Olive-sided Flycatcher (*Contopus cooperi*): A Technical Conservation Assessment

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Rocky Mountain Region,
Species Conservation Project

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Natasha B. Kotliar is a research wildlife biologist for the U.S. Geological Survey in Fort Collins, Colorado and is affiliate faculty at Colorado State University. She received her Ph.D. in biology from Colorado State University in Fort Collins, Colorado in 1991. Currently, her research interests include the effects of fire and fire management on avian communities and landscape processes in the Rocky Mountains. Dr. Kotliar initially became interested in fire ecology while studying olive-sided flycatchers in Colorado. Her research has included field studies on the Pike, Arapaho-Roosevelt, Routt, Medicine Bow, White River, Gunnison, Santa Fe, Kaibab, and Coconino national forests.

Summary of Key Components for Conservation of the Olive-sided Flycatcher

The Rocky Mountain Region (Region 2) of the USDA Forest Service lists the olive-sided flycatcher (*Contopus cooperi*) as a sensitive species. The U.S. Fish and Wildlife Service currently lists the olive-sided flycatcher as a Species of Conservation Concern, and it has been included as a priority species for conservation on Watch Lists for both Partners in Flight and the National Audubon Society. The primary basis for national concern is a 3.5 percent annual decline based on the Breeding Bird Survey (1966-2004). In Region 2, the population appears relatively stable overall. Breeding Bird Surveys, however, may not adequately quantify population trends because low densities and high inter-route variability make trend estimates equivocal for this species, particularly in Region 2. In addition, population variation may be correlated with forest dynamics, which may fluctuate over longer time spans than can be accurately quantified by shorter-term survey data.

Olive-sided flycatchers are associated with forest openings and edges occurring in mature forests and following natural and anthropogenic disturbances, such as tree fall gaps, fire, and logging. Essential components of olive-sided flycatcher habitat include the juxtaposition of forest openings and mature forest, and the presence of snags. The scaling of forest gap size resulting from disturbance may affect habitat suitability. Harvesting practices and fire management can affect population dynamics and habitat suitability for olive-sided flycatchers. By altering frequency, severity, spatial patterning, and other fire characteristics, fire management can affect the temporal and spatial dynamics of olive-sided flycatcher habitat on national forests. In particular, the current emphasis on reducing fuel loads and fire severity may negatively affect olive-sided flycatchers by creating even-aged and homogeneous stand conditions. Although olive-sided flycatchers often breed in logged forests throughout their range, there is conflicting evidence about the relative suitability of this habitat. Given their propensity for breeding in burned forests, the characteristics of natural disturbance regimes can provide general guidelines for management until a better understanding of the effects of particular logging practices on olive-sided flycatchers can be determined.

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Introduction

This assessment is one of many being produced to support the Species Conservation Project for the Rocky Mountain Region (Region 2; **Figure 1**) USDA Forest Service (USFS). The olive-sided flycatcher (*Contopus cooperi*) is the focus of an assessment because it is listed as a sensitive species for Region 2. In the National Forest System, a sensitive species is a plant or animal whose population viability is identified as a concern by a Regional Forester because of significant current or predicted downward trends in abundance or in habitat capability that would reduce its distribution [FSM 2670.5 (19)]. A sensitive species may require special management, so knowledge of its biology and ecology is critical.

This assessment addresses the ecology and management of the olive-sided flycatcher throughout its range, but with an emphasis on Region 2. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production.

Goal of Assessment

Species conservation assessments produced as part of the Species Conservation Project are designed to provide forest managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management considerations of certain species based on available scientific knowledge. The assessment goals limit the scope of work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations, but provides the ecological background and conservation context upon which management must be based. The focus is on the

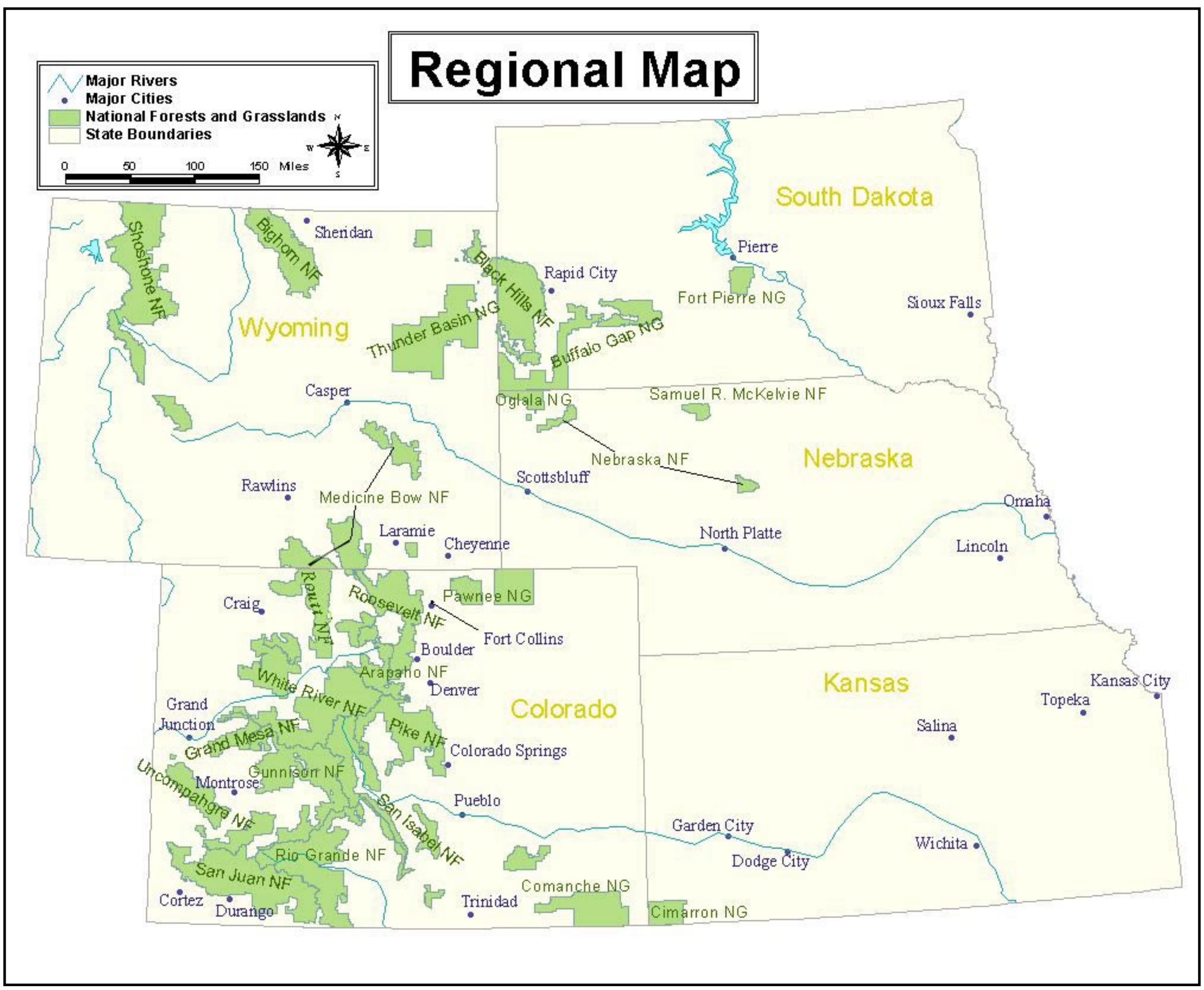

Figure 1. Map of USDA Forest Service Region 2.

consequences of changes in the environment that result from management (i.e., management implications). Furthermore, it cites management recommendations proposed elsewhere and examines the success of recommendations that have been implemented.

