Restoring High Priority Habitats for Birds: Aspen and Pine in the Interior West[1]

Rex Sallabanks,[2,3] Nils D. Christoffersen,[4] Whitney W. Weatherford,[5,6] and Ralph Anderson[5]

Abstract

This paper describes a long-term habitat restoration project in the Blue Mountains ecoregion, northeast Oregon, that we initiated in May 2000. We focused our restoration activities on two habitats previously identified as being high priority for birds: quaking aspen (*Populus tremuloides*) and ponderosa pine (*Pinus ponderosa*). In the interior West, these two habitats have become heavily degraded as a result of ungulate herbivory, fire exclusion, and logging associated with Euro-American settlement. To begin to restore these important habitats, we established 12 permanent study sites, initiated restoration treatments (fence building and conifer removal in aspen; prescribed burning in pine), and collected baseline ecological data (birds and habitat) to describe reference conditions. In two years (2000–2001), we built approximately 7 km of fence around existing aspen stands, burned 400 ha of pine, monitored 816 nests of 46 bird species, and intensively sampled vegetative characteristics at a variety of scales. In 2002, we added another 0.75 km of fence, built 180 protective cages around individual aspen trees, and burned another 400 ha of pine. In this paper, we describe our study area, monitoring techniques, restoration activities, brief summaries of breeding bird abundance and nesting success, project progress to date, and future plans.

Key words: avifauna, Blue Mountains, fire, grazing, habitat degradation, nest monitoring, point counts, ponderosa pine, quaking aspen, restoration.

Introduction

Grazing, fire exclusion, and logging associated with Euro-American settlement have brought about substantial changes to forest conditions throughout the inland West, including the Blue Mountains ecoregion of northeast Oregon (Sallabanks et al. 2001). In particular, the exclusion of natural fires has led to increased tree densities and associated shifts in ecosystem structure, fire hazard, disturbance regimes, and wildlife habitat (Covington and Moore 1994, Agee 1999). To remedy these problems and restore "Eastside" forests to more natural conditions requires immediate action on the behalf of researchers and land managers.

Because of their limited distribution and degraded condition, two habitats have been identified as high priority for nongame landbirds by recent Partners in Flight conservation planning efforts for coniferous forests of the northern Rocky Mountains in Oregon and Washington (Altman 2000): riparian habitat, especially quaking aspen (*Populus tremuloides*), and dry forest, especially ponderosa pine (*Pinus ponderosa*). Both habitats occur extensively throughout the Blue Mountains ecoregion, including the Wallowa Mountains, which is where our restoration efforts are currently focused. Settlement, the introduction of domestic livestock, management for timber, and changes to historical fire regimes have significantly affected both aspen and pine, and both are high priorities for restoration by managers.

Eastside riparian habitat is complex, and includes both low elevation streamside vegetation as well as upland stands of aspen (Chappell et al. 2001). Aspen stands are restricted to present occupation because current grazing pressure (from both wild and domestic herbivores) limits natural regeneration by seedling establishment. As a result, the only way to retain aspen as a component in Eastside forests is to reinvigorate existing stands. Restoration of riparian habitat requires fencing (to exclude herbivory), oftentimes in combination with prescribed burning (especially for aspen, which is fire maintained), and selective vegetation management (i.e., mechanical removal and culling of competing tree species, especially conifers). High priority bird species such as the Red-naped Sapsucker (*Sphyrapicus nuchalis*), Williamson's Sapsucker (*Sphyrapicus thyroideus*), Veery (*Catharus fuscescens*), Red-eyed Vireo (*Vireo olivaceus*), and Yellow Warbler (*Dendroica petechia*) may benefit from this type of management. Many other species, such as the Warbling

---

[1]A version of this paper was presented at the **Third International Partners in Flight Conference, March 20-24, 2002, Asilomar Conference Grounds, California.**

[2]Sustainable Ecosystems Institute, 1543 North Mansfield Place, Eagle, Idaho 83616.
[3]Current address: Nongame and Endangered Wildlife Program, Idaho Department of Fish and Game, P.O. Box 25, Boise, Idaho 83707. E-mail rsallabanks@idfg.state.id.us.
[4]Wallowa Resources, 200 W. North Street, P.O. Box 274, Enterprise, Oregon 97828.
[5]U.S.D.A. Forest Service, Wallowa-Whitman National Forest, 88401 Highway 82, Enterprise, Oregon 97828.
[6]Current address: Trinity Baptist College, P. O. Box 162, Jacksonville. FL 32221.

Vireo (*Vireo gilvus*), Mountain Bluebird (*Sialia currucoides*), and Hairy Woodpecker (*Picoides villosus*), also frequently use aspen woodlands for foraging and nesting habitat (Sallabanks 2000a, 2001).

Within dry forests, managers seek to restore open, park-like stands of mature ponderosa pine using a combination of prescribed burning and selective vegetation management (Covington et al. 1999). Returning this habitat to a more historical condition likely will benefit several high priority bird species, such as the White-headed Woodpecker (*Picoides albolarvatus*), White-breasted Nuthatch (*Sitta carolinensis*), and Flammulated Owl (*Otus flammeolus*). Other species that regularly use pine for nesting and foraging include Hammond's Flycatcher (*Empidonax hammondii*), Chipping Sparrow (*Spizella passerina*), and Pygmy Nuthatch (*Sitta pygmaea*; Sallabanks 2000a, 2001).

To address these management needs, we initiated a habitat restoration project in May 2000 that included a bird-monitoring component (Sallabanks 2000b). Our specific short-term (2-year) study objectives were four-fold:

(1) To locate, map, and establish permanent long-term (minimum of 10 yr) study sites in six aspen stands and six ponderosa pine/Douglas-fir (*Pseudostuga menziesii*) stands in the Wallowa Mountains of northeast Oregon

(2) To build fences around the six selected aspen stands. Exclosures were to initially range from 8 to 16 ha in size, depending on the size of the existing aspen stands (currently 2 to 8 ha). Our goal during the 10-yr period 2000 to 2010 was to create at least six aspen patches >16 ha in size

(3) To initiate burning and selective vegetation management prescriptions in a subset of the selected aspen stands (not all aspen stands will needed burning, for example) and in all six selected ponderosa pine/Douglas-fir stands (pine stands were >200 ha in size)

(4) To establish an extensive monitoring program in all 12 selected study sites to provide a baseline assessment of avian community composition and vegetation composition. This also would include an assessment of avian structure population viability in a subset (8) of the study sites. These assessments would serve as a basis against which to measure future changes in habitat features and bird populations as restoration efforts take effect.

Our long-term (minimum of 10 yr) study objectives were three-fold:

(1) To maintain fences around all aspen stands and conduct some re-burning and selective vegetation management in selected stands in subsequent years

(2) To monitor changes in avian community composition and population viability, as well as habitat structure and plant species composition, as restoration efforts continue through at least 2010

(3) To expand our study to include restoration of additional aspen and pine habitat.

In this paper, we describe our study area, restoration activities, monitoring techniques, and provide an overview of project progress during the first three years, 2000 to 2002. Preliminary summaries of avian community composition, birds caught and banded, nests found, and fledging success also are provided.

