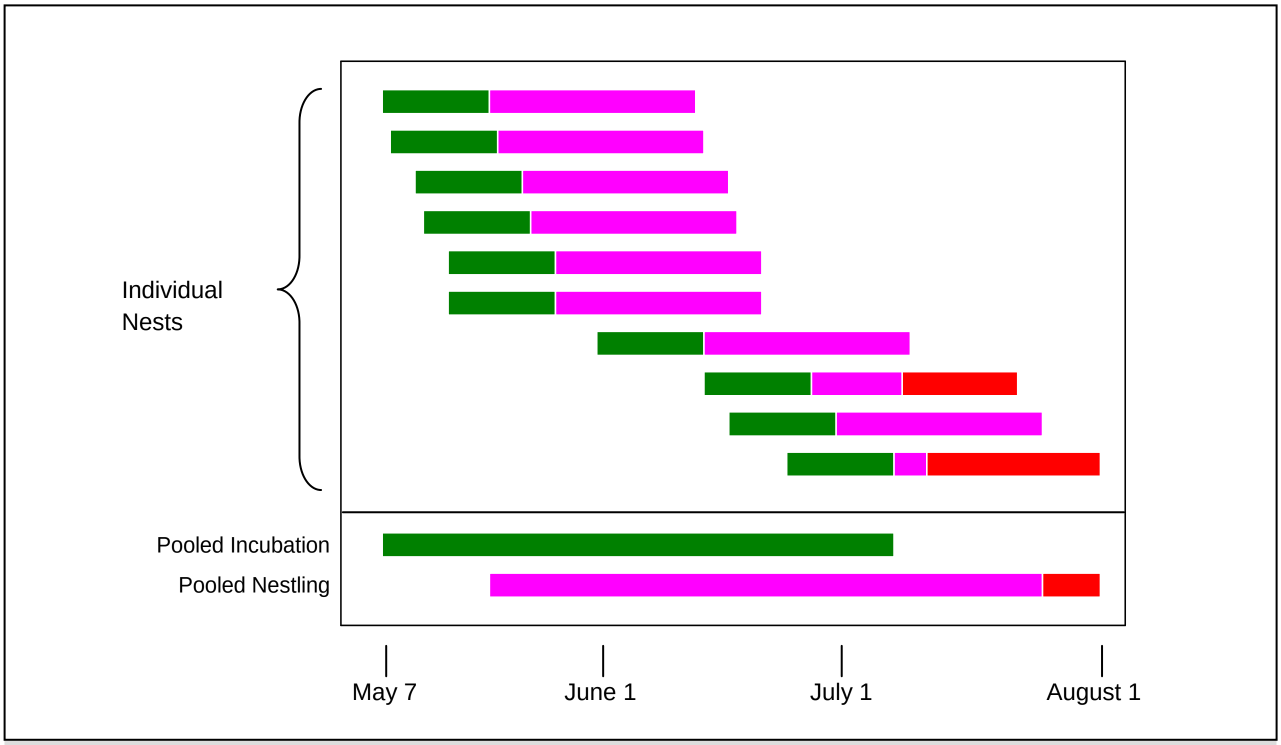

Figure 9. Nesting phenology of 10 Black-backed Woodpecker nests in burned forests of the Lassen National Forest, California, 2011 (Siegel et al. 2012c). Green bars indicate the incubation stage, pink bars indicate the nestling stage, and red bars indicate the expected remainder of the nestling period for nests that failed during the nestling stage.

In California and elsewhere, eggs are laid from April to June and juveniles fledge from June to July (Dixon and Saab 2000, Forristal 2009, Siegel et al. 2012c). Both sexes incubate and brood 2–6 young; from laying of the first egg through fledging, the nesting phase lasts approximately 40 days, with incubation lasting approximately 13 days and approximately 25 days elapsing between hatching and fledging (Ehrlich et al. 1988, Forristal 2009). Nesting phenology of 10 Black-backed Woodpecker nests in relatively low-elevation (<1,525 m above sea level) burned forests of Lassen National Forest in California during one breeding season is shown in Figure 9. Males incubate and brood at night (Dixon and Saab 2000). Nest cavities are usually excavated in snags but can be found in dead portions of live trees, and in, unburned forests, are sometimes excavated in live trees.

Primary food:
Wood-boring beetle larvae

Wood-boring beetle (*Coleoptera*: *Buprestidae*, *Cerambycidae*) larvae are the primary prey of Black-backed Woodpeckers in burned forests. Wood-borer larvae occur in the bark, phloem, and xylem of standing dead trees, although they spend most of their time in the deeper xylem (Powell 2000). Adult wood-borers detect burning or recently burned habitat by sensing smoke (e.g., the cerambycid *Monochamus*) or heat (e.g., the buprestid *Melanophila*), and lay their eggs on the freshly dead trees (Hart 1998). Larvae remain inside the wood for up to three years before emerging as adult beetles (Linsley 1961).

Figure 10. Wood-boring beetle exit hole in a burned tree. Photo by Monica Bond

Based on studies conducted in regions outside California, nest survival of Black-backed Woodpeckers is generally higher in burned than beetle-killed forests, with predation as the major cause of nest failure (*Oregon*: 63% nest success in beetle-killed forest, *n* = 19 nests, Goggans et al. 1989, 88% nest success in burned forests, *n* = 205, Forristal 2009; *Idaho*: >90% nest success in burned forest, *n* = 51, Saab et al. 2007, 2011; *Black Hills*: 44–78% nest success in beetle-killed forests, *n* = 12 and 31 respectively, Bonnot et al. 2008, 80% nest success in high-severity burned forests, *n* = 10, Vierling et al. 2008). Nest success is highest in the first few years after fire and then decreases with number of years after fire (Vierling et al. 2008, Nappi and Drapeau 2009, Forristal 2009 but see Saab et. 2011) or insect outbreak (Bonnot et al. 2008). In a long-term study of the Black-backed Woodpecker in burned forests of Idaho, nest survival increased with increasing distance to unburned forest; daily survival decreased for nests within approximately 100 m from the edge of unburned forests (Saab et al. 2011). Burn severity is another important factor in nest success. Vierling et al. (2008) reported greater nest success in higher-severity burned patches in the Black Hills.

In California, Siegel et al. (2012c) reported that 8 of 10 monitored nests in burned forests on the Lassen National Forest fledged young, but the small sample size in both studies limits interpretation of the findings. Purcell (unpublished data 2010) reported 100% nest success for 8 different nests detected over 8 years in unburned forests of the Sierra Nevada (see Appendix B), and

Foraging – Black-backed Woodpeckers feed primarily on larvae of wood-boring beetles (*Cerambycidae* and *Buprestidae*) and, to a lesser extent, the larvae of bark beetles (*Scolytidae*), as well as other insects, wild fruits, mast, and cambium (Villard and Beninger 1993, Murphy and Lehnhausen 1998, Dixon and Saab 2000). The woodpeckers typically forage on snags or downed logs rather than live trees (Villard and Beninger 1993, Villard 1994, Kreisel and Stein 1999, Murphy and Lehnhausen 1998, Hanson 2007).

Migration – Black-backed Woodpeckers are primarily resident but may migrate to lower elevations during winter (Dixon and Saab 2000). In the eastern part of its range the species periodically irrupts southwards into New England from its usual boreal forest habitat (Yunick

1985). The California Department of Fish and Game (CDFG; Zeiner et al. 1988–1990) suggested seasonal altitudinal migration in California, but more recently, CDFG personnel were unable to find information that would corroborate this phenomenon (Comrack and Applebee 2011).

***Additional Research Needs* – Information is needed on seasonal movements and winter habitat use by Black-backed Woodpeckers in California.**

Dispersal – In most bird species, females disperse greater distances than males (Greenwood 1980, Clarke et al. 1997). However, genetic analysis throughout the Black-backed Woodpecker's range, but not including California, indicates male Black-backed Woodpeckers disperse over long distances and unforested habitat at greater rates than females (Pierson et al. 2010). Very large gaps in forested habitat do form substantial barriers to dispersal even for males; this includes the gaps between the Cascade region, the Black Hills, and the contiguous northern boreal forest (Pierson et al. 2010).

Little is known about adult and juvenile dispersal through forested habitats. Mechanisms of dispersal from post-fire stands after several years (when local wood-borer beetle and Black-backed Woodpecker populations tend to decline), or colonization of newly burned stands, are not known for this species. In Canadian boreal forests, Black-backed Woodpeckers apparently traveled approximately 50 km to occupy newly burned forests, as no birds were detected within this distance from a burn perimeter (Hoyt and Hannon 2002). In California, occupancy probability in unburned forests was lowest approximate 4–8 km from perimeters of recent fires (<10 years) and began to increase beyond 8 km (Fogg et al. 2012).

***Additional Research Needs* – An important question in California is the degree to which founder populations of newly burned areas recruit from other local or distant burned areas, versus the surrounding unburned forest. Information is also needed on the relative importance of males, females, young birds, and adult birds in dispersal and colonization dynamics.**

Habitat Needs

Summary Points

- **Density of Black-backed Woodpecker populations is substantially higher in forests recently burned (1–8 years post-fire) at high and moderate severity with high densities of snags, than in unburned forests.**
- **Total snag basal area increases in importance as a predictor of occupancy with time since fire, suggesting that areas with greater snag density and snag sizes retain their habitat value longer after fire.**
- **Nests are typically in hard snags (not heavily decayed), but, in unburned forests can be in living trees, including dead portions of live trees.**
- **Nests are excavated in conifer trees, with little if any preference for particular conifer species. Size of nest trees in burned and unburned study sites in California ranged from 18–77 cm in diameter. Average dbh of nest snags in two studies of birds nesting in recent fire areas in California was 33 cm and 36 cm, respectively. Snags selected for nesting in one of the studies were smaller than randomly selected**
- **Elsewhere in the species' range, increased snag density and average snag size, pre-fire canopy cover, fire patch size, and fire severity were positively correlated with increased probability of nesting within a stand.**
- **Nest success of Black-backed Woodpeckers in burned forest in Idaho increased with greater distance from the burned-unburned forest edge.**
- **Abundance of wood-boring beetle larvae is a predictor of nest-stand and foraging-habitat selection in the Rocky Mountains. Black-backed Woodpeckers may track prey density of individual trees when deciding where to forage.**
- **Black-backed Woodpeckers preferentially selected larger snags (>50 cm diameter) for foraging in a study of 3 fire areas in the Sierra Nevada.**
- **In burned boreal forest, increasing snag density, snag size, snag intactness, and burn severity were positively correlated with increased use of a stand for foraging.**
- **Black-backed Woodpeckers foraged primarily in >80 year-old stands in unburned forests in Canada, and selected mature forests over younger stands for foraging in beetle-killed forests in Oregon.**
- **Individual home-range sizes, based on the 100^{th} percentile of the minimum convex polygon method, ranged from 175–429 ha across a variety of habitats outside California. Preliminary information from burned forests on Lassen National Forest in California indicates an average home range of approximately 400 ha.**

Black-backed Woodpeckers are not correlated with any particular tree species or forest type (Hutto 1995, Saracco et al. 2011), but are found most frequently in older coniferous forests comprised of relatively high densities of larger trees, most often burned but also uncommonly in unburned (Saab et al. 2002, Smucker et al. 2005, Russell et al. 2007, Hanson 2007, Vierling et al. 2008, Hanson and North 2008, Forristal 2009, Nappi and Drapeau 2009, Saab et al. 2009). In unburned forests of the Sierra Nevada, Black-backed Woodpeckers avoided lower-elevation west-side pine-hardwood (Fogg et al. 2012).

Figure 11. Male Black-backed Woodpecker with a wood-boring beetle larva. Photo by Monica Bond

The species also has also been found to use beetle-killed forest stands in Oregon (Goggans et al. 1989) and the Black Hills (Bonnot et al. 2008). No empirical data exist on correlations between beetle outbreaks and Black-backed Woodpecker numbers and nest success within California, but the birds have been observed in smaller groups of beetle-killed trees in the Tahoe Basin (R. Burnett, personal communication). Based on work elsewhere in the species' range, Powell (2000) surmised that forests with bark-beetle outbreaks probably support lower wood-borer beetle abundance than burned forests because trees in bark-beetle outbreaks are killed over several years, so many snags are in the advanced stages of decay less favorable for wood-boring beetles. Moreover, in trees killed by bark beetles, much of the nutrient-rich phloem is consumed by these beetles, so later-arriving wood-boring beetles (which produce larger larvae favored by Black-backed Woodpeckers) face heavy competition. Also, bark beetles are host-tree-specific, so outbreaks in mixed-species forests rarely kill all the trees, which may result in lower total snag density than in a burned forest of similar tree species composition. Powell (2000) noted lower densities of Black-backed Woodpecker pairs in beetle-killed than burned forests in both the northern Rockies and eastern Cascades, suggesting that bark beetle outbreaks are not equivalent to burned forests in foraging value.

***Additional Research Needs* – Research is needed to assess the relative importance of beetle outbreaks compared with burned forests for the Black-backed Woodpecker in California**.

In a survey of 51 recent fire areas (1–10 years post-fire) throughout the Sierra Nevada and southern Cascades of California, Saracco et al. (2011) detected Black-backed Woodpeckers on the west and east slopes of the Sierra-Cascades axis and across nearly the full latitudinal range of the study area, which spanned from the southern boundary of Sequoia National Forest to the

Oregon border. Black-backed Woodpeckers were found at the most northerly, and nearly the most southerly, fire areas. Relatively few woodpeckers were detected in white fir forest and no detections were recorded in pinyon-juniper forests; most detections were in Sierra mixed-conifer (although the rate of detection in that habitat, where many surveys were conducted, was relatively low), Jeffrey pine, eastside pine, ponderosa pine, and red fir. Few large fires and therefore, few survey locations were in lodgepole pine forest, which may be important habitat based on surveys and anecdotal information from unburned forests (Fogg et al. 2012 and unpublished data from R. Burnett and K. Purcell, see Appendix B). Occupancy probability at survey stations was strongly correlated with more northerly latitude, higher elevation, and fewer years since fire (Saracco et al. 2011).

Population densities and breeding pairs of Black-backed Woodpeckers are greatest in burned forest stands during the first several years after fire (*Canada*: detected 3, 4, 8 but not 16 years post-fire, Hoyt and Hannon 2002; *Idaho:* nest densities peaked 4–5 years post-fire and rapidly declined, Saab et al. 2007; *California*: occupancy probability declined 6 years post-fire, Saracco et al. 2011), especially in the most severely burned areas that had high pre-fire canopy closure (*Idaho*: Russell et al. 2007, *Oregon*: Forristal 2009) and contained high densities of dead trees (*Canada*: Hoyt and Hannon 2002; *Idaho*: Saab et al. 2009; *Oregon*: Forristal 2009; *Black Hills*: Vierling et al. 2008; *California*: Hanson 2007, Hanson and North 2008). Black-backed Woodpeckers were detected at 258 unique survey points (21%) within 39 of 67 (58%) fires surveyed during 2009 and 2010 throughout the Sierra Nevada; occupancy was significantly determined by elevation, fire age, fire severity , and pre-fire canopy cover (Tingley et al. in review).

Prescribed fire also can create suitable habitat for Black-backed Woodpeckers; prescribed fire treatments that resulted in a ~30% increase in snags >23 cm resulted in increased occupancy rates of Black-backed Woodpeckers relative to unburned forest in eastern Washington (Russell et al. 2009a). Black-backed Woodpeckers were detected in prescribed fires, some <50 ha in size, in the Sierra Nevada, and nesting was confirmed in a prescribed fire on the Eldorado National Forest in 2011 and 2012 (A. Fogg unpublished data).

In California, Blacked-back Woodpeckers appear to select medium-sized snags (35–50 cm) for nesting (Raphael and White 1984, Seavy et al. in press, K. Purcell unpublished data, R. Siegel unpublished data; see data in **Nesting Habitat: Nesting Trees**, below), even where larger snags are available (Seavy et al. in press, R. Siegel unpublished data).

Hanson and North (2008) found preferential foraging on large snags (>50 cm) in a study of 3 fire areas in the Sierra Nevada. Preliminary data from an ongoing study at two recent fire areas on Lassen National Forest suggests that Black-backed Woodpeckers forage on all available size classes of snags, but forage on snags <10 cm less than their proportion in the stand would indicate (R. Siegel unpublished data). Nappi et al. (2003) found Black-backed Woodpeckers preferentially foraged on larger, less-deteriorated snags in burned boreal forests in Quebec, Canada. Large snags may host larger numbers of wood-boring beetle larvae.

***Additional Research Needs* – Assess the relationship between snag characteristics (such as snag size) to availability of beetle prey in California forests.**

Not all newly burned forest habitat is apparently colonized by Black-backed Woodpeckers. Black-backed Woodpeckers were detected at fewer than 6% of 3,128 point counts in recently burned forests in the northern Rockies (Hutto 2008). Between 30 and 50% of 1- to 8-year old burned stands were occupied by Black-backed Woodpeckers in Canada (Hoyt and Hannon 2002). The proportion of survey stations occupied by Black-backed Woodpeckers in recent fire areas (<10 year old) in the Sierra Nevada was 25% (Saracco et al. 2011). Annual monitoring throughout recent fire areas in California between 2009 and 2011 has yielded mean occupancy probability values between 0.19 (95% CI: 0.17–0.21) and 0.25 (95% CI: 0.22–0.31) during each of the three years of monitoring (Siegel et al. 2011, 2012b). The probability of woodpeckers occurring at a point count station was greater in more recent fires and with increasing latitude and elevation (Saracco et al. 2011). Some evidence suggests that total basal area of snags increases in importance as a predictor of occupancy with time since fire. Snag basal area (estimated at each survey point using variable-radius plots to stem counts using a 10 Basal Area Factor timber-cruising crutch) was higher at detection than non-detection survey stations in ≥6 year-old fires in the Sierra Nevada/southern Cascades, but was similar in ≤5 year-old fires (Saracco et al. 2011), suggesting that burned areas with higher snag basal area may retain their habitat value longer.

In the boreal forest, dense stands of larger-sized trees are important Black-backed Woodpecker habitat not only after fire but also in unburned stands. Studies of Black-backed Woodpeckers in unburned Canadian boreal forests suggest the birds depend upon stands of forest ≥80 year old for persistence (Setterington et al. 2000, Hoyt and Hannon 2002, Tremblay et al. 2009). Black-backed Woodpeckers in unburned balsam fir forests in Newfoundland were detected significantly more in 80-year old stands where tree densities averaged 1,253 stems/ha, than in forests of younger ages (Setterington et al. 2000). Presence of Black-backed Woodpeckers was positively associated with density of snags >20 cm and negatively associated with the total number of snags in the Newfoundland study. In Alberta, Black-backed Woodpeckers were detected in

Figure 12. Female Black-backed Woodpecker guarding nest cavity. Photo by Stephen Shunk

unburned forests with significantly higher densities of standing trees than where the birds were not detected: the mean density of standing trees where Black-backed Woodpeckers were detected was 5,650.0/ha [95% CI = 4,099.4–7,200.5/ha] and where they were absent was 4,635.6/ha [95% CI = 4,191.1–5,080.1/ha] (Hoyt and Hannon 2002).

Data on unburned habitats occupied by Black-backed Woodpeckers in California are sparse, but suggest the birds are found more often at higher elevations (K. Purcell unpublished data), in most conifer forest types but typically in old-growth lodgepole pine (K. Purcell and R. Siegel unpublished data) as well as in lodgepole pine stands <100 years old surrounding mid-elevation meadows (Raphael and White 1984, R. Burnett unpublished data), and in red fir forests (Fogg et al. 2012).

***Additional Research Needs* – More information on wood-boring beetle ecology in unburned lodgepole pine and red fir compared with mixed-conifer forests may help explain Black-backed Woodpecker distribution in unburned forest.**

Nesting Habitat: Nest Trees – Four studies have collected data on attributes of Black-backed Woodpecker nests in California (Raphael and White 1984, Siegel et al. 2012c, Seavy et al. in press, K. Purcell unpublished data; see Table 1 below for summary). Raphael and White (1984) surveyed for Black-backed Woodpeckers in unburned and 15-year old burned forests at Sagehen Creek basin in the eastern slope of the Sierra Nevada near Truckee, California. Seven Black-backed Woodpecker nests were located over 4 years: 2 nests in unburned lodgepole-meadow,1 in burned pine-fir edge, 2 in burned red fir, and 2 in burned red fir edge. Five of the nests were in snags and 2 were in dead portions of a live tree; 3 nests were in lodgepole pine, 3 in red fir, and 1 in a Jeffrey pine. Mean nest height was 2.8 m (SE = 0.59), mean nest tree diameter was 44.5 cm, and mean nest tree height was 16.8 m (no variation or range provided).

In unburned forests in the southern Sierra Nevada, K. Purcell (unpublished data; see Appendix B) documented 8 nests from 18 multi-species study sites surveyed over 8 years, 7 of which were in lodgepole pine snags at relatively high (>2,097 m) elevations. Mean nest height was 5.8 m (range = 1.7–11.3 m), mean diameter of the nest tree was 53 cm (range = 33–77 cm), and mean height of the nest tree was 16 m (range = 12.0–27.7 m).

From a study of 31 Black-backed Woodpecker nests in recently burned forests in the northern Sierra Nevada, Seavy et al. (in press) report mean nest tree diameter of 33 cm (range = 18–50 cm), and most nests in ponderosa/Jeffrey pine and true fir. Selected nest trees were smaller than randomly selected trees. Working in three recently burned areas on Lassen and Plumas National Forests in the northern Sierra Nevada/southern Cascades, R. Siegel and others (unpublished data) took measurements at 21 nests, and found them to occur in similarly-sized trees (average = 36 cm, range = 22–90 cm) with nesting occurring in completely charred snags of yellow and sugar pine and incense-cedar (Siegel et al. 2012c).

Reported mean nest-tree sizes in California (Table 1) are similar to those in other parts of the range (e.g., *Idaho*: 39.7 ± 2.1 cm, Saab et al. 2002; *Idaho*: 32.3 ± 2.8 cm, Saab and Dudley 1998; *Oregon*: 27.7 ± 0.8 cm, Forristal 2009). Bull et al. (1986) suggested that the species may prefer nesting in trees <50 cm because trees of this size contain a higher percentage of sapwood than do larger trees, and this species often excavates nests in sapwood. Nest-tree size remained consistent for the first three years post-fire in Oregon, but increased in year four (Forristal 2009). Finally, anecdotal information suggests that when nesting in unburned forest, the species frequently excavates cavities in the trunks of living trees (Gaines 1992).

Table 1. Summary data on Black-backed Woodpecker nest-tree characteristics in California.

	Raphael and White 1984: Burned and unburned, *n* = 7	K. Purcell unpublished data: Unburned, *n* = 8	Seavy et al. in press: Burned, *n* = 31	Siegel et al. unpublished data: Burned, *n* = 21
Avg. Nest Height	2.8 m	5.8 m	-	3.0 m (SD=1.3 m)
Avg. Nest Tree Height	16.8 m	16 m	-	14.0 m (SD=5.4 m)
Avg. Nest Tree Diameter	44.5 cm	53 cm	33 cm (SD=7 cm)	36 cm (SD=15 cm)

Forristal (2009) reported that 90% of nests were in lodgepole pine and ponderosa pine snags at a study site in eastern Oregon, and the birds gradually switched from nesting primarily in lodgepole pine to ponderosa pine as years since fire increased. The author noted that lodgepole pine experienced high post-fire decomposition rates, which may offer a potential explanation for the switch.

***Additional Research Needs* – Further nest monitoring efforts could elucidate whether this phenomenon of switching nest-tree species over time occurs in mixed-species stands in California**.

Figure 13. Male Black-backed Woodpecker excavating a nest cavity. Photo by Joseph Leibrecht

***Nesting Habitat: Nest Stands* –** Snag density and size, pre-fire canopy closure, patch area, and burn severity were important factors in nest-stand selection in the Rocky Mountains. Several publications have emerged from a long-term research project conducted by the Rocky Mountain Research Station in burned forests of western Idaho (Saab and Dudley 1998, Saab et al. 2002, Saab et al. 2004, Russell et al. 2007, Saab et al. 2009). This project has consistently has documented that Black-backed Woodpeckers selected nest stands with the highest tree densities of all cavity-nesting bird species (average of 316 trees >23 cm per ha; Saab et al. 2009). Saab et al. (2002) found that high pre-fire crown closure was the most important variable in predicting presence of nests in stands of severely burned Douglas-fir forest. Probability of nest occurrence was highest in stands with high pre-fire crown closure (>70% crown closure pre-fire) covering >30 hectares. The best model describing Black-backed Woodpecker nest locations in Idaho included higher pre-fire crown closure, higher burn severity, larger diameter of trees, higher large-snag densities, and larger patch area of similar pre-fire vegetation type (Russell et al. 2007). More recently, Saab et al. (2009) again confirmed the best model for nesting habitat included greater patch area, large tree diameter, and higher snag density, as well as greater area of medium (40–70%) or high (70%) pre-fire crown closure in a 1-km area surrounding the nest.

A study conducted in burned forests of the Oregon Cascades also found significantly greater number of snags per hectare and significantly higher burn severity at Black-backed Woodpecker nests (n = 210) compared with random sites (Forristal 2009). The odds of nest occurrence nearly doubled for every 50 additional snags over 23 cm within a 50-m radius around the nest tree. Odds ratios indicated that Black-backed Woodpeckers selected nest sites in areas with higher snag densities and larger burned areas; tree density increased odds of nesting only if it coincided with increasing area of moderate or high burn severity. Vierling et al. (2008) documented that Black-backed Woodpeckers in burned forests of the Black Hills, South Dakota, selected larger-than-available trees for nesting that were farther from the edge of the burn, with less low-intensity fire and a greater snag density surrounding the tree than randomly sampled potential nest sites. The number of Black-backed Woodpecker nests was higher in sites with greater pre-fire canopy cover: 95% of nests were in areas where pre-fire canopy cover was medium (40–70%) or high (70–100%). In burned forests of the northern Sierra Nevada, Seavy et al. (in press) reported Black-backed Woodpeckers selected nest stands with significantly higher snag densities than random stands; mean number of snags >15 cm per 11.3 m radius plot surrounding the nest tree was 13.3 (range 1–29), equating to 332 snags/ha. Finally, Nappi and Drapeau (2009) found that Black-backed Woodpecker nest density and reproductive success were higher where high-severity fire occurred in old stands (canopy height >7 m), rather than in young stands (canopy height <7 m), in burned boreal forests of Quebec, Canada.

High tree densities appear to be important for nest-site selection in beetle-killed forests as well. In beetle-killed forests in Oregon, most Black-backed Woodpeckers nested in unlogged areas (silvicultural treatments were shelterwood cuts converted to stocking rate of 30 trees/acre prior to overstory removal), and selected mature or multi-storied stands for nesting (Goggans et al. 1989). In beetle-killed forests in the Black Hills, Bonnot et al. (2009) found the most important predictors of nest-site selection at the nest-area scale (12.5 m around nest) were increasing density of all pine and aspen snags >15 cm (used areas averaged 267.8 snags/ha) and decreasing diameter of those snags (average diameter = 22.3 cm). At a larger territory scale (20 ha around nest), the overriding feature of nest-site selection was a high abundance of wood-boring insects.

