Chapter 3

Using Bird Ecology to Learn About the Benefits of Severe Fire

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3.1   INTRODUCTION

In this chapter we do not provide an encyclopedic review of the more than 450 published papers that describe some kind of effect of fire on birds. In other words, we are not systematically proceeding through a litany of fire effects on birds of southeast pine forests, California chaparral, Australian eucalypt forests, South African fynbos, and so forth. Instead, we have chosen to highlight underappreciated principles or lessons that emerge from selected studies of birds in ecosystems born of, and maintained by, mixed- to high-severity fire. Those lessons show how important and misunderstood basic fire ecology is when it comes to managing fire-dependent forest lands and shrublands, and the lessons apply to all fire-dependent ecosystems that have historically experienced severe fire—fires that are severe enough to stimulate an ecological succession of plant communities (as described in Chapter 1). We also focus our attention primarily on conifer forest ecosystems of the western United States because they undergo an amazing transformation following severe fire and because studies of these systems clearly reveal how birds evolved with, and now require, severe fire. Insight that emerges from the study of bird populations is overlooked in management circles worldwide. This is unfortunate because the insight one can gain by studying the ecology of individual bird species argues strongly that severe fire needs to be maintained in the landscape if we hope to maintain the integrity of most fire-dependent ecological systems.

Most studies of fire effects on birds are disappointingly "empty" because they are merely lists of birds that benefit from or are hurt by fire; they are not placed in the broader context of what a self-sustaining fire-dependent system looks like. To understand whether a particular change in abundance is "good" or "bad" requires insight into what ought to be, which requires an understanding of the patterns that occur under conditions that are as natural as possible for any

given vegetation system. That, in turn, requires replicated study of what we can expect to find after "natural" fire in any given system. Thus, a study of the effects of, say, prescribed understory fire on birds is meaningless without knowing what a "natural" fire in that system would ordinarily produce. Many studies might show that bird species A increases after a prescribed fire, but is that a good thing? If bird species B increases after postfire salvage logging, is that a good thing? If bird diversity is higher in one fire treatment versus another, is that a good thing? For studies of fire effects to be useful, we need to address questions that inform management by tapping into a solid understanding of what constitutes a "natural" response to fire, and that requires knowing something about the fire regime under which a given system evolved. Only through distribution patterns and adaptations of individual species (not through effects on bird guilds or on diversity and similar composite metrics) can we begin to understand which kind of fire regime necessarily gave rise to specific patterns of habitat use and to adaptations that have evolved over millennia. Birds are excellent messengers; they carry all the information we need to reconstruct the historical conditions under which they evolved. All we have to do is listen.

3.2 INSIGHTS FROM BIRD STUDIES

Lesson 1: The Effects of Fire Are Context Dependent; Species Respond Differently to Different Fire Severities and Other Postfire Vegetation Conditions

One extremely important lesson that has emerged from studies of the fire effects on birds is that a given effect depends entirely on the vegetation type, the kind of fire, and the time since the fire (Recher and Christensen, 1981; Woinarski and Recher, 1997). For years, individual bird species have been labeled as "positive responders" or "negative responders" or "mixed responders" when, in fact, any species can be all of the above. The actual response of a bird species (or of any species) to fire, then, is dependent on context. The earliest papers on fire effects rarely provided details about the nature of the fire being studied, so the first attempt to conduct a meta-analysis based on a compilation of published results of fire effects (Kotliar et al., 2002) necessarily generated a lot of "mixed" responses by birds because some papers said a species was positively affected and others said the same species was negatively affected by fire. The seeming disagreement among studies was, in most cases, a simple result of researchers looking at different postfire vegetation conditions and times since fire. It was not until Smucker et al. (2005) separated their data into categories of fire severity and time since the fire that responses began to look much more consistent among studies that share a particular vegetation type, fire type, and time since the fire. As soon as one accounts for these factors, it becomes clear that the responses of most bird species are quite consistent and that most bird species benefit from severe fire (as we will more fully discuss below).

Time Since Fire

Species that benefit from severe fire are not only those that flourish during the first year or two following the disturbance event. The same can be said for species that are restricted to years 2-4, years 5-10, or even years 50-100 following severe fire. In fact, *most* plant and animal species are present only during a limited time period following a disturbance. Therefore, *most* plant and animal species in disturbance-based systems depend on disturbance to periodically create the conditions they need. Many bird species that thrive after fire have been mislabeled as species hurt by fire because studies of bird response to fire typically involve only a brief period of time soon after the fire. For example, although Williamson's sapsucker (*Sphyrapicus thyroideus*) was labeled a "mixed responder" and brown creeper (*Certhia americana*) a "negative responder" in the meta-analysis by Kotliar et al. (2002), and the change in house wren (*Troglodytes aedon*) abundance was labeled "insignificant" in a recently published study by Seavy and Alexander (2014), each of these species typically reaches its peak abundance several years after a fire, as revealed in an 11-year postfire study conducted after the Black Mountain fire, which burned near Missoula, Montana, in 2003 (Figure 3.1). Thus, each species clearly benefits from severe fire when viewed in the proper (and perhaps very restricted) time frame after fire.

By extending the duration of a postfire study beyond the first few years after a fire, most bird species reveal a unimodal response to time since fire, and most benefit from fire; they reveal a greater probability of detection in the burned forest at some point during that postfire period than in the same forest before fire or in the surrounding unburned forest (Taylor and Barmore, 1980; Reilly, 1991a, 2000; Taylor et al., 1997; Hannon and Drapeau, 2005; Saab et al., 2007; Chalmandrier et al., 2013; Hutto, 2015). These results force one to appreciate that if for a period of time after a fire conditions remain better than they are in very old plant communities near the end of the late seral stage of succession, then disturbance is periodically necessary to create the conditions needed by that species. Thus a species being "hurt" in the short term by fire is not evidence that fire is somehow "bad" for that species and that it would have been better off without fire. In fact, once a system is beyond the ideal postdisturbance time period for a species, the only way to periodically "restore" conditions needed by that species is to disturb the system with another severe fire and then wait for the appropriate time period following disturbance again. The lesson is this: one cannot assess the effects of fire on any plant or animal species without examining whether the species is restricted to a period of time preceding the oldest possible vegetation condition.

A necessary consequence of different species occurring at different points in time following fire (in association with changes in vegetation type and structure) is that we must embrace natural severe disturbance processes because they create starting points for the development of the full range of vegetation-age
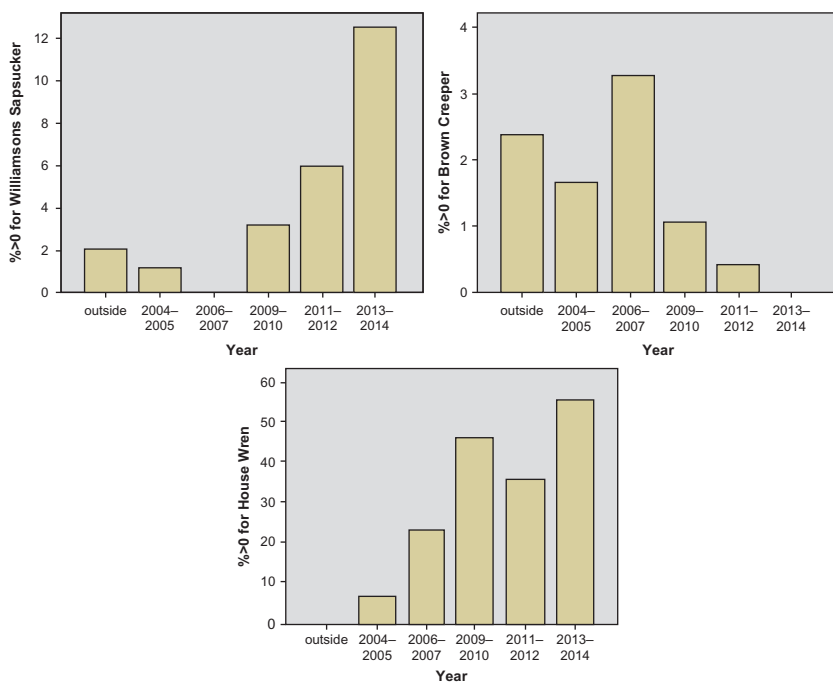
FIGURE 3.1 The probabilities of occurrence of Williamson's sapsucker, brown creeper, and house wren were significantly greater several years after the 2003 Black Mountain fire than they were either before the fire (as determined from survey data "outside" the burn perimeter in unburned, mixed-conifer forest of the same type) or during the first 2 years following the fire (R.L. Hutto, unpublished data; sample sizes exceed 150 point counts for each time period; $P < 0.05$, log linear analyses). Therefore, the benefit of severe fire for some species cannot be detected without restricting data collection to within a specific time period after the fire event.

categories, which, in turn, are needed for the maintenance of biological diversity (in particular beta diversity, the turnover in species number across gradients). Moreover, mixed-severity fires (which can result only from high-severity fire events) help provide a variety of kinds of starting points, which, in turn, also help maintain biological diversity (Smucker et al., 2005; Haney et al., 2008; Rush et al., 2012; Sitters et al., 2014; see also Chapters 4-6).

