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Large-Scale Conservation Assessment for Neotropical Migratory Land Birds in the Interior Columbia River Basin

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Interior Columbia Basin Ecosystem Management Project: Scientific Assessment

Thomas M. Quigley, Editor

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Abstract

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The status and habitats of Neotropical migratory land birds (NTMB) are evaluated within the interior Columbia River basin (interior basin). Objectives are to examine population trends, estimate NTMB responses to alternative management activities, and provide recommendations by habitat and species for the long-term persistence of NTMB populations. Among 132 NTMBs that breed in the interior basin, 38 species showed significant population trends over two time periods, 1968-94 (26 years), and 1984-94 (10 years). Fourteen species had significant declines over the 26-year period and 13 over the 10-year period; 13 and 12 species showed significant increases over those periods, respectively. Among 16 defined habitats, riparian vegetation was used by more species (64 percent) than any other habitat. Other habitats used by many species included young coniferous forest (38 percent) and old-growth/mature forest (35 percent). Nine habitats had more species with significantly decreasing than increasing populations (26-year period), and seven habitats had more increasing species. Five habitats (riparian, old-growth forests, shrub-steppe, grasslands, and juniper) are identified for management priorities based on declines in species, vulnerability to human activities, and habitat loss. Among the four management themes considered, more species (63) were of high concern under consumptive management than any other theme. Active and passive management themes are predicted to have negative effects on the fewest species, 23 and 16, respectively.

Keywords: Neotropical migrants, migratory birds, interior basin, population trends, conservation assessment, land use planning, management themes, bird-habitat associations.

Preface

The Interior Columbia Basin Ecosystem Management Project was initiated by the Forest Service and the Bureau of Land Management to respond to several critical issues including, but not limited to, forest and rangeland health, anadromous fish concerns, terrestrial species viability concerns, and the recent decline in traditional commodity flows. The charter given to the project was to develop a scientifically sound, ecosystem-based strategy for managing the lands of the interior Columbia River basin administered by the Forest Service and the Bureau of Land Management. The Science Integration Team was organized to develop a framework for ecosystem management, an assessment of the socioeconomic and biophysical systems in the basin, and an evaluation of alternative management strategies. This paper is one in a series of papers developed as background material for the framework, assessment, or evaluation of alternatives. It provides more detail than was possible to disclose directly in the primary documents.

The Science Integration Team, although organized functionally, worked hard at integrating the approaches, analyses, and conclusions. It is the collective effort of team members that provides depth and understanding to the work of the project. The Science Integration Team leadership included deputy team leaders Russel Graham and Sylvia Arbelbide; landscape ecology—Wendel Hann, Paul Hessburg, and Mark Jensen; aquatic—Jim Sedell, Kris Lee, Danny Lee, Jack Williams, Lynn Decker; economic—Richard Haynes, Amy Home, and Nick Reyna; social science—Jim Burchfield, Steve McCool, and Jon Bumstead; terrestrial—Bruce Marcot, Kurt Nelson, John Lehmkuhl, Richard Holthausen, and Randy Hickenbottom; spatial analysis—Becky Gravenmier, John Steffenson, and Andy Wilson.

Thomas M. Quigley
Editor

United States Department of Agriculture

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Interior Columbia Basin Ecosystem Management Project

Introduction

Widespread population declines among many species of Neotropical migratory birds (NTMBs) (Hagan and Johnston 1992, Martin and Finch 1995, Rappole 1995, Terborgh 1989) have intensified interest in avian conservation among citizens of the United States and Canada and have generated new conservation initiatives at the international level. The North American Breeding Bird Survey (BBS), a continentwide program that collects information annually on songbird populations, found that 75 percent of forest-dwelling migrants in eastern North America declined in population during the 1980s (Robbins and others 1989). In 1990, this fact prompted the creation of an international conservation network, Partners in Flight (PIF), an initiative aimed at conserving migratory land birds that breed mainly in temperate North America and winter primarily south of the United States-Mexico border (Finch and Stangel 1993, Rappole 1995, Rappole and others 1993). Partners In Flight has since led to an unprecedented network of individuals, agencies, and nongovernmental organizations operating not only in the breeding habitats of North America but also in the wintering habitats of Mexico, Central America, the Caribbean, and South America.

Although conservation action originated from population monitoring in the rich deciduous forest avifauna of the Eastern United States, densities of breeding migrants are much higher in riparian habitats of the Western United States (Bock and others 1993b, Finch 1991, Knopf and others 1988, Krueper 1993, Saab and Groves 1992). These habitats comprise less than 1 percent of the landscape in the arid Western United States, and are disproportionately valuable to, not only birds, but amphibians, bats, small and large mammals, and most other wildlife. Because of the presence of free water, however, riparian habitats have been greatly exploited and have suffered two centuries of degradation from livestock grazing, conversion to agriculture, water diversion, timber harvest, recreation, urbanization, and other activities (Bock and others 1993b, Knight and Gatzwiller 1995, Knopf and others 1988, Saab and others 1995, Thomas and others 1979).

In the interior Columbia River Basin (hereafter referred to as the interior basin) (fig. 1), 64 percent of 132 breeding migrants use riparian vegetation for nesting and foraging habitat (appendix 1). Compared to Eastern forest bird populations, migratory land birds using riparian habitats in the West might be particularly vulnerable to disturbance and habitat loss. Their habitats are fragmented and limited in distribution so that total population numbers probably are much smaller than those of migrants in woodlands of eastern North America (Terborgh 1989). Thus, protection of existing healthy riparian woodlands and restoration of degraded or destroyed riparian ecosystems is a high priority for PIF in the West.

Although fewer migrants inhabit shrub-steppe and grassland habitats, species that depend on them have suffered habitat losses through fire, livestock grazing, spraying, plowing, seeding, and conversion for agriculture (Bock and others 1993a, Knick and Rottenberry 1995, Saab and Groves 1992). For example, although perennial bunchgrasses, which historically provided 100 percent canopy coverage of grass on shrub-steppe sites, are undoubtedly important to nesting birds (Gregg and others 1994, Saab and others 1995), the long history of high-intensity grazing in the West greatly reduced the grass component of this ecosystem long before any studies were in place to evaluate its role. Similarly, the most productive Western grasslands were converted to agricultural crops a century or more before wildlife use was known. Thus, major declines in bird populations likely occurred without documentation. Yet despite these massive historical losses, consistent long-term population declines currently are noted for several species breeding in shrub-steppe habitats of Idaho (Saab and Groves 1992), Oregon (Andelman and Stock 1994a), and Washington (Andelman and Stock 1994b). Continentally, grassland species likewise have shown declines in numbers (Johnson and Schwartz 1993, Knopf 1988).

Coniferous forests provide nesting and foraging habitat for 45 percent of breeding migrants in the interior basin; thus, coniferous forests are the second most used habitat (after riparian) in the basin. In western North America, human-induced changes in coniferous forests have

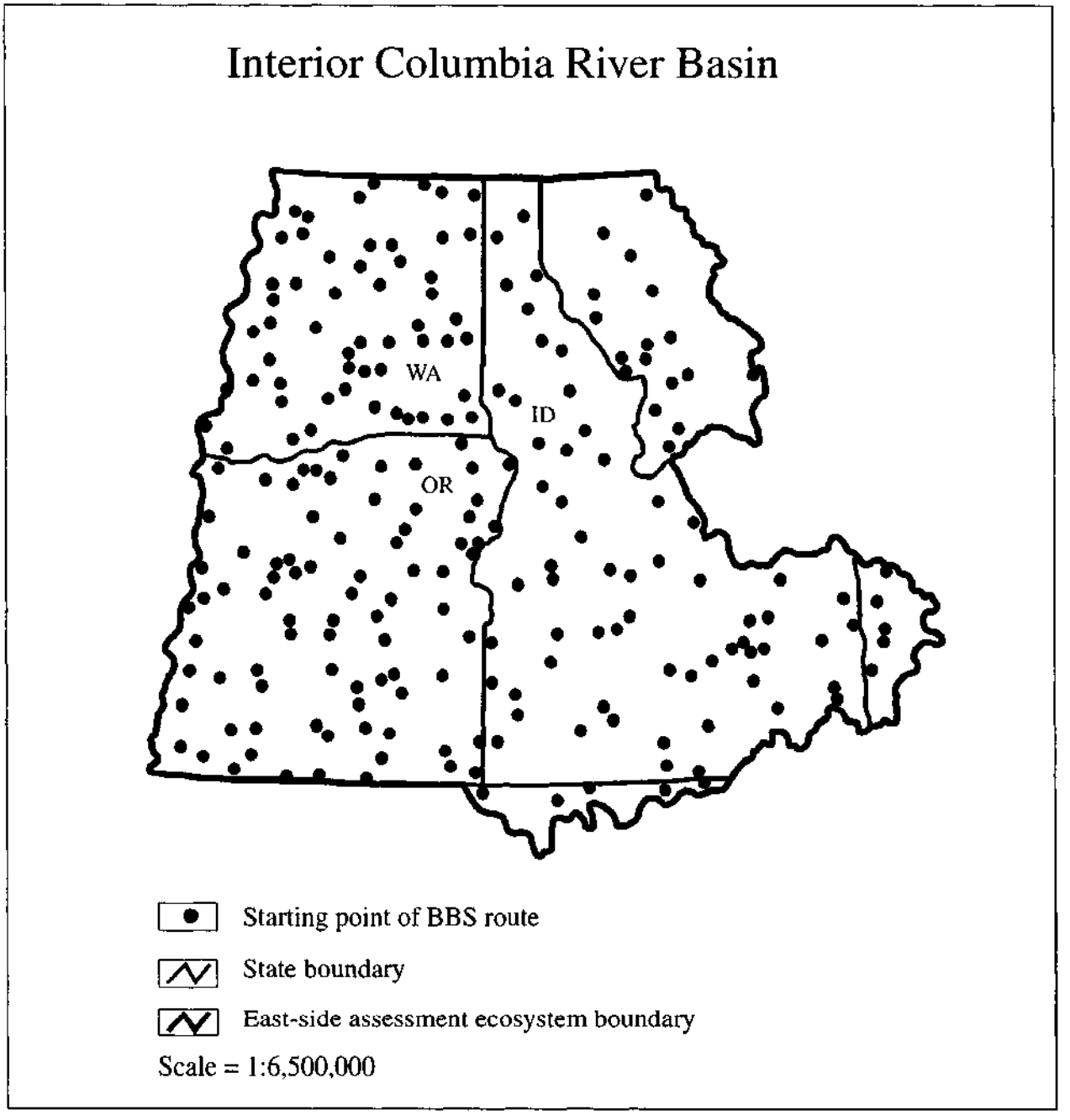

Figure 1—Location of BBS routes used for population-trend analysis for the periods 1968-94 (183 routes) and 1984-94 (175 routes).

altered bird populations during the past 100 years (Hejl 1992, 1994). Fire suppression and widespread timber harvest have modified landscape patterns of the northern Rocky Mountains, and subsequent changes in bird species composition and abundance have been observed (Hejl 1992, Hutto 1995a).

This report evaluates the status and habitats of Neotropical migratory land birds that breed within the interior basin (fig. 1). We consider landscape-level processes that are influenced by human activity and predict potential consequences for NTMB species. Objectives of our assessment were to (1) summarize and interpret

existing data on population trends of NTMBs within the interior basin; (2) estimate NTMB responses to alternative management activities outlined for the interior basin; and (3) provide recommendations by habitat and individual species on management activities for persistence of NTMB populations within the interior basin.

Methods

Species and Habitats

Methods were guided by existing protocol developed at national (Carter and Barker 1993) and regional levels (Andelman and Stock 1994a, 1994b). The PIF conservation assessment strategy, national PIF database (Carter and Barker 1993), and interior basin database (analysis by U.S. Geological Survey, Biological Resources Division) were used to analyze information on the status of the 132 NTMB species that breed in the interior basin. Procedures used to develop the analysis are presented in appendix 2. Interpretation of the PIF database relied primarily on BBS population trend data from 1968 to 1994 (26-year trends) and from 1984 to 1994 (10-year trends) that were estimated by the U.S. National Biological Service. Carter and Barker (1993) provide explanations of how population trends were interpreted.

To address regional concerns and evaluate conservation needs of NTMBs from a habitat basis, we followed methods, with some modifications, outlined by Andelman and Stock (1994a, 1994b). Data fields added to the national PIF database included several habitat associations for each species, a habitat risk ranking for four interior basin management themes over a 100-year period, habitat specialization, evidence for population decline, and a management index of concern (appendix 2). Note that management concern rankings are projected for the entire basin over a 100-year period. Population responses in more localized areas, or during some portion of the 100-year period, may be different from the broad projection. Analyses and management actions at finer scales will determine more localized effects and effects within different timeframes.

The list of breeding NTMB species and associated habitats in the interior basin was developed from reports by PIF committees from Oregon (Andelman and Stock 1994a), Washington (Andelman and Stock 1995b), Idaho (Ritter and Partners in Flight, Idaho Working Group 1994), and Montana (Casey and Partners in Flight, Montana Working Group 1994) (appendix 1). Each species was assigned as using one or more of 16 habitats which, in turn, represent aggregations of 180 cover types and structural stages identified for the interior basin ecosystem assessment (appendix 3). Habitat risk rankings were qualitatively assigned based on historic, current (Andelman and Stock 1994a, 1994b), and predicted rates of habitat loss, conversion, and degradation over a 100-year period from current time for interior basin management themes (appendix 4 tables 6-9). Because there are too many species (132) and cover type-structural stages (180) to evaluate simultaneously, this reduction of habitat categories helped focus our efforts on species likely to be most affected by alternative management activities. By aggregating 180 cover type-structural stages into 16 habitats, however, we may have masked impacts to certain species and cover types.

Habitat associations included both primary and secondary habitats used by a species for nesting and feeding during the breeding season. In many cases, secondary habitat included several habitats. Information on habitat use by each NTMB species was derived from PIF committee reports for Oregon (Andelman and Stock 1994a), Washington (Andelman and Stock 1995b), Idaho (Ritter and Partners in Flight, Idaho Working Group 1994), and Montana (Casey and Partners in Flight, Montana Working Group 1994), and from other selected regional publications (Dobkin 1993, Saab and Groves 1992). Knowledge is lacking on which habitats and landscapes have the greatest influence on the survival and reproduction of a given species. Thus, habitat assignments for each species entailed some subjectivity, and thus, habitat-level interpretations presented here should be considered with caution.

Specific habitat conservation priorities were based on results of known population trends for individual species, species-habitat associations, qualitative habitat risk rankings, and patterns of population trends within habitats. Monitoring,

research, and management recommendations were then developed for priority habitats. Species-specific recommendations were targeted primarily for species that require specialized monitoring techniques to determine population trends.

Land Management Activities

Land management activities are actions, usually created or controlled by humans, that have a direct influence on the environmental factors affecting the fitness of migrant bird species. These activities were used to develop the habitat risk rankings for current conditions (based on rate of habitat loss or conversion) by Andelman and Stock (1994a, 1994b) and for the interior basin management themes on public lands (appendix 4 tables 6-9).

Below are activities with a brief explanation of the nature and scope of the activity:

1. Livestock grazing—A widespread land use in the interior basin that removes vegetation, alters plant community composition and physical structure, increases the spread of exotic plants, attracts parasitic cowbirds, and negatively affects many migrants breeding within grazed habitats, particularly in arid portions of the interior basin (Bock and others 1993b, Saab and others 1995).

2. Public recreation—Recreational use often is concentrated in riparian areas in both open and forested habitats. Human activities can remove and damage vegetation, attract nest predators, destroy nests and nestlings, and generally disrupt the nesting activities of many bird species (Knight and Gutzwiller 1995, Saab 1996).

3. Water management—Stream channelization, dams, water diversion, spring development, willow spraying, cottonwood removal, and irrigation have altered the composition and structure of riparian vegetation and the associated bird communities (Saab 1996).

4. Fire suppression—Changes in natural fire regimes since the start of the 20th century have altered the structure and composition, primarily of forested plant communities and their associated bird communities (Hejl 1992, 1994; Hutto 1995a).

5- Habitat fragmentation—Fragmented habitats on the breeding grounds can negatively affect "habitat interior" species are species that nest away from habitat edges, and "area sensitive" species, those species whose densities and reproductive success are consistently higher in extensive habitat tracts (Finch 1991, Freemark and Collins 1992, Robinson 1992). As large habitat patches are fragmented into smaller patches, the proportion of edge to interior habitat increases. Nests along forest-agricultural edges and in small habitat patches are subject to higher rates of predation by corvids, raccoons, skunks, feral cats, dogs, and other animals (Finch and Stangel 1993). Brood parasitism also contributes to increased nesting losses along edges (Robinson and others 1993, 1995). Habitats are fragmented by the following activities:

a. Urban development—Removal of vegetation for residential or commercial development, particularly within low-elevation riparian zones of the interior basin (Saab 1996).

b. Agricultural development—Conversion of natural vegetation to agricultural crops, particularly within low-elevation riparian zones of the interior basin (Saab 1996).

c. Timber harvest—Removal and conversion of forested vegetation and concurrent road building (often in streamside habitats) (Hejl 1994).

d. Invasions of exotic plants—Conversion of native vegetation to exotic vegetation, particularly in shrub-steppe habitats vulnerable to invasions by exotic plants (Knick and Rotenberry 1995).

e. Exotic plant seedings—Conversion of native shrub-steppe habitats to crested wheatgrass seedings (Reynolds and Trost 1980).

f. Juniper control—Removal of junipers (plant scientific names listed in appendix 3) by logging or other mechanical methods (McCoy 1993).