Scope and Limitations of Assessment

The olive-sided flycatcher assessment examines the biology, ecology, conservation status, and management of this species with specific reference to the geographic and ecological characteristics of the Rocky Mountain Region. Although a majority of the literature on the species originates from field investigations outside the region, this document places that literature in the ecological and social context of the south-central Rocky Mountains. Similarly, this assessment is concerned with reproductive behavior, population dynamics, and other characteristics of olive-sided flycatchers in the context of the current environment rather than under historical conditions. The evolutionary environment of the species is, however, considered in conducting the synthesis, but placed in current context.

In producing this assessment, I reviewed refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies. Not all publications on olive-sided flycatchers are referenced in the assessment, nor were all published materials considered equally reliable. The assessment emphasizes refereed literature, as this is the accepted standard in science. Non-refereed literature publications or reports were regarded with greater skepticism, but were used when information was otherwise unavailable.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct experiments that produce clean results in the ecological sciences. Often, we must rely on observations, inference, good thinking, and models to guide our understanding of ecological relations. In this assessment, we note the strength of the evidence for particular ideas, and we describe alternative explanations where appropriate.

Publication of Assessment on the World Wide Web

To facilitate the use of species assessments in the Species Conservation Project, they are being published on the Region 2 World Wide Web site. Placing the documents on the Web makes them accessible to agency biologists and the public more rapidly and easily than publishing them as reports. More importantly, Web publication facilitates revision of the assessment, which will be accomplished based on guidelines established by Region 2.

Peer Review

Assessments developed for the Species Conservation Project have been peer-reviewed prior to release on the Web. This report was reviewed through a process administered by the Society for Conservation Biology, employing two recognized experts on this or related taxa. Peer review was designed to improve the quality of communication and increase the rigor of the assessments.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

At the national level, both federal management agencies and national conservation organizations have listed the olive-sided flycatcher as a sensitive species or species of concern. It was initially a candidate for federal Category 2 species under the Endangered Species Act (Altman and Sallabanks 2000), and the U.S. Fish and Wildlife Service (USFWS) currently lists it as a Species of Conservation Concern (U.S. Fish and Wildlife Service 2002). The olive-sided flycatcher has been included as a priority species for conservation on Watch Lists for both Partners in Flight (PIF; Carter et al. 1996) and the National Audubon Society (National Audubon Society 2002). The Natural Heritage Program ranks this species as a G4 (global heritage status); this rank applies to species that are widespread, uncommon, with possible long-term concerns although apparently secure (>100 occurrences; >10,000 individuals; http://www.cnhp.colostate.edu/heritage.html). The primary basis for national concern is a 3.5 percent (n = 789, P <0.001) annual decline based on the Breeding Bird Survey (1966-2004; http://www.mbr-pwrc.usgs.gov/bbs).

The status of olive-sided flycatchers varies regionally, in part because of variation in population trends. In 2002, the USFWS developed a comprehensive, national assessment that was designed to identify and prioritize birds that are of conservation concern (excluding species already classified as threatened or endangered), thereby stimulating and coordinating pro-active conservation among Federal, State, and private cooperators (U.S. Fish and Wildlife Service 2002). Species were evaluated at multiple scales and the criteria for inclusion were based on the PIF evaluation, including population threats, distribution, abundance, and area importance (U.S. Fish and Wildlife Service 2002). The olive-sided flycatcher was listed as a bird species of conservation concern for the following USFWS Bird Conservation Regions: northern Pacific forests, Sierra Nevada, Atlantic northern forests, and Appalachian Mountains (U.S. Fish and Wildlife Service 2002). Likewise, the olive-sided flycatcher is listed as conservation priority in USFWS administrative Regions 1 (Pacific), 4 (southeast), and 5 (northeast). The olive-sided flycatcher was not listed on the two Bird Conservation Regions corresponding to Region 2 (i.e., the northern and southern Rocky Mountains) apparently because BBS data indicate the populations are stable in this region. Although initially listed for USFWS Region 6 (mountain-prairie), which corresponds to USFS Region 2 (U.S. Fish and Wildlife 1995), the olive-sided flycatcher was not listed in the more recent assessment for this Region (U.S. Fish and Wildlife 2002).

USFS Region 2 designated the olive-sided flycatcher as a sensitive species (Finch 1992), but this species is not currently designated as sensitive for any other USFS region. Within Region 2, both Colorado and Wyoming PIF (the primary breeding areas of olive-sided flycatchers in this region) have special designations for olive-sided flycatchers (**Table 1**). The Wyoming PIF prioritization plan lists olive-sided flycatchers as Level II priority, in which monitoring is the primary recommendation (Nicholoff 2003). In the Colorado Partners in Flight Conservation Plan, the olive-sided flycatcher is listed a priority species in the spruce-fir habitat (Beidleman 2000).

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

As with other neotropical migrant birds, olive-sided flycatchers are broadly protected under the federal Migratory Bird Treaty Act (1918), the National Forest Management Act (1976), and the Neotropical Migratory Bird Conservation Act (2000). Currently, there are no federal regulatory provisions or management plans that specifically address olive-sided flycatcher conservation. As noted above, olive-sided flycatchers have been designated a sensitive species within Region 2, primarily because of concerns over possible declines. To assure their conservation needs are met on National Forest System lands, sensitive species ideally receive special emphasis in planning and management activities. Currently, no monitoring or planning activities by USFS within Region 2 specifically target olive-sided flycatchers.

The USFS has identified general management guidelines for olive-sided flycatcher for the Interior Columbia River Basin (Wisdom et al. 2000). Based primarily on general habitat affinities and habitat

Table 1. Management status of olive-sided flycatchers for states with published Partners in Flight Bird Conservation Plans. States occurring in USDA Forest Service Region 2 are in bold print.

State	Status	Citation
Colorado	**Priority for spruce/fir**	**Beidleman 2000**
Wyoming	**Priority II**	**Nicholoff 2003**
Arizona	Priority species for mixed conifer and pine forests	Latta et al. 1999
Alaska	Priority species for southeast and central regions	Andres 1999
California	Priority II, Bird species of special concern Focal species for coniferous forest and Sierra Nevada conservation plans Based on 4.1 percent western Breeding Bird Survey decline and low productivity	Robinson and Alexander 2002; Siegel 1999
Idaho	High priority breeding species for high-elevation mixed conifer	Ritter 2000
Nevada	Priority bird species for coniferous forest	Neel 1999
Oregon/ Washington	East slope Cascade: Focal species for mixed conifer Northern Rocky Mountains: focal species for mesic mixed conifer Western Coniferous Forests: early seral	Altman 2000a Altman 2000b Altman 1999b
Utah	Not a priority species	Parrish et al. 2002

trends, the emphasis of these guidelines is to accelerate the development of both early successional forests resulting from fire and silvicultural practices and of old-forest conditions. The juxtaposition of early and late seral stages is recommended. Several PIF management plans have provided similar guidelines. The Wyoming and Colorado PIF plans highlight the benefits of stand-replacement fires and other disturbances (e.g., blowdowns, insect outbreaks); beaver creation of forest openings, ponds, and tall snags; and snag retention following severe disturbances (Beidleman 2000, Nicholoff 2003). The most specific recommendations are outlined in the Pacific Northwest PIF management plans and are primarily related to fire and timber management practices (Altman 2000a, b). It is unclear how the specific recommendations (e.g., over 2 percent of landscape as post-fire and over 40 percent of post-fire landscape as unsalvaged; Altman 2000b) were determined and the validity of these recommendations needs to be evaluated empirically.