An ongoing study in burned forests on the Lassen National Forest (Siegel et al. 2012c) documented Black-backed Woodpeckers nesting in moderate- and high-severity (but not low-severity) patches of two recent fire areas. Some nests were in rather small (approximately 0.5 ha) higher-severity patches and were only tens of meters from the edges of low-severity areas, unburned areas, or post-fire clearcuts.

Distance to unburned forest is an important factor in nest-site selection and nest success in burned forests. Vierling et al. (2008) documented that Black-backed Woodpecker nests in the Black Hills were farther from the edge of the fire, and Saab et al. (2011) reported greater nest survival with increasing distance to the unburned edge (Figure 14). Saab et al. (2011) suggested that unburned forests may be a source of nest predators and may also indicate lower-quality habitat. In contrast, Black-backed Woodpeckers foraged less frequently in the interior of a fire area in Alaska (Murphy and Lehnhausen 1998).

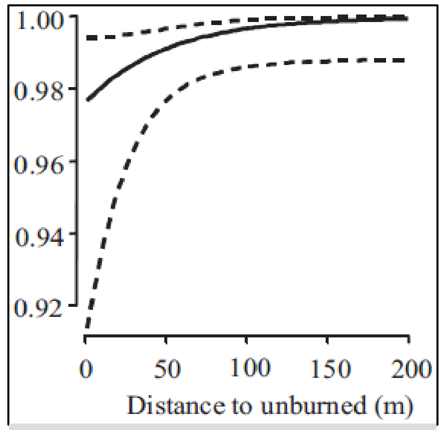

Figure 14. Daily nest survival rates of Black-backed Woodpeckers in burned forests of Idaho, 1994-2004 (from Saab et al. (2011).

Some types of timber harvesting may reduce habitat suitability and nesting densities, but may not completely preclude nesting. Saab and Dudley (1998) documented 13 Black-backed Woodpecker nests in unlogged burned forests, and 2 nests in "standard salvage" and 2 nests in "wildlife salvage" treatments (see Appendix D for description of treatment prescriptions). In unburned boreal forests of Quebec, Canada, Black-backed Woodpeckers were observed nesting in recent cuts subjected to uneven-aged stand management, where large snags suitable for nesting were left standing (unpublished data cited in Tremblay et al. 2009). In unburned beetle-killed lodgepole pine forests in Oregon, "mature and overmature" stands were preferentially selected for nesting but 26% of the nests (n = 35) were located in harvested stands: 5 were in partial cuts, one was in a stand being converted to a shelterwood cut where only live trees >25 cm were removed, one was in a shelterwood cut, and two were adjacent to shelterwood cuts by (Goggans et al. 1989). In both Goggans et al. (1989) and Tremblay et al. (2009) studies, Black-backed Woodpeckers were occasionally documented nesting in and around harvested stands, but preferentially foraged in older forests not recently subjected to timber harvest (see below).

Foraging Habitat – In 3 fire areas in the Sierra Nevada, Black-back Woodpeckers preferentially selected larger snags (>50 cm) for foraging (Hanson 2007) and were observed foraging exclusively in high-severity burned patches that were not subject to post-fire snag removal (Hanson and North 2008). In burned areas on the Lassen National Forest, Siegel et al. (2012c) found a strong positive correlation between snag size and probability of use for foraging. This study is ongoing, and more detailed data will be available upon completion. In the same study, other factors that correlated with probability of use for foraging included the degree of scorch on the trunk and the amount of bark retained on the trunk, indicating that the woodpeckers selected trees that had been severely burned but had not yet decomposed substantially (Siegel et al. 2012b). At the spatial scale of a 10-m radius circle, Siegel et al. (2012b) found that the following factors, in decreasing order of importance, predicted stand-level use for foraging: abundance of large (>60 cm dbh) snags, abundance of medium snags (30–60 cm), abundance of small (10–30 cm) snags, abundance of live trees, and abundance of logs.

Results are similar in other areas of the birds' range. Probability of foraging increased with increasing density of snags >25 cm in burned forests of Idaho (V. Saab unpublished data). Foraged-upon snags were significantly larger than available snags in burned forests in Idaho and Montana, but the woodpeckers foraged in patches with higher-than-average densities of >30 cm snags only in one of two fire sites (Powell 2000).

In burned black spruce boreal forests of eastern Canada, the probability that a snag was used by foraging Black-backed Woodpeckers increased with a higher diameter and a lower deterioration value (Nappi et al. 2003). Larger, less-deteriorated snags were linked to greater availability of wood-boring beetle larvae. Black-backed Woodpeckers at two fire areas in the northern Rockies chose foraging locations with high prey densities at the individual-tree level, but not at the larger patch scale (Powell 2000). Powell suggested that the woodpeckers tracked prey density of individual trees when deciding where to forage.

***Additional Research Needs* – Future research may determine whether and how selection of forage trees changes with time since fire, as beetle populations decline.**

Murphy and Lehnhausen (1998) postulated that Black-backed Woodpeckers may have foraged less frequently in the interior of a fire area in Alaska because trees were heavily scorched by the fire, resulting in relatively low larval survival there due to rapid desiccation of sapwood. However, Powell (2000) counted many wood-borers and signs of woodpecker foraging on completely scorched trees in the northern Rockies, and surmised that as long as moisture remained in the phloem, severely burned trees can contain high larvae densities and thus high foraging value for woodpeckers. Differences in woodpecker foraging between the study in Alaska and the northern Rockies might be attributable to bark thickness; thicker-barked trees that burn may retain more moisture in the phloem than thinner-barked trees.

In unburned boreal forests of eastern Canada, Black-backed Woodpeckers foraged mostly in coniferous stands >90 years old, and never in defoliated or old cut stands (Tremblay et al. 2009). At the home-range scale, the birds avoided recent (<5 year-old) cuts. "Cut stands" consisted of both even- and uneven-aged timber harvesting.

Home-Range Size – Home-range sizes of Black-backed Woodpeckers are relatively large, typically well over 100 ha. However, size appears to vary with habitat type and time since fire. Average home-range size of 2 males in 6-year-old post-fire forests, and 2 males in 8-year-old post-fire forests in Idaho was 429 ha (range = 150–766 ha) using 100 percent minimum convex polygon, and 207 ha (range = 115.6–420.9 ha) using fixed-kernel estimates (Dudley and Saab 2007). While sample sizes were small, home ranges were significantly larger 8 years than 6-years after fire, suggesting that woodpeckers forage over larger areas as the beetle population decreases over time. In an ongoing study in burned forests of California, Siegel et al. (2012c) report an average of minimum convex polygon (100^{th} percentile) home range of 400 ha (range = 102–796 ha) for six birds in forest stands that had burned 2 or 3 years earlier.

Goggans et al. (1989) reported the median minimum convex polygon home-range size for 3 individual woodpeckers was 175 ha (range = 72–328 ha) in beetle-killed forests of Oregon; larger home ranges had smaller proportions of unlogged (i.e., not subjected to shelterwood cuts) and mature habitats, suggesting a need to range farther in areas of lower-quality habitats, although sample size was small. Minimum convex polygon home-range sizes of 7 Black-backed Woodpeckers in unburned boreal forests of eastern Canada averaged 151 ha (range = 100–256 ha), with a home-range size of 358.8 ha for a female whose breeding attempt failed (Tremblay et al. 2009).

Additional Research Needs – **Current and future research could determine correlations between home-range size, stand characteristics, and beetle populations in burned, beetle-killed, and unburned forests in California, as well as characteristics that determine habitat selection of wood-boring beetles.**

Habitat Photo Gallery

Forest Stands Occupied by Black-backed Woodpeckers in California (nesting in the stand not confirmed)

Figure 15. Rich Fire, Plumas National Forest. Photo by Joanna Wu

Figure 16. Mud Fire, Stanislaus National Forest. Photo by Dayna Mauer

Figure 17. Mountain Fire, Stanislaus National Forest. Photo by Dayna Mauer

Figure 18. Broder Beck Fire, Sequoia National Forest. Photo by Dayna Mauer

Figure 19. Clover Fire, Sequoia National Forest. Photo by Dayna Mauer

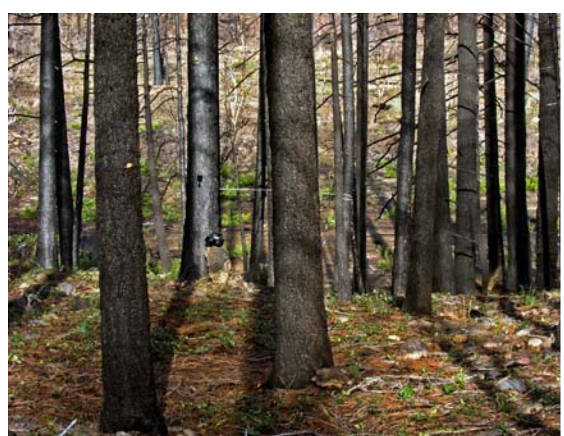

Figure 20. Sugarloaf Fire, Lassen National Forest. Photo by J. Leibrecht

Figure 21. Bassets Fire, Tahoe National Forest. Photo by Eric Huston

Figure 22. Fletcher Fire, Modoc National Forest. Photo by Eric Huston

Figure 23. Blue Fire, Modoc National Forest. Photo by Eric Huston

Figure 24. Moonlight Fire, Plumas National Forest. Photo by Eric Huston

Figure 25. Crater Fire, Inyo National Forest. Photo by Stephen Shunk

Figure 26. Black-backed Woodpeckers are occasionally detected in unburned lodgepole pine forests far from burned areas, as was the case in this stand in Yosemite National Park. Photo by Bob Wilkerson

Black-backed Woodpecker Nest Trees and Forest Stands Confirmed to Have Black-backed Woodpecker Nests in California

Figure 27. Black-backed Woodpecker nest cavity, Peterson Fire, Lassen National Forest. Photo by S. Shunk

Figure 28. Black-backed Woodpecker nest cavity, Peterson Fire, Lassen National Forest. Photo by Stephen Shunk

Figure 29. Black-backed Woodpecker nest cavity, Crater Fire, Inyo National Forest. Photo by Dayna Mauer

Figure 30. Black-backed Woodpecker nest cavity, Angora Fire, Lake Tahoe Basin Management Unit. Photo by Stephen Shunk

Figure 31. Black-backed Woodpecker nest stand in burned forest, Sugarloaf Fire, Lassen National Forest. Photo by Anna Szeitz

Figure 32. Black-backed Woodpecker nest stand in burned forest, Mud Fire, Stanislaus National Forest. Nest cavity visible on snag in the upper-right. Photo by Jade Ajani

Figure 33. Black-backed Woodpecker nest stand in burned forest, Angora Fire, Lake Tahoe Basin Management Unit. Nest cavity visible on snag in the forefront. Photo by Stephen Shunk

Figure 34. Black-backed Woodpecker nest stand in unburned lodgepole pine forest, Sierra National Forest. Photo by Kathryn Purcell

Potential Threats

Summary Points

- **Probability of occupancy and nesting by Black-backed Woodpeckers in burned forest is positively correlated with snag density and negatively correlated with years since fire during the decade after fire.**

- **Most studies show that even partial or less-intensive post-fire snag removal that eliminates some but not all standing snags nevertheless reduces occupancy and nesting density of Black-backed Woodpeckers, at least for the degree of snag removal studied.**

- **Pre-fire forest thinning might adversely impact Black-backed Woodpeckers by reducing tree density and canopy cover in unburned and subsequently burned habitats. Further research is needed in California.**

- **Fire suppression in California may have reduced the amount of habitat for post-fire associates like the Black-backed Woodpecker during the 20th century. While fire size appears to have increased recently compared to the previous century, it remains unresolved whether areas of high-severity fire are increasing or approaching rates comparable to the pre-suppression era.**

- **Efforts to model future distribution of Black-backed Woodpeckers in a warming climate based on predicted vegetation changes suggest potential range contractions in the northern Sierra Nevada and southern Cascades, the portion of California where Black-backed Woodpeckers are currently most abundant. However, changes in fire regime were not explicitly considered in these models.**

Studies indicate that certain forest management practices, including fire suppression, thinning to reduce risk of high-severity fire, and especially post-fire salvage logging may be threats to Black-backed Woodpeckers. Additional threats may include pesticide use and other efforts to reduce wood-boring and bark beetle populations in Black-backed Woodpecker habitat. These threats or potential threats are discussed in more detail below.

Figure 35. Forest management that removes a large proportion of post-fire snags, as in this image, may be incompatible with Black-backed Woodpecker occupancy and reproduction; more research is needed to identify minimal snag retention thresholds for the species. Photo by Joanna Wu

Salvage Logging and other Management Involving Post-fire Snag Removal –

Wildfire in forested environments is sometimes followed by the removal of dead or dying trees, in pursuit of one or more of many possible management goals. Commonly referred to as 'salvage' or 'salvage logging', it may be done to capture the economic value of wood products or for other reasons. Strictly speaking, as defined by the Society of American Forester's *Dictionary of Forestry*, salvage refers to "the removal of dead trees or trees damaged or dying because of injurious agents other than competition, to recover economic value that would otherwise be lost." Other reasons for post-fire snag removal include:

- mitigating hazards associated with roads, trails, administrative sites, and/or other sites where people may find themselves in unacceptably hazardous situations.
- reducing hazards in areas where accelerated restoration of forested environments is desired for multiple reasons, including, for example, wildlife habitats that would otherwise be delayed without prompt reforestation actions.
- reducing long-term fuel levels that could subject developing forest trees to intense heat and resultant mortality.

The specific number and arrangement of trees removed can vary greatly, depending on the site-specific ecological context and management objectives. However, 'salvage' does not necessarily mean extensive and complete removal of snags from an area. This variation in the intensity and design of projects involving post-fire snag removal complicates comparisons of studies that evaluate the effects of salvage or other management activity involving snag removal on Black-Backed Woodpeckers, particularly when metrics are not available on how many snags were removed and/or retained on the landscape. **Below we summarize research on the effects of salvage and other post-fire snag removal activities on Black-backed Woodpeckers, but we caution that snag removal treatments, including treatments described as 'salvage', vary substantially between studies – in many cases more detail about specific forest treatments is provided in the cited reports and publications.**

Black-backed Woodpecker abundance and reproductive success were reduced by post-fire snag removal in the Rocky Mountains, Canada, and Oregon (Saab and Dudley 1998, Hutto and Gallo 2006, Saab et al. 2007, Koivula and Schmiegelow 2007, Hutto 2008, Cahall and Hayes 2009, Saab et al. 2009). Saab and Dudley (1998) documented nest densities in Idaho were more than four times greater in unlogged postfire stands versus both "standard salvage" and "wildlife salvage" treatments (13 nests in unlogged, and 2 each in both logged treatments), despite partial snag retention in the treatments (see Appendix D for description of treatment prescriptions). Saab et al. (2007) reported that nest densities (n = 51) were more than 5 times higher in unlogged post-fire areas than in partially logged (40% of snags >23 cm were removed after the fire) post-fire area.

In Montana, Hutto and Gallo (2006) found 10 nests in 148 ha of burned stands not salvage logged, but 0 nests in 275 ha of stands where all merchantable fire-killed trees >15 cm had been removed. In recently burned forests of Alberta, Canada, 30 of 32 Black-backed Woodpecker nests were in stands not subjected to salvage logging; treatments within salvage-logged stands ranged from 20 to 70% of merchantable trees removed (Koivula and Schmiegelow 2007). Burnett et al. (2011) did not find any Black-backed Woodpecker nests in two years of nest searching on heavily salvaged private lands where many merchantable trees were removed, while they found 0.61 nests per 20-ha plot on adjacent unsalvaged lands in the Moonlight Fire.

In the eastern Oregon Cascades, Cahall and Hayes (2009) found that densities of Black-backed Woodpeckers were greater in unlogged compared to moderate and heavily salvage-logged stands. Moderate salvage logging retained 30 snags >35.6 cm per ha, and heavy salvage logging retained 5–6 snags >50.8 cm per ha. However, in the eastern Oregon Cascades, Forristal (2009) found that treatments retaining at least 25 snags/ha of various diameters, often leaving more standing snags, especially snags <23 cm. did not significantly reduce densities of snags—particularly lodgepole pine— at a landscape scale (1 km surrounding nest site) and did not negatively impact occurrence of Black-backed Woodpecker nests or nest survival.

Using both passive and broadcast surveys, Siegel et al. (2012b) found that Black-backed Woodpecker occupancy within 67 different fire areas throughout the Sierra Nevada and Southern Cascades was positively associated with high elevation, high fire severity, high pre-fire canopy cover, and high snag density in stands less than 10 years post-fire, but the authors detected no direct effect of post-fire snag removal on occupancy independent of these factors. However, the effects of snag removal were indirectly manifested by the significant and positive relationship between snag density and Black-backed Woodpecker occupancy – stands with low snag density, regardless of whether the low density was a result of post-fire snag removal or pre-fire forest structure, were less likely to be occupied by Black-backed Woodpeckers than stands with higher snag densities. Siegel et al. also determined that both Black-backed Woodpeckers and snag-removal treatments disproportionally occur in sites with the same characteristics – areas of high snag densities in younger fire areas – suggesting that snag-removal treatments tend to be located in the very same places that are most attractive to the woodpeckers. Snag densities averaged 10.2 snags/ha at sites where some type of management action involving snag removal was implemented, and 16.6 snags/ha at sites without snag removal.

Data from California also suggest that post-fire snag removal may decrease foraging habitat suitability for Black-backed Woodpeckers. Using passive surveys in 3 fire areas in the Sierra Nevada, Hanson and North (2008) detected Black-backed Woodpeckers only in high-severity burned stands that were not subject to any post-fire snag removal. Using broadcast methods in a larger sample of fires, Siegel et al. (2008, 2010) identified strong associations with the most intensely burned forests but also detected woodpeckers in moderately burned and, rarely, in low-intensity burned stands and occasionally in areas that had been previously treated with some degree of snag removal.. Results from radio-telemetry studies indicate that Black-backed Woodpeckers strongly avoid foraging in areas where most of the snags had been in post-fire forest in California (Siegel et al. 2012a) and beetle-killed forests in Oregon (Goggans et al. 1989).

***Additional Research Needs* – Further research might quantify the relative effects of different intensity post-fire snag removal treatments on Black-backed Woodpecker occupancy and demographics in California forests**.

Figure 36. Post-fire fuelwood cutting during May-July can destroy active nests. The stumps in this picture taken on Lassen NF were cut for firewood in early June, close to a Black-backed Woodpecker nest (indicated by red arrow) with week-old nestlings. Photo by Monica Bond

Fuelwood-cutting for Personal Use in Recent Fire Areas – Although systematic data on the effects of fuelwood cutting on nesting Black-backed Woodpeckers are not available, small-scale harvesting of fuelwood by the public for personal use, from recent fire areas as well as unburned lodgepole pine forests, can destroy active Black-backed Woodpecker nests. Nests are active between early May and late July, and felling of nest trees with nestlings during that period will cause nest failure.

Thinning of Unburned Forests – Black-backed Woodpecker abundance in forests that were commercially thinned and then later burned in wildfire was lower than in burned forests that were not thinned before fire in the Rocky Mountains (Hutto 2008). Pre-fire tree densities and canopy cover are correlated with high post-fire occupancy rates and nest densities (Russell et al. 2007, Vierling et al. 2008, Forristal 2009, Saab et al. 2009, Siegel et al. 212b). Moreover, high densities of trees (*Alberta, Canada*: occupancy sampled in 191 stands using broadcast methods, Hoyt and Hannon 2002) and medium- and large-sized snags (*Eastern Oregon Cascades*: 395 foraging bouts from 3 radio-tagged birds, Goggans et al. 1989) are correlated to Black-backed Woodpecker occupancy in unburned forests. Thus, pre-fire forest thinning can decrease post-fire occupancy rates and nest densities of Black-backed Woodpeckers, and thinning or removal of medium- and large-sized snags may decrease habitat suitability in unburned forests. However, some anecdotal evidence suggests that Black-backed Woodpeckers increase in abundance in aspen forests after conifers have been removed (R. Burnett, personal communication 2012).

***Additional Research Needs* – Further research would be useful to quantify the relative effects of different pre-fire thinning treatments on Black-backed Woodpecker post-fire occupancy and habitat suitability in California's forests.**

Fire Suppression and Trend in Forest Fire – If fire suppression reduces the amount of mid- and high-severity post-fire habitat available for Black-backed Woodpecker, it could be thought of as a threat to the species. Below we provide a brief summary of information on fire suppression in California, as well as a cursory discussion of the trend in how much post-fire habitat is being produced by wildfire. Additional information on this topic is provided in Appendix B, in the sections by T. Meyer and D. Passovoy, C. Hanson, and Jay Miller, Hugh Safford, and Donald Yasuda.

A national policy of active forest-fire suppression on public lands in the United States began in the early 1900s. Fire suppression has been ubiquitous in California forests, and there are few areas within the range of the Black-backed Woodpecker that have not been subjected to the influence of this management policy (Skinner and Chang 1996). The policy successfully reduced the extent and frequency of fire in a variety of forest types in the Klamath, Cascade, and Sierra Nevada mountains during the 20th century as compared to the pre-suppression era [i.e., before 1900] (Kilgore and Taylor 1979, Taylor 1993, Bekker and Taylor 2000, Beaty and Taylor 2001, Taylor and Skinner 2003, Beaty and Taylor 2008, Fry and Stephens 2006, Scholl and Taylor 2010). Research in areas relatively free of human manipulation other than fire suppression has indicated changes in tree-species composition, increases in stand densities, and decreases in size and increases in distance between forest openings (Parsons and DeBenedetti 1979, Skinner 1995, Taylor 2000, Taylor and Skinner 2003, North et al. 2007, Scholl and Taylor 2010). Throughout California, the overall acreage of mixed-conifer forests burned annually during the pre-settlement era [i.e., before 1800] was far greater than that which burned in the latter half of the 20th century (Stephens et al. 2007). Because of the reduction in fire area, fire suppression in California may have reduced the amount of habitat for post-fire associates like the Black-backed Woodpecker (although densification of these forests may increase beetle activity as well as improve potential habitat conditions once fire occurred, effects which have not been quantified).

During the pre-suppression era, average fire size in montane and upper montane forests was likely less than 200 ha (Taylor and Skinner 1998, Taylor 2000, Beaty and Taylor 2001, Taylor and Solem 2001, Collins et al. 2007, Scholl and Taylor 2010). Studies based on forest structural analysis, stand ages, and fire history also suggest that high-severity patches more than a few hectares in size were relatively unusual (Show and Kotok 1924, Kilgore 1973, Stephenson et al. 1991, Weatherspoon et al. 1992, Skinner 1995, Skinner and Chang 1996, Weatherspoon and Skinner 1996). However, fires that burned very large patches of mixed-conifer forest at high severity did occur historically during certain dry years (Bekker and Taylor 2000, Beaty and Taylor 2001, Odion and Hanson 2006), and sometimes fires burned across entire watersheds

(Beaty and Taylor 2001), indicating that high-severity burns are an intrinsic part of California's mixed-conifer fire regime.

The question remains how contemporary [i.e., late 20th and early 21st century] fire patterns (frequency, size, severity) in California's forests may differ from pre-suppression patterns. This question has important implications for the conservation of the Black-backed Woodpecker. While fire suppression was largely successful over the previous century, some evidence shows an increase in fire size in California forests beginning in the mid-1980s compared with earlier fire sizes during the suppression era (Miller et al. 2009, Odion et al. 2004, Westerling et al. 2006), with multi-year patterns in fire frequency, fire size, and total burned area all trending upward (Westerling et al. 2006, Miller et al. 2009, Dillon et al. 2011). The increase in fire size and frequency over the past few decades might be due to the combined effects of a warming climate, a century of intensive timber harvesting and fire suppression, and increases in the human population in and surrounding forests.

A related question is whether or not overall size or proportion (within a fire) of *high-severity* fire area is increasing in recent years as compared with the pre-Euroamerican settlement era (pre-1850). Data collected since the mid-1980s on a large subset of fires in the Sierra Nevada that at least partially burned on Forest Service lands suggested that contemporary fires that are still managed under fire suppression are burning larger areas at high severity than in the past, and the temporal trend is upwards (Miller et al. 2009). These trends have recently been confirmed and temporally extended using a dataset of all fires >80 ha in size in the Sierra Nevada, southern Cascades, and Modoc Plateau (Miller and Safford in review). Dillon et al. (2011) found similar results in other summer-dry regions of the southwestern US, including Arizona, New Mexico, southern Utah and southern Colorado, where proportion and/or area of high severity fire had increased over the same period as the Miller et al. (2009) study. Supporting the idea that fire suppression played a role in the increase of fire severity in the Miller et al. (2009) study, Collins et al. (2009) found that fire severity over the same time period had remained approximately stable in a large area of Yosemite National Park where naturally ignited fires are allowed to burn. In an earlier paper, Odion and Hanson (2006) used soil burn severity data to analyze fire effects to vegetation in three recent fires, and concluded that modern fires in the Sierra Nevada were similar to presettlement fires with respect to their amount and patchiness of high severity fire. Odion and Hanson's (2006) results were challenged by Safford et al. (2008), who repeated the Odion and Hanson analyses using standardized vegetation burn severity data and found different results. Additional information and perspectives on fire-severity patterns in California's forests are provided in several of the sections in Appendix B.

Consensus in the scientific literature is that fire suppression successfully reduced extent and frequency of fires during the 20th century, particularly the smaller fires that were most easily controlled. Fire suppression also altered stand structure by changing species composition and stand densities in some forests. Fire *size* appears to be increasing in recent years compared to most of the 20th century. However, it remains unresolved whether fire *severity* currently is increasing or whether it has reached rates comparable to the pre-suppression era. In the future, if fire occurrence and severity increase with a warming climate (see below), species like the Black-backed Woodpecker that have life histories closely tied to burned forests are likely to benefit, provided that sufficient amounts of post-fire forests are retained during management activities. If, however, fire occurrence and severity decline in the future, burned-forest habitat for the Black-backed Woodpecker will be more limited.

Although managers have placed increased emphasis on restoration of fire on public lands areas where feasible outside of the wildland-urban interface (a policy direction initiated in California's national parks several decades ago), the policy of forest fire suppression currently remains widespread across the range of the Black-backed Woodpecker in California.

***Additional Research Needs* – More information on past, current and future temporal and spatial patterns of fire severity would help facilitate population viability analysis for Black-backed Woodpecker in California.**

Climate Change – An analysis of Christmas Bird Count (CBC) data suggests that the center of abundance of Black-backed Woodpeckers during the winter has significantly shifted 100 miles north and over 130 miles inland throughout its North American range over the past 40 years, corresponding with increases in temperature (Audubon 2009). Furthermore, the Black-backed Woodpecker was listed as at-risk to climate change based on a recent vulnerability assessment (Gardali et al. 2012).