Methods

Study Area

Our study occurred within the Sheep Creeks/Imnaha Collaborative Stewardship Initiative (SCICSI) planning area in the Wallowa Mountains, northeast Oregon, which form part of the Blue Mountains ecoregion. The SCICSI planning area is located in Wallowa County, approximately 20 km northeast of the town of Enterprise and just southwest of the small community of Imnaha. The planning area encompasses approximately 80,000 ha of mid-elevation (1,500 to 1,600 m asl) forest and grassland habitat within the Imnaha subwatershed of the Snake River drainage. The Imnaha River and the ridgeline above Little Sheep Creek form the east and west boundaries, respectively. The confluence of Little Sheep Creek and the Imnaha River forms the north-end of the planning area near Imnaha. The Eagle Cap Wilderness Area forms the south boundary. Several major ridges and associated canyons run north and south through the planning area, separated by Big and Little Sheep Creeks and the Imnaha River. These include Clear Lake, Deadhorse, and Beeler Ridges.

Ridge tops in the planning area are dominated by native bunchgrass communities of Idaho fescue (*Festuca idahoensis*), with bluebunch wheatgrass (*Elytrigia spicata*) and Junegrass (*Koeleria nitida*) also common. Sandberg's bluegrass (*Poa sandbergii*) is common on scablands and other areas of shallow soil. These grassland communities provide habitat for a wide range of wildlife species including deer (both mule [*Odocoileus hemionus hemionus*] and white-tailed [*O. virginianus ochrourus*]) and Rocky Mountain elk (*Cervus elaphus nelsoni*), raptors such as the Prairie Falcon (*Falco mexicanus*) and Ferruginous Hawk

(*Buteo regalis*), and rare birds such as the Upland Sandpiper (*Bartramia longicauda*) and Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*). Due to the low, open road density on Clear Lake and Deadhorse Ridges, elk can often be found using this open grassland habitat year-round. A resident herd of over 350 elk can be found on the Clear Lake/Deadhorse Ridge section alone. More than 1,000 elk use the planning area as winter and transitory range during spring and fall. The timbered slopes create a classic, grass-tree mosaic habitat with mixed conifer stands of pine and fir. Ponderosa pine is dominant in the numerous draws. At the heads and in the bottoms of these draws are substantial remnant hardwood communities of aspen, hawthorn (*Crataegus* spp.), upland willows (*Salix* spp.), mountain ash (*Sorbus scopulina*), and serviceberry (*Amelanchier alnifolia*). Approximately 100 aspen clones are known to occur within the planning area totaling approximately 100 ha. Some of these clones are within existing exclosures (built during the 1970s) or have received other treatments, but the majority are in fair-to-poor condition and exposed to grazing. The upper elevations in the south portion of the planning area have mixed conifer communities of lodgepole pine (*Pinus contorta*), western larch (*Larix occidentalis*), Douglas-fir, and true firs near the wilderness boundary. In the bottom of Devil's and Bear Gulches are relatively intact riparian zones of cottonwood (*Populus* spp.), aspen, alder (*Alnus* spp.), and birch (*Betula* spp.), providing excellent habitat for a wide variety of Neotropical migratory songbirds including the Red-eyed Vireo and Veery, as well as Ruffed (*Bonasa umbellus*) and Blue (*Dendragapus obscurus*) Grouse, Wild Turkey (*Meleagris gallopavo*), and Mountain Quail (*Oreortyx pictus*).

A unique feature to the planning area is the high-elevation, natural playa lakes that give Clear Lake Ridge its name. These small lakes and ponds total approximately 84 surface ha of water and emergent habitats. The largest of these is Downy Lake, which covers over 40 ha in years of average precipitation. Sensitive amphibians such as the Columbia spotted frog (*Rana luteiventris*) inhabit the lake and many species of bats, including the sensitive pale western big-eared bat (*Corynorhinus townsendii ingens*), catch insects over the lakes in the summer months.

The riparian and wetland vegetation surrounding these small lakes provides habitat for a variety of waterfowl and shorebirds, including many species of ducks and geese, Horned (*Podiceps auritus*) and Eared (*P. nigricollis*) Grebes, and Trumpeter Swans (*Cygnus buccinator*). Downy Lake has the only nesting colony of Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) within at least 80 km and used to be the only known nesting area in the lower 48 states for the Greater Yellowlegs (*Tringa melanoleuca*); whether yellowlegs still breed there today remains unconfirmed.

This vegetation zone also provides habitat for several rare, sensitive plant species including Spalding's Silene or Catchfly (*Siliene spaldingi*) and Henderson's Rice-grass (*Oryzopsis hendersonii*). The lakes provide a ridgetop water supply for livestock and native ungulates. All lands lying between Little Sheep Creek and the Imnaha River also are historic Rocky Mountain Bighorn Sheep (*Ovis canadensis canadensis*) range and lie adjacent to the Hells Canyon Bighorn Sheep Initiative Area to the east.

The planning area is divided into a number of private, state, and federal ownerships as follows:

(1) U.S. Forest Service (USFS), approximately 70 percent

(2) private ranches, approximately, 20 percent

(3) U.S. Bureau of Land Management <10 percent

(4) Oregon Department of Fish and Wildlife, <5 percent

(5) Oregon Nature Conservancy (ONC), approximately 2 percent.

Within the SCICSI planning area, we proposed to focus our initial restoration efforts on USFS and private lands during 2000–2001. Specifically, we targeted degraded stands of quaking aspen and ponderosa pine along Beeler Ridge. Over the course of our long-term study, however, we anticipate expanding restoration activities to include the natural playa lakes and other important wetland habitats within the planning area. As a result, we hope all landowners will eventually become involved as habitat restoration occurs on other lands. By mid-summer 2000, 11 permanent study sites had been established within the planning area: 5 in aspen habitat and 6 in ponderosa pine habitat. During the 2001 season, a sixth aspen study site was added to the project (*table 1*).

Monitoring Techniques

During the 2000 and 2001 avian breeding seasons, we collected several different types of data, as outlined below.

Table 1— *Study sites selected for a long-term habitat restoration project in the Wallowa Mountains, northeast Oregon, 2000–2001.*

Habitat	Site name	Plot size	Ownership	Lat-long (deg., min. sec)
Aspen	Target Springs	13 ha	FS (WVRD)	N45° 14.475′, W117° 04.623′
	Marr Flat	16 ha	FS (WVRD)	N45° 19.366′, W116° 53.591′
	Road Canyon	18 ha	FS (WVRD)	N45° 17.920′, W116° 55.577′
	Bristow Flat	16 ha	FS (WVRD)	N45° 23.015′, W116° 50.436′
	Marks	24 ha	Private	N45° 18.470′, W116° 57.127′
	Timber Creek	20 ha	Private/FS (WVRD)	Lat-long not recorded
Pine	Hidden Springs	25 ha	FS (HCNRA)	N45° 06.919′, W116° 58.902′
	Indian Crossing	25 ha	FS (HCNRA)	N45° 06.899′, W117° 00.338′
	Ollokot	25 ha	FS (HCNRA)	N45° 08.411′, W116° 52.990′
	Evergreen	25 ha	FS (HCNRA)	N45° 06.815′, W116° 59.742′
	Sierra Flat	25 ha	FS (HCNRA)	N45° 06.794′, W116° 54.607′
	Imnaha	25 ha	FS (HCNRA)	N45° 08.813′, W116° 52.850′

Notes: FS (WVRD) = U.S. Forest Service (Wallowa Valley Ranger District); FS (HCNRA) = U.S. Forest Service (Hells Canyon National Recreation Area). Timber Creek site added in 2001.

Relative avian abundance

We measured relative breeding bird abundance at all sites using the standard fixed-radius (50 m) point-count censusing technique in both years (Ralph et al. 1993). With one exception, six point-count stations, at least 150 m apart, were established at each site; one aspen stand, Target Springs (*table 1*), was only large enough to accommodate five stations. We visited each station three times, except for Timber Creek, which was added to the study in 2001 and only visited twice (*table 1*) during the period of 12 May through 14 July 2000 and 2 June through 1 July 2001. During counts, all vocal and visual avian detections were identified to species. Birds flying above the canopy were recorded as such, and birds known or suspected to have been recorded at a previous count station within the survey area were ignored.