Management Themes

We calculated four management concern indices for each NTMB species to evaluate bird responses to several interior basin management themes for a planning period of 100 years (appendices 5 and 6). Analyses and management activities at smaller scales will determine more localized effects and effects within differ-

ent timeframes The four management themes considered here represent various management activities (see previous section) proposed for public lands within the interior basin Assumptions of the themes are listed in appendix 5 The following are brief descriptions of the management themes

1 The no action (NA) theme follows the Forest and Bureau of Land Management plans as currently written Management would be similar to the past few years, restrictions on logging, grazing, and mineral extraction, wildfire suppression and limited prescriptive fire

2 The consumptive demand (CD) theme emphasizes the extraction of resources to meet social demands and economic efficiency All resource uses would be maximized for sustained yield with few restrictions on logging, grazing, or mineral extraction Fire management would be used to maximize commodity production

3 The active management (AM) theme emphasizes the maintenance and restoration of ecosystem functions and processes Timber harvest and silvicultural treatments focus on achieving forest structure and composition to provide for ecosystem function and processes There would be an emphasis on prescriptive fire with other vegetation management for ecosystem functions

4 The passive management (PM) theme emphasizes activities for ecological processes and management for nonconsumptive uses—no timber harvest, livestock grazing, mineral extraction, or prescriptive fire Fire prevention would be used only to protect the public

Results

Population Trends

Breeding Bird Survey data from 183 routes (1968-94) and 175 routes (1984-94) were used to estimate long-term population trends, based on the percentage of population change per year (fig 1) Among the 132 species of Neotropical migratory land birds considered in this analysis, 38 species (29 percent) demonstrated significant population trends over either the 26- or 10-year period (table 1) This includes 14 species with significant declines over the 26-year period and 13 species with significant declines over the 10-year period Thirteen and twelve species have shown significant increases over those periods, respectively

Considering only those species that showed significant trends in the same direction over both periods, there are seven species that declined and seven that increased (table 1) Consistent declines (and the percentage of population change per year over the 26-year period, table 1) are exhibited by the following species[/] killdeer (-4 3), olive-sided flycatcher (-2 9), willow flycatcher (-2 5), red-winged blackbird (-1 5), Western meadowlark (-0 8), brewer's blackbird (-1 3) and brewer's sparrow (-4 6) Consistent increases are evident in the red-tailed hawk (+4 3), spotted towhee (formerly Rufous-sided) (+3 5), black-headed grosbeak (+4 8), orange-crowned warbler (+3 5), gray catbird (+4 0), house wren (+4 4), and mountain bluebird (+4 0)

Focusing attention on species showing long-term consistent declines can conserve avifaunal diversity and prevent the need to list the species on the Federal "candidate, threatened or endangered" listing Similarly, species that show stable populations for the longer 26-year period but have had highly significant declines in the past 10 years may reflect serious new problems (for example, pine siskin, table 1)

Black-headed grosbeaks have experienced highly significant increases over both the 10- and 26-year periods, and a small group of species seems to be increasing more rapidly in the last 10 years than over the longer period These include the spotted towhee, orange-crowned warbler, gray catbird, house wren, and mountain bluebird The only species to move from stable to rapidly increasing is the osprey (table 1)

No species showed a reversal in significant trends, that is, no species declined significantly during the 26-year period and increased significantly during the 10-year period or vice versa Because the 10-year data are a subset of the 26-year data, this perhaps is not surprising

This analysis does not provide cause-effect explanations for current population trends of given species Natural history characteristics such as the location of nest placement, or nest

[/] Scientific names of bird species are given in appendix 1

Table 1—Neotropical migratory land birds in the interior basin for which Breeding Bird Survey sample size is sufficient (recorded on ≥14 routes) to quantify significant long-term declines or increases in population trends by percentage of change per year for 26-year (1968-94) and 10-year (1984-94) periods"

		Decline		Increase	
Species	Nest layer[6]	26 years	10 years	26 years	10 years
Osprey	CA				6.4"*
Red-tailed hawk	CA			4.3'"	4.0"
Golden eagle	CA				10.9"
Killdeer	GR	-4 3"*	-10 5"'		
Long-billed curlew	GR			5.1*"	
Mourning dove	SH	-2.2'"			
Red-naped sapsucker	CA			12.0'	
Calliope hummingbird	CA		-13.4"		
Olive-sided flycatcher	CA	-2.9"*	-4.2"		
Willow flycatcher	SH	-2 5"	-4 3"'		
Gray flycatcher	SH				13.6"
Say's phoebe	CA			5.4*	
Horned lark	GR	-2 9**			
Cliff swallow	CA			2.8***	
House wren	CA			4.4**	5.7*
Marsh wren	SH				8.8*
Mountain bluebird	CA			4.0***	8.1**
American robin	CA		-1.5'		
Gray catbird	SH			4.0**	6.3***
Loggerhead shrike	SH	-2.7**			
Warbling vireo	CA			4.1**	
Orange-crowned warbler	GR			3.5*	7.5**
Yellow warbler	SH		-2.1"		
Townsend's warbler	CA			5.2***	
Common yellowthroat	SH				2.8*
Black-headed grosbeak	SH			4.8***	5.4***
Spotted towhee	GR			3.5*	7.6***
Chipping sparrow	SH	-2.7***			
Brewer's sparrow	SH	-1.3***	-4.3***		
Lark sparrow	SH	-2.9"			
Savannah sparrow	GR		-3.2*		
Song sparrow	SH	-2.7***			
Red-winged blackbird	SH	-1.5'	-2.3*		
Western meadowlark	GR	-.8'	-3.7***		
Brewer's blackbird	SH	-1.3'	-4.3***		
Pine siskin	CA		-8.8***		
American goldfinch	CA	-2.1'			

[a]* $P < 0.10$ ** $P < 0.05$ and ***$P < 0.01$

[b]Nest layer abbreviations CA = subcanopy and canopy-nesting species, GR = ground-nesting species, SH = shrub-nesting species, based on characteristics described by Ehrrich and others (1988) and Martin (1993)

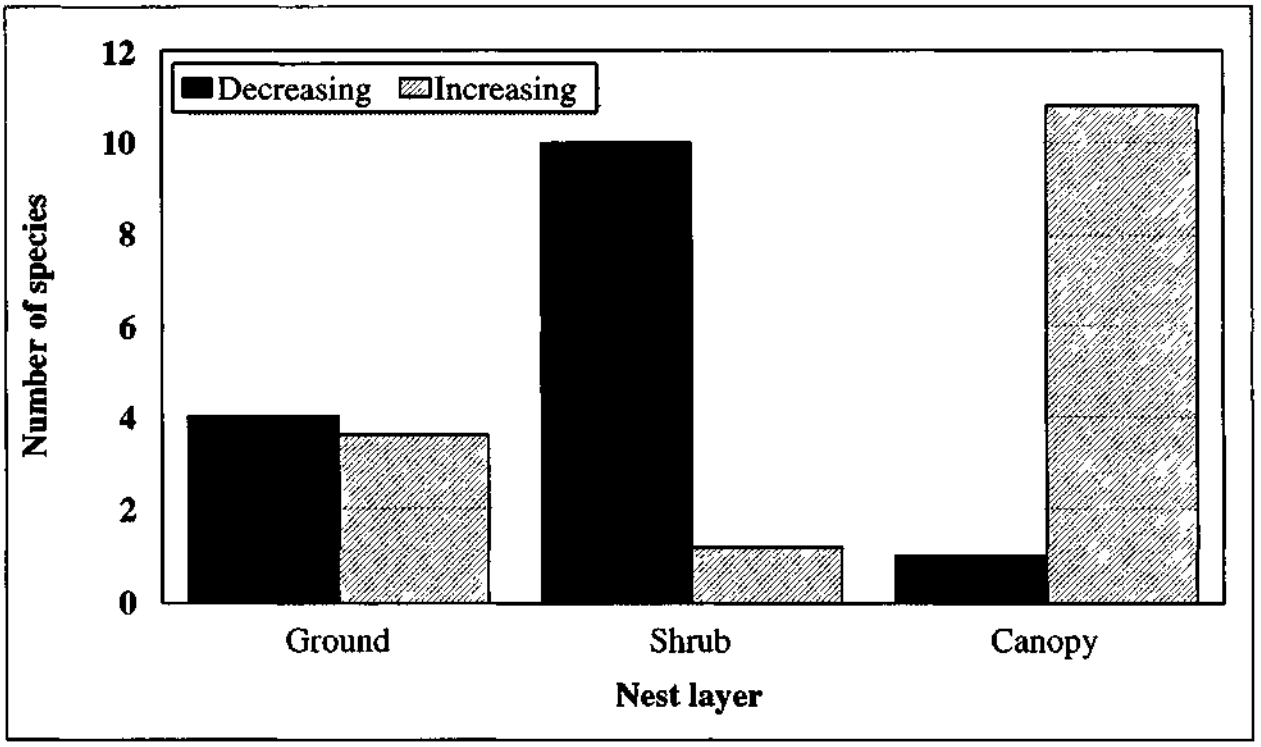

Figure 2—Number of NTMB species in each nest layer that show significant increases or decreases in population trends. The direction of population trend was not independent of nest layer (x^2 = 13.85, d.f.= 2, and P< 0.001).

layer, however, have been shown to be highly correlated with reproductive success and survival of many North American land birds (Martin 1993, 1995) and this pattern can be readily tested. The 28 species showing significant 26-year increases and decreases were categorized into one of three nest layers, based on location of the typical nest: ground, shrub, or canopy (table 1). Species with increasing population trends and those with decreasing trends were not equally distributed among nest layers (fig. 2, x^2 = 13.85, P < 0.001). Species with decreasing populations tend to be those nesting in the shrub layer, whereas species with increasing populations tend to nest in tree canopies. This is consistent with other findings and suggests that nest predation and cowbird parasitism may be playing a role in the reproductive success and survival of shrub-nesting species (Martin 1993, 1995). Additionally, shrub understories, which provide habitat for nesting birds, could be declining due to fire suppression. Changes in fire regimes among forests have caused losses in shrub understories and increases in closed multistory canopies, especially in lower montane ponderosa pine and dry Douglas-fir forests within the interior basin (table 2). This increase in closed canopies also could be an explanation for the increases in canopy-nesting birds. Canopy nesters also tend to increase in abundance as compared to shrub or ground nesters in habitats grazed by livestock (Saab 1996, Saab and others 1995).

Nearly 47 percent (62 of 132) of the Neotropical migratory land birds show no detectable population trend over both the 26- and 10-year periods (appendix 6). Thus, populations for almost half of the migrant species seem to be stable. This result should be viewed with caution, however, because the BBS is not appropriate for monitoring population trends or some of these species (see below).

Thirty-three species (25 percent), based on 26-year data, are not adequately sampled by the BBS method (status "I" and "P," table 3). These include 21 species (status "I," table 3) for which there are inadequate sample sizes because these

Table 2—Ecologically significant changes in broadscale cover type-structural stages within the interior Columbia River basin[a]

Cover type	Structural stage	Historic percentage	Current percentage
		Percent	
Big sagebrush	Open low shrub	20 83	15 24
Interior ponderosa pine	Old single-layer forest	5 52	1 01
Agropyron bunchgrass	Closed herbland	4 81	1 56
Mountain big sagebrush	Open mid shrub	3 26	03
Fescue bunchgrass	Closed herbland	5 53	2 53
Interior ponderosa pine	Stem exclusion closed canopy	3 47	83
Fescue bunchgrass	Open herbland	2 65	21
Agropyron bunchgrass	Open herbland	1 90	24
Big sagebrush	Closed low shrub	2 39	1 00
Big sagebrush	Closed herbland	1 35	21
Interior Douglas-fir	Stem exclusion closed canopy	2 78	1 78
Interior ponderosa pine	Stem exclusion open canopy	1 09	2 59
Low sage	Open low shrub	38	1 90
Grand fir and white fir	Stem exclusion closed canopy	10	1 69
Interior Douglas-fir	Young multilayered forest	18	2 35
Interior ponderosa pine	Young multilayered forest	09	3 34

[a] Riparian cover types were not included because the 1 kilometer resolution used to estimate percentages was not adequate for estimating the naturally small patch sizes of and land riparian vegetation

[2]Source Hann and others 1997

species typically do not sing, are secretive, are not active in the morning, or are too rare to be detected with sufficient frequency by the BBS Nothing can be said about trends in populations of these species

Twelve species (status "P," table 3) are rare in the area of analysis because they are on the periphery of their ranges Further concern over population trends or future monitoring of these species in the interior basin probably is not warranted A third group includes 28 species (status "S," table 3) that technically may have an adequate sample size in the BBS data but whose ecology and behavior indicate that a more specialized monitoring technique will provide better information

Specialized monitoring techniques are needed for 49 species that are designated by "I" and "S" (table 3)—"specialized" in the sense that something other than BBS must be used if biologists want to track their populations Specialized techniques already exist for some species For example, raptor biologists use various specialized techniques for owls and forest-nesting raptors (Fuller and Mosher 1981) But new techniques will have to be developed, or existing techniques significantly refined, for many other species

Habitat Use Patterns

Riparian habitat was used by more species than any other habitat (fig 3) Among the 16 habitats used in this analysis, 84 of 132 species (64 percent) use riparian habitat during the breeding season Other habitats used by a relatively large number of species include young conifer-

Table 3—Neotropical migratory birds in the Columbia River basin requiring specialized monitoring

Species	Status	Species	Status
Upland sandpiper	I[a]	Tennessee warbler	P
Sharp-shinned hawk	I	Northern mockingbird	P
Cooper's hawk	I	Long-billed curlew	S[c]
Northern goshawk	I	Swainson's hawk	S
Peregrine falcon	I	Ferruginous hawk	S
Merlin	I	Prairie falcon	S
Long-eared owl	I	Short-eared owl	S
Flammulated owl	I	Burrowing owl	S
Red-breasted sapsucker	I	Red-naped sapsucker	S
Common poorwill	I	Williamson's sapsucker	S
Black swift	I	Lewis' woodpecker	S
White-throated swift	I	Common nighthawk	S
Black-chinned hummingbird	I	Calliope hummingbird	S
Broad-tailed hummingbird	I	Cordilleran flycatcher	S
Ash-throated flycatcher	I	Gray flycatcher	S
Purple martin	I	Bobolink	S
Black-throated gray warbler	I	Yellow-headed blackbird	S
Hermit warbler	I	Purple finch	S
Northern waterthrush	I	Red crossbill	S
American pipit	I	Grasshopper sparrow	S
Blue-gray gnatcatcher	I	Sage sparrow	S
Yellow-billed cuckoo	*P*[b]	Lincoln's sparrow	S
Black-billed cuckoo	P	Green-tailed towhee	S
Least flycatcher	P	Bank swallow	S
Tri-colored blackbird	P	Red-eyed vireo	S
Lesser goldfinch	P	American redstart	S
Clay-colored sparrow	P	Marsh wren	S
Black-throated sparrow	P	Veery	**S**
Blue grosbeak	P	Western bluebird	**S**
Lark bunting	P	Mountain bluebird	**S**
Virginia's warbler	P		

[a] I = BBS data are insufficient Because of the ecology and natural history of these species it is unlikely that the sample size would increase with more BBS routes

[b] P = BBS data are insufficient Species occurs rarely in the interior basin because it is on the periphery of its range Species are considered on the periphery of their ranges if their range occupies < 10 percent of the interior Columbia River basin

[e] S = BBS data are technically sufficient but the ecology and behavior of these species indicate that specialized monitoring will provide more accurate information

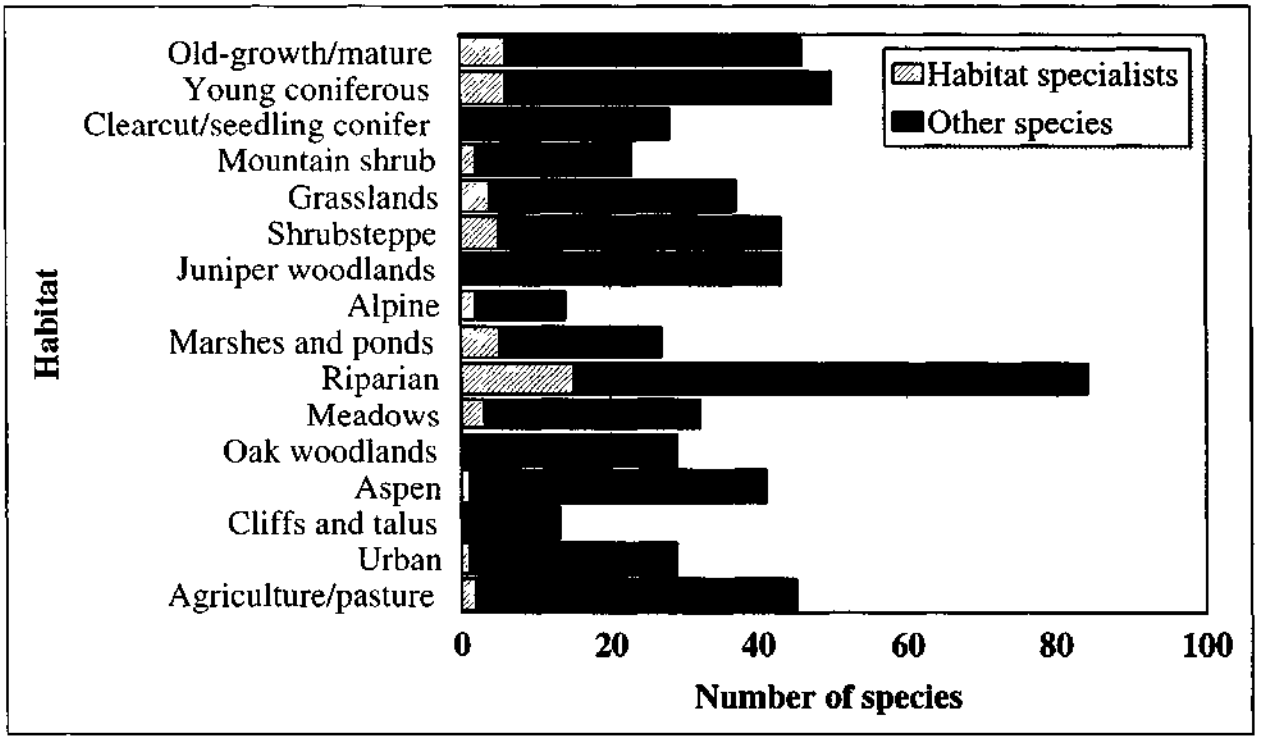

Figure 3—Number of NTMB species using each habitat during the breeding season. Note that many species typically use more than one habitat. Habitat specialists are those species using only one or two habitats.