Existing federal regulations (e.g., 1995 Federal Wildland Fire Management Policy), programs and planning (e.g., National Forest Plans, Healthy Forest Initiatives, Cohesive Strategies), because of the emphasis on reduction in fire severity, contrast with olive-sided flycatcher management recommendations. Low-severity fires have less potential to create forest gaps (i.e., post-fire tree mortality is low) than high-severity fires, and consequently, will less likely benefit this species (Hutto 1995, Kotliar et al. 2002).

In addition to federal regulations, the USFS practice of post-fire salvage logging may be detrimental to the olive-sided flycatcher because it reduces snag availability. Additionally, salvage logging could potentially alter microclimate conditions, which in turn could alter prey availability. However, the effects of salvage logging and the relative suitability of prescribed vs. wildland fire for breeding olive-sided flycatchers are poorly understood.

Biology and Ecology

Systematics

The olive-sided flycatcher is a relatively large member of the Tyrannidae family, averaging 18 to 20 cm in length and weighing 32 to 37 g (Altman and Sallabanks 2000). *Tyrannus borealis* (Swainson and Richardson 1832) was the earliest accepted scientific name for this species although Nuttall (1831) described and named it *T. cooperi* three months earlier (American Ornithologists' Union 1998). The genus name was subsequently changed to *Nuttallornis* (American Ornithologists' Union 1957), and more recently to *Contopus* (American Ornithologists' Union 1983). The species name was briefly changed to *mesoleucus* before reverting to *borealis*, but was most recently changed to *cooperi*, reflecting Nuttall's original nomenclature (American Ornithologists' Union 1998).

The olive-sided flycatcher is generally considered a monotypic species because it varies relatively little in plumage or size across a broad geographic range (Altman and Sallabanks 2000). Currently, two subspecies are recognized. *Contopus cooperi marjorinus*, which breeds from southern California to northern Baja California, is distinguished by its slightly larger size and darker underparts. *Contopus c. cooperi* breeds throughout the rest of North America (Altman and Sallabanks 2000).

Distribution and abundance

Global distribution

The olive-sided flycatcher breeds widely across boreal forests of Canada and the northern United States, extending south along riparian, montane, and subalpine forests of the Rocky Mountains, Sierra Nevada Mountains, and in isolated areas in southern California and northern Baja (**Figure 2**; Altman and Sallabanks 2000). On the western coast, the range extends from Baja California to northern Alaska (Kessel and Gibson 1978). The northern portion of the breeding range spans Canada from the Yukon Territory (Altman and Sallabanks 2000) to Quebec (Sequin 1996), south to Nova Scotia (Altman and Sallabanks 2000) and Ontario (Cheskey 1987), extending farther north in the western portion of their range. In the eastern United States, the breeding range reaches south into central Minnesota, the northern parts of Michigan (Evers 1991) and Wisconsin, and throughout the New England states (Altman and Sallabanks 2000) to northern New York (Peterson 1988). In the west-central regions of the United States, this species occurs south across much of Idaho and Utah (Altman and Sallabanks 2000); western Montana (Bergeron et al. 1992), Wyoming, and Colorado (Jones 1998); northwestern New Mexico, and eastern Arizona (Altman and Sallabanks 2000).

According to the BBS summer distribution map for North America (**Figure 3**), olive-sided flycatchers reach peak densities (number of birds per route) in the Sierra Nevada and Cascade mountains of northern California and southwestern Washington. Smaller regional density peaks occur along portions of the

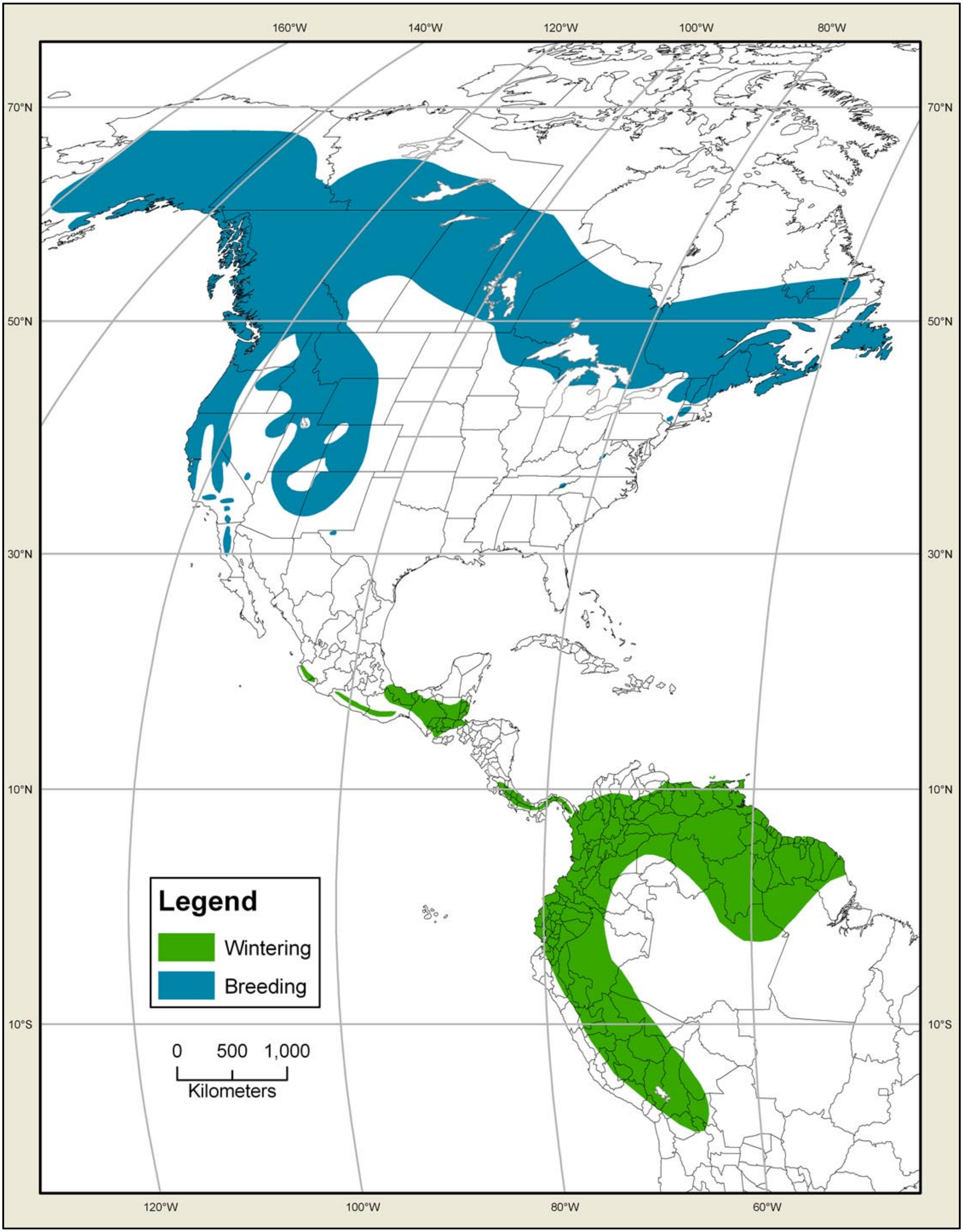

Figure 2. Map of the breeding and wintering distribution of the olive-sided flycatcher in North America. The figure is modified from Altman and Sallabanks (2002).