Nest success and fledging rates

We conducted nest searching and monitoring at five aspen sites (all except Timber Creek) and at three pine sites (Hidden Springs, Indian Crossing, and Ollokot) using standardized techniques in both years (Martin and Geupel 1993). Eight sites are all that we could effectively monitor given available funding and associated field personnel. All nests found were monitored every 3 to 4 d and their fate recorded (i.e., successful, deserted, depredated, parasitized by cowbirds, or fate unknown). Where possible, numbers of eggs laid, eggs hatched, and young fledged were recorded for all nests monitored.

Mist netting and color banding

We used mist nets and leg bands to catch and mark birds following protocols of the national Monitoring Avian Productivity and Survivorship Program (MAPS; DeSante 1992), with some modifications. Establishing a population of marked birds is useful for long-term demographic studies and also would facilitate the assessment of within-season reproductive success of individual pairs of birds. Over the 2-yr period, mist netting and banding occurred at all aspen sites with the exception of Timber Creek; MAPS protocols were followed most stringently at Marr Flat (see below), with more selective targeted mist-netting occurring at the remaining sites. No banding occurred at Target Springs in 2001 because of the driving distance to the site. In addition to standard USFWS metal bands, which were placed on all caught birds, we used color bands to uniquely identify a subset of species. Species selected for color banding represented those that were relatively common and for which we were able to find and accurately monitor nests. We did not want to color band birds unnecessarily, such as species for which we would rarely find nests or that nested in the canopy where we could not monitor them. In both years, we conducted intensive banding at Marr Flat, where ten 12-m nets were opened for 6 hr (0600–Noon) 1 d every 10 d for a 100-d period beginning in late May. Pyle (1997) was used to identify species and make detailed recordings of plumage, age, sex, body weight, molt, fat, and reproductive status (if appropriate); for a more detailed description of the data collected, refer to Ralph et al. (1993).

GPS surveys

With the exception of Timber Creek (see *table 1*), which wasn't added to the study until 2001, we surveyed all point-count station locations using a Global Positioning System unit in 2000 for later downloading into a U.S. Forest Service Geographical Information System database. Mapping study sites in this way will facilitate the repeated location of count stations throughout the duration of restoration efforts, even following burning events, as well as allow for landscape-level analyses of variation in bird population parameters and study site juxtaposition.

Restoration Activities

During 2000–2001, we built five different kinds of fence that varied in construction costs and herbivore-control objectives. To exclude cattle only, we built four-strand barbed wire fence (*fig. 1A*). To exclude cattle and small ungulates (e.g., deer), we built four-strand barbed wire fence fitted with outriggers of two or three strands of 8-gauge smooth wire or white electric tape (*fig. 1B*). To exclude all ungulates, including elk, we built three fence types: (1) 2.4 m woven wire (*fig. 1C*); (2) welded-wire stock panels and pole top (*fig. 1D*); and (3) buck and pole (*fig. 1E*). One of our interests was to compare the different fence types in terms of their ability to exclude ungulate herbivores. Another was to compare the cost-effectiveness of the different fence types to protect aspen from herbivory and, therefore, promote restoration. Hence the reason for building a variety of fence types, even for fence with the same ungulate exclusion objectives. Where possible, we used conifers (primarily lodgepole pine) removed from aspen stands to build the fences (e.g., *fig. 1D*).

During the summer and fall of 2000, we initiated a combination of fence removal (old fences that were no longer excluding herbivores), fence building, and selective conifer removal at one aspen site (Target Springs). We removed 1.3 km of old fence and built 0.58 km of new fence (0.45 km of four-strand barbed wire and 0.13 km of welded-wire stock panels and pole top). In 2001, we expanded restoration efforts to all other aspen sites included in our study (with the exception of Timber Creek), constructing a total of 6.2 km of new exclosure fencing. The majority of fence built in 2001 consisted of four-strand barbed wire fence designed to exclude domestic cattle. These fences were built as large, single exclosures that encompassed all aspen trees included in our monitoring. Most recently (spring and summer 2002), we added another 0.75 km of buck and pole fence and constructed 180 stock panel cages (*fig. 1F*) around individual clumps of regenerating aspen within the larger exclosures at Marr Flat (84 cages), Road Canyon (67 cages), Bristow Flat (17 cages), and Target Springs (12 cages). These cages were designed to exclude all herbivory, including by deer and elk. In addition, we have repaired fences at Target Springs and Bristow Flat that were damaged by snow, fallen trees, and/or elk. Finally, although not part of our monitoring project, approximately 0.3 km of new buck and pole fence has been constructed on ONC land near Findley Buttes in partnership with Wallowa Ranch Camp and Oregon Youth Conservation Corps.

Prescribed burns totaling approximately 400 ha were ignited at two ponderosa pine sites (Imnaha and Ollokot) over a 2-d period beginning on 7 October 2000. Steeper upslope sections of the burn units were "black-lined" by hand-crews using drip-torches; downslope sections were ignited using a plastic sphere dispenser (PSD or "ping-pong" machine) mounted to a light helicopter. Multiple passes were made with the helicopter in an attempt to establish fire in several stringers of Douglas-fir. Except for building firelines, there was no pretreatment of fuels prior to ignition. At the time of the burn, relative humidity was in the range of 22 to 30 percent and temperatures were between 15 to 20 ºC. Winds were mostly out of the south at speeds of 5 to 10 km/hr, with occasional gusts to 20 km/hr. As fire crews worked downslope from the top of the units, flame lengths increased from 0.3 m to 0.6–1.0 m. Throughout both sites, fuels did not burn well, primarily because of moisture from heavy rains approximately one month prior to burning. As a result, objectives were not met for either fuels consumed (fuels were measured before and after burning) or mortality achieved in the understory saplings. Target fuels for these burns were in the 0 to 7.6 cm diameter range. Direct tree mortality was minimal and large wood consumption, for the most part, was moderate for a fall prescribed burn. Two years post-burn (i.e., October 2002), there were signs of secondary fire effects such as large-diameter ponderosa pine and Douglas-fir being attacked by bark beetles (compared to adjacent unburned stands).

Burning of the remaining pine sites was scheduled for fall 2001, but unfavorable environmental conditions prevented any treatments from occurring. On 10 October 2002, however, three additional sites (Hidden Springs, Evergreen, and Indian Crossing) were burned (total area = 400 ha). These burns also were implemented using a combination of hand-crew and helicopter ignitions. In general, conditions were considerably drier than described above for 2000. As a result, prescribed burns implemented in 2002 were considered "textbook" in terms of meeting prescription objectives. Average flame lengths were in the 1.0 to 1.2 m range, and the fire continued to consume large fuels for two weeks following ignition. Our remaining pine site (Sierra Flat) currently is scheduled for burning in 2003.