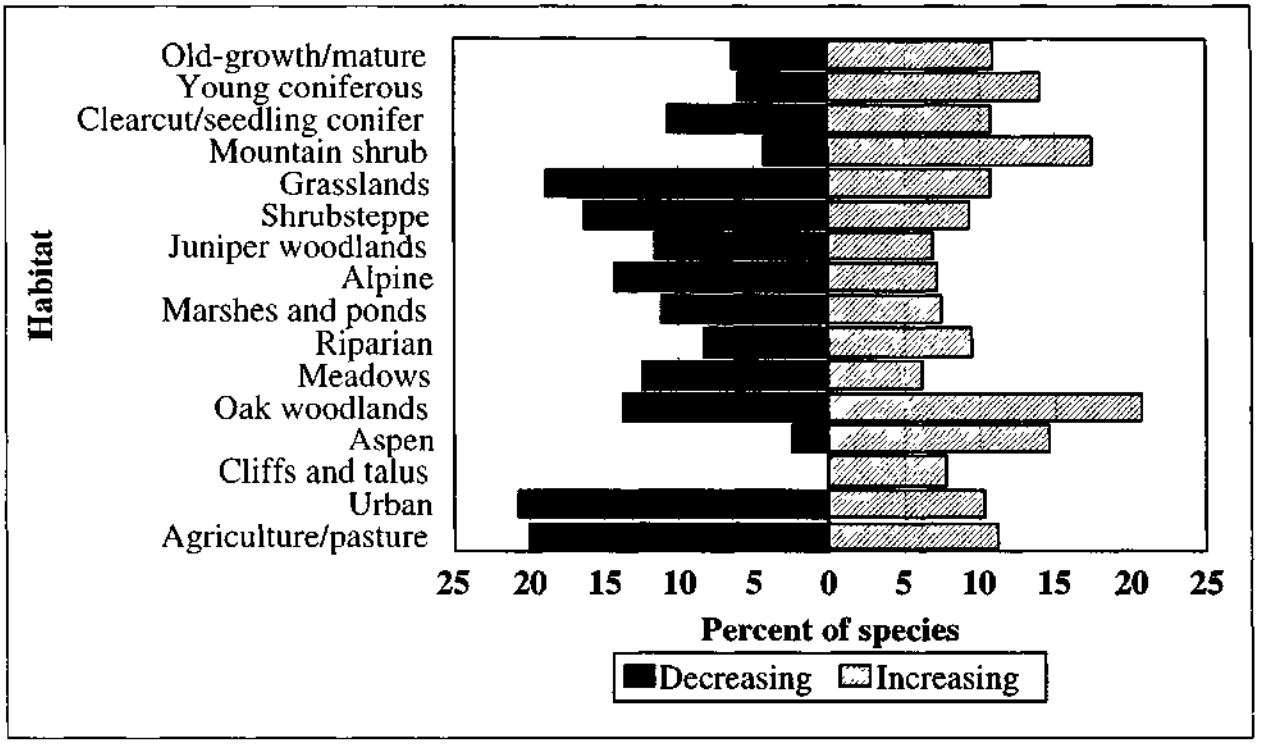

Figure 4—Percentage of NTMB species in each habitat with significant increasing or decreasing population trends from 1968 to 1994.

ous forest, 50 species (38 percent of all species); old-growth coniferous forest, 46 species (35 percent); agriculture-pastureland, 45 species (34 percent); shrub-steppe, 43 species (33 percent); and juniper woodlands, 43 species (33 percent). Cliffs, rocks, and talus had the least use, with 13 species (10 percent), whereas alpine (14 species or 11 percent) and mountain shrub-prairie brushfield (23 species or 17 percent) also were less used.

Considerable variation exists among species in the number of habitats they use. For example, willow flycatchers are found only in riparian habitats, whereas American kestrels use 14 of the 16 types in the planning area. In summary, 11 species used one habitat, 21 species used two habitats, 22 species used three habitats, and 28 species used four habitats. The remaining 50 species used five or more habitats.

Thirty-two species were considered habitat "specialists" based on their use of only one or two habitats (appendices 1 and 7). Again, riparian habitat emerges as important with 15 specialists (fig. 3). Other habitats important for specialists include old-growth coniferous forest and young coniferous forest with six species each. Freshwater marshes and ponds, and shrub-steppe habitats each host five specialists. Clearcuts, juniper woodlands, oak woodlands, cliffs, talus, and rocks had no specialists as defined here.

The percentage of avifauna that are specialists within habitats shows roughly the same pattern as absolute species numbers, with freshwater marshes and ponds highest (19 percent), followed by riparian (18 percent), alpine (14 percent), old-growth coniferous forest (13 percent), young coniferous forest (12 percent), and shrub-steppe (12 percent). Although few species use alpine habitats, there "was still a relatively high proportion of specialists when compared to its total avifauna. Several riparian specialists are widely distributed over the North American Continent (for example, gray catbird, veery, yellow warbler) (cf. Knopf and Samson 1995). Their global populations may not be as threatened by local management practices in the interior basin as those species with relatively narrow distributions; for example, species inhabiting shrub-steppe habitats (Brewer's sparrow and sage thrasher).

Key indicators of habitat condition and species for which management decisions may have the most impact are those 10 species that use only a single habitat. These are the yellow-billed cuckoo, black-billed cuckoo, least flycatcher, black-throated sparrow, willow flycatcher, Brewer's sparrow, yellow warbler, veery, gray catbird, and marsh wren. The first four of these are classified as peripheral to the interior basin (table 3) and are of greater concern in regions that include more of their ranges. The long-term conservation of species, however, may depend on the protection of genetically distinct peripheral populations (Lesica and Allendorf 1995).

Among the single-habitat specialists that are not peripheral in the interior basin, marsh wrens occur only in freshwater marshes and have a significantly increasing population (table 1). Brewer's sparrow breeds only in shrub-steppe habitats (and open juniper woodlands with an understory of shrub-steppe vegetation) and has a significantly declining population. The other four species are all riparian specialists. The gray catbird population is significantly increasing, the veery shows no trend (possibly because of inadequate monitoring), and the willow flycatcher and yellow warbler populations (10-year period only) are significantly declining (table 1). Thus, shrub-steppe and riparian stand out from the other 14 habitats as being higher priorities in terms of specialist species.

Evaluating all species with significant 26-year population trends, by habitat, shows that seven habitats have more increasing than decreasing populations (old-growth coniferous, young coniferous, mountain shrub, riparian, oak woodland, aspen, and cliffs and talus) (fig. 4). We view this with caution because (1) both primary and secondary habitats for all species are included; and (2) in many cases, one habitat represents several cover type-structural stages, which could be concealing the results for certain cover types. Sample sizes are not sufficient to consider increasing and decreasing trends of only habitat specialists (those species using only one or two habitats), but specialists have more increasing populations of species.

Nine habitats have more species with significantly decreasing than increasing populations, including urban and agriculture-pastureland.

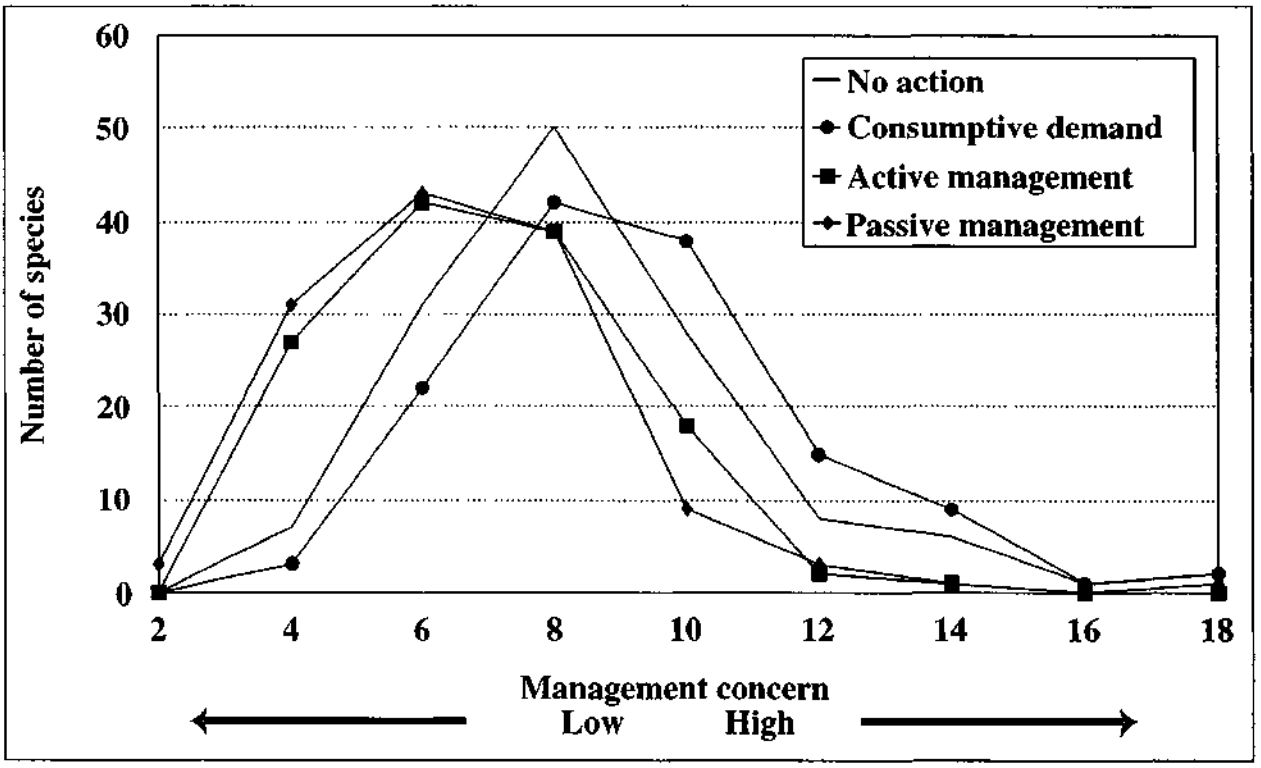

Figure 5—Number of NTMB species within each management index category (or management concern ranking) by management theme.

Urban and agricultural lands do not provide primary habitat for native avifauna but are used secondarily. For example, many declining grassland birds (Western meadowlark, horned lark, and lark sparrows) inhabit human-modified landscapes (appendix 1) after their native grasslands have been altered by urbanization and agriculture.

Management Themes

To summarize a comparison of all species under all themes, we designated species with a management index of ≥ 9 as species of high concern to management (fig. 5). The value of 9 was selected because it is the median of all index values. More species (48 percent or 63 of 132) were of high concern to management under consumptive demand than under any other theme (figs. 5 and 6). Fewer species were of concern under the no action theme (33 percent or 44 species), active management (17 percent or 23 species) and passive management (12 percent or 16 species) themes.

A mean index for management was calculated for all 132 species under each theme to further aid comparison. These values (x+ lsd) are as follows: consumptive demand 9.06 $\pm$ 0.22; no action 8.35 $\pm$ 0.23; active management 6.93 $\pm$ 0.18; and passive management 6.7 $\pm$ 0.21. There was a significant difference among themes (Kruskal-Wallis, $x^2 = 84.6$, $P < 0.0001$). A least significant difference multiple-comparisons test revealed that mean management indices differed among all pairs of themes except between active and passive management.

Birds of riparian, freshwater marshes and ponds and shrub-steppe habitats would be most affected by the consumptive demand theme (figs. 6b and 6c). Nearly half (45 percent) of all riparian species, 44 percent of species using freshwater marshes and ponds, 44 percent of shrub-steppe species, and 43 percent of both grassland and alpine species would be of high concern to management under consumptive demand. In aspen habitats, 34 percent of all species would be of high concern under the consumptive theme, whereas no species would

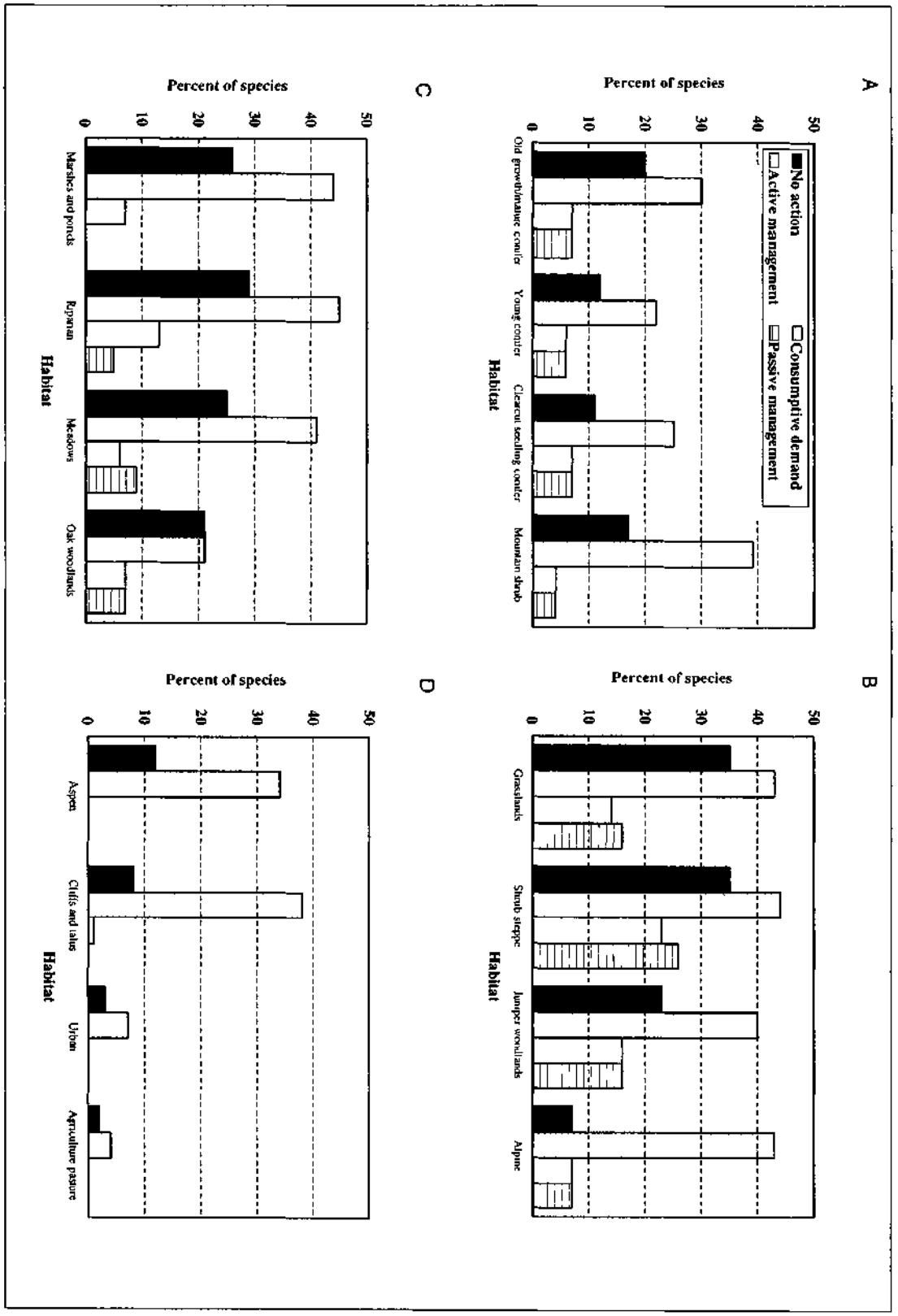
A
Percent of species
No action
Consumptive demand
Active management
Passive management
Old growth/mature conifer
Young conifer
Clearcut seedling conifer
Mountain shrub
Habitat
B
Percent of species
Grasslands
Shrub steppe
Juniper woodlands
Alpine
Habitat
C
Percent of species
Marshes and ponds
Riparian
Meadows
Oak woodlands
Habitat
D
Percent of species
Aspen
Cliffs and talus
Urban
Agriculture pasture
Habitat

Table 4—Species of high concern to management (management index ≥ 9) under all themes

Species	Primary habitats for breeding
Lewis' woodpecker	Coniferous forest, riparian
Olive-sided flycatcher[a]	Coniferous forest
Willow flycatcher[a]	Riparian
Sage thrasher	Shrub-steppe
Loggerhead shrike[a]	Shrub-steppe
Hermit warbler	Coniferous forest
Virginia's warbler	Juniper woodland
Lark bunting	Shrub-steppe, grassland
Lark sparrow[a]	Shrub-steppe
Brewer's sparrow[a]	Shrub-steppe
Sage sparrow	Shrub-steppe
Black-throated sparrow	Shrub-steppe
Western meadowlark[a]	Shrub-steppe, grassland
Brewer's blackbird[a]	Shrub-steppe
Pine siskin[a]	Coniferous forest

[a] Species experiencing long-term population declines based on BBS data

be in this category under active or passive themes Species using cliffs and talus, urban, and agricultural lands would be least affected by any theme (fig 6d)