Modeled shifts in distribution of the Black-backed Woodpecker in California due to climate change (not accounting for changes in fire regime) predict range contractions of the species across the Sierra Nevada and southern Cascades. The most prominent decreases in occurrence are predicted in the northern portion of the species' range in California (Stralberg and Jongsomjit 2008), where the species is most common (Saracco et al. 2011), so the predicted range contraction in this region could signify cause for concern. The most important variables influencing current and projected distribution were annual mean temperature and precipitation in the Maxent and GAM distribution models, as well as vegetation in the Maxent distribution model (Stralberg and Jongsomjit 2008). It is important to note, however, that these climate envelope models do not take into account dynamic processes such as fire and, therefore, might underestimate the suitable habitat for disturbance-dependent species like the Black-backed Woodpecker. Furthermore, most of the data upon which these models were built were from unburned habitats.

Black-backed Woodpeckers on burned forests in California currently breed between 1,000 and 3,000 m in the Sierra Nevada (R. Burnett and R. Siegel unpublished data), and are more likely to occur at the higher end of their elevational range (Saracco et al. 2011). Many species worldwide have shifted their ranges upslope in response to climate change (Pounds et al. 1999, Root et al. 2003, 2005). In the Sierra Nevada, numerous bird species already have responded to climate change by shifting their ranges to track preferred temperature or precipitation conditions (Tingley et al. 2009). If the Black-backed Woodpecker follows this pattern and shifts its range upslope as a result of climate change, even if the overall aerial extent of habitat in California is reduced, substantial areas of coniferous forests are likely to be available for colonization at higher elevations. The exception is the northern Sierra Nevada, where elevations are lower than the central and southern portion of the mountain range.

The primary way climate change is likely to affect the Black-backed Woodpecker is not directly through temperature and precipitation changes per se, but rather through altered fire regimes, given that the species reaches its greatest abundance in moderate- and high-severity fire areas. Some studies predict the frequency and size of high-severity fire will increase in the future due to the interaction between climate warming, increased vegetation from fire suppression, and more profound fire-season drought resulting from anthropogenic climate change (Running 2006, Westerling et al. 2006, Lenihan et al. 2008, Miller et al. 2009, Westerling et al. 2009). If this is the case, the Black-backed Woodpecker is likely to benefit. However, other studies suggest the longer-term changing climate conditions may result in shifts in vegetation communities, with reduced vegetation leading to less frequent and intense wildfires (Parisien and Moritz 2009, PRBO Conservation Science 2011), which would adversely impact the Black-backed Woodpecker.

Contemporary empirical data, patterns in the paleo-record during similar warming periods, and future modeling all suggest that fire activity may increase as temperatures continue to increase (Miller and Urban 1999, Whitlock et al. 2003, Lenihan et al. 2003, 2008; Westerling et al. 2006, Westerling and Bryant 2008, Miller et al. 2009, Gedalof 2011, National Research Council 2011). However, Marlon et al. (2012) note that, given the levels of climate warming that already have occurred, it is remarkable how little fire is occurring in the western U.S. According to the authors, the contemporary disconnect between climate and fire activity is unprecedented in at least the last 1,500 years (the time period of their sedimentary charcoal study). These studies underscore the uncertainty regarding the future of Black-backed Woodpecker habitat in California's forests in a changing climate.

***Additional Research Needs* – Continuing studies on current and future trends in moderate- and high-severity fire will inform efforts to conduct population viability assessments under varying climate scenarios.**

Pesticide Use – Black-backed Woodpeckers are specialized to forage upon larvae of wood-boring beetles and, to a lesser degree, bark beetles. Pesticide use on surrounding forests in response to beetle outbreaks may reduce the abundance of prey. Efforts to reduce impacts of bark and wood-boring beetles through forest thinning, planting genetically modified tree stock, and salvaging beetle-infected trees may also reduce prey for Black-backed Woodpeckers.

Additional Research Needs **– The effects on the Black-backed Woodpecker of pesticide use and other efforts to reduce beetle populations and effects have not been studied**.

Disease – To our knowledge, information on disease in Black-backed Woodpeckers comes from only a single study. For an investigation of Black-backed Woodpecker home-range size and foraging ecology, Siegel et al. (2012c) radio-tagged 9 birds on Lassen National Forest (Shasta and Lassen Counties, California) during the 2011 breeding season. One of the marked birds was found dead after being tracked for a 10-week period in which it successfully nested. A necropsy of the dead bird revealed that it was emaciated and autolyzed, with the presumptive cause being numerous spiruroid nematodes of the genus *Procyrnea* in the gizzard. The life-cycle of *Procyrnea* requires arthropods as intermediate hosts, which are then consumed by the definitive host, where the nematodes parasitize the upper gastrointestinal tract. Apparent intermediate hosts of *P. pileata* include pillbugs (*Armadillidium vulgare*) and earwigs (*Euborellia annulipes*) (St. Leger unpublished data), neither of which are likely to be consumed by Black-backed Woodpeckers foraging by excavating the larvae of wood-boring beetles and bark beetles from within dead or ailing trees. However, during 1,198 observations of Black-backed Woodpecker foraging bouts, the gleaning of prey items from the outer surface of tree bark was noted as part of 113 bouts (9.4%). Gleaning prey items from the surface of tree trunks and logs introduces the potential for more frequent consumption of arthropods that could be *Procyrnea* vectors.

The observation of *Procyrnea* nematodes in a Black-backed Woodpecker is notable because the *Procyrnea* infection was considered lethal and because *Procyrnea* has been implicated in substantial die-offs in other bird species, including woodpeckers (Foster et al. 2002, Siegel et al. 2012a). While the Black-backed Woodpecker fatality reported by Siegel et al. (2012a) is only an anecdotal incident, it has been suggested that helminth parasites may be capable of regulating bird populations in some cases (Peterson 2004).

Current Management Direction

Federal lands managed by the U.S. Forest Service

Vegetation Management – Management direction for the 10 National Forests within the Sierra Nevada is governed by the Land and Resources Management Plan (LRMP) for each National Forest, as amended by the 2004 Sierra Nevada Forest Plan Amendment (SNFPA) and – for the Lassen, Plumas, and Tahoe National Forests – the Herger-Feinstein Quincy Library Group Act. The SNFPA Record of Decision (ROD), which replaced the earlier 2001 SNFPA ROD, adopted "an integrated strategy for vegetation management that is aggressive enough to reduce the risk of wildfire to communities in the urban-wildland interface while modifying fire behavior over the broader landscape" (USDA Forest Service 2004). The SNFPA ROD identifies goals and management strategies to address old-forest ecosystems and associated species; fire and fuels; aquatic, riparian, and meadow ecosystems; lower Westside hardwood ecosystems; and noxious weed management (USDA Forest Service 2004). In addition, desired conditions, management intent, and management objectives are identified by land allocation (e.g., Wildland Urban Interface [WUI] defense zones, WUI threat zones, old forest emphasis areas, species-specific management areas, and general forest). Standards and Guidelines are also identified. The Forest-wide Standards and Guidelines stipulate that treatments are to be strategically placed to interrupt fire spread and achieve conditions that reduce the size and severity of wildfires, with an emphasis on overlapping high-density stands and pockets of insect and disease (ROD page 35). These Standards and Guidelines have the potential to affect the current and future amount of burned-forest habitat for Black-backed Woodpeckers.

Fuels treatments described by the ROD were estimated to cover 25–30% of the land base over a >20 year period, and annual proposed thinning was planned to remove less than 0.3% of the standing inventory and one-fifth of the net annual growth (USDA Forest Service 2004). The Forest Service annually records vegetation treatments in the **F**orest **AC**tivity **T**racking **S**ystem (FACTS) and the **T**imber **I**nformation **M**anager (TIM) and produces a Silviculture Accomplishment Report. A review of these data sources shows that since 2004, the annual acres of vegetation management averaged around 32,000 acres per year in the 10 National Forests in the Sierra Nevada portion of the Pacific Southwest Region ("the Region"). This work includes a variety of forest-treatment activities focused on removal of trees up to approximately 76.2 cm diameter, creation and maintenance of fuel breaks, and post-fire tree removal. This annual amount of vegetation management equates to 0.43% of the approximately 7.5 million acres of forested National Forest System (NFS) land in the Sierra Nevada planning area, which largely corresponds to the range of Black-backed Woodpecker in California..

Decisions by land managers to manage burned areas and areas with insect-killed trees are made at the site-specific level, considering the unique current and expected future conditions of the site and surrounding areas. Considerations that the Forest Service and other land managers must take into account in making land management decisions include short-term and long-term safety to humans from falling trees, required by the Occupational Safety and Health Administration (OSHA), as well as actions to trend burned or other snag-dominated areas towards desired future conditions. The 2004 SNFPA calls for retaining at least 10% of large moderate- and high-severity wildfires in an unsalvaged condition [ROD Forest-wide Standards and Guidelines state on page 52: "In post fire restoration projects for large catastrophic fires (contiguous blocks of moderate to high fire lethality of 1,000 acres or more), generally do not conduct salvage harvest in at least 10 percent of the total area affected by fire."]. For non-fire disturbances, there is no specific retention requirement, however, direction is to design projects to protect and maintain critical wildlife habitat, including specifically providing sufficient quantities of large snags (ROD page 52). Since 2003, about 294,000 acres of conifer forest types have burned on NFS lands in the Sierra Nevada in fires that were generally greater than 1,000 acres. Of these acres, approximately 30,000 acres (10%) have had timber salvage or other management activities that removed snags after the fire. When considering only high-severity fire, about 20% of the approximately 109,000 acres have had snag removal activities. About 6% of the approximately 76,000 acres of moderate-severity fire areas had similar treatments.

Fuels management to influence the behavior and outcome of future fires is planned to achieve a variety of national forest management objectives, including the management of wildlife habitats and other ecosystem services. For example, fuels reduction is often planned adjacent to campgrounds and critical infrastructure like water canals and communication sites to reduce the threat and impacts from future wildfires.

The Pacific Southwest Region of the Forest Service recently issued a statement of Leadership Intent for Ecological Restoration (USDA Forest Service 2010). The leadership intent outlines the expectations of the Regional Forester that all activities be anchored on maintaining and restoring ecosystems and key ecological functions, with the overall goal "to retain and restore ecological resilience of the National Forest lands to achieve sustainable ecosystems that provide a broad range of services to humans and other organisms." Focused activities under the Leadership Intent include: increase forest resilience through treatments (including prescribed fire and thinning) and wildfire, meadow restoration, reforestation, removal of unneeded roads, and decrease the occurrence of uncharacteristically severe wildfires and their associated impacts.

Prescribed fire can be used to approximate the natural vegetative disturbance of periodic fire occurrence if these objectives are derived from a National Environmental Policy Act (NEPA) analysis and incorporated into a prescribed burn plan. These prescribed burn plans are made at the site-specific level, considering the current and expected future conditions of the site and surrounding areas.

Much of the focus of current vegetation management on NFS lands is related to an overall goal of reducing the impact of wildfires to communities and areas of human habitation. In addition, the Forest Service has identified a goal to decrease the occurrence of uncharacteristically severe forest fires and their associated impacts on living forest ecosystems, all of which have an impact on Black-backed Woodpeckers and their habitat.

Response to Wildland Fires – Fire management is considered central to meeting the Forest Service's mission of conserving natural resources, restoring ecological health, and protecting communities; however, the agency is focused on not exposing incident responders to unnecessary risk and has established a risk assessment/decision process (USDA Forest Service 2011), consistent with the Interagency "Guidance for the Implementation of Federal Wildland Fire Policy" (Fire Executive Council 2009). Fire-suppression activities occur across the landscape, including both inside and outside of the wildland-urban interface. The impact of fire on existing old-forest habitat for other wildlife species such as the California Spotted Owl, Northern Goshawk, American marten, and Pacific fisher are some examples of resources that the agency considers when choosing a fire-management strategy. In addition, concerns for firefighter and public safety and impacts on human health from smoke must weigh into strategic and tactical decisions on fire management.

The Departments of the Interior and Agriculture, including the USDA Forest Service, have a single cohesive federal fire policy (Fire Executive Council 2009). The policy identifies wildland fire as any non-structure fire that occurs in the wildland and categorizes wildland fires into two distinct types: (1) wildfires (unplanned ignitions or prescribed fires that are declared wildfires) and (2) prescribed fires (planned ignitions). Fire, as a critical natural process, is integrated into Land and Resource Management Plans and activities on a landscape scale, and across agency boundaries. Response to wildland fires is based on ecological, social, and legal consequences of the fire. The circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and values to be protected, dictate the appropriate response to the fire. A wildland fire may be concurrently managed for one or more objectives and objectives can change as the fire spreads across the landscape. Objectives are affected by changes in fuels, weather, topography; varying social understanding and tolerance; and involvement of other governmental jurisdictions having different missions and objectives.

Within the USDA Forest Service, only natural ignitions (as opposed to human-caused fires) can be managed to achieve desired Land and Resource Management Plan objectives when risk is within acceptable limits. The primary objective is to provide for firefighter and public safety. In addition, all wildfires must have, at a minimum, documented objectives for the protection of life and property (USDA Forest Service 2011). The Forest Service requires a risk-informed response for all wildfires (USDA Forest Service 2011). Managers use the Wildland Fire Decision Support System (WFDSS) to inform and document wildfire management decisions, including a situational assessment and analysis of hazards and values at risk (natural and cultural resources and infrastructure). Fire suppression will continue to be the management response for all human-caused fires, with the primary focus of safety and cost effectiveness. Only natural ignitions can be managed concurrently to achieve Land and Resource Management Plan objectives.

In the wildland-urban interface (the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels), the management intent is to prevent the movement of wildfires from the wildlands into the wildland urban interface area, out of the wildland urban interface area into the wildlands, and improve efficiency of wildfire suppression within the wildland urban interface.

Federal lands managed by the National Park Service

In the national park units where Black-backed Woodpeckers occur in California (Lassen, Kings Canyon, Sequoia, and Yosemite National Parks, and Devils Postpile National Monument), the guiding fire management document is the 2009 implementation guide of the 1995 Federal Wildland Fire Policy, reviewed in 2001, which allows federal agencies the full range of fire response options. In general, park managers strive to restore natural fire regimes where feasible (D. Graber, personal communication 2011). The National Park Service does not routinely conduct commercial post-fire timber harvests; burned trees are left undisturbed except where they present safety hazards in developed campgrounds and along roads.

Private lands

The body of regulation governing the majority of the management actions in Black-backed Woodpecker habitat on state and private lands in California is the California Forest Practices Rules, which is administered by the California Department of Forestry and Fire Protection, and requires timber operators to produce a Timber Harvest Plan (THP) that is intended to serve as a substitute for the planning and environmental protection requirements of the California Environmental Quality Act (CEQA). CEQA requires that actions which may substantially reduce the habitat, decrease the number, or restrict the range of any species which can be considered rare, threatened, or endangered (regardless of status under state or federal law) must be identified, disclosed, considered, and mitigated or justified (California Code of Regulations, Title 14, sections 15065(1), 15380). However, post-fire salvage logging, or the “emergency management” of timber, is exempted from the requirements of the THP process.

Black-backed Woodpeckers became a Candidate for listing as threatened or endangered under the California Endangered Species Act (CESA, Fish and Game Code section 2050 et seq.) on January 6, 2012, which affects burned-forest management on private lands. CESA Candidates are afforded the protections of the act during the one year candidacy period. Therefore, between January 6, 2012 and January 6, 2013, take of the species is prohibited. Otherwise lawful incidental take may be authorized when minimized and fully mitigated through the Incidental Take Permit process (Fish and Game Code section 2081(b)) or through the Natural Communities

Conservation Planning Act process (Fish and Game Code section 2800 et seq.). At the conclusion of the year-long candidacy period the species will either be added to the list of threatened or endangered species in California or revert to a species with no special status under California law.

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APPENDIX A – Black-backed Woodpecker Technical Workshop

In November 2010 The Institute for Bird Populations and the USDA Forest Service co-convened a Black-backed Woodpecker Technical Workshop in Sacramento, California. The workshop brought together subject experts and representatives from federal and state agencies, NGOs, the forest products industry, and academia, and was intended primarily to gather information about the status, ecology, and conservation of Black-backed Woodpecker in California.

Figure 37. Black-backed Woodpecker Technical Meeting. Sacramento, California, November 2010. Photo by Bob Wilkerson

Meeting participants presented research findings, discussed Black-backed Woodpecker ecology, and brainstormed research priorities and conservation recommendations. The group concluded that the next logical step in conserving Black-backed Woodpecker in California was the development of this Conservation Strategy.

Table 2. Participants in the Black-backed Woodpecker Technical Meeting co-convened by The Institute for Bird Populations and the USDA Forest Service.

Participant	Affiliation
Sarah Birkeland	USDA Forest Service, Office of General Council
Monica Bond	The Institute for Bird Populations
Ryan Burnett	PRBO Conservation Science
Lyann Comrack	California Department of Fish and Game
Diana Craig	USDA Forest Service
Stuart Farber	WM Beatty Association
Rachel Gardiner	Simon Frazier University
Barnie Gyant	USDA Forest Service
Chad Hanson	John Muir Project
Mary Beth Hennessy	USDA Forest Service
Dick Hutto	University of Montana
John Keane	USDA Forest Service-Pacific Southwest Research Station
Dawn Lipton	USDA Forest Service
Pat Manley	USDA Forest Service-Pacific Southwest Research Station
Ron Melcer	California Department of Water Resources

Continued on next page

Table 2, continued

Kathryn Purcell	USDA Forest Service-Pacific Southwest Research Station
Kevin Roberts	Sierra Pacific Industries
Jay Roberts	PRBO Conservation Science
Vicki Saab	USDA Forest Service-Rocky Mountain Research Station
Hugh Safford	USDA Forest Service
Jim Saracco	The Institute for Bird Populations
Nat Seavy	PRBO Conservation Science
Rodney Siegel	The Institute for Bird Populations
John Sterling	None provided
Sarah Stock	USDI National Park Service-Yosemite
Bob Wilkerson	The Institute for Bird Populations
Don Yasuda	USDA Forest Service
Susan Yasuda	USDA Forest Service

One of the discussion topics addressed by the Workshop group was to brainstorm areas of uncertainty about Black-backed Woodpecker ecology and conservation, and then suggest research questions to address them. The full list of research questions suggested by the participants is provided below.

- Estimate population size of Black-backed Woodpeckers in burned and unburned forests in California.
- Estimate distribution in unburned forests in California.
- Determine what level of population change could be detected based on current population trends in California, and what level should be detected.
- Assess whether existing habitat suitability models are valid for California. Determine whether population trends can be tracked using burned forest habitat trends. Use existing data and predictions to build new, improved models.
- Determine habitat requirements, home-range size, and food sources in unburned forests in California.
- Determine impacts of prescribed fire on Black-backed Woodpecker habitat use, and establish design criteria for enhancing habitat.
- Quantify factors influencing snag habitat longevity.
- Determine impacts of different styles of salvage logging, and the cost effectiveness of different management choices (engage economists with input from managers).
- Examine the effects of pre-fire thinning on Black-backed Woodpecker occupancy, foraging habitat, and nesting success after fire.

- Assess genetic relatedness to Black-backed Woodpeckers in Oregon and elsewhere, and intra-Sierra relatedness.
- Examine population dynamics, age structure, and dispersal between unburned and burned forests and among burned forest patches. Consider fire-based color banding.
- Determine burn patch-size relationships.
- Assess associations with bark-beetle outbreaks in the Sierra Nevada.
- Explore the implications of climate change on habitat suitability; link habitat models to climate change models.

APPENDIX B – Unpublished Data and Ongoing Research in California

Several scientists and agencies have unpublished data, or ongoing research or monitoring efforts, on Black-backed Woodpecker and its habitat in California. We invited each of them to share brief descriptions of their unpublished results or ongoing research projects – their responses are provided below. Literature citations mentioned in each description are included in the Literature Cited section above.

The Institute for Bird Populations (IBP)

Rodney Siegel, Robert Wilkerson, James Saracco, Morgan Tingley, and Monica Bond

Monitoring and management of the Black-backed Woodpecker has become a major focus of work by IBP's Sierra Nevada Bird Observatory. In collaboration with the Forest Service, we have initiated two inter-related projects, designed to yield new information that will inform management of the species in California:

1) Management Indicator Species (MIS) Black-backed Woodpecker surveys on Sierra Nevada national forests

The Black-backed Woodpecker was recently selected by the Pacific Southwest Region of the USDA Forest Service as a Management Indicator Species (MIS) for snags in burned forests across ten National Forest units in the Pacific Southwest Region: Eldorado, Inyo, Lassen, Modoc, Plumas, Sequoia, Sierra, Stanislaus, Tahoe, and the Lake Tahoe Basin Management Unit. In 2008 we collaborated with Region personnel on a pilot study that developed and field-tested survey procedures and collected preliminary information on Black-backed Woodpecker distribution across Sierra Nevada national forests (Siegel et al. 2008). We used the findings from the 2008 pilot study to inform the design of an annual monitoring program for Black-backed Woodpecker across ten National Forests in the Region, which we began implementing in 2009 (Siegel et al. 2010, 2011, 2012b; Saracco et al. 2011).

The primary goal of the program is to monitor trends in the amount of recently burned forest (fires 1–10 years old) on the study area's ten National Forests that is occupied by Black-backed Woodpecker, so that Forest Service personnel can evaluate the effects of forest plan implementation on Black-backed Woodpecker populations. Additional goals are to better understand Black-backed Woodpecker abundance, distribution, and habitat associations across the Sierra Nevada, to develop information that can inform effective conservation of the species in California, and to collect and analyze information on other bird species utilizing burned forests.

2) Using radio-telemetry to measure home range and study foraging ecology of Black-backed Woodpecker in California

Figure 38. Extracting a Black-backed Woodpecker from a mist net to be fitted with a tail-mounted transmitter for radiotracking. Photo by Dayna Mauer

To complement our spatially extensive MIS monitoring (see #1 above), in 2011 we initiated a two-year, intensive study of Black-backed Woodpecker home range attributes and foraging ecology. Focusing on three fire areas (the Sugarloaf and Peterson Complex fires on Lassen National Forest and the Wheeler Fire on Plumas National Forest) we are using radio-telemetry to mark and track individual birds throughout the breeding season (Siegel et al. 2012c). The study will yield estimates of Black-backed Woodpecker home-range size in burned forest stands in California, an assessment of the degree of overlap between adjacent home ranges, and a better understanding of habitat needs – especially relating to the species' selection of foraging habitat within burned areas. Taken together, this information will inform recommendations for snag retention and other measures to make post-fire forest management compatible with thriving populations of Black-backed Woodpeckers. Moreover, an estimate of home-range size and degree of overlap for Black-backed Woodpeckers in the Sierra Nevada is critically important because estimates of pairs per ha can be used to calculate population densities.

USDA Forest Service, Pacific Southwest Research Station

Kathryn Purcell

Black-backed Woodpecker Use of Unburned Forests in the Southern Sierra Nevada

As part of a study examining abundance and productivity of birds over an elevational gradient, we collected data on Black-backed Woodpeckers. The primary objectives of the study were to assess the abundance and productivity of a wide variety of bird species in four forest types over an elevational gradient and to identify species' breeding habitat requirements, including identification of the most productive habitats for each species. Our data on Black-backed Woodpeckers are limited, but the results we have are nonetheless informative because few studies have investigated the ecology of Black-backed Woodpeckers in unburned forests.

We studied birds in four forest types along an elevational gradient in the High Sierra Ranger District of the Sierra National Forest. Sites at the lowest elevations were in ponderosa pine stands (1,025–1,370 m elevation), followed by mixed-conifer stands (1,710–2,010 m elevation) and true fir stands (2,170–2,350 m elevation), with lodgepole pine stands at the highest elevations (2,470–2,775 m elevation). Each forest type had four replicates, except mixed conifer, which had six replicates. Each site consisted of at least 60 ha of mature forest with relatively high canopy cover, although natural heterogeneity resulted in all sites having some openings and small meadows or streams. A 40-ha gridded plot was established within each of the sites to facilitate censusing and mapping and relocation of nests.

From 1995 through 2002, we censused birds and located and monitored nests of all species on the study sites (see Purcell 2006 for a more extensive description of methods). Birds were censused using a timed transect method, with each site visited six times per year. Care was taken to control for observer variability by selecting only the most proficient observers, retaining observers over as many years as possible, and having observers visit all sites an equal number of times. All observers participated in training at the beginning of the field season and additional training as they moved into higher forest types and encountered new species.

We located and monitored nests until they fledged or failed. When nests were in stable substrates, we climbed to them and checked their contents with a fiberscope (Purcell 1997) once a week. Otherwise, we observed nests from the ground, noting the presence and behavior of the adults and nestlings. Black-backed Woodpecker adults and nestlings are usually quite vocal and visible at nests, which greatly aids in verification of activity and nesting stage. At each nest we recorded a full suite of vegetation variables, including substrate species, nest height, height and diameter of the nesting substrate, and decay class (for snags). In addition, data from Black-backed Woodpecker nests located and monitored in 1989 in the Sierra National Forest as part of an earlier study are included here.

Results

Black-backed Woodpeckers, while uncommon at all locations, were most abundant in lodgepole pine forests, with a total of 44 detections during the study (Fig. 39, below). There were no sightings in the low elevation ponderosa pine forests and only one in mixed conifer forest. Of 12 observations in true fir forests, 7 of those were in an El Niño year when the distributions of many species shifted downward in elevation. This distribution suggests a species sensitive to climate change.

Six nests were located during the study, and two nests were included from the earlier study. Seven of the eight nests were found in lodgepole pine forest. Nests were found on three of the four lodgepole pine study sites and were well distributed across the years of the study. The elevation range of the nests was 2,097 to 2,700 m, averaging 2,480 m (Table 1).

All eight nests were successful, suggesting Black-backed Woodpeckers breed successfully in unburned forests.

Characterization of the substrates used for nesting is helpful in identifying the resources necessary for reproduction. Snags were clearly important nesting substrates, as seven of eight nests were found in snags. Snags were in early stages of decay, with intact boles, most limbs remaining, and firm sapwood. All nests were found in the lower half of the snag or tree. Other nest substrate variables were more variable (Table 3).