Results

In 2000, we detected 3,083 individual birds representing 75 different species; in 2001, this number increased to 3,177 individuals, but representing only 71 species. Combining count data from both years of study, we detected 3,234 individual birds representing 71 species in aspen and 3,026 birds representing 60 species in pine (*table 2*). Many species were detected with similar frequency in 2001 as they were in 2000, although there were some exceptions (e.g., Dark-eyed Junco [*Junco hyemalis oreganus*], European Starling [*Sturnus vulgaris*], Pine Siskin [*Carduelis pinus*], and Western Wood-pewee [*Contopus sordidulus*]). Species closely associated with aspen included Downy Woodpecker (*Picoides pubescens*), Dusky Flycatcher (*Empidonax oberholseri*), Common Raven (*Corvus corax*), House Wren

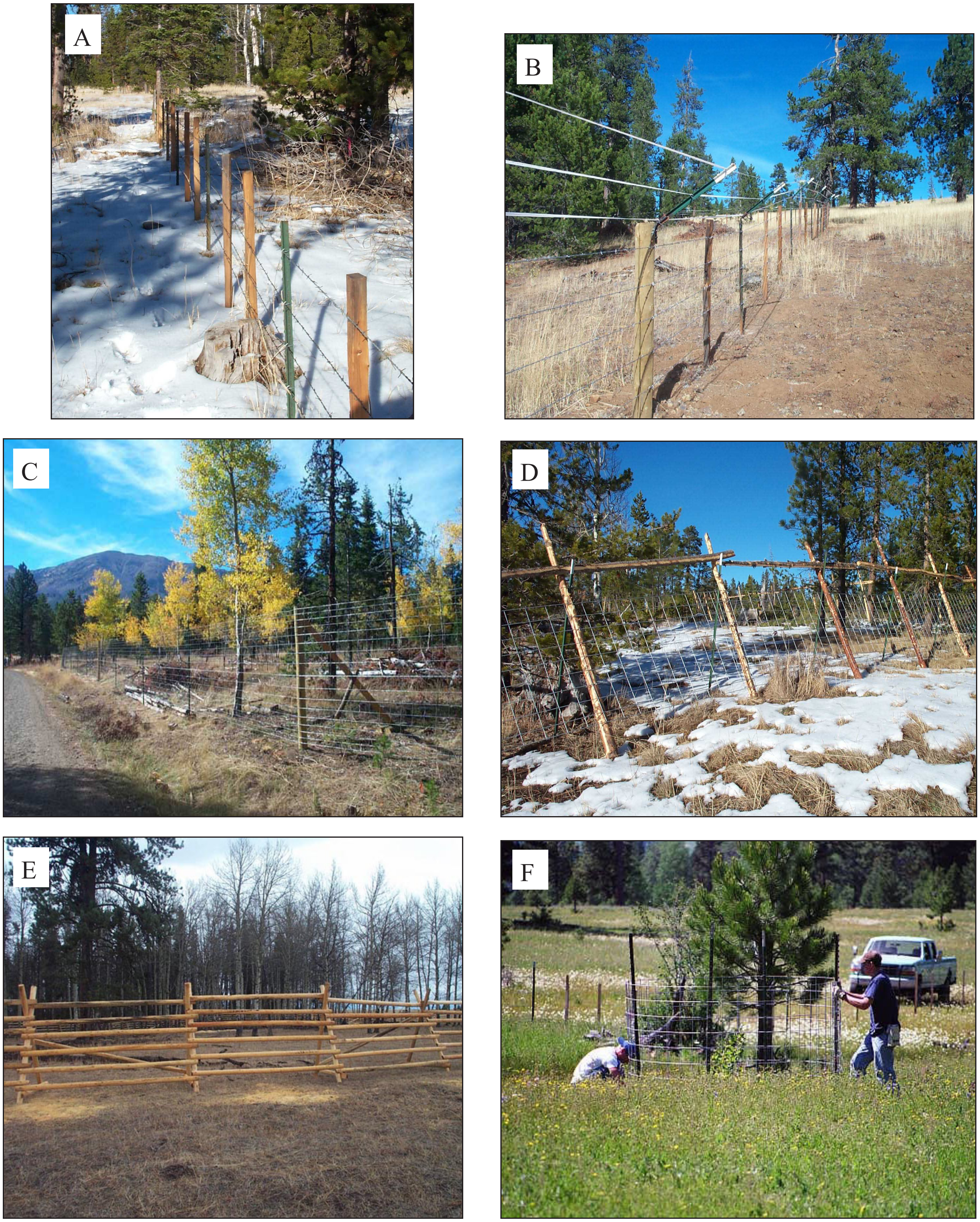

Figure 1— Six different kinds of fence built around aspen as part of a long-term habitat restoration project in the Wallowa Mountains, northeast Oregon, 2000–2001: (A) four-strand barbed wire (excludes cattle), (B) four-strand barbed wire with outriggers having two or three strands of 8-guage smooth wire or white electric tape (excludes cattle and small ungulates, such as deer), (C) 2.4 m woven wire (excludes all ungulates, including elk), (D) welded-wire stock panels and pole top (excludes all ungulates), (E) buck and pole (excludes all ungulates), and (F) stock panel cages built around individual clumps of regenerating aspen (excludes all ungulates). Photos by Nils Christoffersen.

Table 2— *Numbers of birds detected (regardless of distance from observers), summarized by habitat and year, as part of a long-term habitat restoration project in the Wallowa Mountains, northeast Oregon, 2000–2001.*

		Numbers of birds detected in each habitat						
		Aspen			Pine			Grand
Common name	Scientific name	2000	2001	Total	2000	2001	Total	total
American Goldfinch	*Carduelis tristis*	0	2	2	0	6	6	8
American Kestrel	*Falco sparverius*	0	0	0	1	0	1	1
American Robin	*Turdus migratorius*	107	129	236	166	153	319	555
Belted Kingfisher	*Ceryle alcyon*	0	0	0	1	0	1	1
Black-backed Woodpecker	*Picoides arcticus*	0	0	0	3	3	6	6
Black-headed Grosbeak	*Pheucticus melanocephalus*	1	1	2	3	1	4	6
Blue Grouse	*Dendragapus obscurus*	0	0	0	2	0	2	2
Brewer's Blackbird	*Euphagus cyanocephalus*	2	0	2	0	0	0	2
Brewer's Sparrow	*Spizella breweri*	6	6	12	0	0	0	12
Brown Creeper	*Certhia americana*	4	0	4	6	5	11	15
Brown-headed Cowbird	*Molothrus ater*	22	29	51	0	2	2	53
California Quail	*Callipepla californica*	0	4	4	0	0	0	4
Calliope Hummingbird	*Stellula calliope*	6	3	9	1	1	2	11
Canyon Wren	*Catherpes mexicanus*	0	0	0	1	0	1	1
Cassin's Finch	*Carpodacus cassinii*	41	57	98	28	61	89	187
Cassin's Vireo	*Vireo cassinii*	5	1	6	44	27	71	77
Cedar Waxwing	*Bombycilla cedrorum*	1	0	1	6	1	7	8
Chipping Sparrow	*Spizella passerina*	75	92	167	88	115	203	370
Clark's Nutcracker	*Nucifraga columbiana*	4	3	7	0	0	0	7
Common Nighthawk	*Chordeiles minor*	1	0	1	0	0	0	1
Common Raven	*Corvus corax*	32	25	57	7	3	10	67
Common Snipe	*Gallinago gallinago*	1	1	2	0	0	0	2
Cooper's Hawk	*Accipiter cooperii*	0	0	0	1	0	1	1
Dark-eyed Junco	*Junco hyemalis oreganos*	108	67	175	127	62	189	364
Downy Woodpecker	*Picoides pubescens*	5	12	17	0	0	0	17
Dusky Flycatcher	*Empidonax oberholseri*	67	98	165	4	0	4	169
European Starling	*Sturnus vulgaris*	42	120	162	0	0	0	162
Evening Grosbeak	*Coccothraustes vespertina*	0	0	0	14	4	18	18
Golden-crowned Kinglet	*Regulus satrapa*	6	5	11	25	21	46	57
Gray Jay	*Perisoreus canadensis*	2	4	6	1	1	2	8
Hairy Woodpecker	*Picoides villosus*	30	31	61	14	9	23	84
Hammond's Flycatcher	*Empidonax hammondii*	17	2	19	154	175	329	348
Hermit Thrush	*Catharus guttatus*	15	12	27	8	7	15	42
House Wren	*Troglodytes aedon*	104	144	248	0	0	0	248
Killdeer	*Charadrius vociferous*	0	3	3	0	0	0	3
Lazuli Bunting	*Passerina amoena*	1	2	3	1	3	4	7
Lincoln's Sparrow	*Melospiza lincolnii*	20	12	32	0	0	0	32
MacGillivray's Warbler	*Oporornis tolmiei*	18	28	46	42	28	70	116
Mountain Bluebird	*Sialia currucoides*	12	14	26	0	0	0	26
Mountain Chickadee	*Parus gambeli*	82	58	140	79	93	172	312
Mountain Quail	*Oreortyx pictus*	0	8	8	0	0	0	8
Nashville Warbler	*Vermivora ruficapilla*	0	0	0	2	0	2	2
Northern Flicker	*Colaptes auratus*	47	42	89	30	28	58	147
Northern Goshawk	*Accipiter gentilis*	0	0	0	0	1	1	1
Northern Pygmy-owl	*Glaucidium gnoma*	0	2	2	0	1	1	3
Olive-sided Flycatcher	*Contopus borealis*	1	1	2	4	3	7	9