Old Growth

As already emphasized, most bird species clearly depend on severe fire to reset the clock, which stimulates development of the particular postdisturbance "age" to which they are best adapted. Still, many bird species are restricted in their habitat distribution to an end-of-the-line successional stage—they are dependent on old growth. There are also ecosystems (e.g., eucalyptus forests, chaparral) where severe fire is natural but where there are few, if any, early

FIGURE 3.2 Resprouting eucalyptus trees following a severe fire that burned through the area only months earlier. *(Photograph by Richard Hutto, taken in November 1999 near −34.284030°S, 150.725373°E in the tablelands above Wollongong, New South Wales, Australia.)*

fire-dependent bird species because many of the dominant plant species resprout, yielding a plant community structure and composition that "recovers" rapidly after fire (Figure 3.2). In these instances most bird species are associated with "mature" forms of those plant communities and would appear to do well if there were no fire at all (e.g., Taylor et al., 2012).

In all vegetation types that undergo plant succession following mixed- to high-severity fire, there will always be some bird species that depend on long-unburned vegetation. Therefore, discovering that those species are absent in the short term or "hurt" by fire is not unexpected, nor is it a necessarily a problem that needs to be addressed. The fact that fire temporarily removes large parts of a landscape from the pool of suitable conditions for those species is not a problem because the loss of suitable conditions is temporary, and there are usually nearby "refuges" of suitable conditions in places that have not burned for a long time (Bain et al., 2008; Leonard et al., 2014; Robinson et al., 2014; Winchell and Doherty, 2014). Natural systems exist as an ever-changing mosaic of different postfire ages—all vegetation ages are present at some point in space all the time. A significant problem emerges only when humans remove or degrade so much of the older vegetation through timber harvesting or land conversion that there is now a perceived risk of fire to those species that depend on older vegetation stands that are too few and far between. Understand clearly, however, that the absence of late-succession forest refuges is a problem that stems from excessive logging or development, not from the presence of fire per se.

Now that we are down to the last remaining old-growth forest remnants in California and Oregon, some believe that we should thin the forests around those remnants to protect them from fire. The effect of altering mature forest surrounding the last remaining old-growth remnants on the remnants themselves is, however, unknown. Moreover, as has been discussed in reference

to eucalyptus forest systems, many old-growth forest patches are old precisely because they are situated in places that are relatively immune to severe fire (Bowman, 2000); the same is undoubtedly true of many old-growth mixed-conifer forest patches. Unburned forest patches surrounding unburned, old-growth forest patches also have been suggested to be important as dispersal corridors across which old-growth species may recolonize recently burned areas as succession proceeds toward later stages (Pyke et al., 1995; Robinson et al., 2014; Seidl et al., 2014). Therefore, proposals to thin the forest around remaining old-growth stands may be well intentioned but reflect a lack of appreciation for the resilience associated with plant communities born of, and maintained by, natural disturbance processes (a case in point is the spotted owl [*Strix occidentalis*]; see Box 3.1).

Postfire Vegetation Conditions

One must account not only for time since fire but also for fire severity and other forest conditions (e.g., vegetation composition and tree density) to adequately assess fire effects on animal species. Smucker et al. (2005) accounted for both time since fire and fire severity in an analysis of bird occurrence patterns following the Bitterroot fires of 2000 in Montana, and the results were profound.

BOX 3.1 Old-Growth Species and Severe Disturbance Events

There are a number of old-growth-dependent species in North American conifer forests, but severe fire may not pose anywhere near the threat to those species that one might suppose. Consider the spotted owl, one of the most iconic old-growth-dependent bird species in the Pacific Northwest, California, and Southwest (extending into northern Mexico). This federally listed threatened raptor typically nests, roosts, and forages in dense conifer and mixed-conifer-oak forests dominated by large (>50-cm diameter at breast height), older trees and peppered with big decadent snags and fallen logs. High levels of canopy cover (generally >60%) from overhead foliage is an important component of nesting and roosting stands; thus, spotted owls were long presumed to be seriously harmed where severe fire burned the forest canopy. Indeed, over the past several decades, most forest management efforts in the range of the spotted owl (a Forest Service management indicator species) has been driven by logging to prevent or reduce fire to "save" the owl, including the latest U.S. Fish & Wildlife Service recovery plans for the northern and Mexican spotted owls. Yet, the forests where the owl dwells have experienced mixed- and high-severity fire for millennia. So how do these birds actually respond when severe fire affects habitat within their home ranges?

Several studies have demonstrated that all three subspecies of spotted owl can survive and thrive (i.e., successfully reproduce) within territories that have experienced moderate- and high-severity fire (Bond et al., 2002; Jenness et al., 2004;

Continued

BOX 3.1 Old-Growth Species and Severe Disturbance Events—Cont'd

Roberts et al., 2011; Lee et al., 2012, 2013). Exceptionally high levels of severe fire in a nest stand can cause spotted owls to abandon that territory (Lee et al., 2013), but only a small fraction of sites ever exceed that threshold in any given fire. Moreover, a higher probability of abandonment after fire was documented only in a small geographical region where prefire forest patches were limited or isolated (Lee et al., 2013) and in areas that were logged after fire (Lee et al., 2012; Clark et al., 2013); reduced occupancy did not occur in unlogged areas where prefire forest cover was more abundant (Lee et al., 2012, 2013). For example, the year after the 2013 Rim Fire—one of the largest fires to occur in California within the past century—at least six pairs of California spotted owls (*S. occidentalis occidentalis*) were detected in sites where >70% of the "suitable habitat" around their nest stands burned at high severity. (At one occupied site severe fire burned 96% of the habitat!) Why do they stick around in burned territory? One study found California spotted owls selectively hunted (mostly for woodrats and gophers) in stands recently burned by severe fire when those burned forests were available to them and relatively near the nest or roost stand (Bond et al., 2009, 2013). Another study showed that during winter, Mexican spotted owls (*S. occidentalis lucida*) moved up to 14 km into burned forests where prey biomass was 2-6 times greater than in their breeding-season nesting areas (Ganey et al., 2014). Spotted owls are perch-and-pounce predators, so it is not surprising that they avoided foraging in areas that were logged after fire, as there were no longer any perch trees (Bond et al., 2009), nor is it surprising that postfire logging reduced site occupancy and survival rates (Clark et al., 2013; Lee et al., 2013). In these studies, spotted owls still preferred to nest and roost in green forests, underscoring the importance of unburned/low-severity refuges within the larger landscape mosaic of mixed-severity fire. Still, the point is that where severe fire is natural, even old-growth species can partake of its bounty. The spotted owl, too, is sending a message here: A natural fire regime provides a bedroom, nursery, and kitchen for even old-growth-dependent species, as long as the burned forest is left standing.