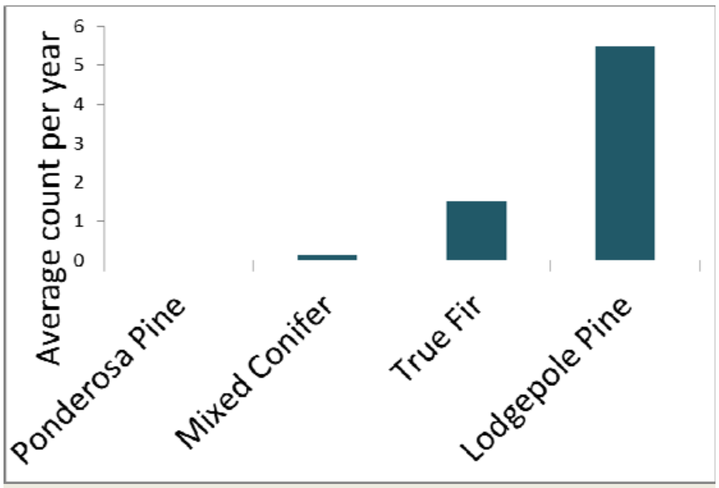

Figure 39. Abundance of Black-backed Woodpeckers across four forest types along an elevational gradient in the Sierra National Forest, California, from 1995 through 2002.

Black-backed Woodpeckers, while uncommon in unburned lodgepole pine habitat, were able to reproduce successfully, suggesting that lodgepole pine forests provide productive habitat for the species.

Table 3. Average nest site parameters for Black-backed Woodpeckers nesting in unburned forest in the Sierra National Forest.

	Mean	Range	N
Elevation	2480 m	2097 – 2700	8
Nest height	5.8 m	1.7 – 11.3	7
Substrate height	16.0 m	12.0 – 27.7	7
Substrate DBH	53 cm	33 – 77	7
Relative height	0.36	0.12 – 0.54	7
Decay Class	1		5

Conclusion

Conservation of biological diversity depends on the identification and preservation of habitat conditions that sustain healthy populations. Black-backed Woodpeckers, while uncommon in unburned lodgepole pine habitat, were able to reproduce successfully, suggesting that lodgepole pine forests provide productive habitat for the species.

Sierra lodgepole pines (*Pinus contorta murrayana*) form extensive, nearly pure stands at high elevations in the Sierra Nevada (Fig. 40). These trees grow on poor soils, and rocky, exposed sites. With a short growing season, they are slow-growing and long-lived. The dense wood provides safe, secure cavities for cavity-nesting birds such as Black-backed Woodpeckers.

Identification of a species' requirements for survival and reproduction is needed to estimate population health and predict vulnerability of species to habitat changes, but such information is lacking for many species, including Black-backed Woodpeckers. Lodgepole pine habitat is extensive in the Sierra Nevada and population estimates for the species need to consider the importance of these habitats to the viability of the species.

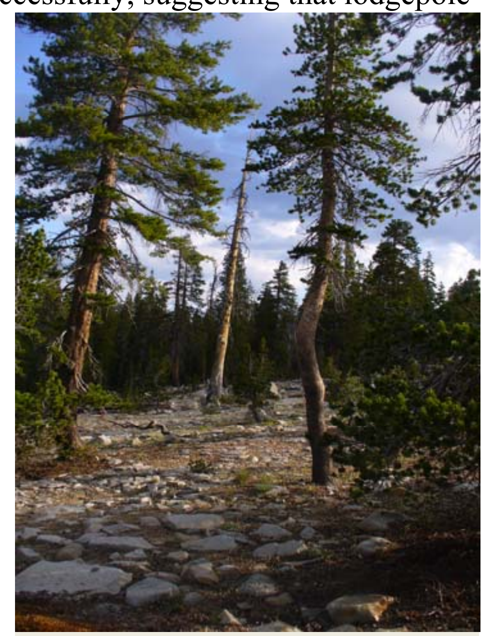

Figure 40. Nesting habitat in lodgepole pine forest in the Sierra National Forest. Photo by Kathrvn Purcell

PRBO Conservation Science

Ryan Burnett and Nathaniel Seavy

PRBO Conservation Science's data on Black-backed Woodpecker (*Picoides arcticus)* comes from up to 15 years of monitoring breeding birds across all National Forests in the Sierra Nevada in unburned habitat and a study of post-fire habitat use in the Lassen and Plumas National Forests. In short, our work in unburned forest suggests that Black-backed Woodpeckers occur at very low densities in these areas, but because these areas are widespread, birds in green forest probably account for a large portion of the total population size. In our post-fire work, we have found little evidence that Black-back Woodpeckers depend on certain types of trees for nesting. Instead, we found that Black-backed Woodpeckers nest most frequently in burned areas with high snag densities. Our data support maintaining areas of high snag densities in post-fire environments, while considering that maintaining conditions that provide high quality habitat across a large expanse of green forest may also be important.

Green Forest

In order to investigate correlations between environmental characteristics and Black-backed Woodpecker detections in unburned forest, we used data from a bioregional monitoring program and other projects in and around the Lassen and Plumas National Forests at the intersection of the Sierra and Cascade ranges.

PRBO's Sierra Nevada Bio-regional Monitoring Program conducted passive point counts across every National Forest in the Sierra Nevada in 2009 and 2010 (Roberts et al. 2011). The project samples the range of terrestrial habitats between 1,000 and 3,000 m, with survey sites limited to areas with slope less than 35% and within 1 km of accessible roads. Survey sites were selected using a Generalized Random Tesselation Stratification approach. In 2009 a total of 2,180 point count stations were surveyed while 2,740 were surveyed in 2010; 65% of sites were re-visited per year. At each station a passive 5 minute exact distance point count survey was conducted. Points were clustered in a 5 point diamond shape (with the 5th point being in the center of the diamond). At the center point call back surveys were conducted for Hairy Woodpecker (*Picoides villosus*) and Mountain Quail (*Oreotyx pictus*) in addition to the passive point count survey.

Point count data from across PRBO's Northern Sierra Program were used to assess Black-backed Woodpecker detections within green forest as well. These projects spanned 15 years (1997–2010), and encompassed a range of projects from a national park inventory to restoration of aspen habitat. Thus, the site selection methods and data collection techniques varied (Humple et al. 2001, Humple and Burnett 2010, Burnett 2011). Data was collected from the Lassen and Plumas National Forests as well as Lassen National Park and a few privately owned meadows in this area. Approximately 3,500 point count stations from these projects were used in the analysis with a 95% revisit rate within years. Sites were visited between 1 and 7 years. Five minute unlimited distance passive point counts were used to sample the avifauna.

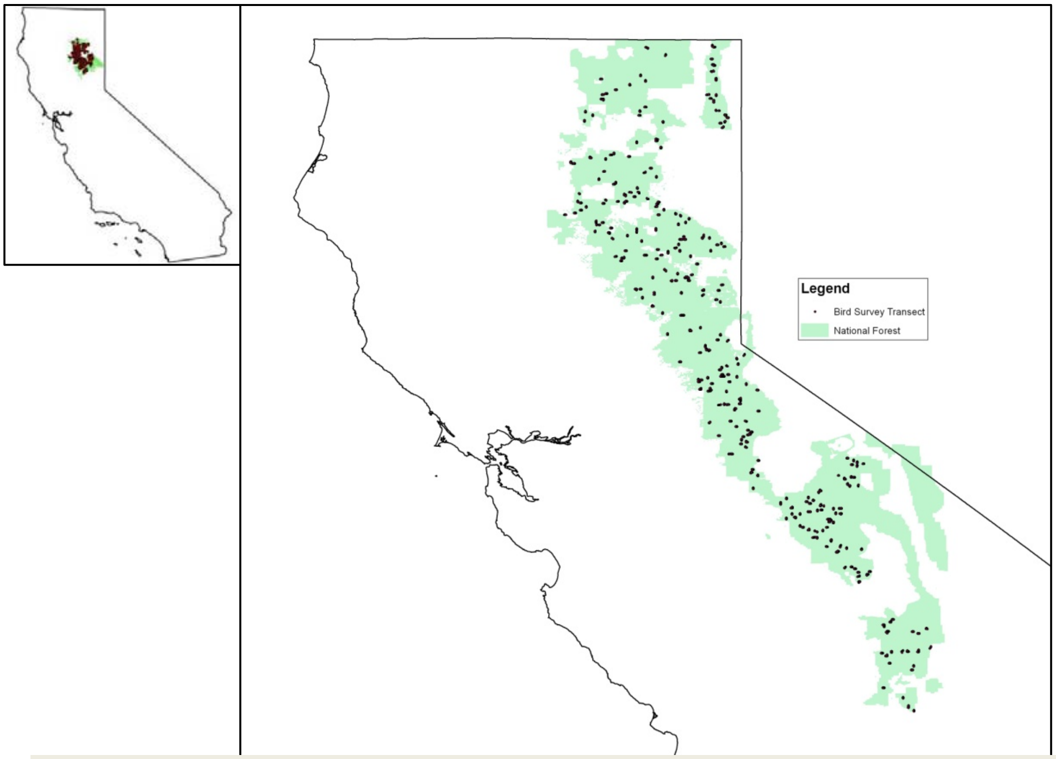

Figure 41. Location of PRBO Sierra Nevada Bio-regional monitoring point count transects across ten National Forests in the Sierra Nevada planning area.

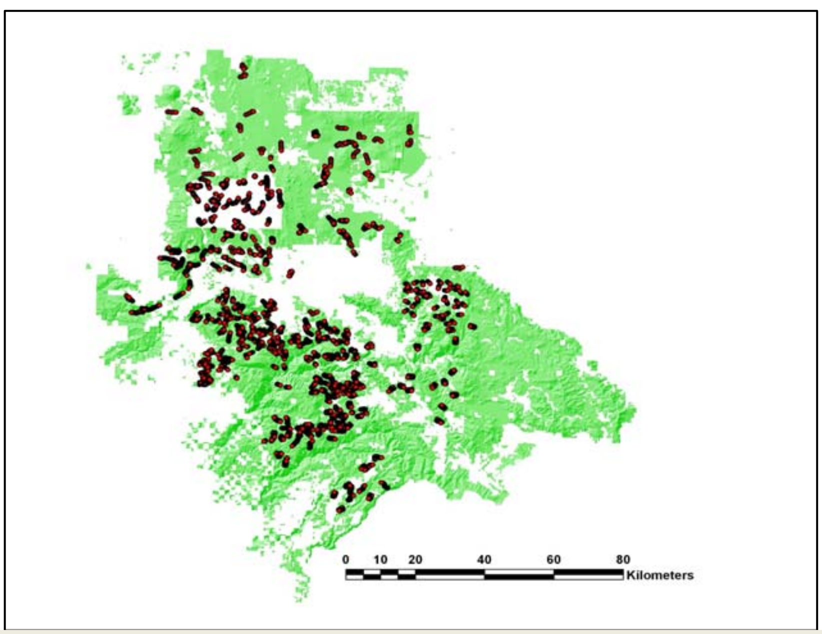

Figure 42. Location of PRBO Northern Sierra Nevada unburned forest point count stations from 1997–2010 used in Black-backed Woodpecker analysis.

Using these two data sets, we generated a presence/absence data set for Black-backed Woodpeckers. Black-backed Woodpeckers were considered present at a site if birds were detected there in any year of the survey. Sites that had burned in a wildfire within 20 years of data collection were excluded from the analysis. The set of points from which Black-backed Woodpeckers were considered absent was generated using only the bio-regional monitoring sample, with Black-backed Woodpeckers considered absent if they were not detected on any of the surveys in either 2009 or 2010.

The bio-regional monitoring sampling resulted in 17 Black-backed Woodpecker detections across the approximately 2,230 points sampled across two years while the Northern Sierra sampling of approximately 3,500 points across 15 years resulted in 81 detections. Detection frequencies were quite low with no more than 2% of survey stations in any one forest recording detections (Fig. 43). We found few differences between environmental characteristics of points where Black-backed Woodpeckers were detected and points where they were not detected. There was a tendency for them to occur at higher elevations, with sites where they were present averaging 2,120 m compared to 1,890 m at sites where they were not detected. They also appeared to select for lodgepole pine forest; with over 20% of all detections occurring in this habitat type while it represented only about 7% of our sample sites; there was also some evidence they selected for Aspen habitat. Interestingly, they occurred in Jeffrey Pine habitat less than would be expected based on its availability even though a large number of our detections were from this habitat type. We found no strong differences between the canopy cover, canopy height, or snag densities of sites where Black-backed Woodpeckers were and were not detected.

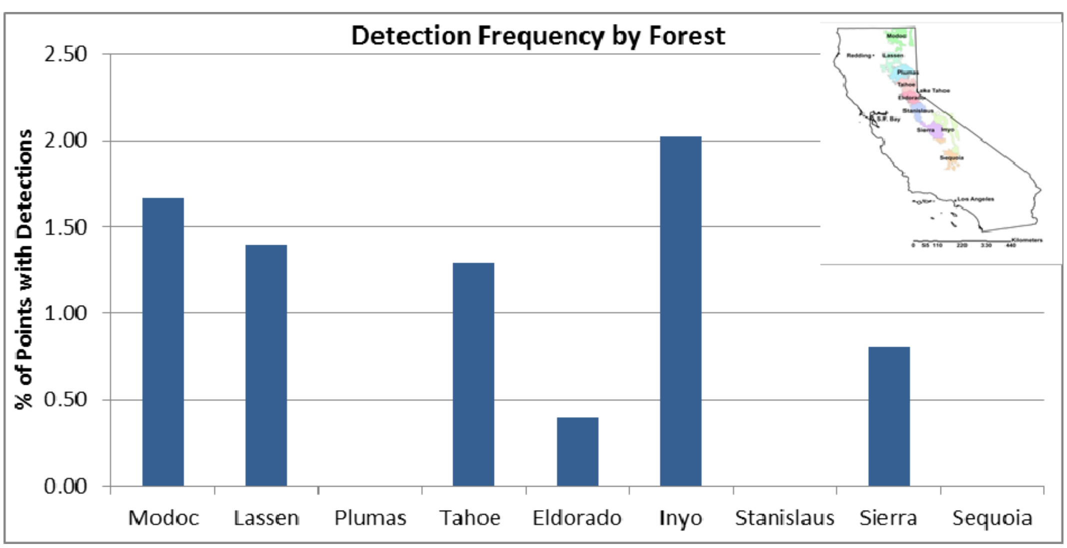

Figure 43. Frequency of Black-backed Woodpecker detections by National Forest across the Sierra Nevada in 2009 and 2010 from unlimited distance passive point count surveys. Forests are listed from North to South (left to right).

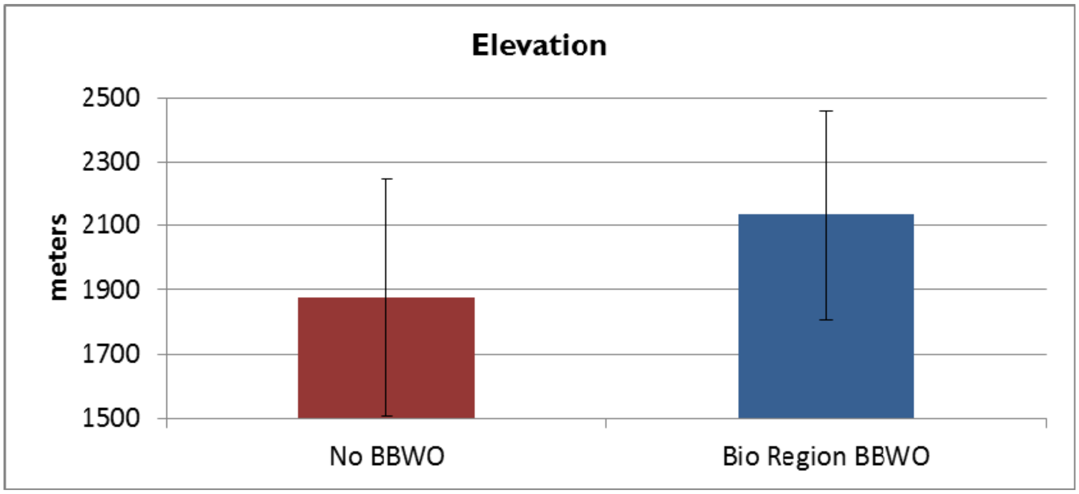

Figure 44. The mean elevation of sites where Black-backed Woodpeckers were detected in the Sierra Nevada compared to sites with no detections from the Bio-regional Monitoring project study sites in 2009 and 2010. Error bars represent 95% confidence intervals.

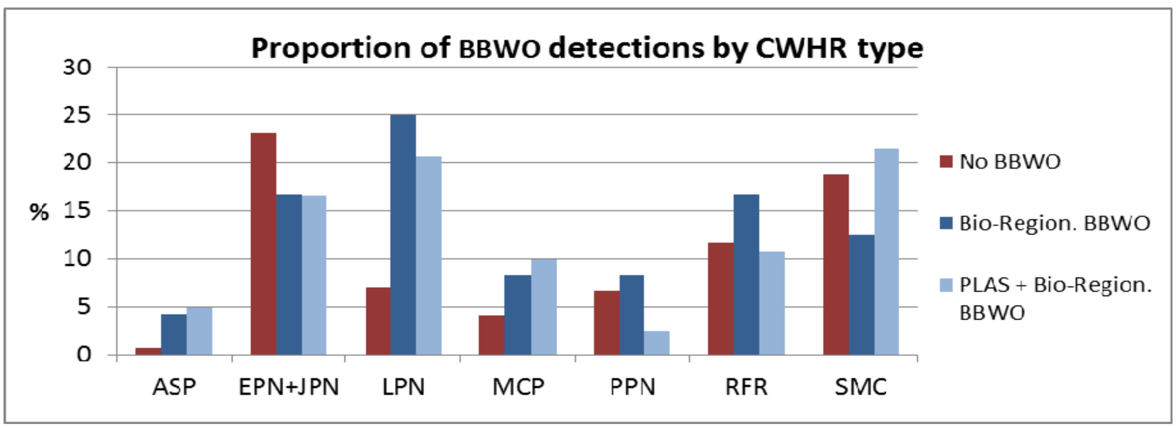

Figure 45. The proportion of Black-backed Woodpecker detections by California Wildlife Habitat Relationships habitat type at bio-regional monitoring study sites and Pluman-Lassen and MIS study sites combined from 1997–2010. ASP = Aspen, EPN/JPN = Eastside Pine/Jeffrey Pine, LPN = Lodgepole Pine, PPN = Ponderosa Pine, RFR = Red Fir, and SMC = Sierra Mixed Conifer.

A few limitations of our results should be considered when interpreting our findings. The number of detections was relatively small. Other studies have shown that detectability of Black-backed Woodpecker from passive point counts is quite low (Saracco et al. 2011) thus, the absence data is unlikely to truly represent real absence of the species from the site. Also, our sample may have under represented the highest elevation sub-alpine habitats where some believe they reach their greatest abundance in unburned forest (K. Purcell personal communication

2010). These studies were not designed to evaluate habitat use and densities of Black-backed Woodpeckers. The northern Sierra studies specifically have certain biases in the habitat that was surveyed and did not represent Sierra Nevada forest as a whole.

Burned Forest

In 2009 and 2010 we located Black-backed Woodpecker nests and quantified the snag densities around them in three areas affected by fire within the boundaries of the Lassen and Plumas National Forests: the Storrie Fire (burned August 2000), the Moonlight (burned September 2007), and the Cub (burned July 2008; Fig. 6). Each of the fires burned at similar elevations (1,126–1,998 m) and through primarily mixed conifer and true fir vegetation communities, but with varying severity patterns. We also collected information on random trees within these fires in order to compare the characteristics of used and available nests trees.

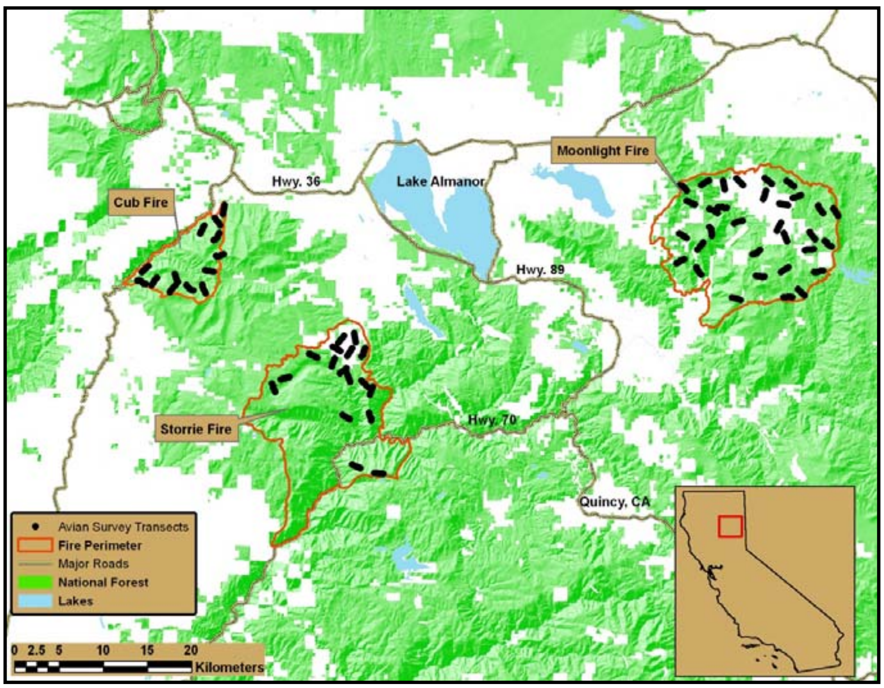

Figure 46. Study area with fire perimeters and nest plot locations at three fires in the Plumas and Lassen National Forests of the Sierra Nevada, California.

We found a total of 20 Black-backed Woodpecker nests across the two years. No nests or individuals were detected in the Storrie Fire in either year. For the nest trees and 247 random trees in the Cub and Moonlight fires, we recorded information about decay class, diameter at breast height, top condition, and species. We also recorded the number of snags >12 cm dbh within an 11.3 m radius of each nest tree and the random trees. Black-backed Woodpeckers selected for dead but not heavily decayed trees. There was little evidence that Black-backed Woodpeckers selected trees with broken tops, trees of a particular size, or trees of particular species. Black-backed Woodpeckers selected nest trees in areas with high snag densities (Fig.

7). These data suggest the distribution of Black-backed Woodpeckers in post-fire environments is influenced more by time since fire and surrounding snag densities than by the characteristics of the trees used for nesting.

Conclusions

Our results show that Black-backed Woodpeckers do inhabit unburned green forest in the Sierra Nevada and southern Cascades though they appear to be quite uncommon in green forest and well below densities in and around recently burned forest (Burnett et al. 2010, Saracco et al. 2011). However, due to the acreage of unburned forest in the Sierra Nevada and southern Cascades of California compared to recently burned forest (several orders of magnitude) it appears that a substantial percentage of their population here, in fact almost certainly the majority, resides in green forest. Without information on primary population parameters such as fecundity and survival and a greater understanding of the potentially complex population dynamics of this species, we advise caution in presuming whether green forest or burned forest are most important for ensuring the viability of the species here. With our current knowledge of the species we would hypothesize that both green forest and recently burned areas are critical to its persistence in the Sierra Nevada and southern Cascades.

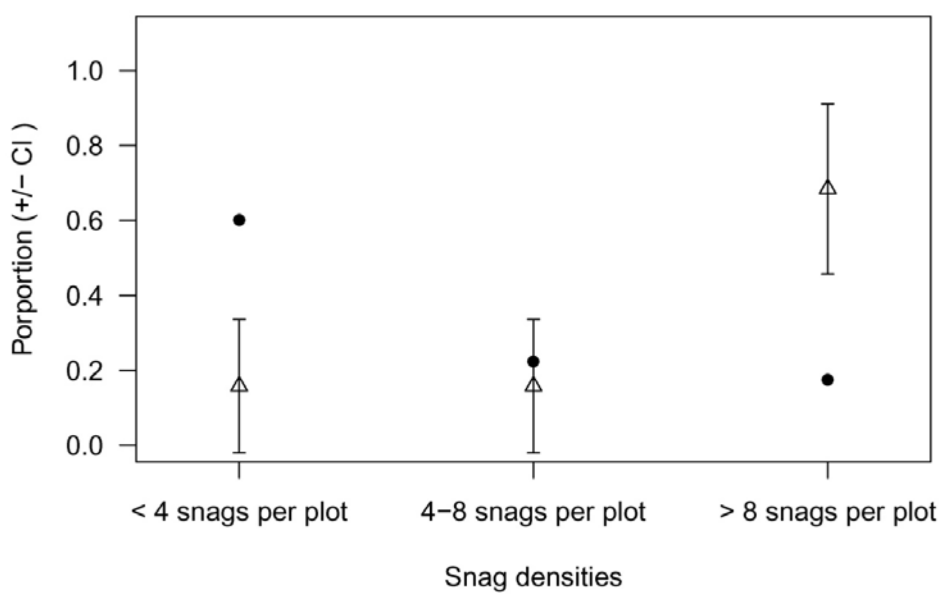

Figure 47. Snag densities at Black-backed Woodpecker nests (9 in the Cub Fire and 10 in the Moonlight Fire) compared to random sites (114 in the Cub Fire and 133 in the Moonlight Fire). Data were collected in 2009 and 2010 in the Plumas and Lassen National Forests. Error bars are 95% confidence intervals.

John Muir Project

Chad Hanson

Habitat Selection

In a study of three fire areas in the Sierra Nevada (Stream [Plumas], Star [Tahoe], and Kibbie [Stanislaus]) using passive point counts, Hanson (2007) found Black-backed Woodpeckers foraging on snags in all size classes (including the smallest size class, 15–24 cm dbh), but the birds foraged significantly more on large snags (≥50 cm dbh) than would be expected based on availability in several burned sites throughout the Sierra Nevada, California ($\chi^2 = 36.36$, $p < 0.0001$).

Table 4. Black-backed Woodpecker foraging on individual trees (97% snags). Observed foraging instances are shown, with expected instances, based upon availability, shown in parentheses.

15-24 cm dbh		25-49 cm dbh		50-100 cm dbh		≥100 cm dbh	
1	(11.9)	4	(8.5)	19	(7.3)	6	(2.4)

Black-backed Woodpeckers were found in all three fire areas studied, and were found foraging only in high-intensity burned stands that were unlogged, and not in unburned, moderate intensity, or salvage logged areas (Hanson 2007, Hanson and North 2008). The unlogged high-intensity burn stands had 92–100% tree mortality, and an average of 252 snags/ha > 25 cm dbh, about half of which were > 50 cm dbh (Hanson and North 2008). Hanson and North (2008) avoided point counts within 100 m of another fire intensity category, so there were no point counts in moderate-intensity areas at the edge of high-intensity areas.

Estimates of California Population in Burned Forest

For the purposes of this analysis, I estimated the current abundance of Black-backed Woodpeckers in suitable habitat in California based upon the best available science.