Table 2— *continued.*

Common name	Scientific name	Numbers of birds detected in each habitat: Aspen 2000	Aspen 2001	Aspen Total	Pine 2000	Pine 2001	Pine Total	Grand total
Orange-crowned Warbler	*Vermivora celata*	6	21	27	5	11	16	43
Pileated Woodpecker	*Dryocopus pileatus*	4	4	8	8	8	16	24
Pine Siskin	*Carduelis pinus*	106	52	158	62	69	131	289
Prairie Falcon	*Falco mexicanus*	0	1	1	0	0	0	1
Pygmy Nuthatch	*Sitta pygmaea*	24	20	44	0	0	0	44
Red Crossbill	*Loxia curvirostra*	28	34	62	44	14	58	120
Red-breasted Nuthatch	*Sitta canadensis*	33	48	81	130	92	222	303
Red-naped Sapsucker	*Sphyrapicus nuchalis*	16	31	47	1	1	2	49
Red-tailed Hawk	*Buteo jamaicensis*	4	2	6	0	5	5	11
Red-winged Blackbird	*Agelaius phoeniceus*	18	47	65	0	0	0	65
Rock Wren	*Salpinctes obsoletus*	0	0	0	2	2	4	4
Ruby-crowned Kinglet	*Regulus calendula*	40	26	66	0	8	8	74
Ruffed Grouse	*Bonasa umbellus*	0	1	1	7	9	16	17
Rufous Hummingbird	*Selasphorus rufus*	3	2	5	0	0	0	5
Sharp-shinned Hawk	*Accipiter striatus*	1	0	1	0	0	0	1
Song Sparrow	*Melospiza melodia*	1	0	1	8	2	10	11
Spotted Sandpiper	*Actitis macularia*	0	0	0	1	1	2	2
Spotted Towhee	*Pipilo maculates*	1	2	3	0	0	0	3
Steller's Jay	*Cyanocitta stelleri*	4	7	11	11	15	26	37
Swainson's Thrush	*Catharus ustulatus*	1	0	1	51	33	84	85
Townsend's Solitaire	*Myadestes townsendi*	1	0	1	2	1	3	4
Townsend's Warbler	*Dendroica townsendi*	3	0	3	2	7	9	12
Tree Swallow	*Tachycineta bicolor*	23	27	50	0	0	0	50
Varied Thrush	*Ixoreus naevius*	0	0	0	1	0	1	1
Vaux's Swift	*Chaetura vauxi*	0	1	1	0	2	2	3
Warbling Vireo	*Vireo gilvus*	77	109	186	34	46	80	266
Western Bluebird	*Sialia mexicana*	35	56	91	1	1	2	93
Western Meadowlark	*Sturnella neglecta*	21	37	58	0	0	0	58
Western Tanager	*Piranga ludoviciana*	26	16	42	134	77	211	253
Western Wood-pewee	*Contopus sordidulus*	43	80	123	11	8	19	142
White-breasted Nuthatch	*Sitta carolinensis*	12	9	21	3	2	5	26
White-crowned Sparrow	*Zonotrichia leucophrys*	6	0	6	0	0	0	6
White-headed Woodpecker	*Picoides albolarvatus*	2	1	3	8	0	8	11
Williamson's Sapsucker	*Sphyrapicus thyroideus*	11	4	15	0	0	0	15
Wilson's Warbler	*Wilsonia citrina*	1	3	4	0	1	1	5
Yellow Warbler	*Dendroica petechia*	2	0	2	1	0	1	3
Yellow-rumped Warbler	*Dendroica coronata*	56	81	137	199	208	407	544

(*Troglodytes aedon*), Mountain Bluebird, Tree Swallow (*Tachycineta bicolor*), and Williamson's Sapsucker. Species closely associated with pine included Evening Grosbeak (*Coccothraustes vespertina*), Golden-crowned Kinglet (*Regulus satrapa*), Hammond's Flycatcher, Swainson's Thrush (*Catharus ustulatus*), and Western Tanager (*Piranga ludoviciana*) (*table 2*).

Nest searching yielded a total of 389 monitored nests of 39 species in 2000 and 427 nests of 37 species in 2001. Combining nests from both years, we monitored 637 nests of 39 species in aspen and 179 nests of 24 species in pine (*table 3*). Nest success was lower in aspen in 2001 (mean ± SE = 47.96 ± 2.70 percent of nests successful) than 2000 (63.85 ± 2.62; *fig. 2*).

Although a useful index of reproductive output, estimates of nest success do not address the production of young (which is presumably an even better measure of habitat quality). Combining data from both years, we therefore calculated productivity (mean no. young fledged per nest) and found birds nesting at Bristow Flat to be the most productive. In contrast, birds nesting at Target Springs were the least productive (*fig. 3*).

Table 3— *Numbers of bird nests found and monitored (scientific names in* Table 2*), summarized by habitat and year, as part of a long-term habitat restoration project in the Wallowa Mountains, northeast Oregon, 2000–2001.*