Despite this evidence, the U.S. Fish & Wildlife Service is now calling for aggressive, large-scale thinning in northern spotted owl habitat in dry forests as a means of reducing fire intensity (U.S. Fish and Wildlife Service, 2011). This "recovery" objective for the owl was developed over objections raised by scientists (Hanson et al., 2009, 2010) and professional societies such as The Wildlife Society and Society for Conservation Biology. Notably, Odion et al. (2014b) simulated changes in owl habitat over a four-decade period following fire and the kind of thinning proposed by federal land managers. The simulation study showed that thinning over large landscapes would remove 3.4-6.0 times more of their dense, late-successional habitat in the Klamath and dry Cascades, respectively, than forest fires would, even given a future increase in the amount of high-severity fire. Further, Baker (2015) documented that before extensive Euro-American settlement, mixed- and high-severity fires shaped dry forests in the Eastern Cascades of Oregon and provided important habitat for northern spotted owls there. These studies challenge the paradigm that severe fire is a serious threat to spotted owls, which evolved in landscapes shaped by such fire, and that extensive logging is needed to ameliorate this widely believed but overstated threat.
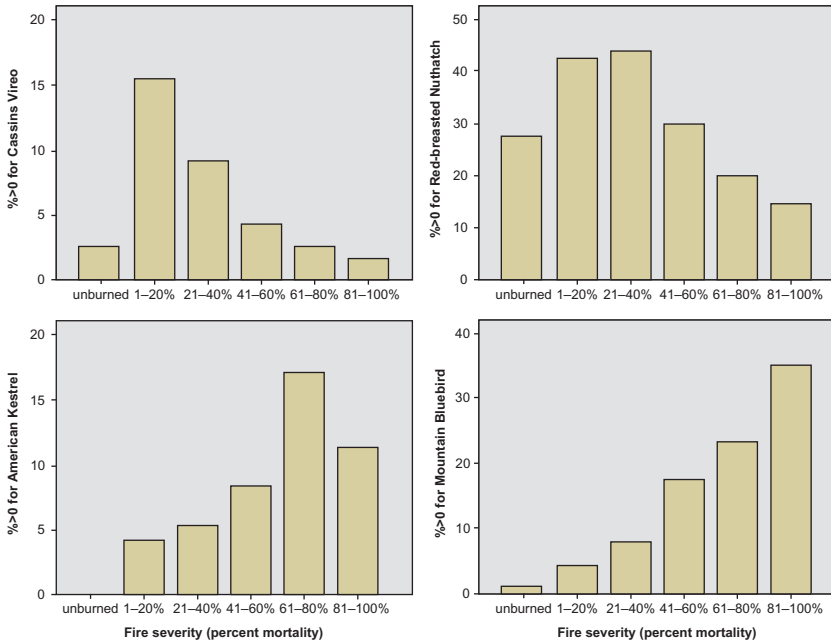
FIGURE 3.3 Example plots of the percentage occurrence of four mixed-conifer bird species in relation to fire severity in the first few years after fire. Data were drawn from 7043 survey points distributed across 110 different fires that burned since 1988 in western Montana. Sample sizes exceed 700 point counts per severity category. All patterns are significant ($P < 0.05$, log linear analyses). Note that each species is more abundant in burned than in unburned forest, and each is relatively abundant at a level of burn severity (percentage of tree mortality) that differs from that occupied by the other species. Scientific names for birds from top left clockwise to bottom right are: *Vireo cassinii, Sitta canadensis, Sialia currucoides, Falco sparverius.*

Once they accounted for fire severity alone, it became abundantly clear that many of the same bird species that had been labeled as "mixed responders" to fire by others (e.g., Kotliar et al., 2002) were not at all mixed in their response to fire. The importance of fire severity is strikingly apparent in even the simplest graphs of percentage occurrence across severity categories (Figure 3.3).

Lesson 2: Given the Appropriate Temporal and Vegetation Conditions, Most Bird Species Apparently Benefit from Severe Fire

After we combine information on the time since fire, fire severity, and perhaps one or two additional vegetation variables, most bird species apparently benefit from severe fire. For each species there is a particular combination of burned forest variables that creates ideal conditions for that species, as evidenced by an abundance that exceeds that in a long-unburned patch of the same vegetation type. Indeed, when Hutto and Patterson (2015) considered just two fire-context variables (time since fire and fire severity), they found 46 of 50 species to be

more abundant in some combination of those two variables than in long-unburned stands (Figure 3.4). Thus, not only are most species relatively abundant in one burned forest condition or another, but the average point in space and time occupied by each species is also species specific (Figure 3.5).

As an introduction to some of the fascinating biology surrounding severely burned forests, consider the following bird species. The black-backed woodpecker (*Picoides arcticus*), American three-toed woodpecker (*Picoides dorsalis*), hairy woodpecker (*Picoides villosus*), northern flicker (*Colaptes auratus*), and Lewis's woodpecker (*Melanerpes lewis*) are all more abundant in severely burned than unburned mixed-conifer forest (see patterns of habitat occurrence for four of the five species in Figures 3.11 and 3.12) because of an abundance of food (beetle larvae and ants) and potential nest sites associated with standing
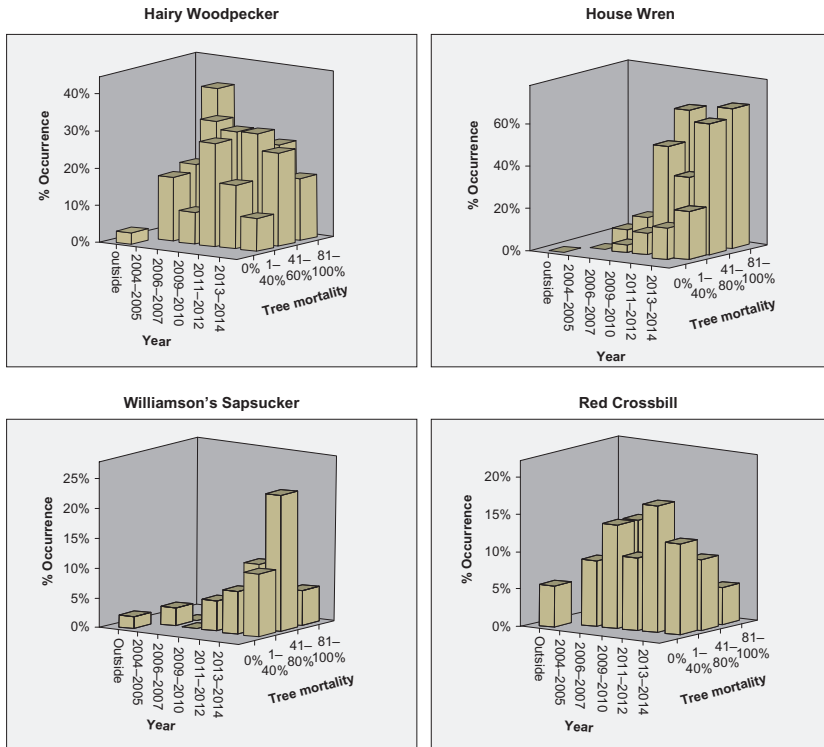
FIGURE 3.4 Example plots of percentage occurrence for various mixed-conifer bird species in relation to both time since fire and fire severity after the 2003 Black Mountain fire near Missoula, Montana (R.L. Hutto, unpublished; sample sizes exceed 35 point counts for each time-by-severity category; all patterns are significantly nonrandom as determined by log linear analyses [$P < 0.05$]). The examples were selected to illustrate that each species is more abundant in burned than in unburned forest (the occurrence rate in unburned forest shown in the first time period), and each is most abundant in a different combination of time since fire and burn severity (percentage of tree mortality).
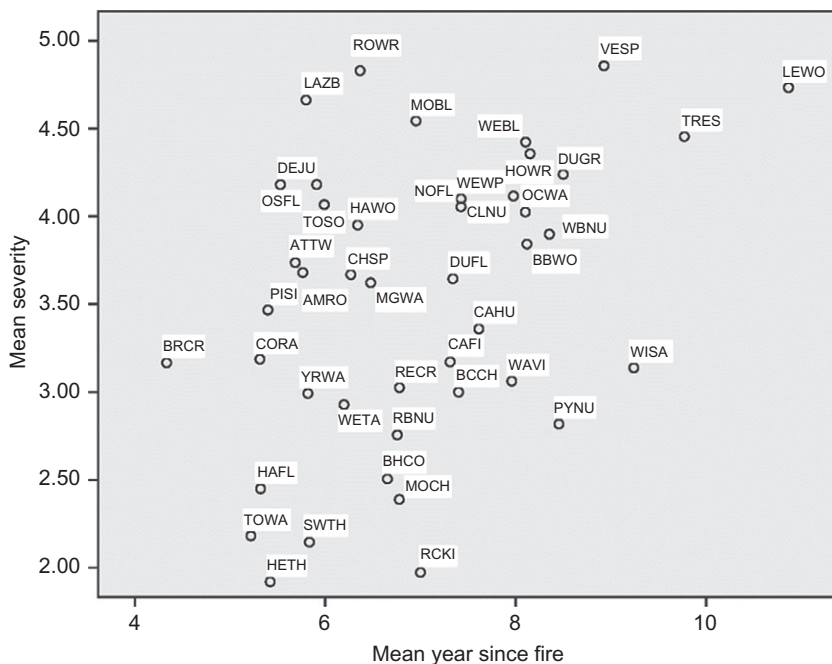
FIGURE 3.5 In combination, the mean time since fire and mean fire severity at points of occurrence for each of 46 (mnemonically coded) species differs from that of every other species. Mean values were calculated from the kind of data presented in Figure 3.4.