I estimate abundance of Black-backed Woodpeckers simply by using the acreage estimate for all fires (all fire intensities included) in montane conifer forest (all pre-fire forest ages, densities and structures included) on public lands within the Black-backed's range in California over the past 10 years (2000–2009), 176,504 ha, and the probability of occupancy figures reported in Hutto (2008), and Fig. 15 of Siegel et al. (2010), for average fire conditions (i.e., neither the highest nor the lowest fire intensities or snag densities), about 8–10%. I can then estimate that about 15,885 hectares (ha) of these fire areas are occupied by Black-backed woodpeckers. Even if I used the unusually high nest density figures of approximately 1.6 nests per 100 ha for the most recent fires from the 2010 survey by Burnett (pers. comm. 2010), this still equates to only about 254 pairs of Black-backed woodpeckers in California in all fire areas within the Black-backed Woodpecker's range in the state. It must be noted, however, that this would likely be an overestimate, since it is based only upon nest density figures for very recent fires (i.e., at peak density), and does not include nest density figures for the first year of Burnett's data collection (2009), which found much lower Black-backed Woodpecker nest density, as discussed above. Burnett's nest density data yielded zero nests in the 10-year-old fire.

All told, then, I estimate less than 300 pairs of Black-backed Woodpeckers in California, including both suitable and marginal habitats, within burned forests.

My estimate of Black-backed Woodpecker abundance in burned forests within California, described above, may be conservative, and the current circumstance could be worse, given that there was relatively little wildland fire in montane conifer forests within the Black-backed Woodpecker's range in California in 2010 and 2011.

Based upon my GIS analysis, a series of maps illustrating the highly specific nature of Black-backed Woodpecker habitat is shown below, with each successive restriction approaching progressively closer to actual estimates of current moderate/high quality suitable habitat. The final map shows suitable Black-backed habitat BEFORE salvage logging on national forests is excluded (I could not provide a map showing suitable habitat after salvage logging on national forests because no GIS layers were currently available for this logging).

This analysis indicates that current moderate/high-quality suitable Black-backed Woodpecker habitat comprises less than 1% of the forest in this species' range in California (see maps, and additional analysis, below).

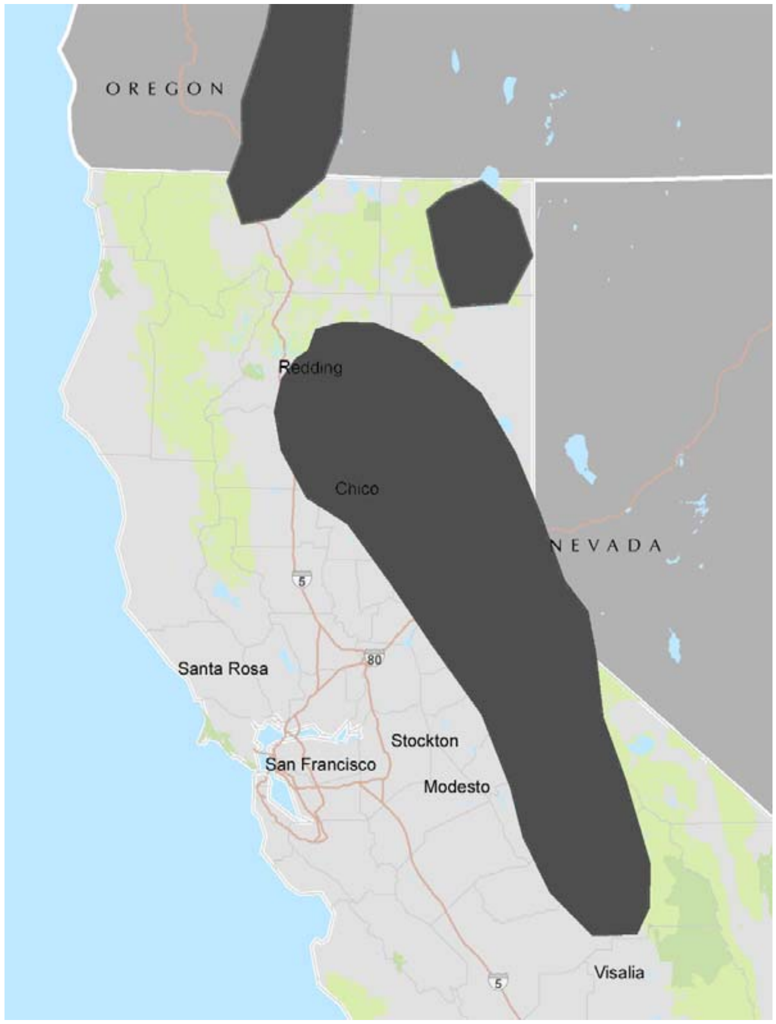

Figure 48a. Black-backed woodpecker potential range in California, digitized from National Geographic.

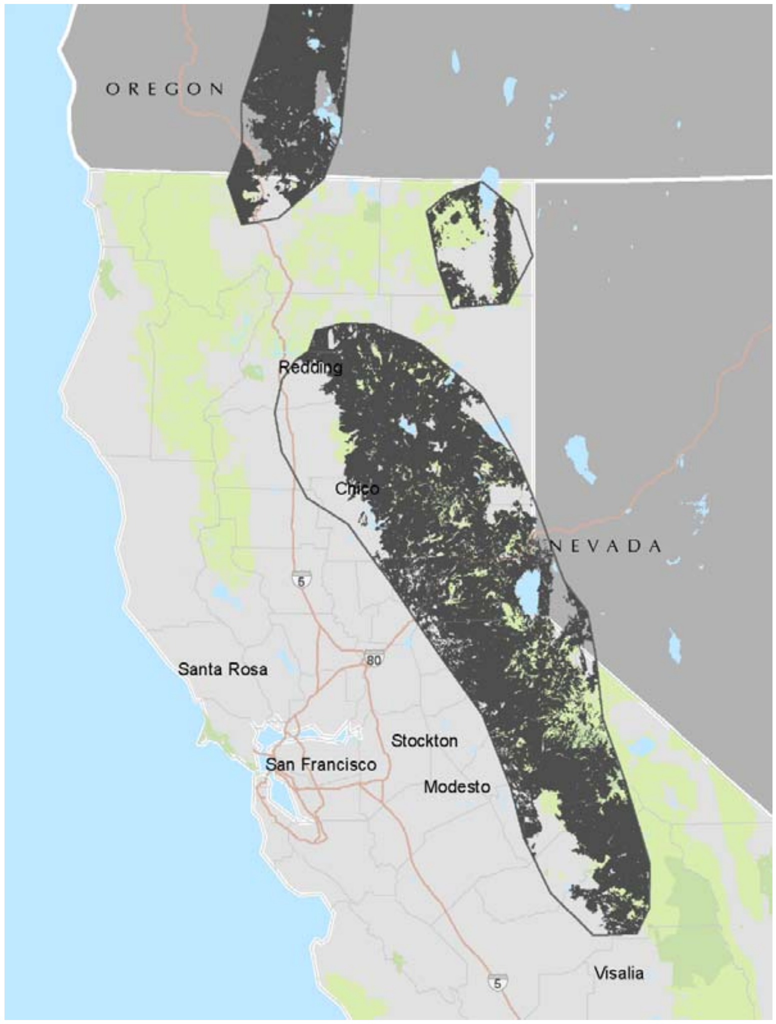

Figure 48b. Black-backed woodpecker potential range in California in conifer forests.

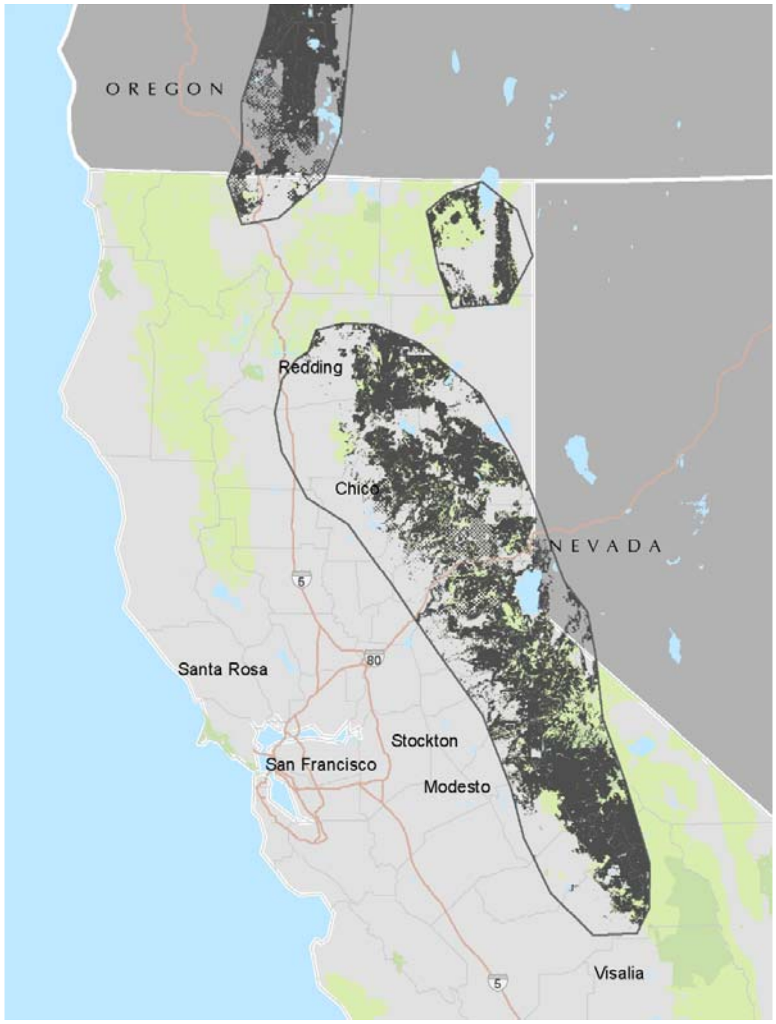

Figure 48c. Black-backed woodpecker potential range in California in conifer forests within public lands.

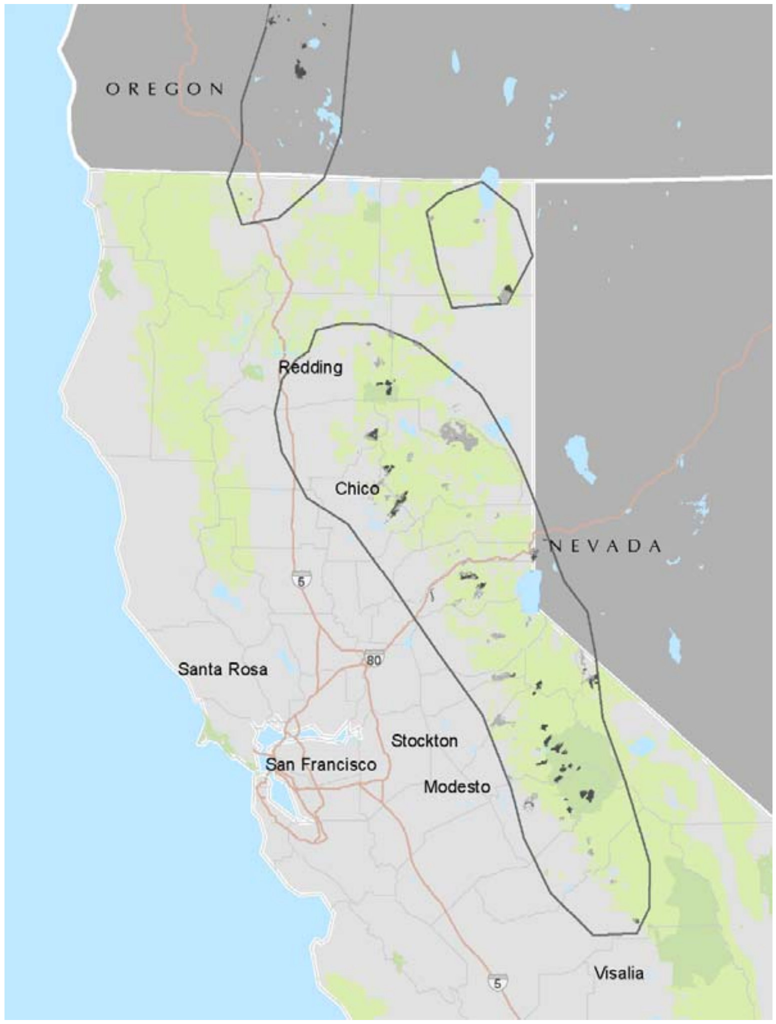

Figure 48d. Black-backed woodpecker potential range in California in conifer forests within public lands that have experienced wildland fire during 2001–2010 (dark grey polygons are on protected lands, while light grey polygons show unprotected areas, many of which have already been salvage logged, or are currently being logged).

Figure 48e. Black-backed woodpecker potential range in California in conifer forests within public lands that have experienced wildland fire during 2001–2010, excluding low-intensity fire areas (dark grey polygons are on protected lands, while light grey polygons show unprotected areas, many of which have already been salvage logged, or are currently being logged).

Estimation of Black-Backed Woodpecker Population in Unburned Forests of California

In the analysis above, I estimated that there are approximately 300 pairs of Black-backed Woodpeckers in burned forest currently in California. Below, I use recently available data to estimate density in unburned forest.

The U.S. Forest Service, in 2009 and 2010, conducted the first two years of a Management Indicator Species study throughout the Sierra Nevada management region (which includes the Modoc region). All data on detections is available at http://data.prbo.org/partners/usfs/snmis/, and the Study Plan is available at http://data.prbo.org/cadc2/index.php (click the link for "Sierra Nevada Avian Monitoring Information", and then click the link that says Study Plan "downloaded here"). As the Study Plan states, each point count station is visited twice in a given year (page 53 of Study Plan), and all bird species detected are recorded (Study Plan, pp. 54-55).

In 2009, 3020 stations were visited, and 2852 stations were visited in 2010 (http://data.prbo.org/partners/usfs/snmis/), for a total of 11,744 point counts (since each station had two point counts per year). In 2009 and 2010 combined, a total of 9 Black-backed Woodpeckers were detected within 50 meters of observers at point counts (http://data.prbo.org/partners/usfs/snmis/). I eliminated the points within or immediately adjacent to (within the diameter of a home range of a recent fire boundary, with home range diameter estimates taken from Dudley and Saab 2007) recent fire areas, which reduced the total point counts to 10,518, and only 7 Black-backed Woodpecker detections remained—i.e., approximately one Black-backed Woodpecker detection for every 0.00066 point counts, or detections at about 0.066% of point counts.

In unlogged *burned* forest, within 50 meters of point counts, Black-backed Woodpeckers were detected on average at about 5–6% of point counts in the Sierra Nevada (Hanson and North 2008), and Hutto (2008 [Fig. 3b]) detected Black-backed Woodpeckers at about 6% of point counts (within 50 meters of observers) on average. Siegel et al. (2010 [Table 5]) reported very similar results in fire areas in the Sierra Nevada. Therefore, Black-backed Woodpecker abundance, as measured by the frequency of detections at point counts, is about 83 times higher in burned forest than it is in unburned forest (i.e., 0.055, or 5.5%, is 83 times larger than 0.00066).

Burnett et al., in 2009 and 2010, conducted a study in three northern Sierra Nevada fire areas as part of the U.S. Forest Service's Plumas Lassen Administrative Study. To determine nest density, in both 2009 and 2010, Burnett et al. surveyed 13 plots of 20 hectares each in the Storrie fire of 2000, 26 plots of 20 hectares each in the Moonlight fire of 2007, and 13 plots of 20 hectares each in the Cub Complex fire of 2008, for a total of 2,080 hectares surveyed in 2009 and 2010 combined. In 2009 and 2010 combined, a total of 18 Black-backed Woodpecker nests were found (R. Burnett, personal communication 2009, 2010). Even if we assume that 20% of the existing nests were undetected on average (R. Burnett, personal communication 2009), this would result in a little under 22 nests over the 2,080 hectares, or about 1 nest per 100 hectares of burned forest. However, this is very likely an overestimate of overall nest density in fires areas 1–10 years post-fire since 75% of the plots were in two very recent fire areas with peak nest densities. Saab et al. (2007 [Fig. 1]) found an average of about 0.2 nests per 40 hectares, or about 0.5 nests per 100 hectares, at 1–10 years post-fire (Saab et al. 2007 is the only peer-reviewed and published study to determine average Black-backed Woodpecker nest density across an entire decade following fire). For this analysis, I use 0.75 nests per 100 hectares, or about 1 pair per 133 hectares, which is the mid-point between these two nest density estimates for burned forest.

Since Black-backed Woodpecker abundance is about 83 times higher in burned forest than in unburned forest in the Sierra Nevada, as discussed above, I can use this to estimate the pairs of Black-backed Woodpeckers in unburned forest—i.e., since nest density is 0.75 nests per 100 hectares in burned forest, in unburned forest it would be approximately 83 times lower, which is about 0.009 nests per 100 ha, or about 1 pair per 11,039 hectares. There are 10,303,657 acres, or 4,171,521 hectares, of montane and subalpine conifer forest in the Sierra Nevada in all land ownerships, according to Table 3.1j of the 2001 Sierra Nevada Forest Plan Amendment Final Environmental Impact Statement, Volume 2 (http://www.fs.fed.us/r5/snfpa/library/archives/feis/vol_2/part_3.1.pdf). Excluding the portion of this that has experienced wildland fire in recent years, there are about 4,000,000 hectares of unburned forest (pinyon/juniper forest was excluded since no Black-backed Woodpeckers are found there [Siegel et al. 2010]). With 4,000,000 hectares of unburned forest, and one Black-backed Woodpecker pair per 11,039 hectares of unburned forest, there would be approximately 362 pairs of Black-backed Woodpeckers in unburned forest in California.

<u>However</u>, this may be a significant overestimate because we included all yellow pine forest, which amounted to 3,168,442 hectares—most of the acreage used for our estimate. Much of this area is on the lower-elevation westside of the Sierra Nevada. While Black-backed Woodpeckers have been found in some mid-montane yellow pine forest that has burned (Siegel et al. 2010), detections in unburned forest have all been above 5,500 feet in elevation in the Modoc and Lassen and above about 7,000 feet in elevation in the central and southern Sierra—well above most of the yellow pine forest in the western Sierra Nevada, and also above much of the eastside yellow pine forest. Thus, there is likely considerably less unburned forest occupied by Black-backed Woodpeckers than my analysis indicates, and considerably fewer Black-backed Woodpeckers in unburned forest. Adjusting for this, when I exclude the lower montane and foothill forests of the lower westside, the estimated number of pairs in *unburned* forest in California is approximately 200–300, though it must be noted that the habitat conditions associated with moderate to high rates of survival, nest success, and reproduction are largely absent in unburned forests, so the number of pairs in unburned forest cannot be assumed to represent the same contribution to the population as an equal number of pairs in burned forest. When the estimated number of pairs in unburned forest (200–300) are combined with the

estimated 300 pairs of Black-backed Woodpeckers in burned forests in California, population is estimated at less than 600 pairs. Using the same approach, I found even less suitable habitat currently in the eastern Oregon Cascades, which may be part of a larger contiguous population with California, but one that is distinct from the northern Rockies population (Pierson et al. 2010).

Recent research indicates a significant risk of extinction when populations are less than about 4,000 to 5,000 individuals, the equivalent of 2,000 to 2,500 pairs (Mace and Lande 1991, Traill et al. 2007, Traill et al. 2010).

More recently, Hanson (2012) recently provided a re-analysis of extant data to estimate the size of California's Black-backed Woodpecker population. Hanson (2012) concludes that a recent report by Fogg et al. (2012) dramatically overestimates Black-backed Woodpecker (BBWO) populations in unburned forests of California because it: 1) assumes one BBWO territory per 100 ha of unburned forest, without citation to data, despite the fact that the existing data indicate far lower BBWO densities in unburned forest even where the recent snag basal area per ha is far higher than the great majority of current unburned forest in California; 2) extrapolates BBWO detections in unburned forest across 1,849,400 ha of forest when BBWOs have only been found in 436,260 ha of unburned forest over three years of surveys (despite thousands of surveys across the 1,849,400 ha area); 3) assumes BBWOs detected 1.5-5 km from fires are nesting in unburned forest, despite clear recent evidence of BBWOs nesting within fire areas and regularly foraging up to 6 km from the fire perimeter into the unburned forest; 4) does not use any empirical data to determine the actual probability of detection relative to known presence, and uses an algorithm that substantially over-adjusts for probability of detection when occurrence of a species is low, such as Black-backed Woodpeckers in unburned forest; 5) reports that Black-backed Woodpecker presence is independent of snags—the source of the bird's food (native beetle larvae)—and assumes Black-backed nest occupancy in areas the great majority of which have snag levels far below the levels found in confirmed Black-backed Woodpecker territories in the scientific literature; and 6) does not account for the substantial overestimation of Black-backed Woodpecker populations that can result from even a small error rate in auditory species identification—especially given that Hairy Woodpecker playback calls were conducted immediately before those for Black-backeds. The population analysis by Hanson (2012) concludes that there are likely fewer than 600 pairs of Black-backed Woodpeckers in California within burned and unburned forest combined.

Landscape Patterns in Black-backed Woodpecker Habitat

Hanson et al. (2009, 2010) investigated high-intensity fire occurrence since 1984 in the California Cascades and Klamath, Oregon Klamath, and Oregon and Washington eastern Cascades, and found no trend of increasing fire intensity (proportion of high-intensity fire effects in each year). Hanson and Odion (in review, 2012) conducted a similar analysis in the Sierra

Nevada, representing the first comprehensive analysis of high-intensity fire patterns since 1984 in the Sierra Nevada range (Miller et al. 2009 did not use 40% of the available fire data), and found no increasing trend in terms of high-intensity fire proportion, area, or patch size, using the Forest Service's RdNBR threshold of 641 (Miller and Thode 2007). This result contradicts previous assumptions that fire intensity will increase due to climate change and past fire suppression. While the climate is getting warmer, the assumption of a hotter/drier climate (which might result in more fire) appears to be incorrect, and recent data indicates that the climate may be getting warmer and wetter, not hotter and drier. For example, the findings of Crimmins et al. (2011) indicate increased precipitation across California's forests. Other data indicate that vegetation changes may result in less fire in most of California's forests, and more fire in desert vegetation (Krawchuk et al. 2009).

Similarly, Odion and Hanson (2006, 2008) specifically investigated the assumption that areas that had missed the greatest number of fire return intervals, due to fire suppression, would experience predominantly high-intensity effects. Odion and Hanson (2006, 2008) found that the areas that missed the most fire return intervals experienced mostly low- and moderate-intensity fire effects, and did not have higher proportions of high-intensity effects than areas that had missed far fewer fire return intervals. In short, fire intensity did not increase progressively over time with increasing time since fire. Odion and Hanson (2006, 2008) suggested that this result may be due to several factors, including increasing fuel moisture, decreasing occurrence of pyrogenic shrubs, and increasing crown base height as forests mature, and canopy cover increases, with increasing time since fire.

Hanson (2010 [available at www.johnmuirproject.org]) comprehensively reviewed and synthesized existing literature on the historical extent of high-intensity fire in California's forests prior to fire suppression, in terms of rotation interval (i.e., the spatiotemporal extent, indicating the average annual area of high-intensity fire). Hanson (2010) found that current high-intensity fire rotation intervals are much longer than historic, natural intervals, indicating a substantial decline in overall high-intensity fire occurrence due to the past century of fire suppression.

Population Trend

In assessments of population trend, it is important to take into account broader temporal scales. In order to further explore the issue of the extent to which higher-intensity fire has been reduced by fire suppression, relative to its historic extent within the Black-backed Woodpecker's range, I assessed the rate of initiation of new stands of trees over time, using U.S. Forest Service stand age data from the agency's Forest Inventory and Analysis (FIA) database (http://www.fia.fs.fed.us/tools-data/). I restricted this analysis to unmanaged forests (Inventoried Roadless Areas, Wilderness Areas, National Parks, and Wild and Scenic River Corridors) to restrict stand initiation to natural disturbance, and eliminate stand initiation from logging from the analysis. I found that the rate of new stand initiation has declined substantially in all areas since the early 20th century, but that the decline has been the most severe within the California and eastern Oregon Cascades populations, which have seen a fourfold decline in habitat since the early 20th century, equating to a substantial lengthening of the rotation interval for stand-initiating natural disturbance (e.g., fire sufficiently intense to kill most or all of the overstory trees, thus initiating a new stand, and re-setting the stand age to zero) (see Figure 49 below).

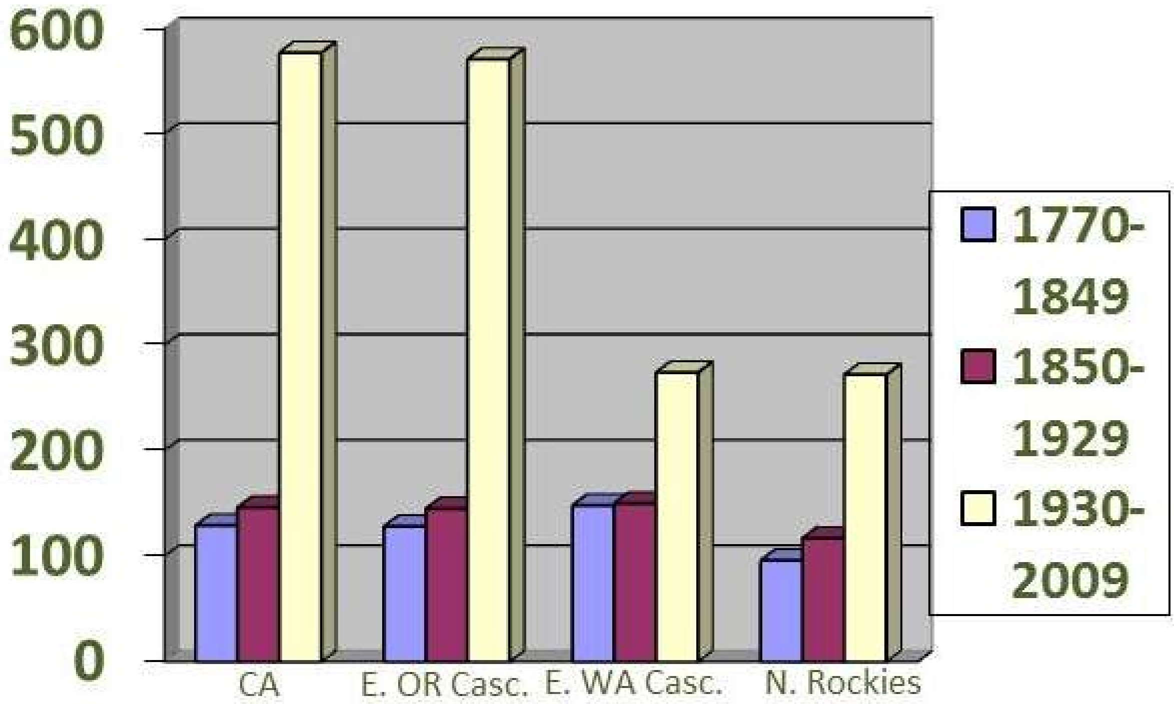

Figure 49. Rotation interval of high-intensity natural disturbance in years (y-axis) since the 19th century in unmanaged conifer forests within the range of the Black-backed Woodpecker in California, eastern Oregon Cascades, eastern Washington Cascades and northern Rockies.