Fifteen species were of high concern under all themes (table 4) Of those, nine use shrub-steppe vegetation as their primary nesting habitat Shrub-steppe cover types (sagebrush and bunchgrass types) have experienced the greatest loss of all habitats within the interior basin (table 2) and are predicted to decline in the future under all management themes (table 5) This indicates a need for greatly increased protection of healthy shrub-steppe ecosystems, restoration of damaged systems, and improved management of all shrub-steppe (see Saab and others 1995)

Two species of high concern to management, Lewis' woodpecker and olive-sided flycatcher, use open, mature coniferous forest and postfire forests as primary nesting habitats (Dobkin 1993, Ehrhch and others 1988, Hutto 1995a). These habitats have declined over the past 100 years because of timber harvest and fire suppression, respectively (Hejl 1994). Of all forest cover types in the interior basin, the fire-maintained, old-growth ponderosa pine forests have suffered the greatest losses (table 2)

Eight of the preceding 15 species also are experiencing long-term population declines, thereby suggesting that current management activities may not be compatible with long-term persistence of these populations. These species include the olive-sided flycatcher, willow flycatcher, loggerhead shrike, lark sparrow, Brewer's sparrow, Western meadowlark, Brewer's blackbird, and pine siskin. Loggerhead shrikes have experienced significant long-term population declines on local (Saab and Groves 1992),

Table 5—Estimated areas (hectares) of habitats representing terrestrial communities for historical, current, and future periods by two management themes (100 years from present)[a]

Habitat	Terrestrial communities	Historic	Current	No action	Active
Agriculture	Agriculture	0	13,437,929	12,770,206	12,770,206
Alpine	Alpine	166,930	166,930	166,930	166,930
Clearcut/ seedling/ shrub coniferous	Early montane, early lower montane, and early subalpine	9,181,194	8,346,540	7,261,489	9,014,263
Old-growth/ mature coniferous forest	Late montane, late lower montane, and late subalpine	11,017,433	6,593,767	10,433,175	12,019,018
Young coniferous forest and mid subalpine	Mid montane, mid lower montane,	15,107,237	22,368,727	20,282,092	17,945,061
Cliffs/rocks/talus	Rock/barren	166,931	166,931	166,931	166,931
Grasslands and wet, dry, hay meadows	Upland herbland and exotics	12,102,483	5,842,578	10,933,967	11,685,156
Shrub-steppe and mountain shrubs	Upland shrubland	30,631,802	21,283,677	16,442,684	16,025,357
Juniper and aspen and oak woodlands	Upland woodland	1,585,843	2,337,031	2,587,427	1,669,308
Urban	Urban	0	166,931	500,792	500,792
Freshwater marshes, ponds, lakes	Water	751,189	751,189	751,189	751,189

" Riparian habitat was not included because the 1-kilometer resolution used to estimate these areas was not adequate for estimating the naturally small patch sizes of and land riparian vegetation

Source Hann and others 1997

regional (Andelman and Stock 1994a, 1994b), and continental scales (Peterjohn and others 1994). Reasons for the decline in shrike populations are not well understood but may include pesticides and some grazing practices (Bock and others 1993, Woods and Cade 1996).

Habitat Conservation Strategies

Managers can maximize the effectiveness of conservation efforts by using habitat or ecosystem-level conservation strategies rather than focusing on individual species, whenever possible. For this approach, patterns of habitat losses in the past, present, and future are considered for setting habitat conservation strategies. The environmental assessment for the interior basin estimated areal extents of vegetative communities for historic (presettlement), current, and future conditions over a 100-year period throughout the interior basin (table 5), and our qualitative habitat risk rankings reflect those predictions for habitat changes based on the no action and active management themes (appendix 4 tables 6 and 8). Areas of riparian vegetative communities were not included because the 1-kilometer resolution was not adequate for estimating the naturally small patch sizes of riparian vegetation. Habitat responses to passive and consumptive demand themes were estimated without areal extent information because it was not available. By using the habitat risk rankings according to management theme and population trend data, we identified three primary factors for setting habitat conservation priorities: (1) habitats with the greatest percentage of species declining, (2) habitats with the greatest percentage of species vulnerable to management activities outlined for the various themes, and (3) habitats that are highly vulnerable to loss, degradation, or conversion under the different themes (cf. Andelman and Stock 1994a, 1994b).

Nine of sixteen habitats had a greater percentage of species with decreasing rather than increasing population trends (fig. 4), although no habitat had statistically more decreasing than increasing populations (chi-square tests, $P > 0.05$). (We caution that these results could be masking effects to certain cover type-structural stages that were aggregated into one habitat.) The natural habitats with more declining species included grassland, shrub-steppe, juniper, alpine, marshes and ponds, and meadows. In addition, three of these habitats (grasslands, shrub-steppe, and juniper) also were considered to be highly vulnerable to loss, degradation, or conversion under at least two themes (appendix 4, tables 6-9, ranked as 5). Of these habitats, shrub-steppe has the highest percentage of species vulnerable to management activities under all themes (fig. 6b). Even under themes where aggressive restoration activities are planned (for example, active management theme), it is thought that the deterioration and loss of sagebrush habitat will outpace restoration successes (table 5).

Other habitats considered highly vulnerable to loss, degradation, or conversion under at least two themes, but with lower percentages of declining species, included riparian, old-growth/mature coniferous forest, and oak woodlands (appendix 4, tables 6-9). Because the historical distribution of oak woodlands was limited and peripheral within the interior basin, this habitat would not be considered a high priority to management for Neotropical migratory land birds.

Evaluating the three criteria listed above (that is, species declines, habitats with species highly vulnerable to alternative management activities, and vulnerability to habitat loss), five habitats were identified as the highest priority for conservation of NTMBs: riparian, old-growth/mature coniferous forests, shrub-steppe, grasslands, and juniper woodlands. Managing priority habitats for presettlement conditions where possible, including restoring natural disturbance regimes or emulating those ecosystem processes with management activities, will improve conditions for the conservation of Neotropical migrants. To evaluate the success of management activities, biologists should determine Loth migrant and resident bird responses through carefully conceived, long-term monitoring of selected populations, species, and communities. Because much is not known about these species and the effects of land use activities, continual feedback, and adaptive management is not only necessary but gives managers an ideal opportunity to test their ability to change management based on a relatively conspicuous and sensitive component of ecosystems.

Recommendations for Monitoring and Research

Population and Species-Based Monitoring and Research

Many of our results are based on the BBS, and these data are counts of individual birds occurring at particular sites during the breeding season. The data do not provide information on habitat relationships or demographic parameters such as reproductive success, productivity, and survival. Thus, when we discuss "population" trends, we are using counts of birds to indicate population size. Although these counts are useful for population trends, biologists do not know the ecological processes responsible for the trends or if specific habitats and landscapes are acting as population "sinks," in which local reproduction is insufficient to compensate for adult mortality (Pulliam 1988).

To augment the BBS and other count data (for example, point count surveys conducted to evaluate habitat relationships), programs designed to monitor productivity and survival are needed. Both the MAPS (monitoring avian productivity survivorship, DeSante and others 1993) and BBIRD (breeding biology research and monitoring database, Martin and Guepel 1993) protocols have been widely tested and have become standardized techniques for demographic data collection. The demographic data are needed to better understand the effects of management actions. This is particularly important for migratory wildlife because at the largest geographic scale, biologists need to know if negative impacts are occurring during the breeding season, wintering season, fall migration, or spring migration. Monitoring programs designed to incorporate demographic data by using existing protocol can be coordinated basinwide to most efficiently gather the needed information on regional and landscape levels.

The lack of clear patterns in population trends among species reinforces our understanding that each species is unique in its natural history, behavior, and habitat requirements. Species are not readily lumped into groups for which broadly applied management guidelines can be prescribed. Ecologists need more detailed demographic data on selected species of high concern to management within priority habitats. In addition, broad knowledge of habitat requirements of birds is needed in all habitats within various landscapes (that is, agricultural, urban, natural managed, and protected public lands) in the interior basin. Gathering information on both populations and communities is an ecosystem approach that will allow us to manage for habitat and landscape conditions that benefit the most species or species of special concern to management.

Given the inability of biologists to generalize about the causes of declines from one species to another, demographic and associated habitat data (or data on trends in habitat condition for species whose habitat requirements are well known, for example, red-winged blackbird) are needed for at least some species with consistent long-term declines. These species include olive-sided flycatcher, red-winged blackbird, Brewer's sparrow, willow flycatcher, killdeer, Western meadowlark, and Brewer's blackbird. Within this group, the first three species not only are declining within the interior basin, but rangewide (Peterjohn and Sauer 1993). Five of these species were of high concern to management under all themes considered for this assessment (table 4). Additionally, the southwestern subspecies of the willow flycatcher *{Empidonax traillii extimus* [found In the Southwestern United States]) was recently listed as federally endangered (U.S. Fish and Wildlife Service 1995). Perhaps similar processes are affecting willow flycatchers in the interior basin.

To better understand geographic differences in population trends for individual species, biologists can examine regional landscape-level habitat conditions. In the interior basin, several species have shown consistent long-term population increases: red-tailed hawk, house wren, spotted towhee, black-headed grosbeak, orange-crowned warbler, gray catbird, and mountain bluebird. The first two species have rangewide increases, whereas the spotted towhee is decreasing at a highly significant rate continentwide (Peterjohn and Sauer 1993). Among these species, only towhee population changes seem to be understood at the landscape scale. An increase of forest cover in the Northeastern United States has apparently reduced towhee

habitat in a predictable way (Hagan 1993). Perhaps the reduction of mature forest and increase in second-growth and young coniferous forests in the interior basin (table 5) has had the converse effect on towhees. We recommend new research on species that are apparently increasing in some regions and decreasing in others.

Within the interior basin, we found that declining species tended to be shrub nesters, whereas increasing species tended to be canopy nesters (fig. 2). This is consistent with patterns observed in forested habitats over North America. Increases in nest predation and brood parasitism are thought to affect the overall fitness of these shrub-nesting species (Martin 1993, 1995). Additionally, fragmented and agricultural landscapes attract nest predators and brown-headed cowbirds, thereby resulting in low reproductive rates of Neotropical migrants in such landscapes (Robinson and others 1995). We recommend that future research and monitoring focus on determining if there are cause-effect relations among nest placement, landscapes, reproductive success and productivity. Determining the influence of these factors on the overall fitness of selected species will lead to management actions compatible with population persistence of NTMBs.

Among 62 species that show no detectable population trend in the interior basin, 38 of these also show no trend at the continental scale (Peterjohn and Sauer 1993, Peterjohn and others 1994). Nine species, however, have significantly declining populations at one or more regional scales across North America (eastern, central, or western): rufous hummingbird, white-crowned sparrow, rock wren, Western bluebird, belted kingfisher, bobolink, grasshopper sparrow, ruby-crowned kinglet, and veery. The first four of these are notably Western in their distribution and should be seriously considered in the interior basin.

In addition to the above species, the 21 species insufficiently sampled by BBS (status "I," table 3), and the 28 species that need improved monitoring (status "S," table 3) all require specialized monitoring techniques. Continued or expanded BBS coverage is unlikely to provide adequate monitoring of these species. Lewis' woodpecker and sage sparrow are species of high concern to management under all themes (table 4) and both require specialized monitoring techniques (status "S," table 3). Biologists could determine other species of high concern to management, then develop methods and a basinwide sampling design to implement specialized monitoring programs.

Habitat-Based Monitoring and Research

Comprehensive habitat management and monitoring efforts are needed at the ecosystem level within each of the five priority habitats (riparian, old-growth/mature coniferous forest, shrub-steppe, juniper woodlands, and grasslands). Habitat management can include conservation (limited management) of cover types and structural stages representative of natural communities (for example, Research Natural Areas and Areas of Critical Environmental Concern) and active management to restore or emulate natural disturbance regimes over large areas. Monitoring programs can be used to evaluate the success of habitat management and should be designed to (1) maximize the number of species monitored (community based), (2) evaluate population trends for individual species across habitats and management regimes (species based), and (3) evaluate habitat quality and quantity in association with population monitoring (population based).

Coordinated basinwide monitoring programs would be most effective for a landscape-level approach with methods standardized from existing protocols (DeSante and others 1993, Martin and Guepel 1993, Ralph and others 1993). Community-based monitoring could be implemented by using point-count and nest surveys (Ralph and others 1993) within cover type-structural stages under specific management regimes. Existing BBS routes and perhaps new routes would be part of the species-based monitoring. In addition to the BBS, species-based monitoring should include habitat and management-specific point-count surveys that are widely conducted across the interior basin. This monitoring could be an expansion of the regional monitoring for the northern Rockies currently conducted by Hutto (1995b) in coordination with the USDA Forest Service. In

addition, population-based monitoring must include programs to monitor reproductive success, productivity, and survival (DeSante and others 1993, Martin and Guepel 1993) of at least one priority species for each priority habitat. Species selected for population monitoring should be habitat specialists (using one or two habitats during the breeding season) and those thought to be the most sensitive to various management activities.

Of the habitats identified for conservation priority, we emphasize the importance of restoring and protecting riparian habitats for maximizing benefits to NTMB species within the interior basin. Riparian habitats are relatively scarce in the interior basin, yet their importance is clearly demonstrated by the fact that 84 of 132 NTMBs (64 percent) use riparian vegetation during the breeding season. Riparian habitats also had the highest number of specialists (15). This disproportional importance of riparian vegetation to birds and other wildlife is typical of arid landscapes in the Western United States (Krueper 1993). Riparian habitats have suffered more degradation by various human activities than other habitats (Knopf and others 1988, Krueper 1993, Saab and others 1995). Because breeding bird populations have shown a dramatic positive response to restoration of native streamside vegetation (Krueper 1993), an emphasis on improving the ecological conditions of degraded riparian habitats would benefit many NTMB species.

To better understand bird-habitat relationships, research and monitoring are needed to evaluate the ecological potential of riparian habitats (and other priority habitats) and associated NTMBs by establishing completely protected study sites and comparing them to managed sites (cf. Bock and others 1993a, 1993b). Representative control sites within each riparian cover type-structural stage could be paired with managed sites to evaluate pervasive and synergistic impacts of activities such as livestock grazing, recreation, timber harvest, and water management. Recommendations with regards to livestock grazing are outlined by Saab and others (1995), with regards to recreation by Saab (1996), and regarding water management by Merigliano (1996).

Two other habitats identified for conservation priority have many NTMB species and several habitat specialists. These are old-growth coniferous forest and shrub-steppe. According to BBS data, none of the habitat specialists in old-growth forest are declining. One nonspecialist, the olive-sided flycatcher is experiencing significant long-term population declines regionally and throughout its range (Peterjohn and others 1994). The primary habitat of this species includes mature, open forests and burned forests (Dobkin 1993, Ehrlich and others 1988). Research is needed to determine the influence of past forest management practices (intensive harvest of mature, open forest and fire suppression) and proposed practices of broad-scale prescribed fire with timber harvest on olive-sided flycatchers and other species (for example, Lewis' woodpecker) associated with open ponderosa pine and other fire-adapted forest habitats. Community- and population-based monitoring is critical for old-growth habitats because of past (fire suppression) and current-future (timber harvest) threats. Old-growth ponderosa pine forests have experienced the greatest decline among forest types within the interior basin (table 2).

Among all cover types within the interior basin, shrub-steppe habitats (that is, mountain big sagebrush, *Agropyron* bunchgrass, Fescue bunchgrass, and big sagebrush) have suffered the most drastic declines (table 2). In shrub-steppe habitat, we recommend the establishment of at least two large (ca. 1000 hectares) protected areas (see Bock and others 1993a) that can serve as reference areas. Currently, few shrub-steppe habitats of adequate size are under protection from livestock grazing except for Department of Energy (DOE) facilities. Outside of DOE lands, nearly every hectare has been impacted by livestock. Thus, it often is difficult to determine the potential for vegetation, animal populations, and overall biodiversity in this ecosystem. We recommend long-term research on the effects of livestock grazing on birds of shrub-steppe habitats. Despite the large areas involved and long history of grazing, no significant long-term research has ever been conducted (Saab and others 1995). Research is needed to address the direct effects of livestock grazing, that is, activity disturbance and trampling, as well as the

indirect, that is, alteration of vegetation and its subsequent effect on productivity of selected priority species. Other research is needed to specifically evaluate the degree and significance of brood parasitism by brown-headed cowbirds, which may have important implications for sage and Brewer's sparrows (Rich 1978, Rich and Rothstein 1985). More detailed recommendations with regards to livestock grazing in shrub-steppe habitats are outlined by Saab and others (1995).

Shrub-steppe habitats have five habitat specialists, with Brewer's sparrow declining at a highly significant rate (table 1). Population monitoring of this priority species is important because it is an obligate of sagebrush vegetation, and research is needed to determine the cause of their persistent population declines. Four additional species (Western meadowlark, loggerhead shrike, lark sparrow, and horned lark) also have significant declines but have more general habitat requirements. Two other shrub-steppe species (gray flycatcher and sage sparrow) have been identified as needing specialized monitoring to adequately track their populations.

In some portions of the interior basin, juniper woodlands (also a priority habitat for conservation) have expanded in distribution, and tree densities have increased due to livestock grazing and fire suppression (Miller and Rose 1995, West and Van Pelt 1987). Reduction and elimination of livestock grazing (Saab and others 1995) and restoration of natural fire regimes (or emulation through selective harvest with underburning) are recommended for habitat management. The sage thrasher is the only habitat specialist in juniper woodlands, and they actually occur with greatest frequency in shrub-steppe habitats. Species with significant declines that use juniper woodlands include loggerhead shrikes and lark sparrows. Ten species breeding in juniper habitats are not adequately monitored, including blue-gray gnatcatcher, black-throated gray warbler, and ash-throated flycatcher. In juniper woodlands, increased monitoring is needed by using point counts (community-based), nest surveys (population and community), and additional BBS routes because few routes incorporate this habitat.