	Numbers of nests found in each habitat						
	Aspen			Pine			
Common name	**2000**	**2001**	**Total**	**2000**	**2001**	**Total**	**Grand total**
American Kestrel	1	0	1	0	0	0	1
American Robin	9	37	46	9	16	25	71
Black-backed Woodpecker	0	0	0	0	1	1	1
Brewer's Blackbird	1	0	1	0	0	0	1
Brown Creeper	1	0	1	0	0	0	1
Calliope Hummingbird	0	1	1	0	1	1	2
Cassin's Finch	0	7	7	0	1	1	8
Cassin's Vireo	0	0	0	3	4	7	7
Chipping Sparrow	13	19	32	10	12	22	54
Common Snipe	1	0	1	0	0	0	1
Dark-eyed Junco	20	8	28	12	5	17	45
Downy Woodpecker	3	4	7	0	0	0	7
Dusky Flycatcher	30	29	59	0	0	0	59
European Starling	17	20	37	0	0	0	37
Fox Sparrow	2	0	2	0	0	0	2
Hairy Woodpecker	6	9	15	1	1	2	17
Hammond's Flycatcher	0	1	1	16	12	28	29
Hermit Thrush	0	0	0	0	1	1	1
House Wren	26	37	63	0	0	0	63
Lincoln's Sparrow	2	4	6	0	0	0	6
MacGillivray's Warbler	2	3	5	1	1	2	7
Mountain Bluebird	7	7	14	0	0	0	14
Mountain Chickadee	15	15	30	3	5	8	38
Northern Flicker	17	10	27	0	1	1	28
Northern Saw-whet Owl	0	1	1	0	0	0	1
Orange-crowned Warbler	0	0	0	0	1	1	1
Pileated Woodpecker	2	0	2	0	1	1	3
Pine Siskin	2	0	2	0	0	0	2
Pygmy Nuthatch	7	11	18	0	0	0	18
Red-breasted Nuthatch	4	7	11	9	5	14	25
Red-naped Sapsucker	13	11	24	0	0	0	24
Red-tailed Hawk	1	0	1	0	0	0	1
Red-winged Blackbird	10	13	23	0	0	0	23
Ruby-crowned Kinglet	2	0	2	0	0	0	2
Ruffed Grouse	0	0	0	2	0	2	2
Swainson's Thrush	0	0	0	2	2	4	4
Townsend's Warbler	0	0	0	0	1	1	1
Tree Swallow	9	11	20	0	0	0	20
Warbling Vireo	23	19	42	3	3	6	48
Western Bluebird	19	27	46	0	0	0	46
Western Tanager	2	1	3	10	9	19	22
Western Wood-pewee	11	13	24	0	0	0	24
White-breasted Nuthatch	5	3	8	0	1	1	9
White-headed Woodpecker	3	2	5	1	0	1	6
Williamson's Sapsucker	6	2	8	0	0	0	8
Yellow-rumped Warbler	7	6	13	8	5	13	26
Totals	299	338	637	90	89	179	816

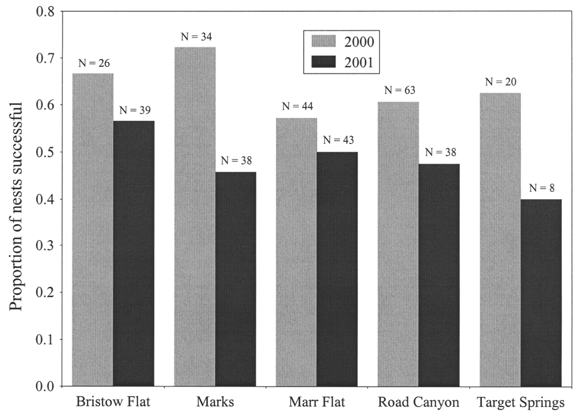

Figure 2— Success rates (proportion of nests successful) of nests found in aspen habitat in the Wallowa Mountains, northeast Oregon, 2000–2001. Numbers of successful nests are provided above each bar for each of five study sites.

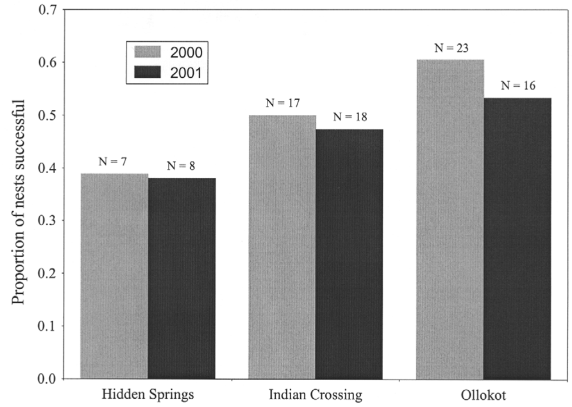

Figure 4— Success rates (proportion of nests successful) of nests found in pine habitat in the Wallowa Mountains, northeast Oregon, 2000–2001. Numbers of successful nests are provided above each bar for each of three study sites.

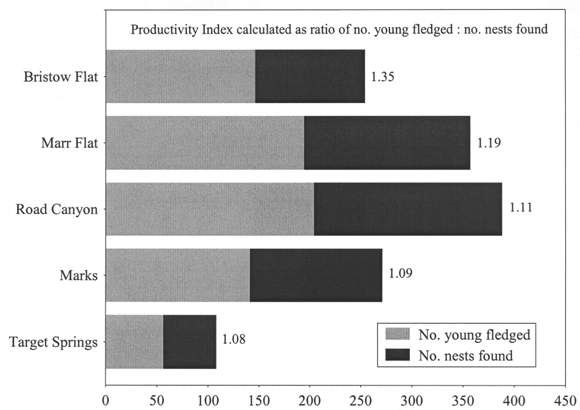

Figure 3— Productivity Index, calculated as the ratio of no. young fledged:no. nests found (i.e., no. young fledged per nest), for five study sites in aspen habitat in the Wallowa Mountains, northeast Oregon. Data have been pooled across years (2000–2001). Sites are ranked in descending order of Productivity Index, which is provided at the end of each bar for each site.

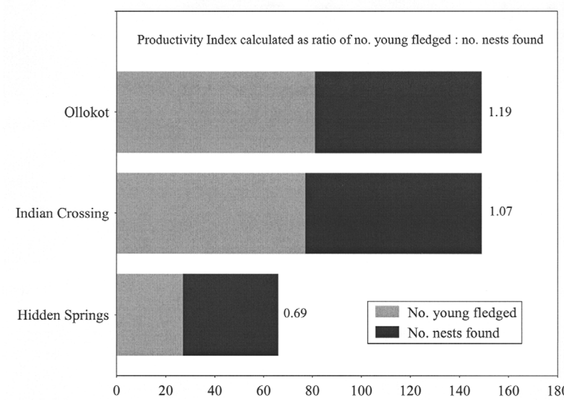

Figure 5— Productivity Index, calculated as the ratio of no. young fledged:no. nests found (i.e., no. young fledged per nest), for three study sites in pine habitat in the Wallowa Mountains, northeast Oregon. Data have been pooled across years (2000–2001). Sites are ranked in descending order of Productivity Index, which is provided at the end of each bar for each site.

Differences in rates of nest success between 2000 (49.81 ± 6.25) and 2001 (46.27 ± 4.44) were negligible among ponderosa pine sites (*fig. 4*). However, while birds nesting at Ollokot and Indian Crossing were equally productive, fledging success for birds nesting at Hidden Springs was extremely low (*fig. 5*).

Banding efforts resulted in 140 banded birds of 29 species in 2000 and 144 birds of 30 species in 2001. Of those birds banded in 2000, 92 individuals of 18 species also were color banded. This number increased to 111 individuals of 18 species in 2001. Species most frequently caught and banded include American Robin (*Turdus migratorius*), Chipping Sparrow, Dark-eyed Junco, Dusky Flycatcher, House Wren, MacGillivray's Warbler (*Oporornis tolmiei*), Warbling Vireo, and Western Bluebird (*Sialia mexicana*). Mist-netting operations were focused on Road Canyon and Marr Flat in 2000, and on Marr Flat, Bristow Flat, and Marks in 2001. After two years of banding, we have marked 284 birds (36 species) with USFWS metal leg-bands and 203 birds (21 species) with auxiliary color leg-bands. Three male Warbling Vireos, one male Red-naped Sapsucker, and one male House Wren that were banded in 2000 were recaptured in 2001; numerous other individuals of several species were resighted but not recaptured.