dead trees. The Williamson's sapsucker and olive-sided flycatcher (*Contopus cooperi*) find the abrupt edges between severely burned and unburned forest to be ideal nest locations (Figure 3.6). A host of secondary cavity-nesting and snag-nesting species (e.g., northern hawk owl [*Surnia ulula*], great gray owl [*Strix nebulosa*], mountain bluebird [*Sialia currucoides*], western bluebird [*Sialia mexicana*], house wren, and tree swallow [*Tachycineta bicolor*]) benefit from new forest openings, where they find a mature-forest legacy of already existing broken-top snags (Figure 3.7), where a disproportionately large number of nest sites are located (Hutto, 1995). These species depend on the kinds of snags that become common only after a forest reaches the mature- to old-growth stage and then burns in a severe fire. A variety of species (e.g., flammulated owl [*Psiloscops flammeolus*], mountain bluebird, Townsend's solitaire [*Myadestes townsendi*], and dark-eyed junco [*Junco hyemalis*]) make use of the cavities created by burned-out root wads or uprooted trees that happen to blow down in the first few years after severe fire (Figure 3.8). Many species (e.g., Clark's nutcracker [*Nucifraga columbiana*], Cassin's finch [*Haemorhous cassinii*], red crossbill (*Loxia curvirostra*), and pine siskin [*Spinus pinus*]) take advantage of seeds that are released or made available in cones that open after severe fire

FIGURE 3.6 Williamson's sapsucker (left) and olive-sided flycatcher (right) are known to nest disproportionately often near the abrupt edges between severely burned and unburned forest. *(Photographs by Richard Hutto (left) and Bruce Robertson (right)).*

FIGURE 3.7 Compared with burned trees with intact tops, broken-top snags that were already snags before the fire burned are used disproportionately more often as nest sites by cavity-nesting bird species. The black-backed woodpecker also roosts almost entirely in burned-out hollows, forked trunks, or other relatively unusual structures that create crevices in "deformed" snags that existed before the forest burned (Siegel et al., 2014). Pictured (left to right) are a young hairy woodpecker in its nest cavity, an American robin (*Turdus migratorius*) nest, and a northern flicker nest. The implications are profound—old-growth elements (snags) are really important to birds that depend on burned forest conditions, so burned, old-growth forests are as valuable to wildlife as unburned old-growth forests. *(Photographs by Richard Hutto.)*

FIGURE 3.8 The architecture of a burned forest becomes modified after trees begin to blow down in the first few years after a fire, and a number of bird species make use of the root wads as nest sites. A Townsend's solitaire nest is highlighted here. *(Photograph by Richard Hutto.)*

FIGURE 3.9 Few people seem to realize how important Clark's nutcrackers are as seed dispersers after severe fire in ponderosa pine forests. Pictured here are examples of a nutcracker extracting seeds from a ponderosa pine (*Pinus ponderosa*) cone that opened after fire (left) and a nutcracker with a throat pouch full of seeds in the scorched ground beneath a ponderosa pine canopy. *(Photographs by Richard Hutto.)*

(Figure 3.9). Still more bird species (e.g., calliope hummingbird [*Selasphorus calliope*], lazuli bunting [*Passerina amoena*], and MacGillivray's warbler [*Geothlypis tolmiei*]) use the shrub-dominated early seral stage for feeding and nesting and as display sites (Hutto, 2014).

Lesson 3: Not only Do Most Bird Species Benefit from Severe Fire, but Some also Appear to *Require* Severe Fire to Persist

The black-backed woodpecker has become an iconic indicator of severely burned forests because its distribution is nearly restricted to such conditions. Bent (1939) provided the first description of the unusual association between this woodpecker species and burned forests when he noted that Manly Hardy wrote to Major Bendire in 1895 about finding the woodpecker to be "... so abundant in fire-killed timber areas that I once shot the heads off six in a few minutes when short of material for a stew." This anecdote, reflecting the importance of severe fire, went largely unnoticed until the 1970s, when Dale Taylor undertook a study of birds in relation to time since fire in the Yellowstone and Grand Teton National Parks. His more systematic study uncovered the same remarkable pattern. Taylor was the first person to evaluate data drawn from a series of burned conifer forest stands of differing ages, and he found the appearance of the black-backed woodpecker to be restricted to the first few years after fire (Taylor and Barmore, 1980). A subsequent before-and-after fire study by Apfelbaum and Haney (1981) and studies of burned versus adjacent unburned forest by Niemi (1978), Pfister (1980), and Harris (1982) provided additional evidence that this bird species is strongly associated with burned forest conditions. Following the Rocky Mountain fires of 1988, Hutto (1995) conducted a more comprehensive study of the distribution of black-backed woodpeckers across a broad range of vegetation types. That study served to reinforce the notion that this species is an ideal indicator of severely burned mixed-conifer forest. More specifically, Hutto provided a meta-analysis of his own and already published bird survey data collected from burned forests and from more than a dozen unburned vegetation types; those data showed the black-backed woodpecker to be relatively restricted to burned forests. To address the potential problem of putting too much faith in distribution patterns derived from bird occurrence rates that were based on a variety of study durations and methods, Hutto subsequently coordinated the collection of standardized bird survey data from more than 18,000 points distributed across every major vegetation type in the U.S. Forest Service Northern Region. The results (Hutto, 2008) were strikingly similar to what earlier studies showed: one is hard pressed to find a black-backed woodpecker anywhere but in a recently burned forest (Figure 3.10).

Numerous studies (most published just in the past decade) provide additional detail that can help us better understand this remarkable association between the black-backed woodpecker and severely burned forests. Here we list some of the insights we have gained:

1. The magical appearance of woodpeckers within weeks of a fire (Blackford, 1955; Uxley, 2014) suggests that either smoke, or perhaps the fire or burned landscape itself, provides a stimulus for birds to colonize newly burned forests.
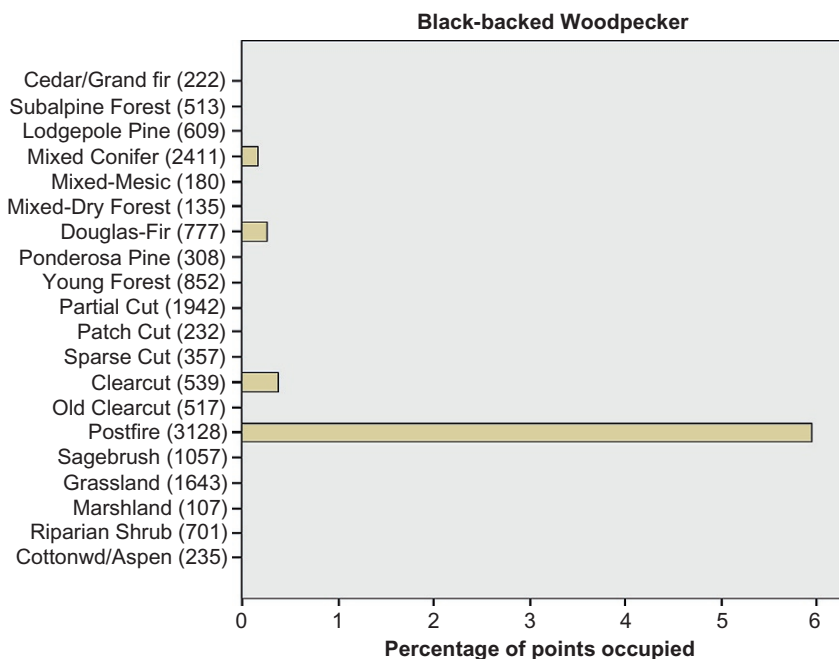
FIGURE 3.10 Histogram bars indicate the percentage of points (sample sizes in parentheses) at which the black-backed woodpecker was detected in each of 21 distinct vegetation types within northern Idaho and western Montana. The distribution is nonrandom ($X^2 = 559.43$; $df = 19$; $P < 0.0001$) and reveals that the black-backed woodpecker is highly specialized in its use of burned conifer forest. *(Data from Hutto (2008))*.

2. Breeding and nest densities increase more rapidly than expected on the basis of recruitment alone (Yunick, 1985; Youngman and Gayk, 2011), which suggests that the process of immigration after fire is significant.
3. Woodpecker diet, which is based mainly on wood-boring beetle larvae that feed almost exclusively on recently burned and killed trees (Murphy and Lehnhausen, 1998; Powell et al., 2002; Fayt et al., 2005), reflects the broad postfire change in animal community composition that accompanies severe fire.
4. The woodpecker's nonrandom use of forest patches containing dense, larger-diameter trees (Saab and Dudley, 1998; Saab et al., 2002, 2009; Nappi and Drapeau, 2011; Dudley et al., 2012; Seavy et al., 2012) that have burned at high rather than low severity (Schmiegelow et al., 2006; Koivula and Schmiegelow, 2007; Hanson and North, 2008; Hutto, 2008; Nappi and Drapeau, 2011; Youngman and Gayk, 2011; Siegel et al., 2013) is striking and consistent among studies.
5. The window of opportunity for occupancy by this species is not only soon after fire, but generally lasts only about a half-dozen years before the birds

(and the abundant native beetle populations) disappear (Taylor and Barmore, 1980; Apfelbaum and Haney, 1981; Murphy and Lehnhausen, 1998; Hoyt and Hannon, 2002; Saab et al., 2007; Nappi and Drapeau, 2009; Saracco et al., 2011).

6. The size of the home ranges of black-backed woodpeckers within burned forests are significantly smaller (indicating better quality habitat) than those outside burned forests (Rota et al., 2014b; Tingley et al., 2014). Even more telling is that nest success is significantly higher inside than outside burned forests (Nappi and Drapeau, 2009; Rota et al., 2014a).

7. Estimated population growth rates are insufficient to maintain a growing population outside burned forests (Rota et al., 2014a). Thus, although one could argue that low woodpecker densities in green-tree forests multiplied by a much larger unburned forest area might yield even more woodpeckers in green forests (Fogg et al., 2014), a sink area alone (no matter how large) can never yield a viable population of woodpeckers (Odion and Hanson, 2013).

8. The importance of severely burned forests as foraging locations for wintering black-backed woodpeckers is virtually unknown; the only detailed work so far (Kreisel and Stein, 1999) revealed densities that were an order of magnitude greater in burned than in unburned forests.

The biology surrounding this single bird species clearly reflects not only the ecological importance but also the necessity of severely burned forests, but major environmental organizations have yet to focus conservation efforts on burned forests (Schmiegelow et al., 2006), and management guidelines developed by state agencies to designate important wildlife habitats (e.g., https://www.dfg.ca.gov/biogeodata/cwhr/) do not even have burned conifer forests on their radar.

The distributional stronghold of the black-backed woodpecker might be considered to lie within the boreal forests of Canada, which nobody doubts are among the most severe-fire-dependent ecosystems in the world, but the bird's distribution south into the California Sierras and Rocky Mountains of the Intermountain West confirms that severe fires in those areas have been historically important as well. A North American forest bird species that is more narrowly restricted to a single forest condition does not exist; the black-backed woodpecker is the definition of a specialist. Everything about this bird species, including its distribution, territory size, breeding success, and even coloration pattern (which matches blackened trees), all indicate that this species needs expansive patches of severely burned forest to persist (Figure 3.11).

We have taken the liberty to provide extensive detail on this particular species because its ecological story carries significant management implications. Because public land managers have a responsibility to manage for the maintenance of all vertebrate species, finding even a single species that depends on severe fire should be enough to raise their awareness that severely burned
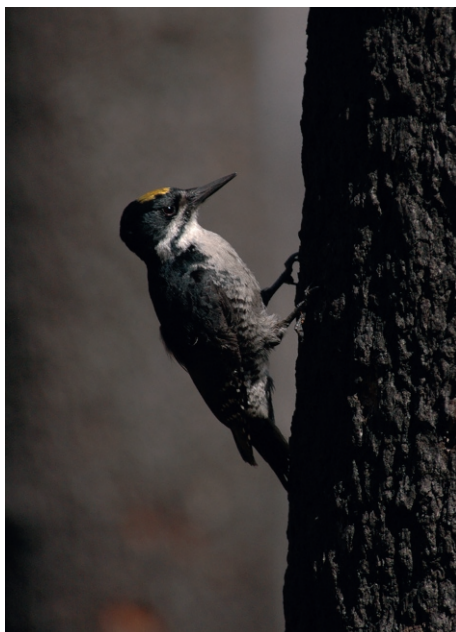
FIGURE 3.11   Black-backed woodpecker—a species that is relatively restricted in its distribution to severely burned forests. *(Photograph by Richard Hutto.)*

mixed-conifer forests provide necessary habitat as well. Thus the black-backed woodpecker is an ideal focal species for bringing attention to the fact that burned forest conditions are important to maintain in the landscape (DellaSala et al., 2014). The evolutionary history that has led to a strong association between burned forests and the woodpecker also raises questions about whether (as many assume) severe fires in mixed-conifer forests are really beyond the historical natural range of variation, whether we need to be thinning forests outside the wildland-urban interface to reduce fire severity, whether we need to be suppressing fire outside the wildland-urban interface, and whether we should "salvage" log trees (including important legacy trees; see Chapter 11) after fire. Yes, the story surrounding this focal species is important.

Bird Species in Other Regions That Seem to Require Severe Fire

Do any other bird species seem not only to benefit from but also to require severe fire to persist? The presence of a species in a specific environment and its absence elsewhere would be a clear indication that it depends on that particular environment. For species that occur across a range of environmental conditions, the places where they are relatively abundant are also likely to represent places that are required for population persistence because they persist in source areas and they are generally less abundant in, and their abundance is

more variable through time in, more marginal areas (Pulliam, 1988; Sergio and Newton, 2003). Although the same level of biological detail that has been amassed for the black-backed woodpecker has not been collected for most other fire-associated bird species, the habitat distribution patterns of numerous bird species reveal that they are nowhere more abundant than in recently burned forests. For example, Hutto (1995) listed 15 species that were more abundant in recently burned forests than in any of 14 other vegetation types. Graphs generated from surveys conducted across an even broader range of vegetation types show just how striking these habitat distribution patterns can be: numerous species are nowhere more abundant than they are in severely burned forests (Hutto and Young, 1999) (Figure 3.12).