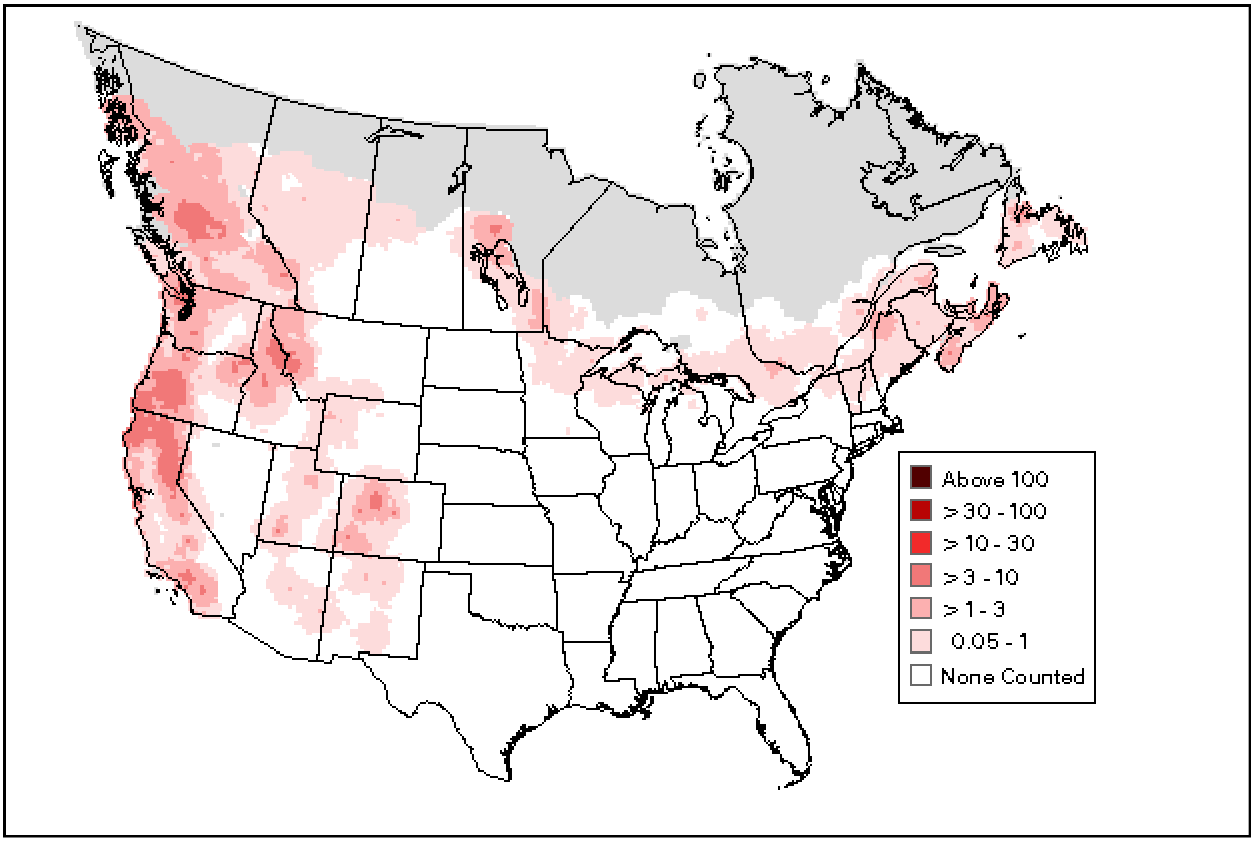

Figure 3. Breeding Bird Survey map showing breeding range and peak abundance of olive-sided flycatchers in North America as estimated from BBS route data from 1994-2003 (Sauer et al. 2005).

Rocky Mountains, including areas in north-central Colorado, eastern Idaho/western Montana, and central British Columbia.

The principal wintering range of olive-sided flycatchers is in northern portions of South America and along the Andean Mountains (**Figure 2**; Ridgely and Tudor 1994). They are also reported from the Guianas (Paytner 1995), southeastern and Amazonian Brazil (Willis et al. 1993), Costa Rica, Trinidad, Venezuela (Ridgely and Tudor 1994), Belize, and Guatemala. Occasionally, olive-sided flycatchers have been observed wintering in southern Mexico and southern California (Altman and Sallabanks 2000).

Regional distribution and abundance

Within Region 2, olive-sided flycatchers are largely restricted to forested areas of the Rocky Mountains in Colorado and Wyoming (**Figure 2**; Johnsgard 1986, Andrews and Righter 1992, Jones 1998). They occur less frequently in the Black Hills area of South Dakota and Wyoming (Tallman et al. 2002). The San Juan, Rio Grande, Uncompahgre, Gunnison, Grand Mesa, San Isabel, Pike, White River, Arapaho/Roosevelt, Routt/Medicine Bow, Shoshone, Bighorn, and Black Hills national forests all include potential breeding and migratory habitat for olive-sided flycatchers. Surveys conducted by Rocky Mountain Bird Observatory (RMBO; 1998-2005) detected olive-sided flycatchers at all Colorado and Wyoming national forests except for the Black Hills (RMBO unpubl. data, Panjabi 2005). Regionally, BBS data indicate that peak densities roughly follow the Continental Divide throughout Colorado (**Figure 3**); much of this area is under the jurisdiction of the USFS (**Figure 1**, **Figure 2**). Some of the highest densities indicated by BBS data occur in north-central Colorado, including portions of the Routt, White River, and Arapaho/Roosevelt national forests (**Figure 1**, **Figure 3**).

Colorado

Olive-sided flycatchers breed in forests (**Figure 4**) between 2,135 to 3,350 m elevation (Jones 1998). Peak densities based on BBS data closely correspond to the distribution of spruce/fir forests (**Figure 4**). This species is generally absent from intermountain parks and the eastern plains (**Figure 4**; Jones 1998). Out of 28 Colorado Breeding Bird Atlas blocks, they