Discussion

According to Covington et al. (1999), far too many ecological restoration projects have been started without clear definition of restoration goals and with little attempt to evaluate success quantitatively. Heeding these words, we have taken a scientific approach to ecological restoration of degraded stands of aspen and pine in the SCICSI planning area of Wallowa County. As recommended by Bradshaw (1993), such an approach implies that we will: (1) be aware of other relevant work; (2) carry out experiments to test ideas; (3) monitor key indicator parameters (in our case, forest avifauna and plant species composition and structure); (4) design further experiments and tests based on results of monitoring; and (5) publish peer reviewed results and conclusions in scientific journals (the first of which is represented by this paper). To help us achieve these goals, as well as provide some guidance on future activities, we adopted a stepwise systems analytic approach to the design of ecosystem restoration experiments developed by Covington et al. (1999; see *table 4*). Most of the steps outlined in such an approach have either been completed or are actively in progress.

Our results are intended to summarize baseline data collected at the beginning of a long-term restoration effort in two high priority habitats in the interior West. Our data were not collected to examine the direct effects of restoration activities on existing breeding bird communities, nor for comparing avian responses to different restoration approaches (e.g., building different types of fence). Rather, our intent is that data summarized here will serve as a basis against which to compare future assessments of the breeding aspen and ponderosa pine avifauna in our study area. We simply chose to use birds, rather than any other taxa, as a tool with which to monitor ecosystem conditions and evaluate hypotheses. Only in this way will we have a mechanism by which to judge the ecological impacts of our restoration efforts (Covington et al. 1999). Although we have no data to support it, our initial impression is that the four-strand barbed wire fence, in combination with some additional stock panel caging around individual clumps of regenerating aspen within the fence perimeter, will provide the most cost-effective protection. Only through additional bird monitoring, in combination with habitat assessments, will we know for sure.

Our results do suggest that aspen habitat in Wallowa County, Oregon, supported a richer breeding bird community compared with ponderosa pine. This finding contrasts with Sallabanks et al. (2001) who analyzed species-habitat associations in Eastside forests of Oregon and Washington. In that review, 77 bird species were associated with upland aspen and 131 species were associated with ponderosa pine. Our results also indicate that bird communities in aspen forests of Wallowa County were richer than other aspen in the interior West (e.g., DeByle 1981, DeByle et al. 1987). One possible reason for the relatively high number of species detected is that the aspen we studied did not occur as pure stands of climax forest but rather as mixed seral forest including ponderosa pine, grand fir, lodgepole pine, and western larch. Indeed, the lack of large tracts of pure aspen is one indication of the degree to which this habitat in our study area has become degraded by conifer encroachment. Increased habitat heterogeneity would presumably support a more diverse bird community. As a result, bird species that are not typically considered aspen associates were abundant at our aspen study sites (e.g., Chipping Sparrow and Pine Siskin). Consequently, birds known to be aspen specialists (e.g., Red-naped and Williamson's Sapsuckers) may suffer negatively from increased competition with other species for resources. Regardless of the reason for the apparent richness of the breeding aspen avifauna in Wallowa County, our data nevertheless confirm the importance of aspen to birds, justify its classification as a high priority habitat by Partners in Flight (Altman 2000), and reiterate the need for our restoration efforts.

Table 4— *A stepwise systems analytic approach to the design of ecosystem restoration experiments (modified from Covington et al. 1999), with the progress of our aspen/pine project in the Wallowa Mountains, northeast Oregon, summarized.*

	Recommended step	Aspen/pine project status
1	Clearly diagnose the symptoms and causes of the ecosystem health problem (i.e., what are the symptoms of degradation and what are the underlying mechanisms?)	Completed
2	Determine reference conditions (i.e., what was the condition of the ecosystem before degradation?)	In progress
3	Set measurable ecological restoration goals (i.e., how close to reference conditions do you intend to get? How will you know if you are moving in the right direction?)	In progress
4	What factors are most limiting to the restoration process?	In progress
5	Develop alternative ecosystem restoration hypotheses	Completed
6	Design restoration treatments that will allow you to test the alternative hypotheses	Completed
7	Implement restoration treatments defined in Step 6	In progress
8	Monitor ecosystem conditions and evaluate hypotheses	In progress
9	Feed the results back into the design and implementation of restoration experiments	Results pending

Abundance of several species differed between years. Such annual variation is typical (Franzreb and Ohmart 1978, Szaro and Balda 1979, Hejl et al. 1988), with numbers often responding to weather-related migration patterns, annual differences in immigration rates from, or emigration rates to, surrounding landscapes, and reproductive success in previous years. In particular, the Dark-eyed Junco and Pine Siskin were more abundant in 2000 whereas the European Starling and Western Wood-pewee were more abundant in 2001. Among these, the Pine Siskin, in particular, is known for sporadic changes in abundance and foraging behavior and has shown significant interactions between habitat use and year elsewhere in the inland west (Tobalske et al. 1991).

In general, average rates of nest success were comparable between aspen and pine, as well as with other published studies (e.g., Martin 1992). Unfortunately, because demographic studies of birds in aspen and pine habitats of the interior West have not been previously conducted, more specific comparisons are not possible. Within our study, rates of nest success and estimates of productivity were highly variable among study sites. These data might reflect habitat quality, suggesting that there was a considerable range in the degree to which aspen and pine stands were degraded in our study area. Indeed, local resource managers readily recognized that aspen at Target Springs were in poorer health than those at other sites included in our sample, which is one reason why we initiated restoration treatments there before moving on to less degraded stands. The extremely low production reported for the Hidden Springs pine stand is suggestive of sink habitat, and again may reflect the severely degraded condition of this particular forest. Additional data and more thorough analyses that incorporate micro- and macro-habitat features are likely needed to interpret why birds at Hidden Springs appear to be doing so poorly.

Recapture and resighting of previously banded birds suggested high site fidelity by several species. In particular, we caught several male Warbling Vireos that had been banded the previous summer. This Neotropical migrant is known to be highly site-faithful from one breeding season to the next (Gardali and Ballard 2000), and aspen stands in Wallowa County appear to be no exception. One male House Wren and one male Red-naped Sapsucker, both long-distance migrants (but not strictly Neotropical migrants), also returned to breed in the same territory in 2001 as they did the year before. These observations, although clearly preliminary, indicate the importance of maintaining existing aspen stands as available breeding habitat for numerous species. Before we can use our marked birds to estimate annual survivorship, however, additional banding in subsequent years will need to occur.

Several years into our long-term restoration project, we believe that significant progress has been made toward the goals and objectives established in 2000. To date, approximately 8 km of fence have been built around aspen stands, 250 ha of aspen habitat have been protected, and approximately 800 ha of pine have been burned as part of our restoration project. With the exception of some prescribed burning in one of our pine sites, all of our short-term goals have been successfully realized. Many project partners have become actively engaged in the restoration process, including private land owners. To date, approximately 18 partners (e.g., foundations, agencies, private individuals) have played a role in implementing this project. Momentum is building toward increased funding and in-kind support for additional treatments, and the potential to at least double the amount of aspen fenced and the amount of pine burned during the 2003–2004 seasons is very realistic. As we have illustrated by presenting brief summaries in this paper, the avian monitoring component of our study also was very successful, yielding a considerable amount of data on nesting success and community composition that has not previously been described for aspen and pine in the interior West. Overall, we are confident that we have sufficient bird and habitat data (habitat data were collected, but not summarized in this paper) to accurately represent baseline conditions and describe bird-habitat relationships.