Many mixed-conifer bird species (e.g., black-backed woodpecker, American three-toed woodpecker, hairy woodpecker, northern flicker, olive-sided flycatcher, western wood-pewee [*Contopus sordidulus*], dusky flycatcher [*Empidonax oberholseri*], mountain bluebird, Townsend's solitaire, house wren, tree swallow, lazuli bunting, Clark's nutcracker, red crossbill) fall consistently into a short-term "benefit" category, as revealed either by some measure of abundance or nest success in studies of burned versus unburned or before versus after fire (Bock and Lynch, 1970; Bock et al., 1978; Taylor and Barmore, 1980; Apfelbaum and Haney, 1981; Raphael et al., 1987; Hutto, 1995; Kotliar et al., 2002; Hannah and Hoyt, 2004; Smucker et al., 2005; Mendelsohn et al., 2008; Seavy and Alexander, 2014). Even severely burned patches within conifer forests that we have come to associate with low-severity fire can provide critically important habitat for species like the buff-breasted flycatcher [*Moucherolle beige*] (Kirkpatrick et al., 2006; Conway and Kirkpatrick, 2007; Hutto et al., 2008).

One of the most celebrated examples of a fire specialist involves the federally endangered Kirtland's warbler (*Setophaga kirtlandii*). It occurs almost exclusively in young (5- to 23-year-old) jack pine (*Pinus banksiana*) forest historically created by severe fire (Walkinshaw, 1983). In addition, pairing success is significantly higher in burned than in unburned forests (98% vs. 58% success; Probst and Hayes, 1987). The need for severe fire is obvious not only because, historically, it must have taken severe fires to stimulate forest succession but also because of how its critically endangered population increased dramatically after a fire accidentally escaped within its breeding range (James and McCulloch, 1995). Managers have had difficulty trying to recreate conditions that mimic natural postfire conditions through the use of logging techniques (Probst and Donnerwright, 2003; Spaulding and Rothstein, 2009), and efforts to use these artificial means to maintain warbler populations miss the point. Conservation efforts should be directed toward maintaining severely burned forests, not toward finding a way around the natural fire disturbance process.

In Australia, where few species are thought to be restricted to recently burned shrubland or forest conditions, early colonists are viewed as generalists, and management concerns are focused on postfire decreases in late-succession specialists (Serong and Lill, 2012). Nevertheless, recent data from Lindenmayer
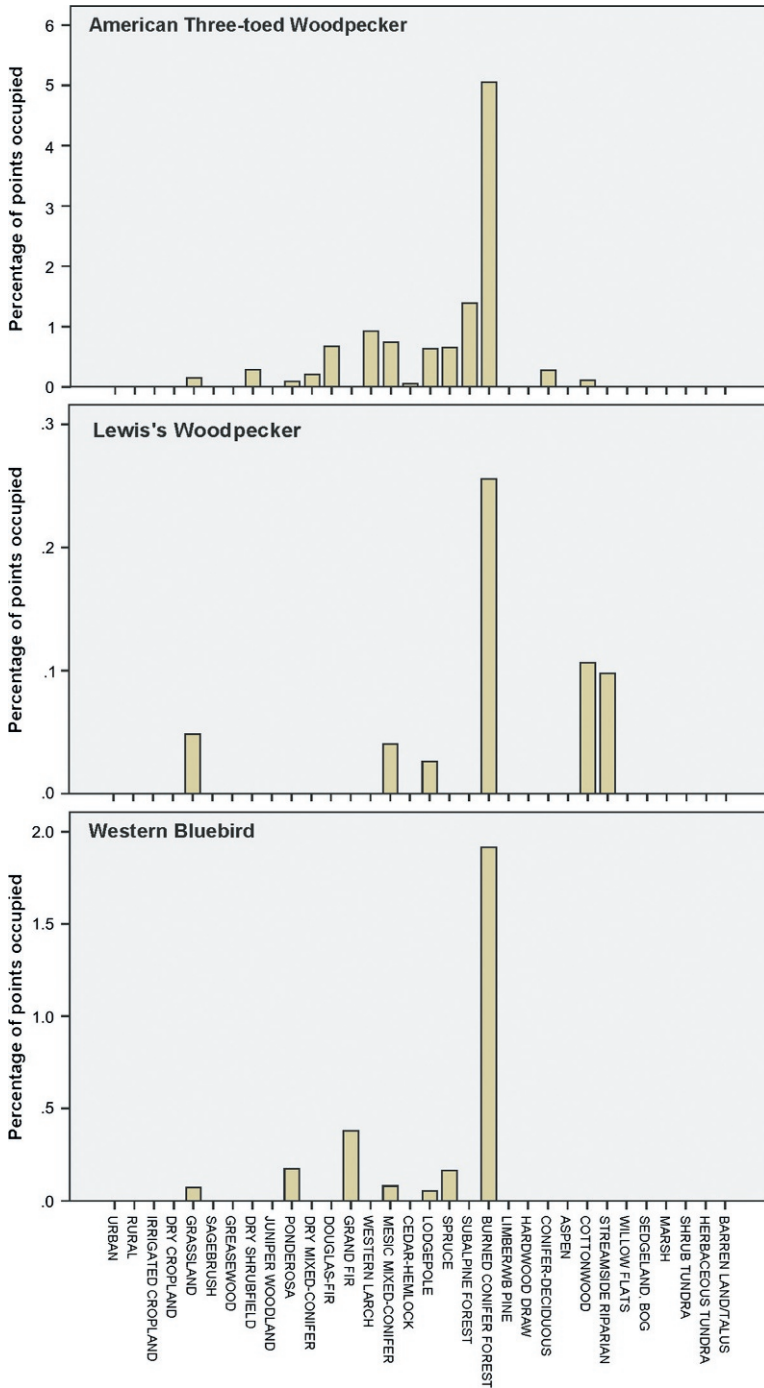
FIGURE 3.12 Several graphs depicting species that seem to be more abundant in burned forests than in any other vegetation type in the northern Rocky Mountains. Data were drawn from a subset of the Northern Region Landbird Monitoring Program database consisting of 20,000 survey points distributed across northern Idaho and western Montana.

et al. (2014) show that a number of bird species decline in abundance 1-2 years after moderate to severe fire but then return to levels comparable to, or *higher* than, those in unburned forests within 3 years following fire. Indeed, upon further inspection, we found that the superb fairywren (*Malurus cyaneus*), gray fantail (*Rhipidura albiscapa*), yellow-faced honeyeater (*Lichenostomus chrysops*), white-fronted honeyeater (*Purnella albifrons*), dusky robin (*Melanodryas vittata*), flame robin (*Petroica phoenicea*), willie wagtail (*Rhipidura leucophrys*), gray shrike-thrush (*Colluricincla harmonica*), varied sittella (*Daphoenositta chrysoptera*), apostlebird (*Struthidea cinerea*), white-browed scrubwren (*Sericornis frontalis*), brown thornbill (*Acanthiza pusilla*), spotted pardalote (*Pardalotus punctatus*), welcome swallow (*Hirundo neoxena*), dusky woodswallow (*Artamus cyanopterus*), black-faced woodswallow (*Artamus cinereus*), and silver-eye (*Zosterops lateralis*) each have been shown by one or more authors to be more abundant in severely burned than in long unburned, dry sclerophyll forests (Christensen and Kimber, 1975; McFarland, 1988; Reilly, 1991a,b, 2000; Turner, 1992; Taylor et al., 1997; Fisher, 2001; Leavesley et al., 2010; Recher and Davis, 2013; Lindenmayer et al., 2014). Thus many eucalyptus forest species also seem to require severe fire to create the early successional forest conditions within which they are most abundant, but most of those species are not restricted to conditions that occur during the first year or two after fire. In comparison with the dramatic change in bird species composition following severe fire in mixed-conifer forests, there is, in fact, a notable lack of turnover in bird species composition following severe fire in eucalyptus forests (compare before-and-after fire data from Australia and the western United States in Table 3.1). This difference in response to fire is presumably because eucalyptus trees resprout rapidly from epicormic shoots (Figure 3.2). Lindenmayer et al. (2014) also note that in montane ash forests, ". . . very rapid vegetation regeneration and canopy closure on severely burned sites . . . may limit the influx of open-country birds and preclude the evolutionary development of early successional species" (p. 474). Nevertheless, the bird species listed above suggest that many may depend on slightly later stages of succession before the development of a fully mature forest and that a slightly different perspective might be needed to expose the ecological importance of severe fire to birds of Australian eucalypt forests.