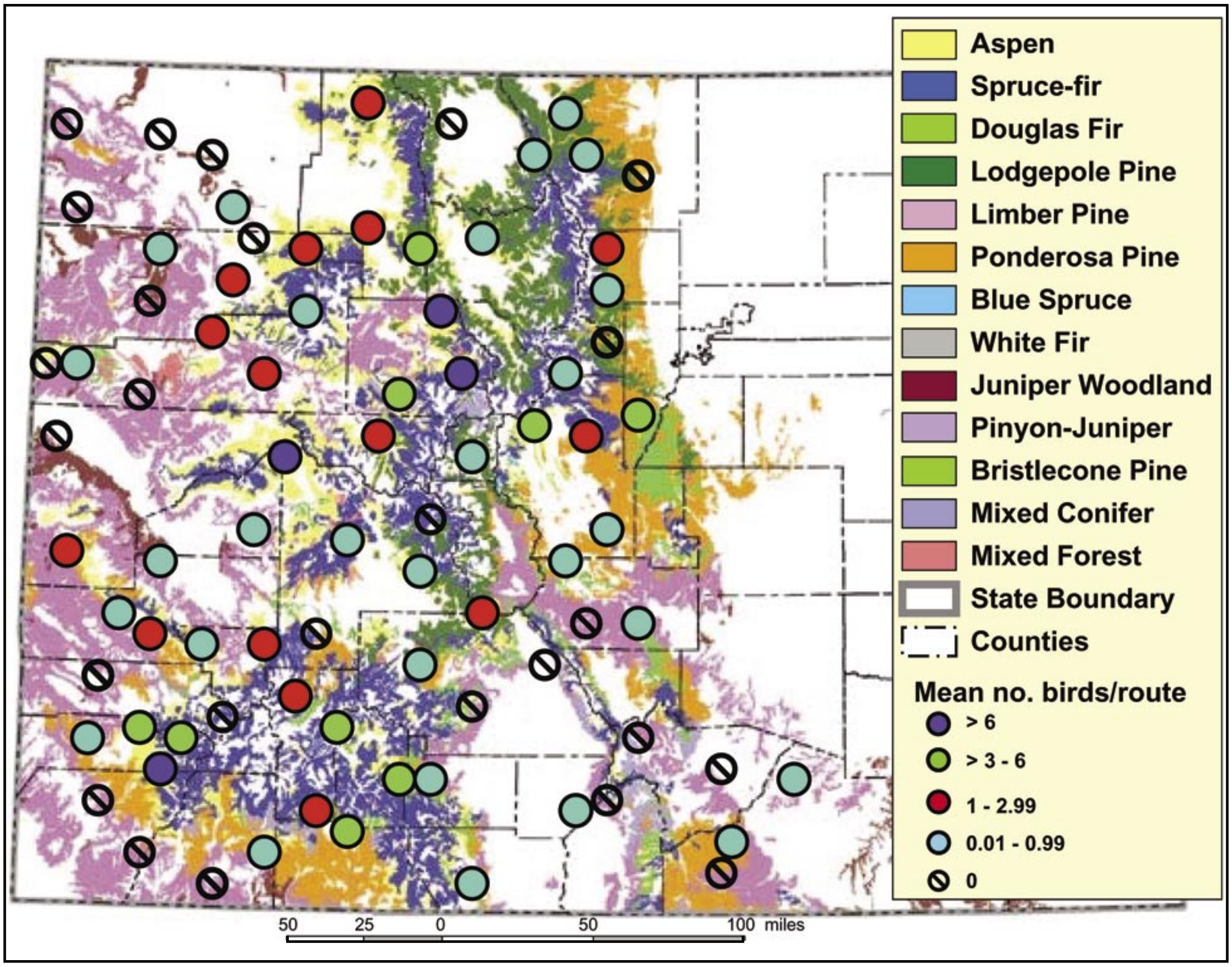

Figure 4. Map of forest types (http://csfs.colostate.edu/foresttypes.htm) and olive-sided flycatcher abundance based on 1966-2004 Breeding Bird Survey data for Colorado. Only routes overlapping forested areas are included; all non-forest BBS transects lacked olive-sided flycatcher detections.

are confirmed breeders in 12 blocks and probably breeders in three additional blocks (Kingery 1998). The Colorado atlas map corresponds closely to the BBS distribution map. A notable discrepancy among these maps is in the extreme southwest and northwest corners of Colorado; the BBS map indicates olive-sided flycatchers occur at low densities (**Figure 2**), whereas the Atlas map shows few occurrences. In this region of the state, olive-sided flycatchers may occasionally occur in localized habitats (e.g., along riparian corridors) in areas otherwise dominated by generally unsuitable shrub-steppe or grassland cover types. In contrast, the Colorado Gap Analysis models predicted the occurrence of olive-sided flycatchers across much of the state. Much of the predicted habitat occurs in the eastern plains and does not correspond to published distribution maps (Andrews and Righter 1992) or the Colorado Atlas (Kingery 1998), because of the inclusion of unlikely habitat affinities (e.g., shrub-dominated cover types) in the GAP models. Although, the Colorado Gap distribution map does not currently provide reliable predictions of potential olive-sided flycatcher habitat, these models are being revised through a joint effort by the USFS, USFWS, and the Wyoming Natural Diversity Database.

Wyoming

Less information is available on the breeding distribution of olive-sided flycatchers in Wyoming. They reportedly occur from ~2300 m to treeline. Wyoming Breeding Bird Atlas data indicate that olive-sided flycatchers are confirmed breeders in 11 atlas blocks and suspected breeders in seven blocks (Cerovski 2004). They were observed (any season) in four of the remaining nine blocks.

The Wyoming Gap Analysis indicates potential habitat that closely follows the distribution of Rocky Mountain forests (**Figure 1**, **Figure 5**; http:

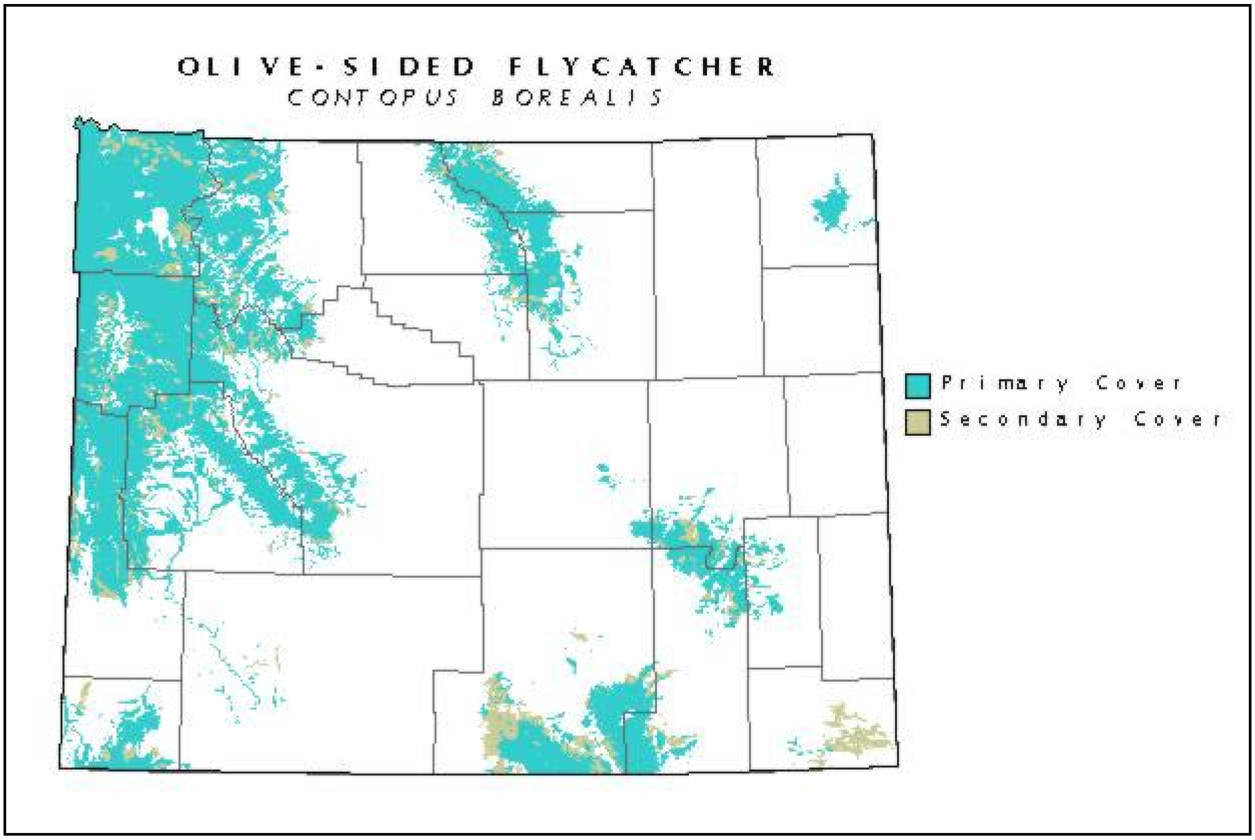

Figure 5. Modeled potential suitable breeding habitat for olive-sided flycatchers in Wyoming. The figure is modified from the Wyoming Gap Analysis.