Because of the extremely close association between Black-backed Woodpeckers and higher-intensity fire, the large decline in high-intensity fire since the early 20th century can be expected to correspond to a similar decline in Black-backed Woodpecker populations within their range in California. Any assumption to the contrary would depart dramatically from the known data about population densities in burned versus unburned forest (see, e.g., Russell et al. 2009[b]). This decline in habitat created by fire is exacerbated by post-fire logging, which further widens the gap between historic and current amounts of Black-backed Woodpecker habitat, and populations.

Climate and High-intensity Fire and BBWO Habitat Trends in California

Historic Data

To expand upon the analysis above (Fig. 2) comparing current to historic high-intensity fire extent, I used standard U.S. Forest Service satellite imagery data (RdNBR data; see www.mtbs.org), with the same RdNBR threshold (641) to define high-intensity fire as that used by the Forest Service (Miller and Thode 2007)—a threshold that defines high-intensity fire broadly and inclusively such that it equates to approximately 60–70% basal area mortality (i.e., significant amounts of moderate-intensity fire are also included)—and found that the current high-intensity fire rotation interval for middle/upper montane westside forests and eastside forests combined is 791 years since 1984. This is longer than rotations prior to the influence of fire suppression based on available research that allows calculations of historic rotations. Bekker and Taylor (2001), in a remote unmanaged area of mixed-conifer and upper montane forest in the southern Cascades of California, found that 50–60% of these forests experienced high-intensity fire over a 76-year period prior to effective fire suppression. Baker (2012), using U.S. Government field plot data from the mid/late 1800s, found a high-intensity fire rotation of 435 years in dry mixed-conifer forests of the eastern Cascades of Oregon, and a mixed/high-intensity rotation of about 165 years. Minnich et al. (2000) studied fire intensity patterns in mixed-conifer forests of northern Baja California, Mexico within an area that had not been logged or subjected to fire suppression. In these forests, similar in most important respects to the mixed-conifer forests of the Sierra Nevada, Minnich et al. (2000) found a natural high-intensity fire rotation of 300 years. In a modeling study reconstructing historic fire patterns, Stephens et al. (2007) estimated a high-intensity fire rate, prior to 1850, of 5% every 12 to 20 years for ponderosa pine and mixed-conifer forests of the Sierra Nevada (rotation of 240 to 400 years), and shorter rotations for upper montane fir forests. In another study, Collins and Stephens (2010), an average of 15% high-intensity fire was found in reference mixed-conifer forests with overall fire frequencies that were similar to those used in Stephens et al. (2007), suggesting similar, or slightly shorter, high-intensity fire rotations relative to those modeled in Stephens et al. (2007). In short, the multiple sources of data strongly indicate that there is substantially less high-intensity fire now than there was historically.

Current Climate and Fire Trend Data

Only one study, Miller et al. (2009), has reported increased fire intensity in Sierra Nevada forests since 1984, but this study did not include 40% of the fire intensity data available at the time the study was prepared, and did not provide a methodology explaining why some data were included and some excluded. Hanson and Odion (revision in review 2012) conducted the first comprehensive assessment of fire intensity since 1984 in the Sierra Nevada, using 100% of available fire intensity data, and, using Mann-Kendall trend tests (a common approach for environmental time series data) found no increasing trend in terms of high-intensity fire proportion, area, mean patch size, or maximum patch size. Hanson and Odion (revision in review 2012) checked for serial autocorrelation in the data, and found none, and used pre-1984 vegetation data (1977 Cal-Veg) in order to completely include any conifer forest experiencing high-intensity fire in all time periods since 1984 (the accuracy of this data at the forest strata scale used in the analysis was 85–88%). The results of Hanson and Odion (revision in review 2012) are consistent with all other recent studies of fire intensity trends in California's forests that have used all available fire intensity data, including Collins et al. (2009) in a portion of Yosemite National Park, Schwind (2008) regarding all vegetation in California, Hanson et al. (2009) and Miller et al. (2012) regarding conifer forests in the Klamath and southern Cascades regions of California, and Dillon et al. (2011) regarding forests of the Pacific (south to the northernmost portion of California) and Northwest.

All studies in California's forests have found unequivocally that increasing time since fire, typically used as a proxy for increased fuel loads, is not associated with increased fire activity or severity and, in fact, is generally associated with decreased fire severity, due to a reduction in pyrogenic shrubs and an increase in cooling shade and fuel moisture as canopy cover increases with increasing time since fire (Odion et al. 2004, Odion and Hanson 2006, Odion and Hanson 2008, Odion et al. 2010).

While temperature has increased somewhat, precipitation, including summer precipitation, has also been on an increasing trend for decades—a more substantial upward trend, in fact (Mote 2003, Hamlet et al. 2007, Gonzalez et al. 2010 [Fig. 1b], Crimmins et al. 2011). This factor, increasing summer precipitation, has a profound suppressing effect on fire activity (even with relatively small increases), one that may well outweigh temperature (Krawchuk and Moritz 2011). Numerous studies project a decrease in future fire in California's forests, while in some cases projecting an increase in desert areas and the Great Basin (see, e.g., Krawchuk et al. 2009 [Fig. 3], Gonzalez et al. 2010 [Fig. 3b], Liu et al. 2010 [Fig. 1]).

Some modeling studies predict that fire will increase in California's forests in the future, but the modeling assumptions chosen by the authors of these studies are based upon the presumption of substantially decreased precipitation, including summer precipitation, in the future, despite a century-long trend of increasing precipitation with climate change, and these studies do not explain why they believe that this longstanding precipitation pattern will reverse itself, and decrease substantially, in the future under the same climate change trend conditions under which precipitation has increased for the past several decades. For example, the projected potential increases for biomass burning in Marlon et al. (2012) are based upon modeling that assumes hotter and drier (drought) conditions (see Fig. 2 of Marlon et al. 2012), rather than the warmer and wetter trend that has actually been occurring in most western U.S. forests, including California, as discussed above. Further, the increases in fire that these studies project, under the assumption of decreased precipitation, are quite modest—generally in the range of 10–20% by the end of the century (see, e.g., Lenihan et al. 2003, Lenihan et al. 2008; see also Moritz et al. 2012)—and such an increase, if it occurred, would not even come close to making up the dramatic current fire deficit relative to natural historic conditions (see, e.g., Stephens et al. 2007).

In addition, Audubon (2009) and Stralberg and Jongsomjit (2008) predict substantial range contractions for the BBWO in the coming decades due to a large-scale loss of middle/upper montane and subalpine conifer forests from climate change. Moreover, the studies that project a modest increase in fire behavior in the future, based upon the assumption that the longstanding trend of increasing precipitation will reverse itself, also project a much larger overall loss of montane conifer forest types, such that the net effect is a dramatic reduction of the intersection of wildland fire and montane conifer forest (see, e.g., Lenihan et al. 2003, Lenihan et al. 2008 [Figs. 1 through 3]; see also Gonzalez et al. 2010 [Figs. 1 through 3—reporting an actual long term trend of increasing precipitation, assuming a future trend of decreasing precipitation, and projecting slight increases in fire in the southernmost Sierra Nevada, and no change or decreases in fire in the northern Sierra Nevada, but also projecting a 80–90% loss of montane conifer forest in the BBWO's range in California]). These results indicate the likelihood of a dramatic contraction of the BBWO's range in the coming decades due to anthropogenic climate change.

USDA Forest Service

Jay Miller, Hugh Safford, and Donald Yasuda

Historical and Current Fire Patterns in California's Forest: Implications for the Black-backed Woodpecker

Much scientific evidence suggests that the contemporary potential for high-severity fire and larger fires is greater than in pre-Euroamerican settlement times, due to the interaction between increasing forest fuels (resulting from fire suppression) and climate warming and more profound fire-season drought (resulting from anthropogenic climate change). Marlon et al. (2012) note that, given the levels of climate warming that have already occurred, it is remarkable how little wildfire is occurring in the western US. According to the authors, the contemporary disconnect between climate and fire activity – the product of fire suppression – is unprecedented in at least the last 1,500 years (the time period of their sedimentary charcoal study), and they hypothesize that the success of suppression policies will erode as climates warm further and fuels continue to accumulate. Evidence documenting the eroding success of fire suppression is already apparent in much of the West, with multiyear patterns in fire activity, fire size, and total burned area all trending upward (e.g., Westerling et al. 2006, Miller et al. 2009, Dillon et al. 2011). Contemporary empirical data, patterns in the paleo-record during similar warming periods, and future modeling all suggest that tendencies toward increasing fire activity and impact will continue and perhaps accelerate, as both temperatures and fuel loads continue to increase (e.g., Miller and Urban 1999, Whitlock et al. 2003, Lenihan et al. 2003, 2008; Westerling et al. 2006, Westerling and Bryant 2008, Miller et al. 2009, Gedalof 2011, National Research Council 2011).

Average fire size before Euroamerican settlement in California montane and upper montane forests was probably well below 200 ha (Taylor and Skinner 1998, Taylor 2000, Beaty and Taylor 2001, Taylor and Solem 2001, Collins et al. 2007, Scholl and Taylor 2010). Mean fire sizes in the Sierra Nevada have been increasing since the beginning of the 20th century, and the average over the most recent 25 year period is nearly 1,000 ha (only fires >10 ha included in the database). The role of fire suppression in causing larger fires in the Sierra Nevada is underlined by the much smaller fires experienced in areas managed without exclusion of naturally ignited fire, such as the wildland fire use (WFU) areas of the Sierra National Parks (e.g., Ililouette Valley, Yosemite NP; mean = 456 ha for fires >10 ha, mean = 61 ha for all fires; Collins et al. 2007), or the Sierra San Pedro Mártir of northern Baja California (mean = 221 ha for fires >10 ha, much lower for all fires; Minnich et al. 2000).

Fire severity has also increased in most montane forest types in the range of the Black-backed Woodpecker in California. Stephens et al. (2007) and LANDFIRE (1999) estimate that before Euroamerican settlement, an average of 3–10% of fire area within mixed conifer and yellow pine forests in the Sierra Nevada burned at "high severities" (>75% canopy mortality). Leiberg

(1902), in a study of 19th century fire and forests in the northern Sierra Nevada, estimated that 8% of the fire area he assessed had burned at stand-replacing severities, and a total of 26% of fire area had burned with tree losses of 50% or greater. Assuming Leiberg's assessment techniques were reasonably accurate (McKelvey et al. 1996 suggested that Leiberg overestimated high-severity area), we can roughly gauge that somewhere between 8 and 13% of the fire area he assessed burned at high severity (>75% mortality). Current data from wildland fire use areas in the Sierra Nevada National Parks and reference sites in northern Baja California show similar percentages to the Leiberg, Stephens, and LANDFIRE estimates (~15% in the former, ~5% in the latter; Collins et al. 2007, Stephens et al. 2008). In comparison, data collected since the mid 1980s show that contemporary wildfires in similar forest types in the Sierra Nevada that are still managed under fire suppression are burning 25–40% of their area at high severity, and the temporal trend is up (Miller et al. 2009).

Miller et al. (2009) found that the size of high-severity patches within Sierra Nevada fires had approximately doubled during the 1984–2006 period of analysis; for example, the mean maximum high-severity patch size among fires in any given year rose from 50 to 118 ha. The largest high-severity patch sizes measured were thousands of acres in size. If presettlement fire sizes in montane and upper montane forests averaged <200 ha and 5–15% of fire area was burning at high severity, then the largest high-severity patch sizes in forest vegetation would typically have been perhaps 10–30 ha in size, except in unusual circumstances. Studies based on forest structural analysis, stand ages, and fire history suggest that high-severity patches more than a few hectares in size were relatively unusual in fires in montane forests in California before Euroamerican settlement (e.g., Show and Kotok 1924, Kilgore 1973, Stephenson et al. 1991, Weatherspoon et al. 1992, Skinner 1995, Skinner and Chang 1996, Weatherspoon and Skinner 1996). Recent assessments of high-severity patch sizes in wildland fire use areas in California support this generalization. For example, van Wagtendonk and Lutz (2007) found that the mean high-severity patch size in forested WFU areas in Yosemite National Park since the early 1970s was 2.4 ha, and Collins and Stephens (2010) found that the median high-severity patch size in the Illilouette Basin over the same time period was 2.2 ha, with 60% of high-severity patches <4 ha and the largest patches only 80–90 ha in area (with most of these in chaparral, not forest).

With respect to habitat for postfire specialists like the Black-backed Woodpecker, the question is whether increases in fire severity over the last half century counterbalance the strongly reduced occurrence of fire in the Sierra Nevada. Calculations based on potential vegetation types and estimates of presettlement and current patterns of fire occurrence and severity suggest that there is little to no deficit in high-severity fire area in drier conifer forests at low to middle elevations (because of much higher modern fire severities), but a notable deficit in moister upper montane and subalpine forests, where fire severities are higher and have not changed much since Euroamerican settlement but fire occurrence has been proportionally more reduced by suppression efforts (Figure 50). These patterns suggest that effects of fire management on the

Black-backed Woodpecker are variable across the Sierra Nevada and caution against a one-size-fits-all response. It is important to note that current and projected future trends in fire occurrence and severity, fuels, and climate seem likely to create more, not less habitat for biota like the Black-backed Woodpecker that have life histories closely tied to burned forests. Although overall there may be more postfire habitat for species like the Black-backed Woodpecker in the future, it remains to be seen what sorts of ecological effects the trend toward much larger patches of severely burned forest may have.

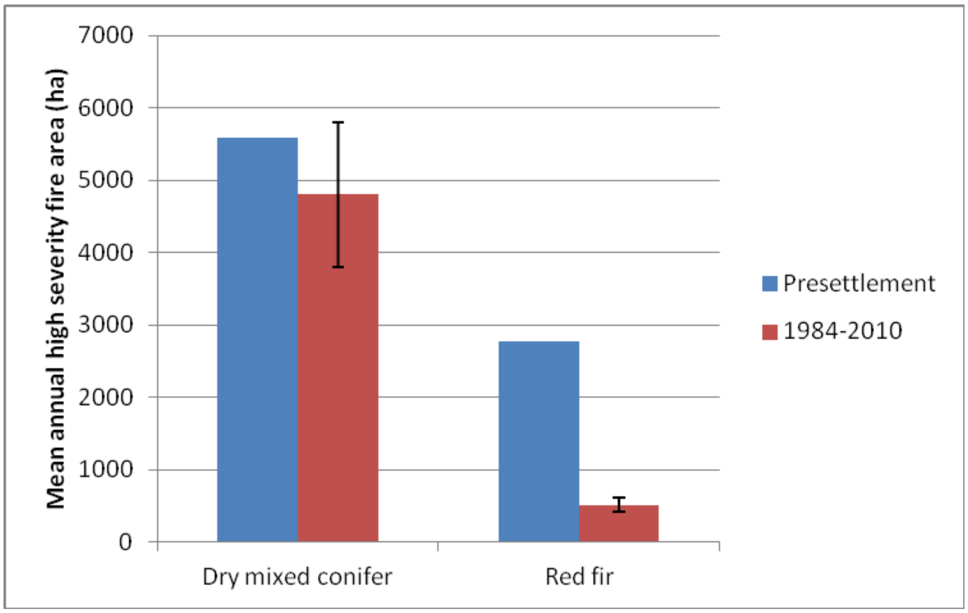

Figure 50. Mean annual area of high-severity fire in the Sierra Nevada Forest Plan Amendment Area, comparing estimate of presettlement period (before 1850) with 1984–2010, for two major forest types representing lower (dry mixed conifer, including yellow pine) and higher (red fir) elevations in the Sierra Nevada. Standard error bars from variability in annual area burned, 1984–2010. Values for presettlement period calculated using fire rotations, area of forest type, and mean % high-severity fire (all values from the literature).

Fire and Resource Assessment Program, California Department of Forestry and Fire Protection

Tiffany Meyer and David Passovoy

Status and trend of forest fire within the range of Black-backed Woodpecker in California

Status and trend of forest fire - overall statewide trends (historic to current):

Fire is an important ecological process in most the Sierra Nevada vegetative communities, and has been for thousands of years (Skinner and Chang 1996). The Mediterranean climate (cool, wet winters and warm, dry summers) predisposes much of the Sierra Nevada to conditions that would carry fire annually, and, prior to the mid-1800s (prior to Euro-American settlement), fires were generally frequent throughout much of the range; however, the frequency and severity varied spatially and temporally depending on climate, elevation, topography, vegetation, soil conditions, and human cultural practices (Skinner and Chang 1996). Estimates of annual acreage burned in California, excluding fires that occurred in the desert, prior to the arrival of European settlers range between 1.8 and 4.8 million ha (4.5 and 12 million acres annually), with 4.5–12 percent of the land area burning every year (Stephens et al. 2007).

Over the last 150 years or so, Euro-American settlement and management activities in the Sierra Nevada have greatly altered fire regimes, resulting in a reduction in the area influenced by low- and moderate-intensity fires in the Sierra Nevada (McKelvey et al. 1996). These changes have contributed to forest conditions that encourage high-severity fires, leading to a change from variable fire severity to predominantly high-severity, large, stand-replacing fires (Skinner and Chang 1996).

The California Department of Forestry and Fire Protection's 2010 Assessment of California's Forests and Rangelands used data on fire records and perimeters from 1950–2008 to assess modern fire trends in the State (California Department of Forestry and Fire Protection 2010). Within this period, an average of 320,000 acres [range 31,000 acres (1963) to 1.37 million acres (2008)] burned annually, with a very large inter-annual variability, due mainly to differing weather conditions and large lightning events that result in many dispersed ignitions in remote locations. Fire in conifer types occurred at an average of 48,000 acres per year in the 1970s, 1980s and 1990s, but increased to an average of 193,000 acres per year in the 2000s. Trend analysis using data since 1990 strongly suggests an upward trend in annual acres burned (California Department of Forestry and Fire Protection 2010).

Status and trend of fire within the Sierra Nevada and the range of the Black-backed Woodpecker:

Miller et al. (2009) conducted an assessment of the trend in fire size and annual area burned between 1908 and 2006, as well as the trend in high-severity (stand-replacing) fire between 1984 and 2006, in the Sierra Nevada and southern Cascade Mountains and found that the extent of forest stand-replacing fire is increasing, with increases in fire number, fire size, annual burned area, and, at least since 1984, fire severity.

We used the CAL FIRE database maintained by the Fire and Resource Assessment Program (FRAP) to assess multi-decadal trends in fire number (Figure 51) and fire size (Figure 52) within the range of Black-backed Woodpecker in California, as delineated by California Department of Fish and Game (2008).

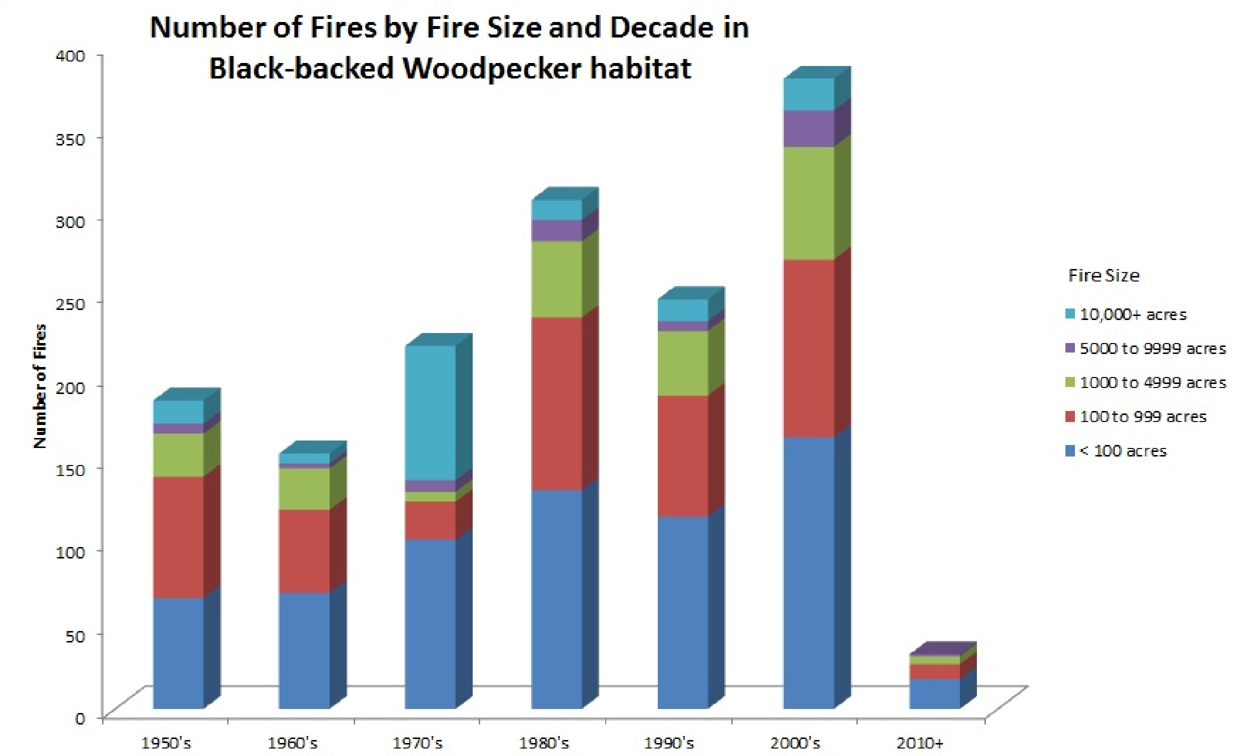

Figure 51. Number of fires by fire size and decade within Black-backed Woodpecker's range in California.

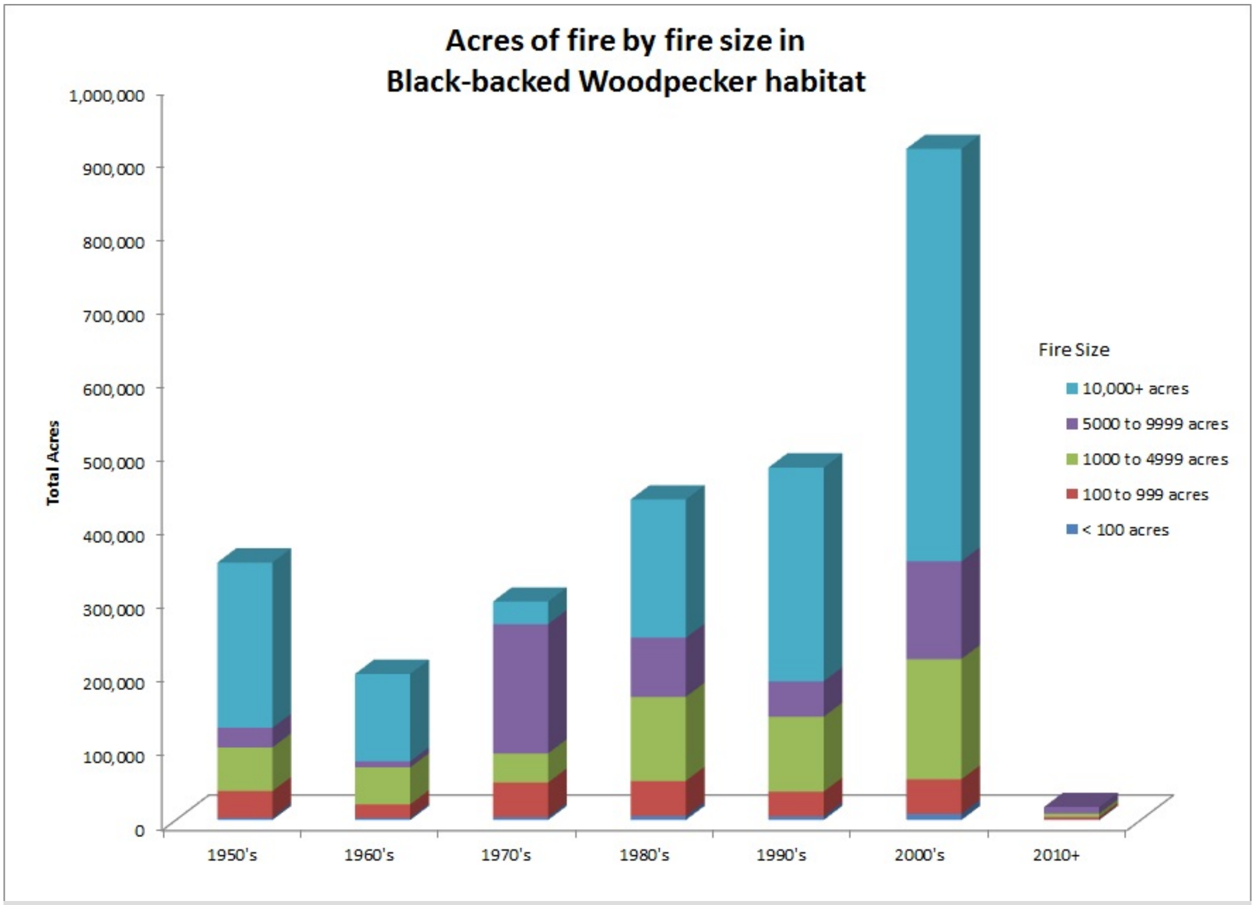

Figure 52. Total area (acres) of fire by fire size and decade within Black-backed Woodpecker's range in California.

For the more recent period 1984–2010, we used Vegetation Burn Severity data from the USDA Forest Service fire and fuels monitoring project (2012) that are calibrated to the plot based Composite Burn Index (CBI; Figure 53). The high-severity level is approximately equivalent to 95% change in canopy cover.