Taken together, we hope we have provided enough ecological information derived from birds to solidify the notion that severe fire in most severe-fire-dependent shrublands and forests is both natural and necessary for maintenance of the ecological integrity of such systems.

Postfire Management Implications

Severe fire is natural and necessary in most—not relatively few—conifer forest types and in many other vegetation types worldwide as well (see Chapters 1 and 2). Current management practices designed to prevent fire,

TABLE 3.1 Probabilities of the occurrence of bird species in burned and unburned Australian eucalypt forests in the tablelands above Wollongong, New South Wales, and in burned and unburned mixed-conifer forests in western Montana (R.L. Hutto, unpublished data). Numbers of survey points are given in parentheses. Birds are ordered by the unburned-to-burned ratio of abundance, and species that are completely absent from or are significantly (Mann-Whitney *U* tests) less abundant in the opposite condition are highlighted in yellow. In both locations are bird species restricted to either early or later successional stages, but the amount of species turnover (degree of replacement of late with early succession specialists) is less pronounced after severe fire in Australia than after severe fire in the western United States

Australian eucalyptus forest			Western North American mixed-conifer forest		
Species	*unburned (n = 39)*	*burned (n = 35)*	*Species*	*unburned (n = 1143)*	*burned (n = 638)*
New Holland Honeyeater	0.161	0	Townsend's Warbler	0.4	0.03
Little Wattlebird	0.095	0	Solitary Vireo	0.238	0.021
Scarlet Robin	0.019	0	Golden-crowned Kinglet	0.235	0.021
Yellow-faced Honeyeater	0.040	0.231	Gray Jay	0.084	0.009
Painted Button-Quail	0	0.035	Pileated Woodpecker	0.052	0.006
Grey Shrike-thrush	0	0.058	Swainson's Thrush	0.43	0.062
Olive-backed Oriole	0	0.131	Varied Thrush	0.103	0.015
			White-breasted Nuthatch	0.017	0.003
			Black-capped Chickadee	0.053	0.012
			Red-breasted Nuthatch	0.591	0.145
			Ruby-crowned Kinglet	0.316	0.086

			Hammond's Flycatcher	0.091	0.027
			Hermit Thrush	0.048	0.015
			Orange-crowned Warbler	0.098	0.036
			Western Tanager	0.398	0.163
			Mountain Chickadee	0.219	0.092
			MacGillivray's Warbler	0.201	0.095
			Yellow-rumped Warbler	0.521	0.249
			Warbling Vireo	0.145	0.098
			Clark's Nutcracker	0.022	0.047
			Pine Siskin	0.111	0.257
			Rufous Hummingbird	0.014	0.038
			Northern Flicker	0.076	0.21
			Calliope Hummingbird	0.01	0.03
			Song Sparrow	0.004	0.015
			Olive-sided flycatcher	0.025	0.107
			Rufous-sided Towhee	0.01	0.044
			Cassin's Finch	0.029	0.13
			American Kestrel	0.003	0.015
			Mourning Dove	0.004	0.021
			Hairy Woodpecker	0.021	0.124
			Three-toed Woodpecker	0.007	0.056
			Northern Waterthrush	0.003	0.033

Continued

TABLE 3.1 Probabilities of the occurrence of bird species in burned and unburned Australian eucalypt forests in the tablelands above Wollongong, New South Wales, and in burned and unburned mixed-conifer forests in western Montana (R.L. Hutto, unpublished data). Numbers of survey points are given in parentheses. Birds are ordered by the unburned-to-burned ratio of abundance, and species that are completely absent from or are significantly (Mann-Whitney *U* tests) less abundant in the opposite condition are highlighted in yellow. In both locations are bird species restricted to either early or later successional stages, but the amount of species turnover (degree of replacement of late with early succession specialists) is less pronounced after severe fire in Australia than after severe fire in the western United States—Cont'd

Australian eucalyptus forest			Western North American mixed-conifer forest		
Species	*unburned (n = 39)*	*burned (n = 35)*	*Species*	*unburned (n = 1143)*	*burned (n = 638)*
			Green-tailed Towhee	0.001	0.012
			White-crowned Sparrow	0.002	0.027
			Lazuli Bunting	0.01	0.148
			House Wren	0.004	0.086
			Western Wood-pewee	0.003	0.104
			Mountain Bluebird	0.004	0.281
			American Robin	0.185	0.441
			Lincoln's Sparrow	0	0.015
			Tree Swallow	0	0.089
			Rock Wren	0	0.044
			Black-backed Woodpecker	0	0.05

suppress fire, mitigate fire severity, "restore" or "rehabilitate" burned forests after fire, and mimic the effects of severe fire are incompatible with the maintenance of ecosystem integrity (Chapter 13). Below we use results from bird research as evidence to support this statement, and we offer positive suggestions about what land managers could be doing differently.

Fire Prevention Should Be Focused on Human Population Centers

The dependence of so many bird (and many other plant and animal) species on conditions created by severe fire is clear. It necessarily follows that we cannot prevent fire and still retain anything close to a natural world. The obvious alternative is to focus prevention efforts toward population centers that are most at risk from severe fire so that fire can be left to periodically restore forest conditions elsewhere. Smokey Bear needs to refine his message so that it reflects a desire to save human lives and property, *not* a desire to save trees from fire in our wildlands (see Chapter 13).

Fire Suppression Should Be Focused on the Wildland-Urban Interface (or Fireshed)

Because many species depend on severe fire, it also necessarily follows that we should focus suppression efforts on areas immediately adjacent to human settlements (see Chapter 13). Wildland firefighters should serve primarily as support for firefighters who defend homes and human lives. Efforts to suppress fire beyond settled areas should be viewed as little more than efforts to save the forest from itself—forests need fire in the same way that they need sunlight and rain.

High-Severity Fires Beget Mixed-Severity Results

In contrast with high-severity fire, low-severity understory fires cannot create as broad a range of postfire conditions as severe fires can, nor can they stimulate the postfire process of ecological succession like a severe fire can. Therefore, managing for the maintenance of biodiversity requires more conscientious management for the maintenance of severe fires and the mixed-severity landscape effects that result from such fires (Nappi et al., 2010; Taylor et al., 2012).

Mitigate Fire Severity Through Thinning only Where such Fuel Reduction Is Appropriate

Because many species depend on severe fire, it necessarily follows that we should focus forest-thinning efforts in the wildland-urban interface and perhaps beyond that in what are basically artificial tree plantations that have resulted from past timber harvesting (see Odion et al., 2014a for review of this topic). The distributions of black-backed woodpeckers and many other fire-dependent plant and animal species make it abundantly clear that a reduction in fire severity is ecologically justified in only a very small proportion of vegetation types (Odion et al., 2014a; Sherriff et al., 2014). The presence of numerous

fire-dependent species in most conifer forests throughout the American West (as illustrated by the abundance of bird research results considered in this chapter) is the strongest possible indication that the same forests have burned severely for millennia and are well within the historical range of natural variation.

The distribution of birds like the black-backed woodpecker and other fire-dependent plant and animal species, which blanket most of the forested land in the American West, are clearly at odds with claims (e.g., Haugo et al., 2015) that as much as 40% of public forested lands in parts of the United States are in need of restoration to prevent or mitigate the effects of severe fire. Lower-severity fires do not produce the mixed- and high-severity conditions needed by the most fire-dependent bird species, so efforts to mitigate fire severity in most places is incompatible with maintenance of the ecological integrity of most conifer forest systems (Odion et al., 2014a). So, what should we be doing differently? We could realize that modeled estimates indicating that our forests are in conditions that lie beyond the historical natural range of variation are just that—modeled estimates that rest strongly on many untested assumptions. We should always compare modeled results with insight gained by ecologists who can also draw strong inferences about historical conditions and, more specifically, about the kind of environments that necessarily led to adaptations of plants and animals—adaptations that reflect the distant past much more accurately than other methods commonly used to reconstruct natural fire regimes.