//www.sdvc.uwyo.edu/wbn/gap.html). The Shoshone National Forest is included in the largest area of potential habitat, which occurs in northwestern Wyoming. The Bighorn and Medicine Bow national forests cover a large proportion of potential olive-sided flycatcher habitat in the north-central and southern portions of the state, respectively. A small, isolated area of potential habitat occurs in the Wyoming Black Hills. However, this area appears to support few if any olive-sided flycatchers; this species was not detected along four point-transects surveyed by RMBO during the breeding seasons between 2001 and 2004 (Panjabi 2005).

South Dakota/Nebraska/Kansas

There is limited published information on olive-sided flycatchers breeding or migrating in the Great Plains. They are rarely observed during migration (Tallman et al. 2002). There are a few breeding season observations in the Black Hills of South Dakota (Tallman et al. 2002), but no published records documenting nesting birds. Surveys on the South Dakota portion of the Black Hills National Forest failed to detect any olive-sided flycatchers during breeding season surveys of 26 point-transects in 2001-2004 (Panjabi 2005). Outside of the Black Hills, there is limited potential habitat in this area.

Regional discontinuities in distribution and abundance

In Region 2, potential olive-sided flycatcher habitat is discontinuous as a result of the dissected nature of forests in the central Rocky Mountains (Knight and Reiners 2000). The ponderosa pine forests in the Black Hills of Wyoming have the greatest likelihood of creating population isolation because the area is small and isolated from large contiguous areas of forest by arid grasslands and shrublands. However, the Black Hills region of Wyoming does not appear to support many breeding olive-sided flycatchers. Additional relatively isolated forests occur in north-central Wyoming, including the Bighorn National Forest, and in southeastern Wyoming, including portions of the Medicine Bow National Forest.

The degree to which the isolated areas of potential habitat create population isolation is unknown. Despite the availability of apparently suitable habitat, the lack of detectable breeding populations in the Black Hills suggests that isolation may constrain immigration rates. On the other hand, the long distances traveled during migration, the ability of birds to colonize new burns rapidly, the large territory sizes, and the lack of strong population differentiation across its range suggest that this species may range widely enough to offset isolating effects of disjunct, forested habitats.

Population trends

Historical information on olive-sided flycatcher population trends is largely anecdotal. By the late 1800's and early to mid 1900's, range contractions were noted across southern New England and the Mid-Atlantic States (Brewster 1906, Bent 1942). Population declines were reported for Nova Scotia in the later part of the 20^{th} century (Tufts 1986) and across the Appalachian Mountains (Williams 1976, Buckelew and Hall 1994). It has been suggested that reforestation, fire suppression, population declines of beaver, and human developments may have reduced habitat availability in many areas of New England and the Mid-Atlantic states (Peterson and Fitchel 1992).

There is also anecdotal evidence of population declines in the western United States. In King's Canyon National Park, California, Marshall (1988) observed olive-sided flycatchers in the 1930's but not in the 1980's and noted the absence of olive-sided flycatchers from apparently suitable habitat. He suspected that their absence was due to logging of Sequoia National Forest and habitat loss on the wintering grounds, although other potential factors, such as fire suppression and forest regrowth, were not considered (Marshall 1988).

Recent breeding range expansions and stable populations have also been noted. In eastern North America, olive-sided flycatchers are believed to be more widespread in Vermont (Fitchel 1985), the Maritime Provinces of Canada (Erskine 1992), and Quebec (Sequin 1996). The ranges of the olive-sided flycatcher for several states in the East are apparently stable based on breeding bird atlas data (Altman and Sallabanks 2000).

The BBS provides the most quantitative assessment of range-wide and regional population trends (http://www.mbr-pwrc.usgs.gov/bbs). From 1966 through 2004, BBS trend analysis indicates survey-wide annual declines of 3.5 percent ($P < 0.001$, $n = 789$). Likewise Canada (-3.5 percent) and the United States (-3.6 percent) have negative trend estimates for the same period (Sauer et al. 2005). Annual declines translate into a 75 percent decline in population over four decades of the survey. In the western United States, the trends are largely negative, except for portions of the central and southern Rocky Mountains where there are no significant trends (**Figure 6**). However, in Region 2, only Colorado had a sufficient number of routes ($n = 46$) to assess population trends; Colorado had no significant trends between 1966 and 2004. Outside of the Pacific Northwest and Southwest, however, regional trend estimates for this species are generally unreliable due to deficiencies of the data (http://www.mbr-pwrc.usgs.gov/bbs/cred.html). Overall, the relatively long-term, broad-scale, and consistent declines estimated by BBS data strongly suggest that the olive-sided flycatcher is declining across much of its principal breeding range. The declining trends detected by BBS routes in California is corroborated by significant declines in the number of olive-sided flycatcher captures and detections during spring and fall migration at the Farallon Islands, California, over a 25-year period (Pyle et al. 1994).

There are a number of caveats, however, regarding the use of BBS trend estimates to establish conservation priorities for olive-sided flycatchers. First, the number of birds detected is low for most routes, particularly in Region 2. The average number of birds per route is 1.41 range-wide. It is higher in the Cascade (5.36 birds per route) and Sierra Nevada mountains (14.55 birds per route), but averages only 0.94 birds per route in USFWS Region 6, which corresponds to USFS Region 2.

Another potential challenge in interpreting declining trends is that the dynamics of olive-sided flycatcher populations may track processes that fluctuate over time spans longer than the four-decade duration of the BBS survey. When examining BBS data at the route level, multiple trajectories of population change are suggested by the considerable variation in population trends among routes and the lack of a single dominant pattern of decline. Although many routes show declining trends, many others show highly variable numbers and lack overall trends, and some routes show increasing trends. Additionally, some routes increased in the first two or three decades of the survey, followed by subsequent declines. The recent significant declines in some regions may simply reflect short-term (e.g., less than 50 years) habitat dynamics, and not a longer-term declining trend.

One possible explanation for such apparent population variation is that forest dynamics, and in turn, habitat availability, vary over several decades or centuries. Olive-sided flycatchers use both early successional forests and old-growth forests, but intermediate successional stages (e.g., dense even-aged