Native grasslands are naturally rare within the interior basin and few species breed in this limited habitat. Grasslands have three habitat specialists, which include clay-colored sparrow, bobolink, and upland sandpiper. The clay-colored sparrow is peripheral in the planning area, and the latter two species are both widespread in North America. Therefore, the future of their populations will likely not depend on management within the interior basin. Most notable about this priority habitat is that 8 of 14 species with significant population declines use grasslands. The relative contribution of grasslands to the total breeding habitat of these species should be assessed in more detail.

Fragmentation of forested habitats has been shown to negatively affect several species of Northeastern (Freemark and Merriam 1986) and Midwestern forests (Robinson and others 1995, Thompson 1993, Thompson and others 1992). Yet little research has been conducted on the effects of habitat fragmentation on populations of migratory birds in the West (Lehmkuhl and Ruggiero 1991, McGarigal and McComb 1995, Rosenburg and Raphael 1986). Research is needed to evaluate the effects of habitat fragmentation on populations of migratory birds in riparian forests, old-growth/mature forests, shrub-steppe, juniper, and grassland habitats.

Management Recommendations

The lack of consistent patterns in population declines within and across habitats indicates that no one management scheme will uniformly benefit Neotropical migrants as a group. Successful ecosystem management must simultaneously consider several taxa, several levels of organization (that is, at the population, species, and community levels), and several spatial scales (Allen and Hoekstra 1992, Noss 1992). Additionally, in the long term, ecosystem management of high-priority habitats at local and regional scales will need to be coordinated with an international strategy focusing on maintaining and restoring breeding, wintering, migrating, and staging habitats.

Basin-wide coordination of inventory and monitoring efforts will provide the baseline, site-specific information on distribution and abundance necessary to effectively implement management and conservation efforts for NTMB populations. Demographic information

on selected species and recommended research efforts must augment inventory and monitoring to develop management plans. Guidelines are needed for the identification, protection, and management of quality habitats within the five priority habitats. Through research and monitoring, habitat and landscape features that most influence avian fitness will be identified. This information will allow us to develop guidelines for determining high-quality habitats that support population sources. Subsequently, critical areas for protection and acquisition, and gaps in protected areas can be identified basin-wide (Caicco and others 1995). Site-specific management plans then could be developed for selected areas.

Of the management themes considered in this assessment, more species (63 of 132) are predicted to be more negatively affected by consumptive demand than any other theme (figs. 4 and 5), followed by no action (44 species), and active management (23). Passive management affected the fewest species, thereby resulting in only 16 (12 percent) species of high concern to management (index $\geq$ 9). Based on the criteria used to derive the management concern indices, mean management index values were not statistically different for active (6.93 ±0.18) and passive (6.70 ± 0.21) management. This suggests that in the long term, the number of NTMB species negatively affected by these two management themes would be similar. Active management negatively affects few species and has the goal to restore ecosystem functions and processes over the long term (100-year period), thus, it is likely to result in conditions improved over the current (no action theme).

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Appendix 1

Following is a list of Neotropical migratory land-bird species breeding in the interior Columbia River basin, grouped by habitat association:

Old-growth/mature coniferous forest

Mourning dove
Zenaida macroura
Sharp-shinned hawk
Accipiter striatus
Cooper's hawk
Accipiter cooperii
Northern goshawk
Accipiter gentilis
Red-tailed hawk
Bu teo jamaicensis
Golden eagle
Aquila chrysaetos
American kestrel
Falco sparverius
Long-eared owl
Asio otus
Flammulated owl
Otus flammeolus
Red-naped sapsucker
Sphyrapicus nuchalis
Red-breasted sapsucker
Sphyrapicus ruber
Williamson's sapsucker
Sphyrapicus thyroideus
Lewis' woodpecker
Melanerpes lewis
Northern flicker
Colaptes auratus
Common poorwill
Phalaenoptilus nuttalli
Common nighthawk
Chordeiles minor
Vaux's swift
Chaetura vauxi
Broad-tailed hummingbird
Selasphorus platycercus
Calliope hummingbird
Stellula calliope
Olive-sided flycatcher
Contopus borealis
Western wood-pewee
Contopus sordidulus
Cordilleran flycatcher
Empidonax occidentalis
Hammond's flycatcher
Empidonax hammondii
Dusky flycatcher
Empidonax oberholseri
Cassin's finch
Carpodacus cassinii
Red crossbill
Losiz curvirostra
Pine siskin
Carduelis pinus
Chipping sparrow
Spizella passerina
Dark-eyed junco
Junco hyemalis
Western tanager
Piranga ludoviciana
Violet-green swallow
Tachycineta thalassina
Solitary vireo
Vireo solitarius
Tennessee warbler
Vermivora peregrina
Yellow-rumped warbler
Dendroica petechia
Townsend's warbler
Dendroica townsendi
Hermit warbler
Dendroica occidentalis
House wren
Troglodytes aedon
Brown creeper
Certhia americana
Golden-crowned kinglet
Regulus satrapa
Ruby-crowned kinglet
Regulus calendula
Townsend's solitare
Myadestes townsendi
Swainson's thrush
Catharus ustulatus
Hermit thrush
Catharus guttatus
American robin
Turdus migratorius
Western bluebird
Sialia mexicana

Mountain bluebird
Sialia currucoides

Young coniferous forest

Mourning dove
Turkey vulture
Cathartes aura
Sharp-shinned hawk
Cooper's hawk
Northern goshawk
Red-tailed hawk
Merlin
Falco columbanus
American kestrel
Osprey
Pandion haliaetus
Long-eared owl
Red-naped sapsucker
Red-breasted sapsucker
Northern flicker
Common poorwill
Common nighthawk
Broad-tailed hummingbird
Rufous hummingbird
Selasphorus rufus
Calliope hummingbird
Olive-sided flycatcher
Western wood-pewee
Cordilleran flycatcher
Hammond's flycatcher
Dusky flycatcher
Cassin's finch
Red crossbill
Pine siskin
Chipping sparrow
Dark-eyed junco
Black-headed grosbeak
Pheucticus melanocephalus
Western tanager
Violet-green swallow
Warbling vireo
Vireo gilvus
Solitary vireo
Nashville warbler
Vermivora ruficapilla
Tennessee warbler
Yellow-rumped warbler
Townsend's warbler
Hermit warbler
MacGillivray's warbler
Oporornis tolmiei
American redstart
Setophaga ruticilla
House wren
Brown creeper
Golden-crowned kinglet
Ruby-crowned kinglet
Townsend's solitare
Swainson's thrush
Hermit thrush
American robin
Western bluebird
Mountain bluebird

Clearcut/seedling/shrub coniferous forest

Mourning dove
Turkey vulture
Red-tailed Hawk
Golden eagle
American kestrel
Northern flicker
Common poorwill
Common nighthawk
Black-chinned hummingbird
Archilochus alexandri
Broad-tailed hummingbird
Calliope hummingbird
Olive-sided flycatcher
Dusky flycatcher
Gray flycatcher
Empidonax wnghtii
Brown-headed cowbird
Molothrus ater
Pine siskin
Chipping sparrow
Dark-eyed junco
Fox sparrow
Passerella iliaca
Green-tailed towhee
Pipilo chlorurus
Nashville warbler
MacGillivray's warbler
House wren
Townsend's solitare
Hermit thrush
American robin
Western bluebird
Mountain bluebird

Mountain shrub/prairie brushfield

Mourning dove
Turkey vulture
Red-tailed hawk
American kestrel
Common poorwill

Black-chinned hummingbird
Rufous hummingbird
Calliope hummingbird
Dusky flycatcher
Clay-colored sparrow
Spizella pallida
Fox sparrow
Spotted towhee
Pipilo maculatus
Green-tailed towhee
Black-headed grosbeak
Blue grosbeak
Guiraca caerulea
Lazuli bunting
Passerina amoena
Virginia's warbler
Vermivora virginiae
Nashville warbler
Orange-crowned warbler
Vermivora celata
MacGillivray's warbler
Blue-gray gnatcatcher
Polioptila caerulea
American robin
Western bluebird

Grasslands

Upland sandpiper
Bartramia longicauda
Long-billed curlew
Numenius americanus
Killdeer
Charadrius vociferus
Mourning dove
Turkey vulture
Northern harrier
Circus cyaneus
Red-tailed hawk
Swainson's hawk
Buteo swainsoni
Ferruginous hawk
Buteo regalis
Golden eagle
Prairie falcon
Falco mexicanus
Peregrine falcon
Falco peregrinus
American kestrel
Short-eared owl
Asio flammeus
Burrowing owl
Athene cunicularia
Common poorwill
Common nighthawk
White-throated swift
Aeronautes saxatalis
Western kingbird
Tyrannus verticalis
Say's pheobe
Sayornis saya
Horned lark
Eremophila alpestris
Bobolink
Dolichonyx oryzivorus
Brown-headed cowbird
Western meadowlark
Sturnella neglecta
Brewer's blackbird
Eupbagus carolinus
Vesper sparrow
Pooecetes gramineus
Savannah sparrow
Passerculus sandwichensis
Grasshopper sparrow
Ammodramus savannarum
Lark sparrow
Chondestes grammacus
Clay-colored sparrow
Sage sparrow
Amphisipiza belli
Lark bunting
Calamospiza melanocorys
Cliff swallow
Hirundo fulva
Loggerhead shrike
Lanius ludovicianus
Rock wren
Salpinctes obsoletus
Blue-gray gnatcatcher
Mountain bluebird

Shrub-steppe

Long-billed curlew
Mourning dove
Turkey vulture
Northern harrier
Red-tailed hawk
Swainson's hawk
Ferruginous hawk
Golden eagle
Prairie falcon
Peregrine falcon
Merlin
American kestrel

Short-eared owl
Burrowing owl
Common poorwill
Common nighthawk
White-throated swift
Black-chinned hummingbird
Western kingbird
Ash-throated flycatcher
Myiarchus cinerascens
Say's phoebe
Gray flycatcher
Horned lark
Brown-headed cowbird
Western meadowlark
Bullock's oriole
Icterus bullockii
Brewer's blackbird
Lesser goldfinch
Carduelis psaltria
Vesper sparrow
Grasshopper sparrow
Lark sparrow
Brewer's sparrow
Spizella breweri
Black-throated sparrow
Amphispiza bilineata
Sage sparrow
Green-tailed towhee
Lark bunting
Cliff swallow
Northern rough-winged swallow
Stelgidopteryx serripennis
Loggerhead shrike
Sage thrasher
Oreoscoptes montanus
Northern mockingbird
Mimus polyglottus
Rock wren
Mountain bluebird

Juniper woodlands

Mourning dove
Turkey vulture
Red-tailed hawk
Swainson's hawk
Ferruginous hawk
Golden eagle
Prairie falcon
Merlin
American kestrel
Long-eared owl
Burrowing owl
Northern flicker
Common poorwill
Common nighthawk
White-throated swift
Broad-tailed hummingbird
Ash-throated flycatcher
Say's phoebe
Gray flycatcher
Western meadowlark
Cassin's finch
Lesser goldfinch
Pine siskin
Vesper sparrow
Lark sparrow
Chipping sparrow
Dark-eyed junco
Sage sparrow
Green-tailed towhee
Lazuli bunting
Western tanager
Piranga ludoviciana
Cedar waxwing
Bombycilia cedrorum
Loggerhead shrike
Virginia's warbler
Black-throated gray warbler
Dendroica nigrescens
Sage thrasher
Rock wren
Ruby-crowned kinglet
Blue-gray gnatcatcher
Townsend's solitare
American robin
Western bluebird
Mountain bluebird

Alpine

Golden eagle
Northern flicker
Rufous hummingbird
Calliope hummingbird
Olive-sided flycatcher
Chipping sparrow
Dark-eyed junco
Lincoln's sparrow
Melospiza lincolnii
Fox sparrow
Lazuli bunting
Wilson's warbler
Wilsonia pusilla
American pipit
Anthus spinoletta

Hermit thrush
Mountain bluebird

Freshwater marshes, ponds, lakes

Long-billed curlew
Killdeer
Northern harrier
Red-tailed hawk
Peregrine falcon
Osprey
Pandion haliaetus
Short-eared owl
Belted kingfisher
Ceryle alcyon
Black swift
Cypseloides niger
Eastern kingbird
Tyrannus tyrannus
Brown-headed cowbird
Yellow-headed blackbird
Xanthocephalus xanthocephalus
Red-winged blackbird
Agelaius phoeniceus
Tri-colored blackbird
Agelaius tricolor
Savannah sparrow
Song sparrow
Melospiza melodia
Purple martin
Progne subis
Cliffswallow
Barn swallow
Hirundo rustic a
Tree swallow
Tachycineta bicolor
Violet-green swallow
Tachycineta thalassina
Bank swallow
Riparia riparia
Northern rough-winged swallow
Northern waterthrush
Seiurus noveboracensis
Common yellowthroat
Geothlypis trichas
Yellow-breasted chat
Icteria virens
Marsh wren
Cistothorus palustris

Riparian

Killdeer
Mourning dove
Sharp-shinned hawk
Cooper's hawk
Northern goshawk
Red-tailed hawk
Swainson's hawk
Golden eagle
Merlin
American kestrel
Osprey
Long-eared owl
Yellow-billed cuckoo
Coccyzus americanus
Black-billed cuckoo
Coccyzus erythropthalmus
Belted kingfisher
Red-naped sapsucker
Red-breasted sapsucker
Williamson's sapsucker
Lewis' woodpecker
Northern flicker
Common nighthawk
Black swift
Vaux's swift
Chaetura vauxi
White-throated swift
Black-chinned hummingbird
Broad-tailed hummingbird
Rufous hummingbird
Calliope hummingbird
Eastern kingbird
Western kingbird
Ash-throated flycatcher
Western wood-pewee
Willow flycatcher
Empidonax trailii
Least flycatcher
Empidonax minimus
Hammond's flycatcher
Dusky flycatcher
Brown-headed cowbird
Northern mockingbird
Bullock's oriole
Brewer's blackbird
Cassin's finch
Red crossbill
American goldfinch
Carduelis tristis
White-crowned sparrow
Zonotrichia leucophrys
Dark-eyed junco
Song sparrow
Lincoln's sparrow

Fox sparrow
Spotted towhee
Black-headed grosbeak
Blue grosbeak
Lazuli bunting
Western tanager
Purple martin
Cliff swallow
Barn swallow
Tree swallow
Violet-green swallow
Bank swallow
Northern rough-winged swallow
Cedar waxwing
Red-eyed vireo
Vireo olivaceus
Warbling vireo
Vireo gilvus
Solitary vireo
Vireo solitarius
Virginia's warbler
Nashville warbler
Orange-crowned warbler
Yellow warbler
Dendroica petechia
Yellow-rumped warbler
Black-throated gray warbler
Dendroica nigrescens
Northern waterthrush
MacGillivray's warbler
Common yellowthroat
Yellow-breasted chat
Wilson's warbler
Wilsonia pusilla
American redstart
Gray catbird
Dumetella carolinensis
House wren
Blue-gray gnatcatcher
Veery
Catharus fuscescens
Swainson's thrush
American robin
Western bluebird

Wet, dry, hay **meadows**

Upland sandpiper
Long-billed curlew
Killdeer
Northern harrier
Red-tailed hawk
Swainson's hawk
Golden eagle
Prairie falcon
American kestrel
Long-eared owl
Short-eared owl
Burrowing owl
Common poorwill
Common nighthawk
Broad-tailed hummingbird
Rufous hummingbird
Calliope hummingbird
Eastern kingbird
Horned lark
Bobolink
Yellow-headed blackbird
Western meadowlark
Brewer's blackbird
Vesper sparrow
Savannah sparrow
White-crowned sparrow
Lincoln's sparrow
Red-winged blackbird
Agelaius phoeniceus
Tree swallow
Common yellowthroat
American pipit
American robin

Oak woodlands

Mourning dove
Turkey vulture
Sharp-shinned hawk
Cooper's hawk
Red-tailed hawk
American kestrel
Lewis' woodpecker
Northern flicker
Common nighthawk
Rufous hummingbird
Western kingbird
Ash-throated flycatcher
Western wood-pewee
Brown-headed cowbird
Bullock's oriole
American goldfinch
Lark sparrow
Chipping sparrow
Dark-eyed junco
Spotted towhee
Black-headed grosbeak
Western tanager
Warbling vireo

Nashville warbler
Orange-crowned warbler
Yellow-rumped warbler
Black-throated gray warbler
House wren
Western bluebird

Aspen

Mourning dove
Turkey vulture
Sharp-shinned hawk
Cooper's hawk
Northern goshawk
Red-tailed hawk
Swainson's hawk
Ferruginous hawk
Golden eagle
American kestrel
Long-eared owl
Flammulated owl
Red-naped sapsucker
Red-breasted sapsucker
Williamson's sapsucker
Northern flicker
Common poorwill
Common nighthawk
Broad-tailed hummingbird
Rufous hummingbird
Calliope hummingbird
Western wood-pewee
Cordilleran flycatcher
Hammond's flycatcher
Dusky flycatcher
Cassin's finch
White-crowned sparrow
Dark-eyed junco
Lazuli bunting
Western tanager

Tree swallow
Violet-green swallow
Warbling vireo
Red-eyed vireo
Orange-crowned warbler
Yellow-rumped warbler
Northern waterthrush
House wren
Swainson's thrush
American robin
Western bluebird
Mountain bluebird

Cliff, rocks, talus

Turkey vulture
Red-tailed hawk
Ferruginous hawk
Golden eagle
Prairie falcon
Peregrine falcon
American kestrel
Black swift
White-throated swift
Cliff swallow
Violet-green swallow
Rock wren
American robin

Urban

Killdeer
Mourning dove
Cooper's hawk
Peregrine falcon
American kestrel
Northern flicker
Vaux's swift
Black-chinned hummingbird
Rufous hummingbird
Western wood-pewee
Brown-headed cowbird
Red-winged blackbird
Bullock's oriole
Brewer's blackbird
Purple finch
Carpodacus purpureus
American goldfinch
Chipping sparrow
Song sparrow
Spotted towhee
Black-headed grosbeak
Western tanager
Purple martin
Cliff swallow
Barn swallow
Tree swallow
Violet-green swallow
Cedar waxwing
House wren
American robin

Agriculture/pastureland

Killdeer
Mourning dove
Turkey vulture

Northern harrier
Red-tailed hawk
Swainson's hawk
Golden eagle
Prairie falcon
American kestrel
Short-eared owl
Burrowing owl
Red-breasted sapsucker
Vaux's swift
Rufous hummingbird
Eastern kingbird
Western kingbird
Say's phoebe
Western wood-pewee
Horned lark
Brown-headed cowbird
Yellow-headed blackbird
Red-winged blackbird
Tri-colored blackbird
Western meadowlark
Bullock's oriole
Brewer's blackbird
Purple finch
American goldfinch
Lesser goldfinch
Vesper sparrow
Savannah sparrow
Grasshopper sparrow
Lark sparrow
Chipping sparrow
Spotted towhee
Black-headed grosbeak
Purple martin
Cliff swallow
Barn swallow
Tree swallow
Violet-green swallow
Cedar waxwing
House wren
American robin
Western bluebird

Appendix 2

Criteria and definitions used in appendix 7 to derive management indices for each species

The following database fields are from the Colorado Bird Observatory database (Carter and Barker 1993):

1. Population trend (PT) rank

1. Large increase: Stable or increasing with uncertainty of 1 or > = 5 percent annual increase with uncertainty of 2.

2. Increase: Stable or increasing with uncertainty of 2 or uncertainty of 3 with > = 1 percent annual increase.

3. Trend unknown: Trend is between -1.0 percent and 1.0 percent exclusive and/or uncertainty is 4 or 5.

4. Decrease: Decreasing with uncertainty of 2 or uncertainty of 3 with > = 1 percent annual decrease.

5. Large decrease: Decreasing with uncertainty of 1 or > = -5 percent annual decrease with uncertainty of 2.

2. Population trend uncertainty (PTU) rank

1. Fourteen or more routes with statistical significance and significant proportion of increasing and decreasing routes agree with overall trend.