Postfire "Salvage" Logging in the Name of Restoration or Rehabilitation Is Always Inappropriate

Postfire "salvage" logging, seeding, planting, and shrub removal have overwhelmingly negative effects on natural systems (Lindenmayer et al., 2004; Lindenmayer and Noss, 2006; McIver and Starr, 2006; Swanson et al., 2011; DellaSala et al., 2014; Hanson, 2014), and birds have been instrumental in uncovering that fact. There is nothing as obvious to a birdwatcher as the negative effect of postfire salvage logging on the most fire-dependent birds (Uxley, 2014), and these anecdotal impressions are backed up by the strongest and most consistent scientific results ever published on any wildlife management issue (Hutto, 1995, 2006; Morissette et al., 2002; Nappi et al., 2004; Hutto and Gallo, 2006; Koivula and Schmiegelow, 2007; Hanson and North, 2008; Cahall and Hayes, 2009; Saab et al., 2009; Rost et al., 2013). One look at (Figure 3.13), or one walk through, a salvage-logged forest (also see Chapter 11) after knowing something about the biological wonder associated with a severely burned forest should be enough to convince any thinking person that there is no justification for this kind of land management activity.

It is bad enough that forests logged after fire are made unsuitable for black-backed woodpeckers and other early postfire specialists, but much worse is that postfire logging and shrub removal through mechanical or chemical means may also act as an "ecological trap" (Robertson and Hutto, 2006). This can occur

FIGURE 3.13   A vivid view of what can only be described as an ecological disaster following this postfire salvage logging operation, which took place after the 1988 Combination fire in Montana. *(Photograph by Richard Hutto.)*

when birds are attracted to burned areas that seem to be suitable and then those areas are suddenly transformed by logging or shrub removal into unsuitable habitat in an unnaturally rapid period of time. This is the most reasonable explanation for why black-backed woodpeckers are more abundant in dense, burned forests that are logged after fire than they are in burned forests that are logged before fire—birds are not attracted to the latter, where tree densities are too low and sizes are too small to provide suitable habitat, but they are attracted to the former before the trees are unexpectedly removed (Hutto, 2008). Similarly, the disproportionate use of recently logged, unburned, old-growth forests in Canada (Tremblay et al., 2009) suggests that black-backed woodpeckers sometimes make the best of a marginal situation, not that they "prefer" recently logged forests.

Although the ecological responses of birds to postfire salvage logging may differ among globally different ecosystems (Rost et al., 2012), there is absolutely no ecological justification for this kind of logging in the mixed-conifer forests of the western United States, nor is there an economic justification to salvage log after fire, because there are always better places to harvest timber without anywhere near the negative ecological consequences associated with postfire salvage logging. This is a matter of setting priorities for timber harvest, and burned forests should be at the bottom of the list. Burned forests not only provide unique ecological value, they also set the stage for the development of a variety of future forest conditions—conditions that are much more varied than those associated with development after artificial disturbance from logging. Forests have their own rules and timetables associated with the natural process of ecological succession, and we should embrace that variety and complexity. What could be done differently? Postfire rehabilitation should focus on roads, culverts, and other infrastructure issues, and nothing else. We need to recognize

that new forest conditions get created after fire, and a disturbance-dependent forest does not need to be "fixed" after disturbance takes place.

We Can Do more Harm Than Good Trying to "Mimic" Nature

Prescribed burning, forest thinning, and the use of other forms of artificial disturbance in an effort to mimic nature are often poor substitutes for natural disturbance processes. Prescribed burning is usually done out of season, too frequently, and in a manner that is far too mild to have the necessary effects in most systems that evolved with fire (England, 1995; Tucker and Robinson, 2003; Penman and Towerton, 2008; Peters and Sala, 2008; Arkle and Pilliod, 2010; Rota et al., 2014a). Thinning forests in a manner thought to mimic disturbance effects is also likely to be problematic because natural disturbance (the process of fire itself) produces effects that cannot be emulated through artificial means (Schieck and Song, 2006; Reidy et al., 2014). Moreover, a thinned forest that subsequently burns in a natural fire event will not be suitable as postfire habitat for early postfire specialists because of the reduction in tree densities and sizes (Hutto, 2008). Finally, the use of forest thinning in the name of forest restoration is inappropriately applied to relatively mesic mixed-conifer forests that are unlikely to be in need of restoration, as indicated by a lack of posttreatment change in bird communities toward what one would expect if the forests were actually outside the historical range of natural variation (Hutto et al., 2014).

Except in the case of an endangered species, the worst management approach is one that focuses narrowly on creating *artificial* conditions needed by a single species. This is "single-species management," which is not the same thing as using a "management indicator approach." Management indicators are not meant to be tools that enable land managers to artificially modify land conditions to benefit a single species. Instead, a management indicator species should be used as an indication of a particular kind of "natural" condition that needs to be maintained on the landscape and as a check that the land condition is indeed acceptable to a species that requires such conditions. Even for an endangered species, we should always be thinking about maintaining the "natural" conditions that historically maintained its population. Thus although artificial tree plantations may provide conditions used by Kirtland's warbler (Spaulding and Rothstein, 2009), the bird historically nested beneath the canopy of young trees born of fire. Therefore we should create conditions safe enough to allow natural severe fire events to unfold throughout most of its historical range. As clearly stated in the Endangered Species Act (ESA, Section 2), "the purposes of this act are to provide a means whereby the *ecosystems upon which endangered species and threatened species depend* may be conserved …" (our italics). Conservation should be about the larger system (e.g., maintaining a fire disturbance-based jack pine forest system), not about finding a way to maintain a species through artificial means. Thus the black-backed

woodpecker is an "indicator" or "focal species" that should be used to inform us about a critically important "natural" disturbance process and vegetation condition we need to maintain—severely burned forests and all the associated organisms that thrive within them.

What could we be doing differently? We need to trust that disturbance-dependent systems need severe disturbance (yes, that means a lot of tree death) to stimulate ecological succession in a manner that is indeed natural. We also need to appreciate that modeled *means and standard deviations* associated with measures of forest structure are not the same things as historical *ranges of variation* associated with the same measures. While some places have tree densities that exceed some estimated historical average value, it does not mean they fall outside the historical range of natural variation. Land managers need to relax in response to severe fire. As long as we can reduce the frequency of human-caused fires and remain safe during naturally ignited fire events, a management option that lets nature take its course will work just fine (Gill, 2001; Bradstock, 2008). In this context, noting that safety is best achieved through mechanical treatments in small areas immediately adjacent to structures (Cohen, 2000; Cohen and Stratton, 2008; Winter et al., 2009; Stockmann et al., 2010; Gibbons et al., 2012; Syphard et al., 2014), and not through mechanical treatments in more remote wildlands, is important. Given this fact, why treatments in relatively remote, publicly owned wildlands have become the tactic most commonly used to reduce wildfire risk is puzzling (Schoennagel et al., 2009).

Concluding Remarks

The most important ecological lessons we can take away from the bird research described in this chapter are that (1) many species have evolved to the point where they now require severe fire to create the conditions they need, and (2) even though some ecological systems may have departed significantly from what are believed to be historical conditions (e.g., tree plantations in the Pacific Northwest), birds are telling us (through their behavior and distribution patterns) that the vast majority of fire-dependent ecosystems are still well within the historical range of natural variation, are plenty "resilient," and are fully capable of proceeding quite naturally through the process of succession following a severe-fire event. Therefore, thinning forests in the name of restoration is largely unnecessary. If this were not true, the world would be full of places that experienced a severe fire disturbance and then underwent an unnatural transformation or "type conversion" following the disturbance event, never to return to what was there before disturbance. It is most telling that those kinds of places are rare indeed.

For those who would like to read, view, or hear more about the relationship between birds and severe fire, there are excellent children's books (e.g., Peluso, 2007; Collard, 2015); several informative videos, including a field trip that illustrated many of the patterns discussed here (listed in the Preface); and a

Fire Ecology Lab Facebook page (https://www.facebook.com/FireEcologyLab) devoted to building an appreciation for the role of severe fire in our forests.

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