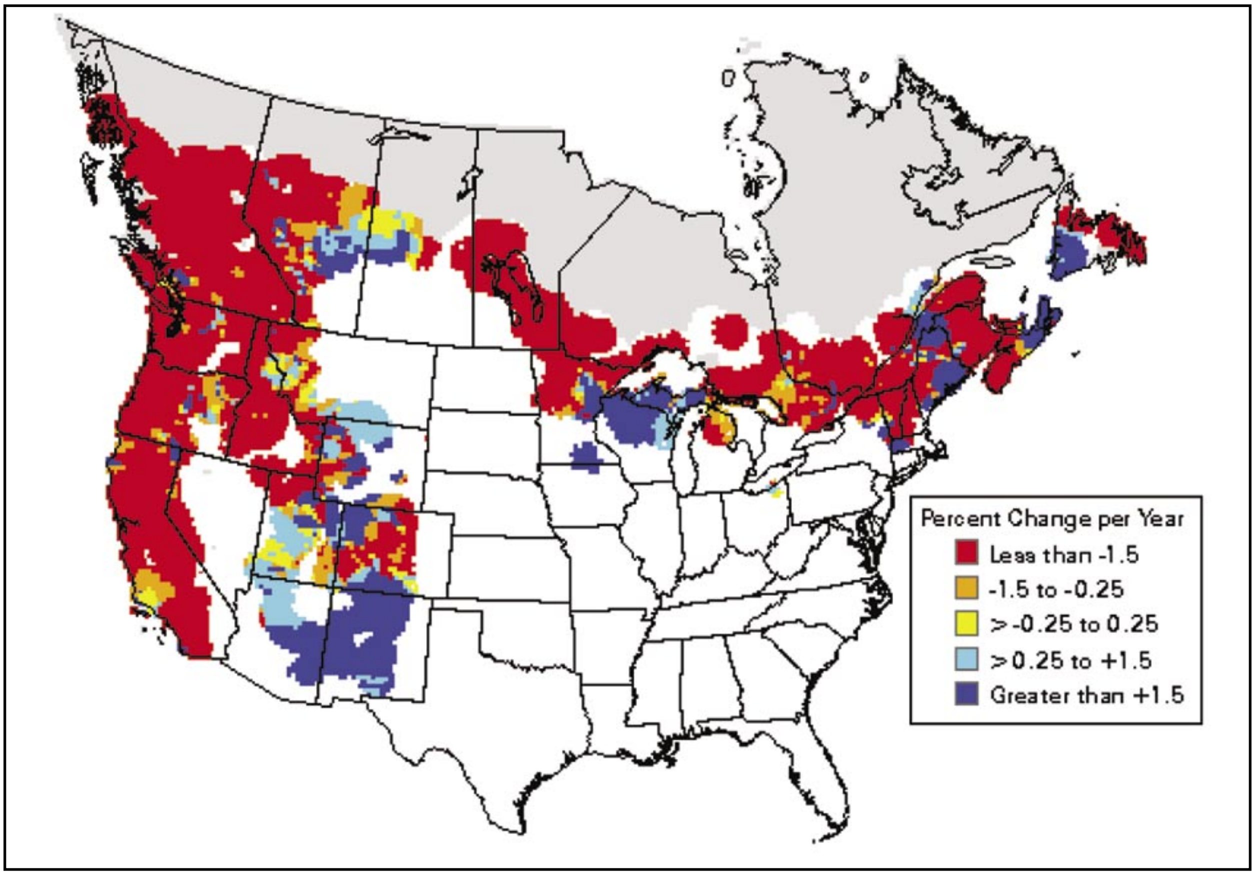

Figure 6. Population trend map for olive-sided flycatchers, based on Breeding Bird Survey trend analysis 1966-2003 (Sauer et al. 2005).

sapling-pole or mature forests) are generally not suitable. Consequently, regional shifts in logging practices or decadal-scale fluctuations in fire occurrence could create local or regional variation in habitat availability, without necessarily leading to a net decline in habitat. If habitat availability does indeed fluctuate over multiple decades, the patterns detected could also be sensitive to the timing of transect initiation. Indeed, more than 50 percent of BBS transects with olive-sided flycatcher detections were surveyed for less than 25 years. Thus, the duration of surveys for many, if not most, transects may be too short relative to the shifting availability of habitat resulting from long-term forest dynamics (both natural and anthropogenic) to distinguish between long-term declines and population variation.

Legacies of historical anthropogenic disturbance can affect current habitat availability and dynamics. An illustration of olive-sided flycatcher habitat dynamics at large spatial and temporal scales is provided by a model developed for the 61,000,000 ha Interior Columbia Basin. The analysis indicates that overall availability of potential habitat has not changed since the mid-1800's; however, the distribution of habitat across the landscape has shifted (Wisdom et al. 2000). In Sierra Nevada Mountains, where olive-sided flycatchers reach peak densities, timber production from national forests reached a peak in the late 1970's, and has subsequently declined by two-thirds (University of California 1996, Gruell 2001). Forest trend analysis for Douglas-fir fir forests of northwestern California predicted a decline in potential olive-sided flycatcher habitat from historical to future time periods (Raphael et al. 1988); their predictions were based on a logging rotation of 100 years, assuming 20 percent of the landscape in the sapling stage at a particular time period. They predicted a shift in dominance from mature forests (over 100 years old) to the pole/sawtimber stage, which is generally not suitable for olive-sided flycatchers. In New England, an increase in forest cover since the late 1800's (Lorimer 2001), and concomitant decrease in forest edges and openings, could contribute to declines that have also been attributed to wetland and forest conversion resulting from human developments (Gross 1992). In many areas of the Rocky Mountains, anthropogenic disturbance, including intensive logging and severe fires set by humans during Euro-American settlement in the late nineteenth century, contributes to the structure (e.g., stand age, fuel loadings, landscape heterogeneity) of existing forests (Veblen and Lorenz 1991, Smith 2000).

Given the potential problems with BBS data, there is a high level of uncertainty about the reliability of the BBS trends for olive-sided flycatchers. Indeed, a 75 percent survey-wide decline, as predicted by BBS results, is usually viewed as grounds for possible endangerment (Dunn 2002) and would be expected to result in other indications of dramatic population changes, such as range contractions or a significant decrease in the average number of birds/route, yet there is no evidence of such changes. Particularly for species, such as olive-sided flycatcher, with low densities and highly variable abundance data, BBS declining trends should be used to identify species of concern and to target additional monitoring so that the validity of the patterns can be independently evaluated (Dunn 2002). Although BBS trends are the primary justification for designation of olive-sided flycatchers as a sensitive species, such declines should not be used as the only basis for justifying immediate intervention to prevent further declines (Dunn 2002).

Population data for olive-sided flycatchers on the wintering grounds is lacking (Altman and Sallabanks 2000). Although it is frequently suggested that declining trends on the breeding grounds may be due to loss of habitat on the wintering grounds, habitat changes have not been quantified. Because olive-sided flycatchers use second-growth forest and edges in the winter, forest logging in the tropics does not necessarily translate into habitat loss (Altman and Sallabanks 2000). Thus, population status on wintering grounds needs further research.

Movements

Home range

Although data on daily movement patterns during the breeding season are limited, territories can be quite large and movements within territories may exceed 1 km (Wright 1997). Once the young have fledged, family groups may remain on territory, but birds nesting at higher elevations may move to lower elevations (Altman and Sallabanks 2000).

Migration

Olive-sided flycatchers have the longest migration route of any North American flycatcher (Murphy 1989). The chief migratory route of olive-sided flycatchers is through forested areas of Central America, Mexico, and western North America (Bent 1942). Olive-sided flycatchers are most common during migration along western North and Central America (Bent 1942). They are uncommon through the mid-western and southeastern United States (Duncan 1988). However, records from Florida (Duncan 1988) and along the Gulf Coast indicate a possible trans-gulf migration route to Central America (Altman and Sallabanks 2000).

Migration routes and the timing of migration vary based on geographic location and elevation (Altman and Sallabanks 2000). In northern breeding grounds, such as Alaska (Kessel and Gibson 1978) and Canada (Campbell et al. 1997), fall migration begins in early August (Altman and Sallabanks 2000). Migrants are commonly observed in mid-August to late September across middle latitude states (Altman and Sallabanks 2000). Most individuals have departed breeding grounds by late September. Migrants generally arrive in wintering grounds from early September to November (Monroe 1968, Paynter 1995). Olive-sided flycatchers typically depart wintering grounds for spring migration between late March and early May (Bent 1942, Johnson 1980, Paynter 1995) and arrive on breeding grounds between mid-April to mid-June (Altman and Sallabanks 2000). In Region 2, migration begins in late April and peaks in late May (Andrews and Righter 1992). In Colorado, records of arrival are about a week earlier than those reported for Wyoming and have slightly later departure dates in the fall (Johnsgard 1986).