2. Fourteen or more routes with statistical significance and proportion of increasing and decreasing routes agreeing with overall trend.

3. Fourteen or more routes without statistical significance and/or the proportion of increasing and decreasing routes do not agree with overall trend.

4. Sample size for species from BBS is insufficient.

5. No quantitative monitoring information exists for species in the area.

3. Breeding distribution (BD)

Breeding distribution identifies the total breeding range of the species relative to the interior basin. A value of 5 indicates a species breeding in interior basin whose range is confined to less than 10 percent of North America, making it very local to the basin.

1. Very widespread: > = 76-100 percent of temperate North America.
2. Widespread: 51-75 percent of temperate North America.
3. Intermediate: 26-50 percent of temperate North America.
4. Local: 11-25 percent of temperate North America.
5. Very local: < = 10 percent of temperate North America.

The following database fields are additional fields adopted from Andelman and Stock 1994a, 1994b.

4. Evidence of decline (ED)

The population trends of uncertainties were used to identify an evidence of decline (ED) value for each species. The criterion for each ED rank value follows:

5 (PT10/PT26 = 3 or 4 and PTU10/PTU26 = 2 or 3)
5 (PT10/PT26 = 4 or 5 and PTU10/PTU26 = 1 or 2)
1 (PT10/PT26 = 1, 2, 3, 4 or 5 and PTU10/PTU26 = 3, 4 or 5)
0 (PT10/PT26 = 1 or 2 and PTU10/PTU26 = 1 or 2)
0 (PT10/PT26 = 1 or 2 and PTU10/PTU26 = 2 or 3)

5. Habitat
Several habitat assignments were given for each species based on PIF state reports (see "Methods"). Habitat assignments based on breeding or foraging habits, or both, while breeding. A list of habitats and associated numerical codes is provided in appendix 4.

6. Habitat rank
Assignment of a qualitative habitat risk ranking based on management theme threats to habitat loss, conversion and fragmentation in the interior basin (see appendix 4). Possible rank values are:

5 = High threat of habitat loss, conversion, or fragmentation
3 = Medium threat
1 = Low threat
0 = Little or no threat

7. Threats to habitat (TH)
A threats to habitat (TH) value was assigned to each species based on the habitat risk rankings of each habitat assigned to the species. If a species was associated with > 1 habitat, then the threats to habitat value was calculated as the sum of the habitat risk rankings divided by the total number of habitats used by the species.

8. Habitat specialization (HS)
A habitat specialization (HS) rank was assigned by taking the value for habitat threats divided by the total number of habitats used by each species.

9. Management index
This value provides an index of need for management considerations.
Mgmt. index = ED + TH + HS + BD.

Appendix 3

Cross reference of 16 habitats for the Neotropical migratory birds (NTMB) analysis and aggregations of interior basin cover types and structural stages

NTMB habitats	Columbia River basin cover types
1. Old-growth and mature coniferous forest	Structural stages: Old multistrata Old singlestrata Cover types: Pacific silver fir-mountain hemlock *(Abies amabilis)-(Tsuga mertensiana)* Grand fir-white fir *(Abies grandis)-(Abies concolor)* White bark pine-alpine larch *(Pinus albicaulis)-(Larix lyallit)* Red fir *(Abies procerd)* Mountain hemlock Engleman spruce-subalpine fir *(Picea engelmanii)-(Abies lasiocarpa)* Whitebark pine Interior douglas-fir *(Pseudotsuga menziesii)* Western larch *(Larix occidentalis)* Western white pine *(Pinus monticold)* Lodgepole pine *(Pinus contorta)* Limber pine *(Pinus flexis)* Western redcedar-western hemlock (*Thuja plicata)-(Tsuga heterophylla)* Interior ponderosa pine *(Pinus ponderosa)* Sierra Nevada mixed-conifer Pacific Ponderosa Pine
2. Young coniferous forest	Structural stages: Stem exclusion closed Stem exclusion open Understory reinitiation

	Young/mutlistrata
	Cover types: Pacific silver fir-mountain hemlock Grand fir-white fir White bark pine-alpine larch Red fir Mountain hemlock Engleman spruce-subalpine fir Whitebark pine Interior douglas-fir Western larch Western white pine Lodgepole pine Limber pine Western redcedar-western hemlock Interior ponderosa pine Sierra Nevada mixed conifer Pacific ponderosa pine
3. Clearcut/seedling/shrub coniferous forest	Structural stages: Stand initiation
	Cover types: Pacific silver fir-mountain hemlock Grand fir-white fir White bark pine-alpine larch Red fir Mountain hemlock Engleman spruce-subalpine fir Whitebark pine Interior douglas fir Western larch Western white pine Lodgepole pine Limber pine Western redcedar-western hemlock Interior ponderosa pine Sierra Nevada mixed conifer Pacific ponderosa pine
	Structure stages: Closed herb Open low shrub Open medium shrub Open tall shrub
	Cover types: Seral shrub-regeneration
4. Mountain shrub/prairie brushfield	Structure stages: All
	Cover types: Chokecherry-serviceberry-rose *(Prunus* spp.*)-(Amelanchier* spp.)-

	(Rosa spp.)
5. Grasslands	Structure stages: All
	Cover types: Open grassland Bluebunch wheatgrass *{Agropyron spicatum)*
	Idaho fescue-bluebunch wheatgrass *(Festuca idahoensis)*
	Wheatgrass-needlegrass *(Agropyron spp.)-(Stipa* spp.)
	Crested wheatgrass *(Agropyron cristatum)*
	Exotics
6. Shrub-steppe	Structure stages: All
	Cover types: Bitterbrush-bluebunch wheatgrass *(Purshia tridentata)*
	Mountain mahogany *(Cercocarpus ledifolius)*
	Basin big sagebrush *(Artemisia tridentata tridentata)*
	Mountain big sagebrush *(Artemisia tridentata vaseyana)*
	Wyoming big sagebrush *(Artemisia tridentata wyomingensis)*
	Low sage *(Artemisia arbuscula)*
	Salt desert shrub
7. Juniper woodlands	Structure stages: All
	Cover types: Utah juniper-big sage-bluebunch wheatgrass *(Juniperus osteosperma)-(Artemisia* spp.)- *(Agropyron* spp.)
	Juniper woodlands *(Juniperus* spp.)
	Mixed-conifer woodlands Juniper-big sage-bluebunch wheatgrass
	Western juniper-big sagebrush-

	bluebunch wheatgrass *(Juniperus occidentalis)*
8. Alpine	Structure stages: All Cover types: Barren
9. Freshwater marshes, ponds, lakes	Structure stages: All Cover types: Herbaceous wetlands Water
10. Riparian	Structure stages: All Cover types: Herbaceous wetland-shrub Cottonwood-willow *(Populus spp.)-(Salix* spp.)
11. Wet, dry, hay meadows	Structure stages: All Cover types: Native forb
12. Oak woodlands	Structure stages: All Cover types: Oregon white oak (*Quercus garryand*)
13. Aspen	Structure stages: All Cover types: Aspen *(Populus tremuloides)*
14. Cliffs, rocks, talus	Structure stages: Cliffs, rocks, talus Cover types: Cliffs, rocks, talus
15. Urban	Structure stages: Urban Cover types: Urban
16. Agriculture/pastureland	Structure stages: All Cover types: Irrigated cropland and pasture Dry cropland and pasture

Appendix 4

Table 6—Rationale for habitat risk rankings under current management or the no action theme[a]

Habitat	Rank	Rationale
1. Old-growth/mature coniferous forest	5	Old-growth policy not established; high levels of concern for old-growth ponderosa pine forests in particular; being logged at rapid rate; long-term fire suppression policies.
2. Young coniferous forest	1	Managed for single-species tree production; forest health and salvage policy; low concern as habitat-land use areas not limiting.
3. Clearcut/seedling/shrub coniferous	1	Not limiting in current rotations; some Forest concern because this system is replaced more rapidly than would occur naturally.
4. Mountain shrub/prairie brush field	3	High-intensity grazing; fire suppression; invasion of exotics. Some conversion due to development pressures.
5. Grasslands	5	Rare habitat in region with patchy distribution with insufficient inventory; fire suppression; high-intensity grazing with no plan of reducing; invasion of exotics.
6. Shrub-steppe	5	Habitat generally in poor condition; high-intensity grazing; fire sup - pression; agricultural conversion, introduction-invasion of exotic species (for example, crested wheat grass, cheat grass).
7. Juniper woodlands	3	High-intensity grazing, erosion and fire suppression affecting productivity; control of pioneering junipers; commercial logging of old stands.
8. Alpine	1	Most habitat protected in high-elevation wilderness areas; some areas could be impacted by recreational activities, and others are grazed by sheep, fewer by cattle.

9 Freshwater marshes, ponds, lakes	3	Except for mountain lakes and ponds, habitat rare in region, fill controlled by permit, but risk from development proposals, eutrophication, channelization
10 Riparian	5	Risk of damage particularly serious due to high-intensity grazing, recreation pressure, water control preventing regeneration, restoration policies of land management agencies need to be addressed and coordinated
11 Wet, dry, hay meadows	3	Heavy grazing, pressure in some areas, soil compaction, recreation pressure, watershed issues—sedimentation and erosion
12 Oak woodlands	5	Habitat has declined significantly and trend continues, conversion to agriculture, urban growth, fire suppression, grazing preventing regeneration, cutting for firewood
13 Aspen	3	Heavy grazing, logging, and fire suppression
14 Cliffs, rocks, talus	1	Risks limited, however mineral-aggregate extraction and recreational rock climbing are threats, some planning regulations for control activities
15 Urban	0	No risk, area will increase
16 Agnculture/pastureland	0	Not limiting, influencing land use management policy for wildlife may be appropriate

[a]The qualitative ranking represents relative habitat quality loss or conversion based on recent management activities (following Andelman and Stock 1994a)

Table 7—Rationale for habitat risk rankings under the consumptive demand theme over a 100-year period, developed by interior basin staff biologists

Habitat	Rank	Rationale
1. Old-growth/mature coniferous forest	5	High levels of concern for old-growth. Policy for old-growth protection not established. Old-growth ponderosa pine of particular concern. Logging rate of old-growth will continue at high levels.
2. Young coniferous forest	1	Not limiting.
3. Clearcut/seedling/shrub coniferous forest	1	Not limiting.
4. Mountain shrub/prairie brush field	4	High levels of grazing and fire suppression in combination with the high risk of invasion of exotics leave this community at risk.
5. Grasslands	5	Rare habitat type with patchy distribution within the assessment area. High levels of grazing and fire-suppression activities in combination with the high risk of invasion or introduction of exotics leave this community at high risk.
6. Shrub-steppe	5	Same as habitat type 5.
7. Juniper woodlands	5	Similar risks as in type 5; however, risk of afforestation (control of pioneering juniper) as well as logging of old stands of juniper also of concern.
8. Alpine	3	Though somewhat protected mostly in wilderness areas, there is a risk due to livestock grazing as well as invasion of exotics through nonnative livestock (including pack animals). Fragile ecosystem.
9. Freshwater marshes, ponds, lakes	5	High risk due to development proposals, eutrophication, channelization, invasion of nonnative vertebrate and plant species.
10. Riparian	5	High levels of grazing, logging, and road building leave riparian areas at high risk.
11. Wet, dry, hay meadows	5	Heavy grazing pressures, fire suppression, and risk to exotics leave this community at high risk. Also of concern is soil compaction and increasing sedimentation.
12. Oak woodlands	5	Continued high risk to oak woodlands due to high levels of grazing, firewood cutting, fire suppression, and development proposals.
13. Aspen	5	High levels of logging, grazing, and fire suppression continue to leave this community at high risk.
14. Cliffs, rocks, talus	1	Though this community is relatively secure, risk to inappropriate mineral/aggregate extraction is present.
15. Urban	0	Not limiting.
16. Agriculture/pastureland	0	Not limiting.

Table 8—Rationale for habitat risk rankings under the active management theme over a 100-year period, developed by interior basin staff biologists

Habitat	Rank	Rationale
1 Old-growth/mature coniferous forest	3	Risk to old-growth is moderate because of logging of stands with high levels of insect and disease and the risk to loss through wildfires Prescribed fires would help reduce the risk of high-intensity wildfire
2 Young coniferous forest	1	Not limiting
3 Clearcut/seedling/shrub coniferous forest	2	Not limiting
4 Mountain shrub/prairie brushfield	1	Control of livestock grazing to provide for ecosystem function and control of exotics provide for healthy communities of mountain shrub/prairie brushfields
5 Grasslands	3	Rare habitat with patchy distribution within the assessment area Control of grazing and using effective management techniques to control exotics where possible will have positive effects Prescribed fires where effective also may be useful
6 Shrub-steppe	3	Widespread habitat in the interior basin otherwise same as habitat 5
7 Juniper woodlands	5	Though somewhat similar to 5, the risk of afforestation (control of pioneering juniper) as well as logging of juniper stands is of high concern for this community
8 Alpine	1	Most of this habitat is protected in high-elevation areas, with little threat to resource extraction
9 Freshwater marshes, ponds, lakes	3	Moderate risk due to development proposals, eutrophication, channelization, and invasion of nonnative vertebrate and plant species
10 Riparian	3	Risk to riparian areas is rated as moderate because of some grazing, logging, water control, and recreation
11 Wet, dry, hay meadows	2	Through control of grazing and invasion of exotics, these communities, though scarce are at a fairly low risk
12 Oak woodlands	3	Risk to oak woodlands is moderate because of grazing pressure, firewood extraction, and development proposals
13 Aspen	1	Through use of effective restoration activities, and control of grazing, the risk to aspen communities are low
14 Cliffs, rocks, talus	1	Though these communities are relatively secure, risk to inappropriate mineral/aggregate extraction is present
15 Urban	0	Not limiting
16 Agnculture/pastureland	0	Not limiting

Table 9—Rationale for habitat risk rankings under the passive management theme over a 100-year period, developed by interior basin staff biologists

Habitat	Rank	Rationale
1 Old-growth/mature coniferous forest	4	Lack of prescribed fire and fire-control activities leave the limited amount of old-growth communities at moderately high risk Due to past fire-suppression activities, fuel loads are unnaturally high and may lead to high and devastating fire intensities
2 Young coniferous forest	1	Not limiting
3 Clearcut/seedhng/shrub coniferous forest	1	Not limiting
4 Mountain shrub/prairie brushfield	1	Control of livestock grazing to provide for ecosystem function and control of exotics provide for healthy communities of mountain shrub/prairie brushfields
5 Grasslands	4	Rare habitat with patchy distribution within the assessment area Threat of invasion of exotics through lack of any management control leave these communities at moderately high risk
6 Shrub-steppe	5	Widespread habitat otherwise similar to habitat 5 Threats to unsuppressed fire increase the threats of introduction or invasion of exotics
7 Juniper woodlands	5	Same as habitat type 6
8 Alpine	1	Most of this habitat is protected in high-elevation areas with little threat to resource extraction
9 Freshwater marshes, ponds lakes	2	Moderately low risk because of development proposals, eutrophication, channelization, and invasion of nonnative vertebrate and plant species
10 Riparian	1	Lack of grazing, logging, and road building leave riparian areas at low risk although recreation would continue
11 Wet, dry, hay meadows	2	Uncontrolled spread of exotics leave these communities at moderately low risk
12 Oak woodlands	4	Lack of fire-suppression activities, and the potential for invasion of exotics as well as the risk to development proposals leave these communities at a moderately high risk
13 Aspen	1	Aspen communities are at a low risk because of lack of logging and lack of grazing
14 Cliffs, rocks, talus	1	This community is secure
15 Urban	0	Not limiting
16 Agriculture/pastureland	0	Not limiting

Appendix 5

Assumptions of interior basin management themes considered for the NTMB analysis

Theme: Consumptive demands

Theme: Consumptive-use of resources to meet social demands

Assumptions:

1. New roads
   Road construction is allowed in areas where commodity production occurs.
2. Existing roads
   Roads are maintained where cost-effective.
3. Timber harvest and silvicultural treatments.
   Timber harvesting, including salvage harvesting, and other silvicultural treatments emphasize maximizing the sustained yield of timber products.
4. Livestock grazing and forage management
   Livestock grazing maximizes red meat production with sustained yield of forage.
5. Noxious weeds management
   Efforts are taken to control exotic (noxious and nonnoxious) species where they detract from resource values. This includes replacement with more desirable forage or timber species, that is, through seeding, to reclaim infested sites.
6. Fire fighting— emphasis on prevention and suppression
   Fire-fighting resources are used to protect standing crop resource values, private property, existing structures, and public safety.
7. Prescriptive fire
   Fire management will be used to maximize commodity production.
8. Special forest products
   Collection of special forest products is permitted.
9. Mineral development
   Exploration for and development of mineral resources are encouraged.
10. Wilderness allocations
    Wilderness is managed according to the Wilderness Act but with minimum cost to the government.