Monitoring of ecosystem conditions (plant and avian community structure, as well as the productivity of breeding bird species) needs to continue for several years, pending sufficient funding. Such monitoring is critical for gauging habitat recovery, restoration progress, and ultimately therefore, project success. The first of several planned analyses will be to describe the current composition and population health of breeding bird communities in degraded stands of aspen and pine in Wallowa County. Subsequent analyses will focus on the short-term (3 to 5 yr) response of plant and bird communities to fence building and burning in aspen and pine, respectively. Following our initial period of data collection (2000–2001), monitoring does not need to occur on an annual basis, but perhaps only every other year for vegetation and every 3 to 5 years for birds. For example, in 2002, we did not collect any bird data but did revisit all aspen stands and collect habitat data as done previously in 2000; pine stands will be re-sampled pending additional burning in the fall. Alternatively, we might envision a series of short-term monitoring periods, each of which lasts 2 years, occurring in 2005, 2010, 2015, etc. Such a schedule would allow us to monitor ecosystem changes over time, but without the added burden of finding funding on an annual basis.

Acknowledgments

Support for this project to date has been provided by the National Fish and Wildlife, Packard, Ford, LaSalle-

Adams, and Oregon Community Foundations; the American Bird Conservancy; the USDA Forest Service; Rocky Mountain Elk Foundation; Blue Mountains Elk Initiative; Oregon Nature Conservancy; Oregon Department of Fish and Wildlife, Wallowa Resources; and the Sustainable Ecosystems Institute. We are especially grateful to private landowners Don Marks and Don Buhler for allowing us access to their land to conduct bird monitoring and initiate restoration activities. Nick Nolte of the Wallowa Fire Zone provided information on the fall prescribed burns. The Oregon Youth Conservation Corps and Wallowa Ranch Camp kindly assisted with the construction of fences, clearance of competing conifers, and vegetation monitoring. Bob Altman and Terry Rich provided valuable comments on a previous version of this paper. We also thank the following for collecting bird and habitat data during field seasons 2000–2001: Ben Flemer, Craig Fosdick, River Gates, Eric Hallingstad, Jason Meyer, Courtney Sherwood, and Kevin Warner.

Literature Cited

Agee, J. K. 1999. **Fire effects on landscape fragmentation in interior west forests.** In: J. A. Rochelle, L. A. Lehmann, and J. Wisniewski, editors. Forest fragmentation: Wildlife and management implications. Leiden, The Netherlands: Brill Academic Publishers; 43–60.

Altman, B. 2000. **Conservation strategy for landbirds in coniferous forests of the Northern Rocky Mountains.** Version 1.0. American Bird Conservancy and Partners-in-Flight. 86 p., plus Appendices. See http://community.gorge.net/natres/pif/con_plans/north_rocky/north_rocky.html.

Bradshaw, A. D. 1993. **Restoration ecology as a science.** Restoration Ecology 1: 71–73.

Chappell, C. B., R. C. Crawford, C. Barrett, J. Kagan, D. H. Johnson, M. O'Mealy, G. A. Green, H. L. Ferguson, W. D. Edge, E. L. Greda, T. A. O'Neil. 2001. **Wildlife habitats: Descriptions, status, trends, and system dynamics.** In: D. H. Johnson and T. A. O'Neil, managing directors. Wildlife-habitat relationships in Oregon and Washington. Corvallis: Oregon State University Press; 22–114.

Covington, W. W., and M. M. Moore. 1994. **Postsettlement changes in natural fires regimes and forest structure: Ecological restoration of old growth ponderosa pine forests.** In: R. N. Sampson and D.L. Adams, editors. Assessing forest ecosystem health in the inland west. New York: The Haworth Press; 153-181.

Covington, W. W., W. A. Niering, E. Starkey, and J. Walker. 1999. **Ecosystem restoration and management: Scientific principles and concepts.** In: N. C. Johnson, A. J. Malk, W. T. Sexton, and R. C. Szaro, editors. Ecological stewardship: A common reference for ecosystem management. New York: Elsevier Science; 599–617.

DeByle, N. V. 1981. **Songbird populations and clearcut harvesting of aspen in northern Utah.** Res. Note INT-302. Ogden, UT: Intermountain West Research Station, Forest Service, U.S. Department of Agriculture; 8 p.

DeByle, N. V., C. D. Bevins, and W. C. Fischer. 1987. **Wildlife occurrence in aspen in the interior western United States.** Western Journal of Applied Forestry 2: 73–76.

DeSante, D. F. 1992. **Monitoring avian productivity and survivorship (MAPS): a sharp, rather than blunt, tool for monitoring and assessing landbird populations.** In: D. R. McCullough and R. H. Barrett, editors. Wildlife 2001: Populations. London: Elsevier Applied Science; 511–521.

Franzreb, K. E., and R. D. Ohmart. 1978. **The effects of timber harvesting on breeding birds in a mixed-coniferous forest.** Condor 80: 431–441.

Gardali, T., and G. Ballard. 2000. **Warbling Vireo (*Vireo gilvus*).** In: A. Poole and F. Gill, editors. The birds of North America, No. 551. Philadelphia, PA: The birds of North America, Inc.; 28 p.

Hejl, S. J., J. Verner, and R. P. Balda. 1988. **Weather and bird populations in true fir forests of the Sierra Nevada, California.** Condor 90: 561–574.

Martin, T. E. 1993. **Breeding productivity considerations: What are the appropriate habitat features for management?** In: J. M. Hagan, III, and D. W. Johnston, editors. Ecology and conservation of Neotropical migrant landbirds. London: Smithsonian Institution Press; 455–473.

Martin, T. E., and G. R. Geupel. 1993. **Nest monitoring plots: Methods for locating nests and monitoring success.** Journal of Field Ornithology 64: 507–519.

Martin, T. E., and C. J. Conway. 1994. **BBIRD field protocol.** Unpublished Report. Missoula: Montana Cooperative Wildlife Research Unit, University of Montana; 39 p.

Pyle, P. 1997. **Identification guide to North American birds.** Part 1. Bolinas, CA: Slate Creek Press; 732 p.

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. **Handbook of field methods for monitoring landbirds.** Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41 p.

Sallabanks, R. 1995. **Avian biodiversity and bird-habitat relationships in conifer forests of the inland northwest: an ecosystem management approach.** Unpublished annual report. Eagle, ID: Sustainable Ecosystems Institute,; 150 p.

Sallabanks, R. 2000a. **Nongame landbird conservation and the restoration of aspen and ponderosa pine habitat in Wallowa County, northeast Oregon.** Unpublished 2000 interim report. Eagle, ID: Sustainable Ecosystems Institute; 21 p.

Sallabanks, R. 2000b. **Birds in the Blues: Restoration of priority habitats in Oregon's Blue Mountains.** Bird Conservation 14: 8.

Sallabanks, R. 2001. **Nongame landbird conservation and the restoration of aspen and ponderosa pine habitat in Wallowa County, northeast Oregon.** Unpublished 2001 annual report. Eagle, ID: Sustainable Ecosystems Institute; 23 p.

Sallabanks, R., B. G. Marcot, R. A. Riggs, E. B. Arnett, and C. A. Mehl. 2001. **Wildlife of eastside (interior) forests and woodlands.** In: D. H. Johnson and T. A. O'Neil, managing directors. Wildlife-habitat relationships in Oregon and Washington. Corvallis, OR: Oregon State University Press; 213–238.

Szaro, R. C., and R. P. Balda. 1979. **Bird community dynamics in a ponderosa pine forest.** Studies in Avian Biology 3: 1–66.

Tobalske, B. W., R. C. Shearer, and R. L. Hutto. 1991. **Bird populations in logged and unlogged western larch/Douglas-fir forest in northwestern Montana.** Research paper INT-442. Ogden, UT: Intermountain West Research Station, Forest Service, U.S. Department of Agriculture; 12 p.