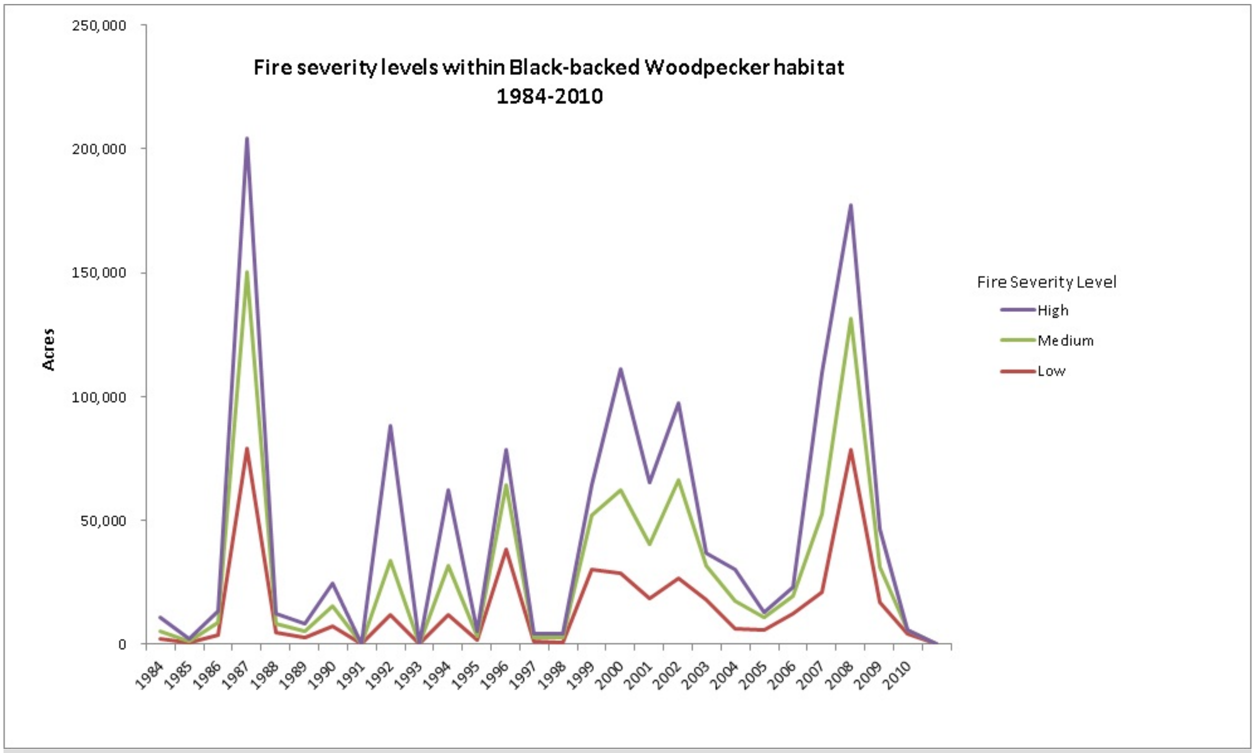

Figure 53. Number of acres of low, medium and high vegetation burn severity levels within Black-backed Woodpecker's range in California, where high burn severity represents areas where the dominant vegetation has high to complete mortality.

Finally, for a snapshot of the recent distribution and area of fire within the California range of Black-backed Woodpecker, we mapped fire occurrences within the species' range (Figure 54).

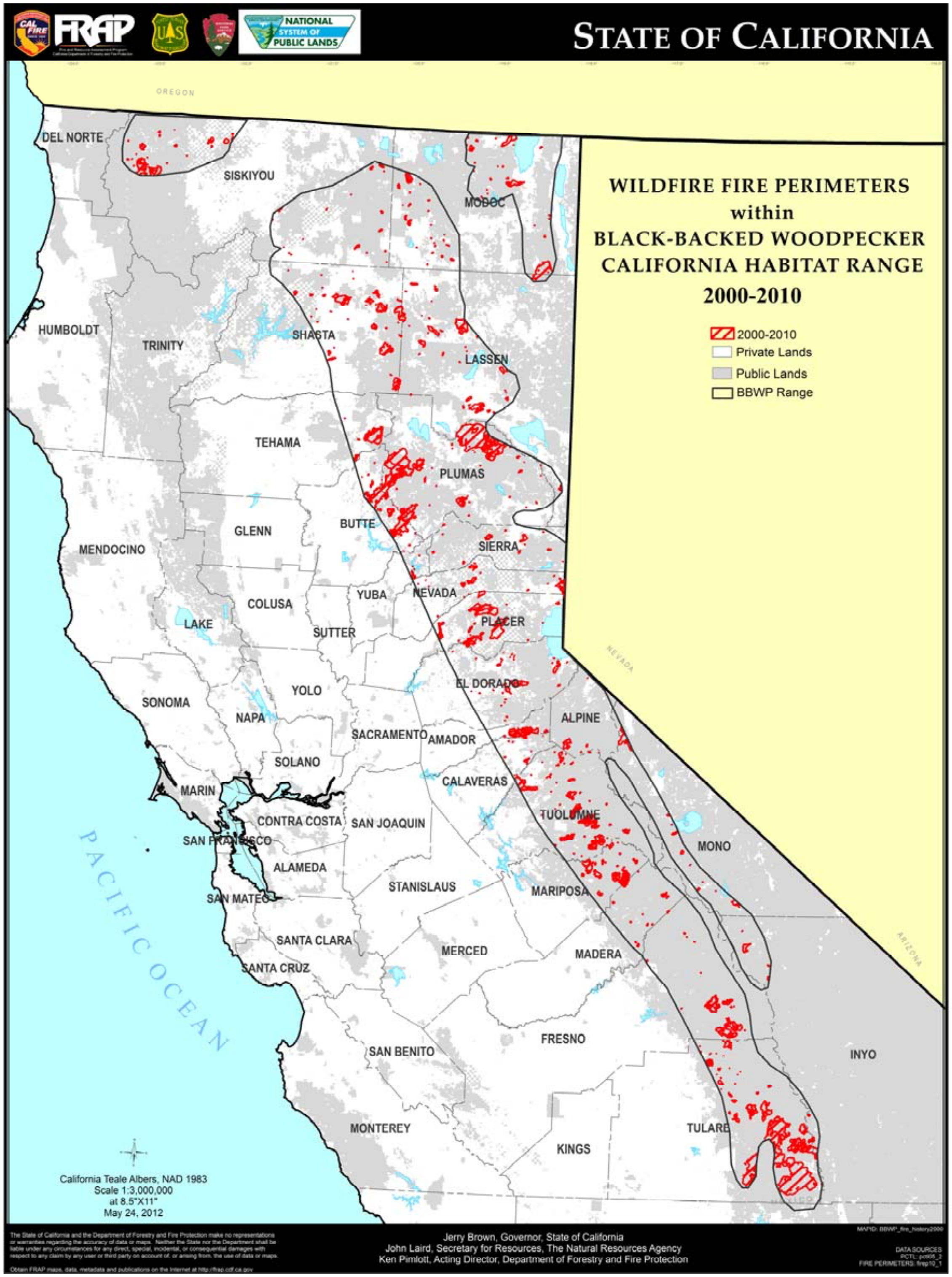

Figure 54. Wildfire perimeters within Black-backed Woodpecker's range in California, 2000-2010. The fire perimeter database was developed by BLM, CDF, NPS, and USFS and represents the most complete digital record of fire history in California, although it is still incomplete in many respects. For more information on potential errors and their sources please visit http://frap.cdf.ca.gov/projects/fire_data/fire_perimeters

Table 5 displays the acres and severity of fires over 1,000 acres in size that occurred on or adjacent to the ten National Forests in the Sierra Nevada from 2000 to 2010 (USDA Forest Service 2012).

Table 5. National Forest SN Forest fire burn severity acres for fires from 2000 to 2010.

Forest	Unchanged[1]	Low Severity[2]	Moderate Severity[3]	High Severity[4]	Total
Eldorado	2,025	6,742	8,576	9,616	26,959
Inyo	4,691	11,980	11,343	16,632	44,646
Lake Tahoe Basin MU	348	606	981	1,560	3,495
Lassen	14,173	26,103	19,071	17,234	76,582
Modoc	5,618	7,191	7,895	10,399	31,103
Plumas	10,134	48,367	43,832	59,724	162,077
Sequoia	19,578	35,678	46,248	39,158	140,661
Sierra	2,318	6,246	1,938	624	11,127
Stanislaus	4,006	11,672	9,300	4,752	29,730
Tahoe	4,606	16,716	11,478	11,067	43,867
Grand Total	**67,497**	**171,301**	**160,662**	**170,766**	**570,247**

[1]Unchanged: areas indistinguishable from pre-fire conditions one year after a fire.
[2]Low Severity: areas with little change in cover and little mortality of the structurally dominant vegetation.
[3]Moderate Severity: areas with a mixture of effects on the structurally dominant vegetation.
[4]High Severity: areas where the dominant vegetation has high to complete mortality.

The annual area burned decreased from the 1930s through the 1950s, and has increased since the 1970s, particularly since the early 1980s. Mean and maximum fire size have been rising since 1908, but the increase entirely occurred over the last 2–3 decades: the current 11-year averages for mean and maximum fire size are 40–70% higher than any values before 1980.

From 1984–2004, trends in the proportional area of wildfires burning at high severity (stand-replacing) showed significant increases, changing from a 10-year average of approximately 17% of the burned area burning at high severity to a 10-year average of approximately 30% at the end of this period. During 1984–2009, 25–40% of the total area burned by wildfires in lower- to middle-elevation coniferous forests was stand-replacing. Across all forest types, high-severity effects were measured on 26% of the burned areas analyzed. In addition, during 1984–2008, the average and maximum sizes of contiguous area (patches) of stand-replacing fire within coniferous forest fires approximately doubled: during the first 10 years, the mean was 2.8 ha (mean maximum 50 ha); during the last 10 years, the mean was 5.3 ha (mean maximum 118 ha).

APPENDIX C – Population Estimates for the Black-backed Woodpecker in California

Estimating overall population size for the Black-backed Woodpecker in California is made challenging by the species' variable – but generally quite large – home range size and its relatively low probability of being detected by passive, multi-species survey techniques. Several groups and individual researchers have aimed to provide estimates of population size in different habitats in California using various methods: Hanson and Cummings 2010, Siegel et al. 2010, Fogg et al. 2012, and Hanson (2012).

Burned Forests

(1) Hanson and Cummings (2010) estimated the current abundance of Black-backed Woodpeckers on public lands based on the amount of suitable habitat in the Sierra Nevada and South Cascades of California in 2009. Using density estimates of 0.80 nests/100 ha in 1–6 year old fires and 0.25 nests/100 ha in 7–10 year old fires (see Table 6 below for nest density estimates by study), the authors calculated the number of woodpeckers in all pre-fire CWHR[2] 4M, 4D, 5M, 5D and 6 habitat stands that burned at moderate and high severity as determined by RdNBR[3]. A nest was assumed to represent a pair of woodpeckers. This analysis yielded a total of 21,714 ha of burned Black-backed Woodpecker habitat in fires 1-6 years old on public lands in California as of 2009. Of the 21,714 ha of suitable habitat, at least 7,291 ha were salvage logged (and many additional areas were proposed for salvage logging at the time of analysis, but no decision had yet been made), leaving 14,423 ha of suitable habitat (assuming salvage-logged areas represented an elimination of nest sites and therefore reduction in pairs). Of this amount, only about 21% was in protected lands such as National Parks, Wilderness Areas, or Inventoried Roadless Areas. At 0.8 pairs per 100 ha, this amount of habitat equated to about 115 pairs of Black-backed Woodpeckers in California within moderate to high-severity unlogged burn areas in 1-6 year old fires. When older fire areas (7-10 years old) were included, this represented an additional 18,424 ha which, at approximately 0.25 pairs per 100 ha for areas 7–10 years post-fire, equated to an additional 46 pairs of Black-backed Woodpeckers. Overall, this method estimated about 115 pairs of Black-backed Woodpeckers within the 32,847 ha of moderately and

[2] California Wildlife Habitat Relations habitat classifications: size class 4 = trees averaging 11–24 inches dbh; size class 5 = trees averaging > 24 inches dbh; canopy cover M = 40–60% cover; canopy cover D is cover > 60%; size class 6 = old forest

[3] Relative difference Normalized Burn Ratio = Hanson and Cummings (2010) used an RdNBR fire intensity threshold of 800 to define high severity. This is conservative, as it equates to only about 60% mortality of overstory trees (trees > 50 cm dbh, i.e., the size selected by Black-backed Woodpeckers in Hanson 2007) in mature stands (Hanson et al. 2010). High severity is typically defined as equating to at least 75% mortality of overstory trees (Schwind 2008). To be conservative, we also included moderate intensity areas with RdNBR values of 574–799. An RdNBR value of 574 equates to only about 40% mortality of overstory trees >50 cm dbh

highly burned habitat in 1–6 year old fires and an additional 46 pairs within the 18,424 ha of moderate and highly burned habitat in 7–10 year old fires in California's forests as of 2009, for a total of 161 pairs.

Table 6. Number of Black-backed Woodpecker nests located per 100 ha in burned and beetle-killed Forests throughout the species' range

Study	Location	Years since disturbance	Number of nests per 100 ha	
			Burned	*Insect kill*
Saab et al. (2007)	Rocky Mts, ID	1-6	0.85	-
Saab et al. (2007)	Rocky Mts, ID	7-10	0.25	-
Dixon and Saab (2000)	Rocky Mts, ID	1-5	0.80	-
Vierling et al. (2008)	Black Hills, SD	1-4	0.30	-
Bonnot et al. (2008)	Black Hills, SD	1-7 yr	-	0.33 nests
Powell (2000)	Rocky Mts, MT	> 1 yr	-	0 nests
Burnett (unpublished)	Northern Sierra Nevada, CA	1-6 7-10	1.6 0.25	-

Hanson and Cummings (2010) also estimated population size in burned forests using nest densities from PRBO Conservation Science's surveys in the northern Sierra Nevada. In this method, abundance of Black-backed Woodpeckers in all burned forests was estimated simply by using the acreage estimate for all fires (all fire severities included) in montane conifer forest (all pre-fire forest ages, densities and structures included) on public lands within the species' range in California from 1999 to 2009, 176,504 ha, and the probability of occupancy figures reported in Fig. 15 of Siegel et al. (2010) for average fire conditions (i.e., neither the highest nor the lowest fire intensities or snag densities), about 8–10%. Using a higher nest-density estimate of 1.6 nests/100 ha in recent fires and 0.25 nests/ha in older fires and lower RdNBR values, Hanson and Cummings (2010) estimated 254 pairs of Black-backed Woodpeckers in forests burned from 1999 to 2000.

(2) Siegel et al. 2010 produced somewhat higher population estimates for recently burned areas of national forests in the species' range in California, but cautioned that the estimates were preliminary only. Siegel et al. (2010) conducted surveys in recent (1 to 10 year-old) fire areas on national forests in California across a sampling frame that comprised 323,358 ha of habitat (all burn severities) distributed among 72 fire areas, including areas subjected to post-fire

management that removed some snags, and estimated the occupancy rate at 25.3%, yielding an estimate of 81,814 ha of occupied habitat (95% credible interval = 71,921 – 93,610 ha). Dividing this total area by home-range sizes reported from elsewhere in the species' range (Goggans et al. 1988: 174 ha home-range size = 470 pairs in California; Tremblay et al. 2009: 152 ha home-range size = 538 pairs in California) yielded estimates of approximately 500 pairs in California's burned forest. However the authors emphasized that:

> *"...this preliminary range of population estimates is not reliable until data on home range size (and perhaps information regarding the degree to which home ranges overlap) are available from within the Sierra Nevada region. Moreover, our sampling frame only included fires that occurred between 1999 and 2008, comprised at least 50 ha of conifer forest that burned at mid-severity and/or high-severity, and that occurred at least partially on one or more of the ten national forest units in our study area. Black-backed Woodpeckers occupying habitat in fire areas that burned more than ten years prior to our study, fire areas that did not include any land on national forests, or fire areas that burned <50 ha of conifer forest are not accounted for in our estimate. Our estimates also do not account for any Black-backed Woodpeckers that may have held territories partly or entirely within 'green forest'—areas that have not recently burned."*

Unburned Forests

(1) Hanson and Cummings (2010; Appendix F) estimated population size of Black-backed Woodpeckers in unburned forests in the Sierra Nevada management area, including the Modoc region. The authors used Forest Service/PRBO MIS data to calculate that Black-backed Woodpecker abundance is about 83 times higher in burned forest than in unburned forest in the Sierra Nevada. The authors used this to estimate number of woodpecker pairs in unburned forest—i.e., assuming that nest density is 0.80 nests per 100 hectares in burned forest, in unburned forest it would be approximately 83 times lower, which is about 0.009 nests per 100 ha, or about 1 pair per 11,039 hectares. With 4,000,000 hectares of unburned forest, and one Black-backed Woodpecker pair per 11,039 hectares of unburned forest, Hanson and Cummings approximated 362 pairs of Black-backed Woodpeckers in unburned forest in California.

(2) Fogg et al. (2012) analyzed data on Black-backed Woodpecker observations between 2009 and 2011 during 498 multi-species point count transects on ten National Forest units in the Sierra Nevada National Forest planning region. Using a combination of passive point counts and broadcasts of Black-backed Woodpecker vocalizations and drumming, they reported overall transect occupancy in unburned forest to be 0.22; point-level occupancy was 0.11. This point-level value is nearly half the occupancy rate estimated in burned forests in the region (Saracco et al. 2011, Siegel et al. 2012b). Fogg et al. (2012) extrapolated their results across the larger landscape to estimate 1,398 – 6,899 uniquely occupied Black-backed Woodpecker sites on unburned National Forest land in the Sierra Nevada.

(3) Hanson (2012) analyzed data (Fogg et al. 2012; Siegel et al. 2012c) that became available subsequent to the analysis reported in Hanson and Cummings (2010), and concluded that no more than 175 pairs of Black-backed Woodpeckers occupy unburned forests in California.

The widely divergent population estimates for Black-backed Woodpecker in unburned forest produced by Fogg et al. (2012) and Hanson (2012) rely on the same detection data, but then make very different assumptions about what those data signify. Interested readers are encouraged to consult the two respective reports for the detailed information needed to make an informed comparison of the estimates.

Table 7 (next page) summarizes data on the various methods used to estimate population size of Black-backed Woodpeckers in burned and unburned forests of the Sierra Nevada, California.

Table 7. Population estimates for Black-backed Woodpeckers in burned and unburned forests of California.

Source		Density estimate	Years post-fire	Total area estimated occupied habitat	Burned / Unburned	Estimated pairs
Hanson and Cummings (2010)	a)	0.8 pairs/100 ha	1-6 yrs	21,714 ha (14,423 ha after salvage)	Burned	161
		0.25 pairs/100 ha	7-10 yrs	18,424 ha		
	b)	1.6 pairs/100 ha	1-6 yrs	176,504 ha	Burned	254
		0.25pairs/100 ha and 8-10% occupancy probability	7-10 yrs	15,885 ha		
Siegel et al. (2010)		Home-range sizes: Goggans et al. (1988)=174 ha Tremblay et al. (2009)=152 ha and 25.3% occupancy probability	1-10 yrs	81,814 ha	Burned	470 – 538
Fogg et al. 2012		21.5% occupancy probability	n/a	1,849,400 ha	Unburned	1,398 – 6,899
Hanson and Cummings (2010)		0.009 pairs/100ha assumed 83 times lower than 0.80 pairs/100 ha in burned	n/a	4,000,000 ha	Unburned	362
Hanson (2012)		various densities from other studies	n/a	436,260 ha	Unburned	175

APPENDIX D – Annotated Catalog of Peer-reviewed Scientific Literature on the Black-backed Woodpecker

Here we provide an annotated catalog of peer-reviewed scientific literature about the ecology and management of the Black-backed Woodpecker. This information is also available online in an Excel Spreadsheet at http://www.birdpop.org/Sierra/bbwo_results.htm.

Nesting Habitat

Bull, E. L., S. R. Peterson, and J. W. Thomas. 1986. Resource partitioning among woodpeckers in Northeastern Oregon. Research Note PNW-444. Portland, Oregon: USDA Forest Service Pacific Northwest Research Station.

Location: Blue Mountains, Northeastern Oregon

Focus: Nesting Habitat, Unburned

Synopsis: Sixty percent of the 15 nests were in dead trees. Ponderosa pine, lodgepole pine, and western larch were used. Nests usually were in smaller (<50 cm), tall (>15 m), recently dead (<5 years) trees. Ponderosa pine forest types contained 73% of nest sites. Nests were in stands with a mean canopy closure of 46% and basal area of 20 m2ha. Over ¾ of the nest sites contained fewer than 5 stumps per 0.1 ha, less than 10% log cover, and more than 5 dead trees per 0.1 ha. Authors stated "we believe the black-backed woodpecker prefers dead pines because pines have a thicker layer of sapwood than other species of the same size. We also believe trees less than 50 cm are preferred because they contain a higher percentage of sapwood than do trees greater than 50 cm, and this species often excavates nests in sapwood." Young fledged from the nest after 6 July at 63% of the nests.

Saab, V. A. and J. G. Dudley. 1998. Responses of cavity-nesting birds to stand-replacement fire and salvage logging in ponderosa pine/Douglas-fir forests of southwestern Idaho. (Research Paper RMRS-RP-11). Fort Collins: USDA Forest Service Rocky Mountain Research Station.

Location: Western Idaho

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: Followed 17 nests from 1994 to 1996, in forests that burned in 1992 and 1994. Nest densities were more than doubled in unlogged versus both "standard salvage" and "wildlife salvage" forests. Standard salvage prescription included (1) on north slopes, removal of all merchantable trees >25 cm dbh with snag retention requirement of 15 snags/ ha with at least three required to be > 51 cm dbh, two between 30-51 cm, and one between 25-30 cm dbh and (2) on south slopes, removal of 66% of merchantable trees >30 cm and snag retention requirement was met in the area not harvested. For wildlife salvage prescription, 50% of all merchantable trees >30 cm were harvested and snag retention requirement was met in the unharvested area. Numbers of nesting BBWO were significantly reduced in burned, logged stands compared to burned, unlogged stands in Montana and Wyoming as well (Harris 1982, Caton 1996). Nests per km surveyed increased from 1994 to 1996. All nests were successful, although there were only 4 in salvaged logged and 11 in unlogged. Among bird species, BBWO selected nest sites with the highest tree densities (average 122.5 + 28.3 trees >23 cm dbh) per hectare. Nest trees selected by BBWO averaged the smallest diameter (average 32.3 + 2.8) compared with other cavity nesters. BBWO typically nested in trees with light to medium decay and often with intact tops, possibly because the species is a strong excavator and can excavate hard snags and live trees.

Saab, V.A., R. Brannon, J. Dudley, L. Donohoo, D. Vanderzanden, V. Johnson, and H. Lachowski. 2002. Selection of fire created snags at two spatial scales by cavity nesting birds. In P.J. Shea, W.F. Laudenslayer Jr., B. Valentine, C.P. Weatherspoon, and T.E. Lisle (eds.), Proceedings of the symposium on the ecology and management of dead wood in western forests, November 2–4, 1999, Reno, Nevada. USDA Forest Service General Technical Report PSW-GTR-181, pp. 835–848.

Location: Western Idaho

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: Found 29 nests in unlogged burned forests and only 6 nests in logged burned forests in southwestern Idaho. Of all 7 cavity nesting species monitored, snag densities were highest at BBWO nest sites (*n* = 4 in logged and 13 in unlogged), and lowest at random sites (*n* = 49 in logged and 40 in unlogged). BBWO used smallest diameter snags for nesting of 5 woodpecker species (*n* = 35; average 39.7 $\pm$ 2.1 cm). The authors modeled habitat variables for predicting nests. Stand area of burned, Douglas-fir/high crown closure was the most important variable in predicting presence of BBWO nests. Probability of nest occurrence was most high for BBWO when stand area of Douglas-fir/high crown closure was between 30 and 50 hectares. In landscapes where stand area was outside of this range, other landscape features necessary for nesting BBWO were likely reduced in availability or absent. Nests were not present where stand area was less than 12 ha, and probability was highly variable when stand area was between 12 and 25 ha or when area was greater than 55 ha. The authors do not report whether nests were located in burned stands >70 ha, or whether stands this large were not present or whether no surveys were conducted in these large stands.

Saab, V. A., J. Dudley, and W. L. Thompson. 2004. Factors influencing occupancy of nest cavities in recently burned forests. Condor 106:20–36.

Location: Western Idaho

Focus: Nesting Habitat, Burned

Synopsis: Documented 27% of BBWO cavities were re-used by a different guild.

Hutto, R. L. and S. M. Gallo. 2006. The effects of postfire salvage logging on cavity-nesting birds. Condor 108:817–831.

Location: Western Montana

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: Found 10 nests in unlogged plots and none in salvage-logged plots. Located 10 nests in 148 ha unlogged and 0 nests in 275 ha logged forest. Six cavities made by BBWO were re-used by other species including northern flicker (2), white-breasted nuthatch (2), house wren (2), and mountain bluebird (1). Documented 50% BBWO cavities were reused by BBWO and 100% were reused by another species.

Russell, R. E., V. A. Saab, and J. G. Dudley. 2007. Habitat-suitability models for cavity-nesting birds in a postfire landscape. Journal of Wildlife Management 71:2600–2611.

Location: Western Idaho

Focus: Nesting Habitat, Burned

Synopsis: Compared ability of models with remote-sensed data only versus models with field-collected data plus remote-sensed data to identify potential nesting habitat in post-fire landscapes. Microhabitat data = 0.04 ha circular plot around nest. Landscape data = 1-km radius circle around nest. Best model of BBWO nest locations included pre-fire crown closure on pixel and landscape scales, as well as burn severity and patch area. Only 11% of BBWO nests were in pixels with 0-40% prefire crown closure vs 48% of non-nest plots. On average within a 1-km radius of BBWO nests 55% of the area had prefire crown closure >40%, compared to 47% of landscape in non-nest locations. Found it is necessary to have local field-collected data in addition to remotely sensed data to correctly identify nest locations because remote-sensed data alone performed poorly. The greater ability of the models to distinguish between nest and non-nest locations is likely because BBWO is a habitat specialist.

Nielsen-Pincus, N. and E. O. Garton. 2007. Responses of cavity-nesting birds to changes in available habitat reveal underlying determinants of nest selection. Northwestern Naturalist 88:135–146.

Location: Blue Mountains, Northeastern Oregon

Focus: Nesting Habitat, Unburned

Synopsis: Identified nest-site selection by comparing nest site attributes to available habitat attributes and comparing current selection patterns with data from 1970s. Most BBWO nests were in live ponderosa pine and western larch trees or in snags with the least amount of decay. Of nests in snags, BBWO preferred snags that were >10 m tall. Best model for predicting use of a plot as a nest for BBWO included positive relationship with small trees. Nest trees were of similar height, dbh, and retained comparable amounts of bark and branches between the 2 time periods. BBWO exhibited a shift in the use of forest types compared to the 1970s. BBWO nested in areas with more small (23-37 cm dbh) live trees/ha, fewer logs, gentle slope, and were in the Douglas-fir forest type. Similar to Bull et al. (1986). Best model for nest-site selection described conditions structurally similar to nest plots of BBWO in recently burned stands (Saab and Dudley 1998). In both time periods, BBWO chose nest trees that were of small diameter with little decay and excavated nest cavities that were relatively low to the ground.

Saab, V. A., R. E. Russell, and J. G. Dudley. 2007. Nest densities of cavity-nesting birds in relation to postfire salvage logging and time since wildfire. Condor 109:97–108.

Location: Western Idaho

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: BBWO nest densities peaked at about 4-5 years postfire in unlogged burn (studied 1-10 years post-fire). BBWO nest densities were significantly higher in the unlogged burns; the nest densities were more than 5 times lower in partially logged burns. Number of nests = 43 (29 early, 14 late) in unlogged and 8 (5 early, 3 late) in logged.

Koivula, M. J, and F. K. A. Schmiegelow. 2007. Boreal woodpecker assemblages in recently burned forested landscapes in Alberta, Canada: Effects of post-fire harvesting and burn severity. Forest Ecology and Management 242:606–618.