Theme: Passive management of ecological processes

Theme: Public lands are managed for nonconsumptive uses

Assumptions:

1. New roads
   None.
2. Existing roads
   Local and temporary roads will be closed. Permanent, hard-surfaced roads would remain open.
3. Timber harvest and silvicultural treatments
   No timber harvesting, including salvage harvesting. No silvicultural treatments.
4. Livestock grazing and forage management
   No livestock grazing.
5. Noxious weeds management
   No efforts are taken to control exotic (noxious and nonnoxious) species.

6. Fire fighting— emphasis on prevention and suppression
   Fire-fighting resources are used only to protect existing publicly owned structures or public safety.
7. Prescriptive fire
   None.
8. Special forest products
   No collection of special forest products.
9. Mineral development
   No mining.
10. Wilderness allocations
    Bureau of Land Management and Forest Service Wilderness areas are managed similar to the rest of the land except that motorized vehicles are not allowed.

Theme: Actively manage for healthy ecosystems

Theme: Maintain and restore ecosystem functions and processes

Assumptions:

1. New roads
   Construction of new roads is minimized and done in a manner that reduces effects on watersheds and terrestrial species. Management emphasizes short-term entries and temporary road systems.
2. Existing roads
   Roads are restored where negative effects occur. Management emphasizes short-term entries and temporary road systems.
3. Timber harvest and silvicultural treatments
   Timber harvesting, salvage, and silvicultural treatments are primarily focussed on achieving forest structure and composition to provide for ecosystem functions.
4. Livestock grazing and forage management
   Livestock are grazed in conjunction with other wild herbivores to provide for ecosystem function and process.
5. Noxious weeds management
   Efforts are taken to control exotic (noxious and nonnoxious) species where they are a threat to ecosystem function and process.
6. Fire fighting
   Fire-fighting resources are used primarily to protect soil, air, and water quality; ecosystem functions; private property; existing structures; and public safety.
7. Prescriptive fire
   Fire management in conjunction with other vegetation management will provide for ecosystem functions.
8. Special forest products
   Collection is allowed where it does not interfere with ecosystem function and process.
9. Mineral development
   Mineral exploration and production is allowed if and where healthy ecosystems can be permanently reestablished.
10. Wilderness allocations
    Wildfires, prescribed fires, and other disturbances are actively managed to provide for ecosystem functions.

Appendix 6

The following is a list of Neotropical migratory land birds in the Columbia River basin with stable population trends from 1968 to 1994, based on the Breeding Bird Survey.

Turkey vulture
Northern harrier
Swainson's hawk
Ferruginous hawk
Prairie falcon
Kestrel
Short-eared owl
Burrowing owl
Belted kingfisher
Williamson's sapsucker
Lewis' woodpecker
Northern flicker
Common nighthawk
Vaux's swift
Rufous hummingbird
Eastern kingbird
Western kingbird
Western wood-pewee
Cordilleran flycatcher
Hammond's flycather
Dusky flycatcher
Bobolink
Brown-headed cowbird
Yellow-headed blackbird
Bullock's oriole
Purple finch
Cassin's finch
Red crossbill
Vesper sparrow
Grasshopper sparrow
White-crowned sparrow
Dark-eyed junco
Sage sparrow
Lincoln's sparrow
Fox sparrow
Green-tailed towhee
Lazuli bunting
Western tanager
Barn swallow
Tree swallow
Violet-green swallow
Bank swallow
Northern rough-winged swallow
Cedar waxwing
Red-eyed vireo
Solitary vireo
Nashville warbler
Yellow-rumped warbler
MacGillivray's warbler
Yellow-breasted chat
Wilson's warbler
American redstart
Sage thrasher
Rock wren
Brown creeper
Golden-crowned kinglet
Ruby-crowned kinglet
Townsend's solitaire
Veery
Swainson's thrush
Hermit thrush
Western bluebird

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

								Habitat threats*				Habitat specialization*					Management index*			
	Species	Bd4	Pt26'	Ptu26'	PtlO'	Pmi(y	Habitats'	NA'	CD/	AM/	PM/	NA	CD	AM	PM	ED"	NA	CD	AM	PM
	Turkey vulture	1	3	3	2	3	2,3 4 5,6 7 12 13 14,16	27	32	1 9	23	03	03	02	0 23	1	4 97	5 52	4 09	4 53
	Osprey (supp)	1	2	3	1	2	2,9, 10	3 00	3 67	2 33	1 33	1 00	1 22	0 78	0 44	0	5 00	5 89	4 11	2 78
	Northern harrier	1	2	3	2	3	5,6,9 11, 16	32	4	22	26	06	08	04	0 52	1	5 84	6 80	4 64	5 12
	Sharp-shinned hawk	1	3	4	3	4	1,2, 10, 12 13	38	42	22	22	08	08	04	0 44	1	6 56	7 04	4 64	4 64
	Cooper s hawk	1	3	4	3	4	1,2, 10, 12, 13, 15	317	3 50	183	1 83	0 53	0 58	031	031	1	5 69	6 08	4 14	4 14
	Northern goshawk	2	3	5	3	5	1,2, 10, 13	3 50	4 00	2 00	1 75	0 88	100	0 50	0 44	1	7 38	8 00	5 50	5 19
	Swainson's hawk	2	2	3	2	3	5,6,7, 10, 11, 13, 16	3 43	4 29	2 43	2 57	0 49	061	0 35	0 37	1	6 92	7 90	5 78	5 94
	Red-tailed hawk	1	2	2	2	2	1,2,3, 4,5,6,7,9, 10 11, 12, 13, 14, 16	3 07	371	2 14	2 29	0 22	0 27	0 15	0 16	0	4 29	4 98	3 30	3 45
	Ferruginous hawk	3	2	3	2	3	5,6,7, 13, 14	3 40	4 20	2 60	3 20	0 68	0 84	0 52	0 64	1	8 08	9 04	7 12	7 84
	Golden eagle	2	3	3	1	2	1,3 5,6,7,8, 10, 11, 13, 14, 16	291	3 64	2 09	2 27	0 26	0 33	0 19	021	0	5 17	5 97	4 28	4 48
	American kestrel	1	3	3	3	3	1,2,3,4,5,6,7, 10, 11, 12 13, 14, 15, 16	2 86	3 36	1 93	2 14	0 20	0 24	0 14	015	1	5 06	5 60	4 07	4 30
	Merlin	2	3	4	2	3	2,6,7 10	3 50	4 00	3 00	3 00	0 88	100	0 75	0 75	1	7 38	8 00	6 75	6 75
	Peregrine falcon	3	3	5	3	5	5,6,9, 14, 15	2 80	3 20	2 00	2 40	0 56	0 64	0 40	048	1	7 36	7 84	6 40	6 88
	Prairie falcon	3	4	3	2	3	5,6 7 11, 14, 16	2 83	3 50	2 33	2 83	0 47	0 58	0 39	0 47	1	731	8 08	6 72	731
	Killdeer	1	4	2	5	2	5,9, 10, 11,15,16	2 67	3 33	183	1 50	0 44	0 56	031	025	5	9 11	9 89	8 14	775

Appendix 7

Data used to derive management concern indices by interior basin management themes*

							Habitat threats*				Habitat specialization™					Management index*			
Species	Bd[b]	Pt26[c]	Ptu26[d]	Ptl0[e]	Pcul0[f]	Habitats*	NA	CD[f]	AM[f]	PM[f]	NA	CD	AM	PM	ED[g]	NA	CD	AM	PM
Upland sandpiper	3	3	5	3	5	5 11	4 00	5 00	2 50	3 00	2 00	2 50	125	1 50	1	10 00	11 50	7 75	8 50
Long-billed curlew	4	1	2	2	3	5,6,9, 11	4	5	28	33	1	1 3	07	081	0	9 00	1025	7 44	8 06
Mourning dove	1	4	2	3	3	1 2,3,4,5,6,7, 10, 12, 13, 15, 16	3 00	3 42	2 00	2 25	025	0 28	0 17	0 19	5	9 25	9 70	8 17	8 44
Black billed cuckoo	3	3	5	3	5	10	5 00	5 00	3 00	1 00	5 00	5 00	3 00	1 00	1	14 00	14 00	10 00	6 00
Yellow-billed cuckoo	2	3	5	3	5	10	5 00	5 00	3 00	1 00	5 00	5 00	3 00	1 00	1	13 00	13 00	9 00	5 00
Flammulated owl	3	3	5	3	5	1, 13	4 00	5 00	2 00	2 50	2 00	2 50	1 00	1 25	1	10 00	1150	7 00	7 75
Burrowing owl	3	2	3	2	3	5,6,7, 11, 16	3 20	4 00	2 60	3 20	0 64	0 80	0 52	0 64	1	7 84	8 80	7 12	7 84
Long-eared owl	1	3	5	3	5	1,2,7, 10, 11, 13	3 33	4 33	2 50	2 33	0 56	0 72	0 42	0 39	1	5 89	7 06	4 92	4 72
Short-eared owl	1	2	3	2	3	5,6,9, 11, 16	3 20	4 00	2 20	2 60	0 64	0 80	0 44	0 52	1	5 84	6 80	4 64	5 12
Common nighthawk	1	2	3	2	3	1,2,3, 5,6,7, 10, 11, 12, 13	3 60	4 20	2 50	2 80	0 36	0 42	0 25	0 28	1	5 96	6 62	4 75	5 08
Common poorwill	3	3	4	3	4	1,2,3,4,5,6,7, 11, 13	3 22	4 00	2 22	2 67	0 36	0 44	0 25	0 30	1	7 58	8 44	6 47	6 96
Black swift	5	3	4	3	5	9, 10, 14	3 00	3 67	2 33	1 33	100	1 22	0 78	0 44	1	10 00	1089	911	7 78
Vaux's swift	5	3	3	4	3	1, 10, 15, 16	2 50	2 50	150	1 25	0 63	0 63	0 38	031	1	913	9 13	7 88	7 56
White-throated swift	3	3	4	3	4	5,6,7, 10, 14	3 80	4 20	3 00	3 20	0 76	0 84	0 60	0 64	1	8 56	9 04	7 60	7 84
Black-chinned hummingbird	3	3	4	3	4	3,4,6, 10, 15	2 80	3 00	160	1 60	0 56	0 60	0 32	0 32	1	7 36	7 60	5 92	5 92

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

							Habitat threats*				Habitat specialization[a]					Management index[a]			
	Species	Bd[b]	Pt26[c]	Ptu26[c]	Ptl0[/]	Ptu10[/]	Habitats[b]	NA'	CO	AM[b]	PM[/]	NA	CD	AM	PM	ED"	NA	CD	AM	PM
	Calliope hummingbird	4	4	3	5	2	1,2,3,4 8, 10, 11, 13	2 75	3 63	1 63	1 50	0 34	045	0 20	0 19	1	8 09	9 08	6 83	6 69
	Broad-tailed hummingbird	3	3	4	3	4	1,2,3 7, 10, 11, 13	3 00	3 86	2 29	2 14	0 43	055	0 33	031	1	7 43	841	661	6 45
	Rufous hummingbird	4	4	3	4	3	2,4,8, 10, 11 12, 13,15, 16	2 33	3 11	1 33	1 22	0 26	0 35	0 15	0 14	1	7 59	8 46	6 48	6 36
	Belted kingfisher	1	4	3	3	3	9, 10	4 00	5 00	3 00	1 50	2 00	2 50	1 50	0 75	1	8 00	9 50	6 50	4 25
	Lewis' woodpecker	4	4	3	3	4	1, 10, 12	5 00	5 00	3 00	3 00	167	167	1 00	1 00	1	11 67	11 67	9 00	9 00
	Red-naped sapsucker	4	1	2	2	3	1,2, 10, 13	3 50	4 00	2 00	175	0 88	100	0 50	0 44	0	8 38	9 00	6 50	6 19
	Red-breasted sapsucker	4	3	4	3	4	1,2, 10, 13, 16	2 80	3 20	1 60	140	06	06	03	0 28	1	8 36	8 84	6 92	6 68
	Williamson s sapsucker	4	4	3	4	3	1, 10, 13	4 33	5 00	2 33	2 00	144	167	0 78	0 67	1	10 78	11 67	8 11	7 67
	Northern flicker	1	3	3	3	3	1,2,3,7,8,10, 12, 13,15	2 67	3 33	2 00	2 00	0 30	0 37	0 22	0 22	1	4 96	5 70	4 22	4 22
	Olive-sided flycatcher	3	4	2	4	2	1,2,3,8	2 00	2 50	1 50	175	0 50	0 63	0 38	0 44	5	10 50	11 13	9 88	10 19
	Western wood-pewee	2	3	3	2	3	1,2, 10, 12 13, 15, 16	2 71	3 00	1 57	1 57	0 39	0 43	0 22	0 22	1	6 10	6 43	4 80	4 80
	Willow flycatcher	3	4	2	4	2	10	5 00	5 00	3 00	100	5 00	5 00	3 00	100	5	18 00	18 00	14 00	10 00
	Least flycatcher	2	3	4	3	4	10	5 00	5 00	3 00	100	5 00	5 00	3 00	1 00	1	13 00	13 00	9 00	5 00
	Hammond's flycatcher	4	2	3	2	3	1,2, 10, 13	3 50	4 00	2 00	175	0 88	100	0 50	0 44	1	9 38	10 00	7 50	7 19

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

								Habitat threats[h]				Habitat specialization[m]								
	Species	Bd[b]	Pt26[f]	Ptu26[d]	Pc10'	Ptu10[j]	Habitats[b]	NA'	CD'	AM[b]	PM[j]	NA	CD	AM	PM	ED"	NA	CD	AM	PM
	Dusky flycatcher	4	2	3	2	3	1 2, 3 4 10 13	3 00	3 50	1 67	1 50	0 50	0 58	0 28	0 25	1	8 50	9 08	6 94	6 75
	Gray flycatcher	4	2	3	1	2	3,6,7	3 00	3 67	3 00	3 67	1 00	122	1 00	1 22	0	8 00	8 89	8 00	8 89
	Cordilleran flycatcher	4	2	3	2	3	1,2, 13	3 00	3 67	1 67	2 00	1 00	1 22	0 56	0 67	1	9 00	9 89	7 22	7 67
	Say's phoebe	2	1	2	3	3	5, 6, 7, 16	325	3 75	2 75	3 50	081	0 94	0 69	0 88	0	6 06	6 69	5 44	6 38
	Ash-throated flycatcher	3	3	4	3	4	6,7, 10, 12	4 50	5 00	3 50	3 75	1 13	125	0 88	0 94	1	9 63	10 25	8 38	8 69
	Western kingbird	3	3	3	2	3	5,6 10, 12, 16	4 00	4 00	2 40	2 80	0 80	0 80	0 48	0 56	1	8 80	8 80	6 88	7 36
	Eastern kingbird	2	3	3	3	3	9, 10,11,16	2 75	3 75	2 00	125	0 69	0 94	0 50	031	1	6 44	7 69	5 50	4 56
	Horned lark	1	4	2	3	3	5,6, 11, 16	3 25	3 75	2 00	2 75	081	0 94	0 50	0 69	5	10 06	10 69	8 50	9 44
	Purple martin	2	3	5	3	5	9, 10, 15,16	2 00	2 50	1 50	0 75	0 50	0 63	0 38	0 19	1	5 50	6 13	4 88	3 94
	Tree swallow	1	3	3	3	3	9, 10, 11 13 15, 16	2 33	3 33	1 50	1 00	0 39	0 56	0 25	0 17	1	4 72	5 89	3 75	3 17
	Violet-green swallow	3	2	3	2	3	1,2, 9, 10, 13, 14 15, 16	2 25	2 75	1 50	125	0 28	0 34	0 19	0 16	1	6 53	7 09	5 69	541
	Northern rough-winged swallow	1	2	3	3	3	6, 9, 10	4 33	5 00	3 00	2 67	1 44	167	1 00	0 89	1	7 78	8 67	6 00	5 56
	Bank swallow	1	3	3	2	3	9, 10	4 00	5 00	3 00	1 50	2 00	2 50	1 50	0 75	1	8 00	9 50	6 50	4 25
	Cliff swallow	1	2	2	3	3	5,6,9, 10, 11, 14, 15, 16	2 75	3 25	1 88	188	0 34	041	0 23	0 23	1	5 09	5 66	4 11	4 11
	Barn swallow	1	3	3	4	3	9 10, 15 16	2 00	2 50	1 50	0 75	0 50	0 63	0 38	0 19	1	4 50	5 13	3 88	2 94
	Brown creeper	1	4	3	4	3	1 2	3 00	3 00	2 00	2 50	1 50	150	1 00	125	1	6 50	6 50	5 00	5 75

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

							Habitat threats*				Habitat specialization"[1]					Managçment index"			
	Species	Bd[b]	Pt26[c]	Ptu26[d]	Ptl0[/]	Ptul0[/]	Habitats[b]	NA	CD[/]	AM[b]	PM[/]	NA	CD	AM	PM	ED"	NA	CD	AM	PM
	Rock wren	3	2	3	2	3	5,6,7, 14	3 50	4 00	3 00	3 75	0 88	1 00	0 75	0 94	1	8 38	9 00	7 75	8 69
	House wren	1	2	2	1	2	1,2,3, 10 12, 13, 15, 16	2 50	2 75	1 50	1 50	031	0 34	0 19	0 19	0	381	4 09	2 69	2 69
	Marsh wren	3	2	3	1	2	9	3 00	5 00	3 00	2 00	3 00	5 00	3 00	2 00	0	9 00	13 00	9 00	7 00
	Golden-crowned kinglet (supp)	3	3	3	4	3	1,2	3 00	3 00	2 00	2 50	1 50	1 50	1 00	1 25	1	8 50	8 50	7 00	7 75
	Ruby-crowned kinglet	2	2	3	3	3	1,2,7	3 00	3 67	3 00	3 33	1 00	1 22	1 00	1 11	1	7 00	7 89	7 00	7 44
	Blue-gray gnatcatcher	2	3	4	3	4	4,5,7, 10	4 00	4 75	3 00	2 75	1 00	1 19	0 75	0 69	1	8 00	8 94	6 75	6 44
	Western bluebird	3	4	3	2	3	1,2,3,4,7, 10, 12 13, 16	2 89	3 44	2 00	2 00	0 32	0 38	0 22	0 22	1	721	7 83	6 22	6 22
	Mountain bluebird	3	2	2	1	2	1,2,3,5,6,7,8, 13	3 00	3 75	2 25	2 75	0 38	0 47	0 28	0 34	0	6 38	7 22	5 53	6 09
	Townsend s solitaire	3	4	3	4	3	1,2,3,7	2 50	3 00	2 50	2 75	0 63	0 75	0 63	0 69	1	7 13	7 75	7 13	7 44
	Veery	3	4	3	4	3	10	5 00	5 00	3 00	1 00	5 00	5 00	3 00	1 00	1	14 00	14 00	10 00	6 00
	Swainson's thrush	2	3	3	4	3	1,2, 10, 13	3 50	4 00	2 00	1 75	0 88	1 00	0 50	0 44	1	7 38	8 00	5 50	5 19
	Hermit thrush	2	2	3	2	3	1,2,3,8	2 00	2 50	1 50	1 75	0 50	0 63	0 38	0 44	1	5 50	6 13	4 88	5 19
	American robin	1	3	3	4	2	1,2,3,4,7, 10, 11, 13, 14, 15, 16	2 27	2 91	164	1 55	021	0 26	0 15	0 14	5	8 48	9 17	7 79	7 69
	Gray catbird	2	2	3	1	2	10	5 00	5 00	3 00	1 00	5 00	5 00	3 00	1 00	0	12 00	12 00	8 00	4 00
	Northern mockingbird	2	3	5	3	5	6 10	5 00	5 00	3 00	3 00	2 50	2 50	1 50	1 50	1	10 50	10 50	7 50	7 50

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

							Habitat threats[b]				Habitat specialization[m]					Management index[a]			
	Species	Bd[b]	Pt26	Pt26[d]	Pct10	Ptu10[f]	Habitats[b]	NA	CO	AM[k]	PM	NA	CD	AM	PM	ED[n]	NA	CD	AM	PM
	Sage thrasher	4	2	3	3	3	6 7	4 00	5 00	4 00	5 00	2 00	2 50	2 00	2 50	1	11 00	12 50	11 00	12 50
	American pipit	3	3	5	3	5	8 11	2 00	4 00	1 50	1 50	1 00	2 00	0 75	0 75	1	7 00	10 00	6 25	6 25
	Cedar waxwing	2	3	3	4	3	7 10 15 16	2 00	2 50	2 00	1 50	0 50	0 63	0 50	0 38	1	5 50	613	5 50	4 88
	Loggerhead shrike	2	4	2	2	3	5 6 7	4 33	5 00	3 67	4 67	1 44	167	1 22	1 56	5	12 78	13 67	1189	13 22
	Solitary vireo	2	3	3	2	3	1 2 10	3 67	3 67	2 33	2 00	1 22	1 22	0 78	0 67	1	7 89	7 89	6 11	5 67
	Warbling vireo	2	2	2	2	3	2 10 12 13	3 50	4 00	2 00	175	0 88	1 00	0 50	0 44	0	6 38	7 00	4 50	4 19
	Red eyed vireo	2	4	3	2	3	10 13	5 00	5 00	3 00	1 00	5 00	5 00	3 00	1 00	1	13 00	13 00	9 00	5 00
	Tennessee warbler	3	3	5	3	5	1 2	3	3	2	25	1 5	1 5	1	1 3	1	85	85	7	7 75
	Orange crowned warbler	3	2	2	1	2	4 10 12 13	4 00	4 75	2 00	1 75	1 00	1 19	0 50	0 44	0	8 00	8 94	5 50	5 19
	Nashville warbler	3	3	3	2	3	2 3 4 10 12	3 00	3 20	1 80	1 60	0 60	0 64	0 36	0 32	1	7 60	7 84	6 16	5 92
	Virginia s warbler	5	3	5	3	5	4 7 10	3 67	4 67	3 00	2 33	1 22	1 56	1 00	0 78	1	10 89	12 22	10 00	9 11
	Yellow warbler	1	4	3	4	2	10	5 00	5 00	3 00	1 00	5 00	5 00	3 00	1 00	5	16 00	16 00	12 00	8 00
	Yellow rumped warbler	1	3	3	3	3	1 2 10 12 13	3 80	4 20	2 20	2 20	0 76	0 84	0 44	0 44	1	6 56	7 04	4 64	4 64
	Black throated gray warbler	3	3	4	3	4	7 10 12	4 33	5 00	3 67	3 33	1 44	167	1 22	1 11	1	9 78	10 67	8 89	8 44
	Townsend s warbler	4	1	2	2	3	1 2	3 00	3 00	2 00	2 50	1 50	1 50	1 00	1 25	0	8 50	8 50	7 00	7 75
	Hermit warbler	5	3	4	3	4	1 2	3 00	3 00	2 00	2 50	1 50	1 50	1 00	1 25	1	10 50	10 50	9 00	9 75

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

								Habitat threats*				Habitat specialization[m]					Management index[b]			
	Species	Bd[b]	Pt26	Ptu26[d]	Ptl0'	Ptu10[f]	Habitats[b]	NA	CD[j]	AM[k]	PM[l]	NA	CD	AM	PM	ED"	NA	CD	AM	PM
	American redstart	2	3	3	3	3	2, 10	3 00	3 00	2 00	1 00	1 50	1 50	1 00	0 50	1	7 50	7 50	6 00	4 50
	Northern waterthrush	2	3	4	3	4	9, 10 13	3 67	5 00	2 33	1 33	1 22	1 67	0 78	0 44	1	7 89	9 67	611	4 78
	MacGillivray s warbler	4	2	3	2	3	2 3,4, 10	2 50	2 75	1 50	1 00	0 63	0 69	0 38	0 25	1	8 13	8 44	6 88	6 25
	Common yellowthroat	1	2	3	2	2	9, 10 11	3 67	5 00	2 67	1 67	1 22	1 67	0 89	0 56	0	5 89	7 67	4 56	3 22
	Wilson's warbler	3	2	3	2	3	8, 10	3 00	4 00	2 00	1 00	1 50	2 00	1 00	0 50	1	8 50	10 00	7 00	5 50
	Yellow-breasted chat	2	2	3	2	3	9, 10	4 00	5 00	3 00	1 50	2 00	2 50	1 50	0 75	1	900	10 50	7 50	5 25
	Western tanager	3	2	3	2	3	1,2,7,10, 12, 13, 15	3 14	3 71	2 29	2 29	0 45	0 53	0 33	0 33	1	7 59	8 24	661	661
	Black-headed grosbeak	3	2	2	1	2	2,4, 10, 12, 15, 16	2 33	2 50	1 33	1 17	0 39	0 42	0 22	0 19	0	5 72	5 92	4 56	4 36
	Blue grosbeak	2	3	5	3	5	4, 10	4 00	4 50	2 00	1 00	2 00	2 25	1 00	0 50	1	9 00	9 75	6 00	4 50
	Lazuli bunting	3	2	3	2	3	4,7,8, 10, 13	3 00	4 40	2 20	1 80	0 60	0 88	0 44	0 36	1	7 60	9 28	6 64	6 16
	Green-tailed towhee	4	2	3	2	3	3,4,6,7	3 00	3 75	2 50	3 00	0 75	0 94	0 63	0 75	1	8 75	9 69	8 13	8 75
	Spotted towhee	2	2	2	1	2	4, 10, 12, 15, 16	2 60	2 80	1 40	1 20	0 52	0 56	0 28	0 24	0	5 12	5 36	3 68	3 44
	Chipping sparrow	1	4	2	3	3	1,2,3,7,8, 12,15, 16	2 00	2 50	175	2 00	0 25	031	0 22	0 25	5	8 25	881	7 97	8 25
	Clay-colored sparrow	4	3	4	3	4	4,5	4 00	4 50	2 00	2 50	2 00	2 25	1 00	125	1	11 00	11 75	8 00	8 75

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

								Habitat threats[b]				Habitat specialization[n]					Management index[d]			
	Species	Bd[b]	Pt26[c]	Pt26[d]	Pt10[e]	Ptul0[f]	Habitats[l]	NA	CD[j]	AM[k]	PM[j]	NA	CD	AM	PM	ED[n]	NA	CD	AM	PM
	Brewer's sparrow	3	4	2	4	2	6	5 00	5 00	3 00	5 00	5 00	5 00	3 00	5 00	5	18 00	18 00	14 00	18 00
	Vesper sparrow	2	3	3	3	3	5 6,7, 11, 16	3 20	4 00	2 60	3 20	0 64	0 80	0 52	0 64	1	6 84	7 80	6 12	6 84
	Lark sparrow	2	4	2	4	3	5 6, 7 12, 16	3 60	4 00	2 80	3 60	0 72	0 80	0 56	0 72	5	1132	11 80	10 36	11 32
	Black-throated sparrow	3	3	4	3	4	6	5 00	5 00	3 00	5 00	5 00	5 00	3 00	5 00	1	14 00	14 00	10 00	14 00
	Sage sparrow	4	4	3	2	3	5,6,7	4 33	5 00	3 67	4 67	1 44	1 67	1 22	1 56	1	10 78	11 67	9 89	11 22
	Lark bunting	4	3	5	3	5	5,6	5 00	5 00	3 00	4 50	2 50	2 50	1 50	2 25	1	12 50	12 50	9 50	11 75
	Savannah sparrow	1	3	3	4	2	5,9, 11, 16	2 75	3 75	2 00	2 00	0 69	0 94	0 50	0 50	5	9 44	10 69	8 50	8 50
	Grasshopper sparrow	2	3	3	3	3	5,6, 16	3 33	3 33	2 00	3 00	1 11	1 11	0 67	1 00	1	7 44	7 44	5 67	7 00
	Fox sparrow	2	4	3	4	3	3,4,8, 10	2 50	3 25	1 50	100	0 63	081	0 38	0 25	1	6 13	7 06	4 88	4 25
	Song sparrow	1	4	2	4	3	9, 10, 15	2 67	3 33	2 00	1 00	0 89	1 11	0 67	0 33	5	9 56	10 44	8 67	7 33
	Lincoln's sparrow	3	2	3	2	3	8, 10, 11	3 00	4 33	2 00	133	1 00	1 44	0 67	0 44	1	8 00	9 78	6 67	5 78
	White-crowned sparrow	2	3	3	2	3	10, 11, 13	3 67	5 00	2 00	133	1 22	1 67	0 67	0 44	1	7 89	9 67	5 67	4 78
	Dark-eyed junco	1	3	3	3	3	1,2,3,7,8, 10, 12, 13	3 00	3 75	2 25	2 25	0 38	0 47	0 28	0 28	1	5 38	622	4 53	4 53
	Bobolink	3	2	3	2	3	5, 11	4 00	5 00	2 50	3 00	2 00	2 50	125	1 50	1	10 00	11 50	7 75	85
	Red-winged blackbird	1	4	2	4	2	9 10, 15, 16	2 00	2 50	1 50	0 75	0 50	0 63	0 38	0 19	5	8 50	9 13	7 88	6 94
	Western meadowlark	2	3	2	4	2	5,6,7, 11, 16	3 20	4 00	2 60	3 20	0 64	0 80	0 52	0 64	5	10 84	11 80	10 12	10 84

Appendix 7

Data used to derive management concern indices by interior basin management themes[a]

								Habitat threats[b]				Habitat specialization[m]					Management index[d]			
	Species	Bd[b]	Pt26[c]	Ptu26[d]	Ptl0[e]	Ptu10[f]	Habitats[b]	NA[i]	CD[j]	AM[k]	PM[l]	NA	CD	AM	PM	ED[n]	NA	CD	AM	PM
	Yellow-headed blackbird	3	3	3	4	3	9, 11, 16	2 00	3 33	1 67	1 33	0 67	1 11	0 56	0 44	1	6 67	8 44	6 22	5 78
	Brewer s blackbird	3	4	2	4	2	5 6, 10, 11, 15 16	3 00	3 33	1 83	2 00	0 50	0 56	031	0 33	5	11 50	11 89	10 14	10 33
	Brown-headed cowbird	1	2	3	3	3	3, 5,6 9, 10, 12, 15, 16	3 00	3 25	2 00	2 13	0 38	041	0 25	0 27	1	5 38	5 66	4 25	4 39
	Bullock's oriole	3	3	3	4	3	6, 10, 12, 15, 16	3 00	3 00	1 80	2 00	0 60	0 60	0 36	0 40	1	7 60	7 60	6 16	6 40
	Purple finch	3	3	4	3	4	15, 16	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00	1	4 00	4 00	4 00	4 00
	Cassin's finch	3	2	3	3	3	1,2,7, 10, 13	3 40	4 20	2 60	2 40	0 68	0 84	0 52	0 48	1	8 08	9 04	7 12	6 88
	Pine siskin	2	4	3	4	2	1,2,3,7	2 50	3 00	2 50	2 75	0 63	0 75	0 63	0 69	5	10 13	10 75	10 13	10 44
	Lesser goldfinch	3	3	5	3	5	6,7, 16	2 67	3 33	2 67	3 33	0 89	1 11	0 89	1 11	1	7 56	8 44	7 56	8 44
	American goldfinch	1	4	2	2	3	10, 12, 15, 16	2 50	2 50	1 50	1 25	0 63	0 63	0 38	031	5	9 13	9 13	7 88	7 56
	Tn-colored blackbird	5	3	4	3	4	9, 16	1 50	2 50	1 50	1 00	0 75	125	0 75	0 50	1	8 25	9 75	8 25	7 50
	Red crossbill	2	2	3	1	2	1,2, 10	3 67	3 67	2 33	2 00	1 22	1 22	0 78	0 67	0	6 89	6 89	5 11	4 67

a See appendix 2 for derailed field definitions and explanations of calculations
b BD Breeding distribution (Carter and Barker 1993)
c PT26 26-year population trend based on BBS (Carter and Barker 1993)
d PTU26 26-year population trend uncertainty (Carter and Barker 1993)
e PT10 10-year population trend based on BBS (Carter and Barker 1993)
f PTU10 10-year population trend uncertainty (Carter and Baker 1993)
g Habitats Nesting and foraging habitats used during the breeding season
Number codes for habitats 1 =Old-growth conifer, 2=Young conifer, 3=Seedhng conifer, 4=Mountain shrub, 5=Grasslands, 6=Shrub-steppe, 7=Juniper woodlands, 8=Alpine, 9=Marshes and ponds, 10=Ripanan, ll=Meadows, 12=Oak woodlands, 13=Aspen, 14=Cliffs and talus, 15=Urban, 16=Agriculture/pastureland
h Habitat threats (TH) overall threats to species' habitats (see appendix 2)
i NA No action
j CD Consumption demand
k AM Active management
l PM Passive management
m Habitat specialization (HS) overall habitat specialization of the species (see appendix 2)
n ED Evidence of decline (see appendix 2)
o Management index BD + ED + TH + HS

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Saab, Victoria A ; Rich, Terrell D 1997 Large-scale conservation assessment for Neotropical migratory land birds in the interior Columbia River basin Gen Tech Rep. PNW-GTR-399 Portland, OR U S Department of Agriculture, Forest Service, Pacific Northwest Research Station 56 p (Quigley, Thomas M , ed Interior Columbia Basin Ecosystem Management Project scientific assessment)

The status and habitats of 132 species of neotropical migratory landbirds (NTMB) are evaluated within the Interior Columbia River Basin (CRB) Objectives are to examine population trends, estimate NTMB responses to alternative management activities and provide recommendations by habitat and species that will lead to long-term persistence of NTMB populations Five habitats (riparian, old growth forests, shrubsteppe, grasslands, and juniper) are identified for management priorities based on species declines, vulnerability to human activities and habitat loss Among the four management themes considered, more species (63) were of high management concern under Consumptive Management than any other theme Active and Passive Management themes are predicted to have negative effects on the fewest species, 23 and 16, respectively

Keywords Neotropical migrants, migratory birds, Interior Columbia Basin, population trends, conservation assessment, land-use planning, management themes, bird/habitat associations

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