Location: Alberta, Canada

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: BBWO abundance was significantly and negatively affected by salvage logging in mixed-wood forests 1-2 years after fire. In unlogged areas, BBWO responded positively to increasing burn severity. Documented 30 of 32 nests were in unlogged forests.

Vierling, K. T., L. B. Lentile, and N. Nielsen-Pincus. 2008. Preburn characteristics and woodpecker use of burned coniferous forests. Journal of Wildlife Management 72:422–427.

Location: Black Hills, Western South Dakota

Focus: Nesting Habitat, Burned

Synopsis: Examined postfire nest density, reproductive success, and nest-site selection in the context of prefire conditions and postfire effects for 1-4 years after fire. Predation was the major cause of nest failure of all 7 species of woodpecker (does not distinguish between BBWO and other species) and increased between 2-4 years postfire (to the end of the study). Mean dbh of nest tree (n = 20) was 25.7 ± 1.09 cm compared to random sites (n = 151) at 19.8 ± 0.73 cm; mean distance to unburned edge from nest tree was 605.95 ± 61.0 m compared to random 168.7 ± 10.8, and mean % low-severity fire within 1 km of nest tree was 20.8 + 1.90 compared to random 24.9 ± 0.54, and mean snag density within 11.3 m of nest tree was 26.8 ± 4.17 compared to random 13.3 ± 0.94.

Bonnot, T. W., M. A. Rumble, and J. J. Millspaugh. 2008. Nest success of black-backed woodpeckers in forests with mountain pine beetle outbreaks in the Black Hills, South Dakota. Condor 110:450–457.

Location: Black Hills, Western South Dakota

Focus: Nesting Habitat, Beetle-killed

Synopsis: Estimated nest success and evaluated factors correlated with the nest success of BBWO in forests with outbreaks of mountain pine beetles. Monitored 12 nests in nine sites in 2004 and 32 nests in 12 sites in 2005. Predation was the leading cause of nest loss (89%). Number of fledglings per pair in 2004 was 2.0 ± 0.3 (n = 12). In 2005, BBWO nests fledge 1.2 ± 0.2 young per nesting attempt (n = 32). In 2005 authors confirmed renesting by four pairs following failure of their first nest. Nest age and date were the most important predictors of nest survival. The odds of daily nest survival decreased 2% per day over the course of the nesting period, but increased 3% for each 1-day increase in nest age. Estimated nest success was above 80% for nests started early in the season (late April and earl May) and decreased as a function of later nest initiation date. Availability of food is important for nest-site selection but not nest success in areas where overall food abundance is high, such as in a fire or beetle outbreak.

Nappi, A., and P. Drapeau. 2009. Reproductive success of the black-backed woodpecker (*Picoides arcticus*) in burned boreal forests: Are burns source habitats? Biological Conservation 142:1381–1391.

Location: Quebec, Canada

Focus: Nesting Habitat, Burned

Synopsis: Nest success of 106 nests in burned forest declined from 84% the first year after fire to 73% and 25%, respectively, for the second and third years after fire. Nest density and reproductive success were higher in areas with high proportions of burned mature forets than in areas dominated by burned young forests, and higher in proximity to unburned forests.

Forristal, C. D. 2009. Influence of postfire salvage logging on black-backed woodpecker nest-site selection and nest survival. M.S. thesis, Montana State University, Bozeman.

Location: South-central Oregon

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: Monitored 210 nests in burned logged and unlogged forests pre- and post-logging. Postfire logging was light. Nest-tree size was similar for the first 3 years post-fire, but increased in year 4. Lodgepole pine and ponderosa pine snags comprised 90% of all selected nest-tree species, and BBWO gradually switched from nesting primarily in lodgepole pine to ponderosa pine as year postfire increased. Author found significantly greater number of snags per hectare and significantly higher burn severity at nests compared with random sites. The odds of nest occurrence nearly doubled for every 50 additional snags over 23 cm. BBWO selected nest sites in areas with higher snag densities and larger burned areas; tree density increased odds of nesting only if it coincided with increasing areas of moderate-high burn severity.

Russell, R. E., V. A. Saab, J. J. Rotella, and J. G. Dudley. 2009. Detection probabilities of woodpecker nests in mixed conifer forests in Oregon. Wilson Journal of Ornithology 121:82–88.

Location: South-central Oregon

Focus: Nesting Habitat, Burned and Unburned

Synopsis: Found 21 BBWO nests in burned forest and none in unburned. Nest-detection probability varied by nest stage and observer, with later nest stages more detectable. Raw nest counts in burned forests may underestimate nest numbers especially for nests in early stages of development. Additional surveys increased detection probabilities from 0.4 for 1 visit to 0.8 for three visits in the early nesting stages.

Saab, V.A., R.E. Russell, and J.G. Dudley. 2009. Nest-site selection by cavity-nesting birds in relation to postfire salvage logging. Forest Ecology and Management 257:151–159.

Location: Western Idaho

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: BBWO were positively associated with increasing patch areas and increasing tree dbh, increasing snag densities, and increasing area of mnoderate (>40-70%) or high (>70%) pre-fire crown closures in a 1-km area surrounding the nest. Snag densities and diameters were higher than the average snag densitites and diameters in the logged burn. Snag densities averaged 316 trees >23 cm/ha.

Bonnot, T. W., J. J. Millspaugh, and M. A. Rumble. 2009. Multi-scale nest-site selection by black-backed woodpeckers in outbreaks of mountain pine beetles. Forest Ecology and Management 259:220–228.

Location: Black Hills, Western South Dakota

Focus: Nesting Habitat, Beetle-killed

Synopsis: Habitat attributes around 42 BBWO nests in beetle-killed forests were measured. The most important predictors of nest-site selection were wood-borer abundance at the territory scale [~20 ha around nest], snag density (all pines and aspen) at the nest-area scale [12.5 m around nest] and decreasing dbh of these snags, and dbh of tree at the nest-tree scale - the smaller the tree, the more likely it was used as a nest. Most nests were in aspen trees or pine snags ≥3 years old. The overriding feature of site selection was a high abundance of wood-boring insects.

Saab, V.A., R.E. Russell, J. Rotella, and J.G. Dudley. 2011. Modeling nest survival of cavity-nesting birds in relation to postfire salvage logging. Journal of Wildlife Management 75:794–804.

Location: Western Idaho

Focus: Nesting Habitat, Burned (Salvage Logging)

Synopsis: Nest survival probability of 46 BBWO nests (7 in salvage-logged, 39 in unlogged burned forests) increased with increasing distance to unburned forest.

Seavy, N. E., R. Burnett, and P. J. Taille. In press. Black-backed woodpecker nest tree preference in burned forests of the Sierra Nevada, California. Wildlife Society Bulletin.

Location: Northern Sierra Nevada

Focus: Nesting Habitat, Burned

Synopsis: Documented Snag density around 31 nest trees was higher than around randomly-selected trees.

Foraging Habitat

Bull, E. L., S. R. Peterson, and J. W. Thomas. 1986. Resource partitioning among woodpeckers in Northeastern Oregon. Research Note PNW-444. Portland, Oregon: USDA Forest Service Pacific Northwest Research Station.

Location: Blue Mountains, Northeastern Oregon

Focus: Foraging Habitat, Unburned

Synopsis: BBWO scaled 72% of the time and pecked and gleaned the remainder of the time. All forest types were used and 97% of the foraging occurred on ridges. Live and dead trees were used in approximately equal proportions. Live lodgepole pine was preferred for foraging and was used 54% of the time. Tree species was the best discriminator between live trees used and those not used. Height, dbh, and percent of needles were significantly different for dead trees used for feeding from those of available dead trees. BBWO fed in trees that averaged 34 cm dbh and 19 m tall and retained 41% of their needles, suggesting that the trees had been dead less than 2 years.

Villard, P. and C. W. Beninger. 1993. Foraging behavior of male-black-backed and hairy woodpeckers in a forest burn. Journal of Field Ornithology 64:71–76.

Location: Quebec, Canada

Focus: Foraging Habitat, Burned

Synopsis: BBWO searched for food 97% of the time on fire-killed White Pine and 3% of the time on Eastern Hemlock. Insects collected were almost exclusively the larvae of the Whitespotted Sawyer, *Monachamus scutellatus*. BBWO in winter spent 100% of the time foraging on the trunk, and 94% of the time on the trunk in spring, and were never observed foraging on the ground. BBWO were observed foraging on the largest limb size classes (>15 cm) in the winter. In the spring, BBWO foraged on limbs >7.5 cm, and rarely (5% of the time) on limbs smaller than 7.5 cm.

Villard, P. 1994. Foraging behavior of Black-backed and Three-toed woodpeckers during spring and summer in a Canadian boreal forest. Canadian Journal of Zoology 72:1957–1959.

Location: Manitoba, Canada

Focus: Foraging Habitat, Unburned

Synopsis: Studied 156 male and 15 female BBWOs in unburned boreal forests. Dead trees or tree substrates were used 88% of the time. Trunks were used 100% of the time. BBWO spent 41% of the time foraging on dead wood on the ground, and were found significantly more often foraging on lower portions of large-diameter trunks (15-25 cm). BBWO also foraged mostly by scaling bark (systematically flaking off bark) and excavating (digging holes in the wood). No difference between the sexes with regard to foraging behavior. BBWO foraged mainly on fallen logs and at the base of tree trunks, digging deeper in larger trees.

Murphy, E. C. and W. A. Lehnhausen. 1998. Density and foraging ecology of woodpeckers following a stand-replacement fire. Journal of Wildlife Management 62:1359–1372.

Location: Interior Alaska

Focus: Foraging Habitat, Burned

Synopsis: BBWO common 2 years after the fire, by third year it was rare and had left the area by the fourth year post-fire. Nearly all sightings were on moderately to heavily burned standing White Spruces. No sexual differences in foraging mode, but females foraged higher on trees and on more heavily burnt trees than males. BBWO excavated 64.5% of the time in 1984-1985 and 57.8% in 1985-1986. Pecking constituted 33% of observations in 1985-86 and 25.7% in 1984-85. Analysis of stomach contents showed they were feeding primarily on wood-boring beetle larvae (Cerambycidae) which are best extracted from sapwood by excavating. Authors did not observe a secondary outbreak of egg-laying by wood-boring beetles when adults from 1983 cohort emerged in 1985 and 1986. BBWO almost always foraged on portions of fire-damaged spruces where the bark was charred and closely matched their sooty-black dorsal plumage. Abundance of cerambycid eggs was initially low on heavily scorched spruces and larval survival was poor as a consequence of rapid sapwood desiccation. BBWO were observed less frequently in the interior of the burn where the spruces were killed immediately and severely scorched by the fire, likely because larval survival was low due to rapid desiccation of sapwood. Authors surmised BBWO was highly specialized in its foraging ecology and diet.

Kreisel, K. J. and S. J. Stein. 1999. Bird use of burned and unburned coniferous forests during winter. Wilson Bulletin 111:243–250.

Location: Kettle River Range, Northeastern Washington

Focus: Foraging Habitat, Burned

Synopsis: BBWO in burned forests foraged upon standing dead trees 99% of the time and 1% of the time on logs during winter. Study done over 4 winters following fire; BBWO were located all 4 years. Foraged primarily on western larch and Douglas-fir and foraged on middle and lower trunks of trees. For all woodpecker species, trees >23 cm dbh were used significantly more than the proportion available (84% used versus 36% available).

Powell, H. D. W. 2000. The influence of prey density on post-fire habitat use of the black-backed woodpecker. M.S. Thesis, University of Montana.

Location: Idaho and Montana

Focus: Prey Type, Foraging Habitat, Burned

Synopsis: BBWO in two fire sites fed upon large insects, likley wood-borers, in excess of their availability. Mean tree size of foraging trees was significantly larger than random trees (44.4 $\pm$ 1.66 cm versus 21.9 $\pm$ 0.91 cm at site 1 and 30.9 $\pm$ 1.68 cm versus 20.8 $\pm$ 0.62 cm at site 2) and 98% and 97% of foraging incidents were on snags. BBWO foraged in patches with higher-than-average densitites of large (>30 cm) snags only at one site. Prey density on fed-upon trees differed from random only at one site, where tree species varied in prey density; the other site contained one tree species that was consistently prey-rich. In other words, BBWO selected the tree species with higher prey densities in the site where prey densities differed from random. BBWO did not consistently occupy prey-rich patches within the fire; measuring prey density at the individual tree level is appropriate.

Nappi, A., P. Drapeau, J. Giroux, and J. L. Savard. 2003. Snag use by foraging black-backed woodpeckers (*Picoides arcticus*) in a recently burned eastern boreal forest. Auk 120:505–511.

Location: Quebec, Canada

Focus: Foraging Habitat, Burned

Synopsis: Studied BBWO 1 year after a fire in eastern black spruce boreal forest. Plots were in unlogged portions of the fire. Crown condition and dbh were significant predictors of snag use for foraging. Probability that a snag was used increased with a higher dbh and a lower deterioration value. Model predicted use of high-quality snags during 20 of 26 foraging observations. Snags of high predicted quality contained higher densities (mean per snag) of larval entrance holes, larval emergence holes, and foraging excavations of woodpeckers than snags of low predicted quality. Among snags of high predicted quality, entrance hole density was significantly higher for the 1-3 m section than for the 0-1 m section, whereas among snags of low predicted quality, entrance hole density was significantly higher in the 0-1 m and the 1-3 m sections. Results show that selection of larger and less deteriorated snags is linked to higher availability of insect prey. Found that larger snags had higher densities of wood-boring beetle larva entrance holes than smaller snags. Also found that for the same dbh a less-deteriorated snag had a higher probability of use than did a more deteriorated one. Deterioration of snags in post-fire forests may reflect either mortality prior to fire or mortality as a consequence of fire. Snag deterioration combined with dbh influenced density of wood-boring beetle larvae. BBWO avoided more degraded snags (prefire or severely burned postfire snags) in which wood-borers probably oviposited less and where larvae were more susceptible to desiccation.

Hanson, C. T. 2007. Post-fire management of snag forest habitat in the Sierra Nevada. PhD Dissertation. University of California, Davis.

Location: Sierra Nevada, California

Focus: Foraging Habitat, Burned

Synopsis: BBWO foraged more on large snags (>50 cm) than would be expected based on availability. All four of the instances where BBWO were located in the 25-49 cm dbh size class, the birds foraged on snags 40-49 cm dbh. Thus, BBWO may be selecting snags at least 40 cm dbh.

Hanson, C. T. and M. P. North. 2008. Postfire woodpecker foraging in salvage-logged and unlogged forests of the Sierra Nevada. Condor 110:777–782.

Location: Sierra Nevada, California

Focus: Foraging Habitat, Burned

Synopsis: Investigated whether current management prescriptions for salvage logging, involving removal of all but 7.5-15 large (>50 cm) snags/hectare in severely burned forest could reduce foraging habitat quality on three fires throughout the Sierra Nevada. Surveyed for BBWO using point counts in unburned (*n* = 9), moderate-severity/unlogged (*n* = 8), high-severity/unlogged (*n* = 10), and high-severity/logged (*n* = 9) plots, including only patches > 12 ha with one burn category. Density of medium-sized snags (25-49 cm) was greatest in high-severity/logged and high-severity/unlogged plots, and density of large (>50 cm) snags was greatest in high-severity/unlogged and lowest in high-severity/unlogged plots and unburned plots. Some additional snags beyond the minimum retention levels were deemed unmerchantable and retained. The BBWO foraged exclusively in high-severity/unlogged patches. Although passive point counts may not be adequate for detecting BBWO in unburned forests (sensu Siegel et al. 2008), because the stands surveyed in Hanson and North were all heavily burned it is likely that detectability was similar between all burned plots. Of all foraging observations, 97% occurred on snags as opposed to live trees.

Occupancy

Hutto, R. L. 1995. Composition of bird communities following stand-replacement fires in Northern Rocky Mountain (U.S.A.) conifer forests. Conservation Biology 9:1041–1058.

Location: Western Montana and Northern Wyoming

Focus: Occupancy, Burned and Unburned

Synopsis: BBWO were detected at 11 of 33 burned forest sites (33%). In a review of studies, 78% found BBWO in early burned forest and 12% found BBWO in three other cover types. While BBWO were detected on rare occasions in other cover types, often there was either a burned forest nearby or a prior burning treatment on their plot. Found records of BBWO in unburned forests in Idaho and Montana, but based on comprehensive literature review and field experience, these appear to be the exception rather than the rule. Best correlate for abundance of BBWO is number of small trees, and abundance positively correlated to burn size.

Setterington, M. A., I. D. Thompson, and W. A. Montevecchi. 2000. Woodpecker abundance and habitat use in mature balsam fir forests in Newfoundland. Journal of Wildlife Management 64:335–345.

Location: Newfoundland, Canada

Focus: Occupancy, Unburned

Synopsis: Presence of BBWO in unburned balsam fir forests in Newfoundland was positively associated with density of snags >20 cm and negatively to the total number of dead stems. Successfully predicted presence/absence of BBWO 72% of the time. Significantly more BBWO in 80-year old forest than younger age classes.

Hoyt, J. S. and S. J. Hannon. 2002. Habitat associations of black-backed and three-toed woodpeckers in the boreal forest of Alberta. Canadian Journal of Forest Research 32:1881–1888.

Location: Alberta, Canada

Focus: Occupancy, Burned and Unburned

Synopsis: Compared BBWO occupancy of recently burned, mature, and old-growth conifer dominated stands and determined how long after a fire the forest remained suitable habitat for BBWO. Sampled occupancy in 191 conifer-dominated stands in northeastern boreal forest using call broadcasts. Found 24 detections in burned forest, 8 detections in unburned forests >50 km from burns, and none in stands within 50 km from burn. In burn, BBWO more likely to be present in stands with a lower density of deciduous trees and a larger mean dbh. BBWO equally likely to be detected in 3, 4, and 8 year old burns but were not detected in 16 and 17 year old burns. Most likely to be found in 3 to 8 year old burns with a high density of downed trees. Occupied stands had a mean density of downed trees 2634.2/ha (95% CI = 1942.2-3326.3/ha) and BBWO were absent from stands where the mean density of downed trees was 1869.1/ha (95% CI = 1513.6-2224.6/ha). There may be a possible effect of distance from recent burn on BBWO occupancy of unburned old-growth forests especially old black spruce stands. Authors hypothesize that thick bark of jack pine (presence of jack pine may have contributed to prolonged occupancy compared with Murphy and Lehnhausen with >90% spruce) makes them more fire resistant than spruce, and their thick bark promotes moisture retention when dead, prolonging their suitability to wood-boring insect larvae.

Smucker, K. M., R. L. Hutto, and B. M. Steele. 2005. Changes in bird abundance after wildfire: Importance of fire severity and time since fire. Ecological Applications 15:1535–1549.

Location: West-central Montana

Focus: Occupancy, Burned and Unburned

Synopsis: Surveys existed for transects before fire, and were conducted for 3 years post-fire. BBWO was detected at burned points only.

Schwab, F. E., N. P. P. Simon, S. W. Stryde, and G. J. Forbes. 2006. Effects of postfire snag removal on breeding birds of Western Labrador. Journal of Wildlife Management 70:164–1469.

Location: Western Labrador, Canada

Focus: Occupancy, Burned (Salvage Logging)

Synopsis: Investigated effects of 3 intensities of snag removal to guide salvage logging in snag forests. Created 2.5-ha openings within 10-ha plots. BBWO were absent on the 25% and 100% snag-removal plots and had a reduced presence on the 50% snag-removal plots compared to control plots. The negative influence of the removal extends beyond the area cut, and the opening-size threshold to maintain numbers is <2.5 ha.

Hutto, R. L. 2008. The ecological importance of severe wildfires: Some like it hot. Ecological Applications 18:1827–1834.

Location: Northern Idaho and Montana

Focus: Occupancy, Burned and Unburned

Synopsis: Analysis of 48,155 point count conducted in 20 different vegetation types in the USFS Northern Region Landbird Monitoring Program from 1994-2007. Points were >250 m from any other points and distributed along 10-point transects that were distributed in a geographically stratified manner across the region. Used only single visits to a given point using data from the first year a point was visited, resulting in 13,337 independent sample points. Samples within postfire vegetation were collected from an additional 3,128 points distributed along 50 different recently burned (1-4 years post-fire) forests. Concluded BBWO is an "extreme habitat specialist that is relatively restricted to burned forest conditions." BBWO 16 times more likely to be found in burned forest than in the next more commonly occupied vegetation type. BBWO also relatively restricted to severely burned end of the fire severity spectrum. Probability of detecting BBWO decreased with intensity of recent pre-fire and recent post-fire logging.

Russell, R. E., J. A. Royle, V. A. Saab, J. F. Lehmkuhl, W. M. Block and J. R. Sauer. 2009. Modeling the effects of environmental disturbance on wildlife communities: avian responses to prescribed fire. Ecological Applications 19:1253–1263.

Location: Eastern Washington

Focus: Occupancy, Burned (Prescribed Fire)

Synopsis: Prescribed fire increased occupancy rates of BBWO.

Cahall, R. E. and J. P. Hayes. 2009. Influences of postfire salvage logging on forest birds in the Eastern Cascades, Oregon, USA. Forest Ecology and Management 257:1119–1128.

Location: Central Oregon

Focus: Occupancy, Burned (Salvage Logging)

Synopsis: Densities of BBWO were greater in the unsalvaged treatment than the salvaged, and did not differ between salvage intensities. Greater abundance of BBWO in unsalvaged treatmetns even though they have larger territories than the study stands suggest small patches of unlogged forest can positively influence abundance.

Saracco, J. F., R. B. Siegel, and R. L. Wilkerson. 2011. Occupancy modeling of black-backed woodpeckers on burned Sierra Nevada forests. Ecosphere 2:1–17.

Location: Sierra Nevada, California

Focus: Occupancy, Burned

Synopsis: Surveyed 51 fires throughout the Sierra Nevada ranging from 1–10 years old. Overall mean occupancy probability in the average fire area was 0.097 (95% credible interval = 0.049–0.162) but the proportion of surveyed points occupied was higher (0.252, 95% credible interval = 0.219–0.299), indicating that most occurrences were clustered within a few sites or extreme covariate values. The probability of woodpeckers occurring in a given fire was greater in more recent fires and with increasing latitude and elevation.

Fogg, A., R. D. Burnett, and L. Jay Roberts. 2012. Occurrence patterns of Black-backed Woodpecker in unburned National Forest land in the Sierra Nevada. PRBO Conservation Science Contribution Number 1872.

Location: Sierra Nevada, California

Focus: Occupancy, Unburned

Synopsis: Used point counts and playbacks to document Black-backed Woodpecker observations between 2009 and 2011 from 498 point count transects on ten National Forest units in the Sierra Nevada National Forest planning region. When transects with distance to burned areas were included as a covariate, occupancy was positively associated with transects less than 2 km and greater than 6 km from recent burns. Overall transect occupancy in unburned forest for the broad definition was 0.22 and point-level occupancy was 0.11. This point-level value was nearly half of what was estimated for burned forest in the Sierra Nevada. Occupancy at unburned forest locations had a strong positive association with the residuals of latitude on elevation, while snag density and other covariates were not significant predictors. Black-backed woodpeckers showed evidence of preference for red fir (*Abies magnifica*) and lodgepole pine (*Pinus contorta*) forest, used white fir, Jeffrey, and eastside pine in proportion to availability, and avoided Sierra mixed conifer and Ponderosa pine forest.

Home-Range Size

Goggans, R., R. D. Dixon, and L. C. Seminara. 1989. Habitat use by three-toed and black-backed woodpeckers, Deschutes National Forest, Oregon. Oregon Department of Fish and Wildlife Nongame Program.

Location: Central Oregon

Focus: Home-range Size, Beetle-killed

Synopsis: Median home-range size for 3 individual BBWO was 124 ha (range = 72–328 ha) in beetle-killed forests; the largest home ranges had the smallest proportions of unlogged and mature/overmature habitats, although samples were small.

Dudley, J. G. and V. A. Saab. 2007. Home range size of black-backed woodpeckers in burned forests of Southwestern Idaho. Western North American Naturalist 67:593–600.

Location: Western Idaho

Focus: Home-range Size, Burned

Synopsis: Average home-range size of 2 males in 6-year-old post-fire forests, and 2 males in 8-year-old post-fire forests in Idaho was 322 ha (range = 123.5–573.4 ha) using 95% minimum convex polygon and 207 ha (range = 115.6–420.9 ha) using fixed-kernel estimates. Home-range estimates were up to 17 times larger than estimates inferred through nest densities in burned forests. Home-range sizes were significantly larger at 8 years post-fire than 6 years post-fire, suggesting that BBWO had to expand their home ranges as time progressed after fire to meet foraging requirements. They may have moved greater distances to find food. All males moved to adjacent unburned areas, suggesting that older burned forests (6-8 years) may have been less suitable as foraging habitat than recently burned forests. One male had a home range 2-3 times larger than other males. He was often located at distances >1.4 km into the adjacent unburned forest where he foraged in stands with scattered dead and dying trees.

Tremblay, J. A., J. Ibarzabal, C. Dussault, and J. L. Savard. 2009. Habitat requirements of breeding black-backed woodpeckers (*Picoides arcticus*) in managed, unburned boreal forests. Avian Conservation and Ecology 4:2–17.

Location: Quebec, Canada

Focus: Home-range Size, Unburned

Synopsis: Home-range sizes of 7 BBWO in unburned boreal forests averaged 151.5 ± 18.8 ha (range = 100.4–256.4 ha), with the home-range size of 358.8 ha for a female that made a non-successful breeding attempt.

Genetics

Pierson, J.C., F.W. Allendorf, V. Saab, P. Drapeau, and M.K. Schwartz. 2010. Do male and female black-backed woodpeckers respond differently to gaps in habitat? Evolutionary Applications 3:263–278.

Location: Range-wide

Focus: Genetics, Migration

Synopsis: Three genetic groups of BBWO were identified; a large, genetically continuous population that spans from the Rocky Mountains to Quebec, a small, isolated population in Black Hills, South Dakota, and a separate population in western portion of distribution (Oregon). Both males and females disperse but male-mediated gene flow is the main form of connectivity between the continuously distributed group and smaller populations that are separated by unforested habitat which is a barrier to movement by females.

Disease

Siegel, R. B., M. L. Bond, R. L. Wilkerson, B. C. Barr, C. Gardiner, and J. M. Kinsella. 2012. Lethal *Procyrnea* nematode infection in a Black-backed Woodpecker (*Picoides arcticus*) from California. Journal of Zoo and Wildlife Medicine 43:214-217.

Location: California

Focus: Disease

Synopsis: A focal bird that died during a telemetry study in northern California was necropsied and its death was found likely to have been caused by numerous spiruroid nematodes of the genus *Procyrnea* in the gizzard. *Procyrnea* has been implicated in substantial die-offs in other bird species, including woodpeckers.