Habitat

Breeding habitat

Olive-sided flycatchers are generally restricted to coniferous or mixed-coniferous forests. Throughout their breeding range, they primarily occur in montane, subalpine, and boreal forests. In addition, they often occur along wooded shores of lakes, rivers, and bogs where forest edges, variation in tree height, and standing dead trees are found (Salt and Salt 1976, Kessel and Gibson 1978, Cheskey 1987). This species is most often associated with forest edges and openings caused by natural or anthropogenic disturbances, including small forest gaps resulting from tree death in old-growth forests, or along the edges of early successional forests (Peterson 1988, Altman and Sallabanks 2000). Olive-sided flycatchers usually do not occur in closed canopy forests and are uncommon in forests in the sapling-pole or mature forest stages that lack gaps or edges. Thus, the juxtaposition of mature trees and forest openings is an important habitat attribute (Brandy 2001, Kotliar et al. 2002).

In Region 2, olive-sided flycatchers are more commonly found at higher elevations in spruce/fir forests, but they are less frequently observed in aspen/mixed coniferous, ponderosa pine, riparian, and occasionally pinyon/juniper forests (Andrews and Righter 1992; Jones 1998). They are not usually observed in mature lodgepole pine stands because of the even-aged, closed canopy structure typical of these forests.

Olive-sided flycatchers frequently nest in early successional post-fire forests in all montane and subalpine forest types (Hutto 1995, Altman and Sallabanks 2000, Kotliar et al. 2002). In a review of 12 studies comparing severely burned and unburned forests in the western United States, this species was much more abundant or only observed in recently burned forests (Kotliar et al. 2002). Likewise, a literature review found that they were more abundant in early post-fire communities of the northern Rocky Mountains compared to any other major forest cover type (Hutto 1995). Olive-sided flycatchers are usually associated with severely burned patches in which trees have died resulting in forest gaps. Severe burns are most likely to result from wildland fire, or escaped prescribed fire or backfires, rather than prescribed understory burns.

In Region 2, recent severe burns created habitat for nesting olive-sided flycatchers. In the Greater Yellowstone Ecosystem, including portions of the Shoshone National Forest, this species was frequently observed in the first two years following the 1988 fires (Hutto 1995). In north-central Colorado, olive-sided flycatchers were detected in 13 of 15 severe burns (Kotliar and Melcher 1998); in particular, they were detected most frequently along the edges of dead forest patches compared to areas over 200 m on either side of patch edges (Kotliar and Melcher 1998). More recently, olive-sided flycatchers were observed breeding in recent severe burns on the Arapaho/Roosevelt National Forest (e.g., Hourglass 1995; Hi Meadow 2000) and the Pike National Forest (e.g., Buffalo Creek 1996, Turkey Creek 1997, Hi Meadow 2000, Hayman 2002, N. Kotliar unpubl. data).

Other severe disturbances may provide important habitat for olive-sided flycatchers. This species was observed breeding in the recent 5,226 ha blowdown on the Routt National Forest (Skorkowsky 2003). They have also been observed using a variety of logged forests in the northern Rocky Mountains (Hutto and Young 1999) and in the Cascade Mountains (Altman 1998). Although their use of forests undergoing large bark beetle outbreaks has not been documented, olive-sided flycatchers will eat bark beetles (Otvos and Stark 1985). Subsequent high tree mortality (as in the current beetle outbreaks in Region 2) may potentially create olive-sided flycatcher habitat.

Nesting and foraging habitat

Olive-sided flycatcher nests are most commonly found in live coniferous trees, but they sometimes use conifers with brown needles (i.e., dead or dying) (Altman 1998, Kotliar and Clouse 2000, Robertson and Hutto 2007). In addition, they typically use short-needled conifers [e.g., Douglas-fir (*Pseudotsuga menziessi*), hemlock (*Tsuga heterophylla*), true firs (*Abies*), and spruce (*Picea*)] more frequently than long-needled trees (e.g., ponderosa pine) (Kotliar and Clouse 2000). Deciduous trees are not typically used for nesting (Altman and Sallabanks 2000). Their nests are loose, open-cup structures that are generally placed on horizontal branches well out from the tree trunk (Altman and Sallabanks 2000). Nests have been found as low as 1.5 m and as high as 60 m; higher placement heights are associated with taller trees in the western mountain ranges of the United States (Altman and Sallabanks 2000).

Olive-sided flycatchers typically forage in forest openings, along edges, and over forest canopies. They often use prominent perches, especially snags and dead-topped trees (Wright 1997, Altman 1999a, N. Kotliar unpubl. data). Males tend to forage from higher perches and farther from the nest than females, which often use understory perches (Altman 1998). Foraging bouts are generally initiated from the upper third of trees or snags regardless of sex (Altman 1999a, Altman and Sallabanks 2000). Cool or windy weather may lead to use of lower perches (Altman and Sallabanks 2000).

Migratory habitat

During migration, olive-sided flycatchers use a greater diversity of forest types, such as lowland and deciduous forests, than they use during the breeding season. In Colorado, migrants occur in all types of woodlands (Andrews and Righter 1992). One of the highest elevations (3050 m) for olive-sided flycatcher occurrence was recorded in Colorado (Altman and Sallabanks 2000), although spring and fall migrants are typically observed at much lower elevations (Andrews and Righter 1992). Migrant birds in Mexico and northern Central America use pine-oak, evergreen, and mixed deciduous forests (Altman and Sallabanks 2000). Occasionally, migrants occur at lower elevations in Florida and the lowlands of Honduras (Monroe 1968) and Costa Rica (Stiles 1994).

Wintering habitat

Olive-sided flycatchers also appear to use a broad array of forest types (e.g., broad-leaved mature evergreen forest) on their wintering grounds (Fitzpatrick 1980, Petit et al. 1995). Uncommon visitors in northern Central America and Mexico have been observed in pine-oak and semi-deciduous forest (Altman and Sallabanks 2000). They typically occur along forest edges and in openings with snags or scattered trees above the canopy (American Ornithologists' Union 1983, Stotz et al. 1992, Ridgely and Tudor 1994). For example, in the Amazon River basin and Andes Mountains of southern Peru, olive-sided flycatchers use primary and secondary forest tree fall gaps or the edges of water bodies (Robinson et al. 1988, Robinson et al. 1995). They primarily inhabit foothill and montane forests (Robinson et al. 1988, Willis et al. 1993, Ridgely and Tudor 1994, Stotz et al. 1996), typically between 1,000 and 2,000 m elevation, although occasionally birds have been observed as low as 400 m (Venezuela) and as high as 2290 m (Costa Rica) (Altman and Sallabanks 2000).

Food habits

Olive-sided flycatchers are primarily aerial insectivores (Eckhardt 1979), but they occasionally glean insects from foliage (Melcher personal communication 1998). The birds generally fly from exposed perches to capture insects and will actively pursue their prey (Altman and Sallabanks 2000). They may eat smaller insects during flight whereas they will beat larger prey against a branch before consumption (Altman and Sallabanks 2000). There is limited information on the diet of olive-sided flycatchers, but it includes Arachnida, Orthopetera, Hemiptera, Coleoptera, Lepidoptera, Diptera, and Hymenoptera (Meehan and George 2003). In a study of 63 birds collected from across the United States, Hymenoptera (chiefly winged ants and honeybees) constituted 82.5 percent stomach contents (Beal 1912). In the Sierra Nevada Mountains, the principal prey for a sample of 12 birds was Coleoptera, with Hymenopterans comprising only 10 percent of the food volume (Otvos and Stark 1985). Hymenoptera comprised 84 percent of stomach contents (four birds) during migration though Costa Rica (Sherry 1984). Variation among studies and the diversity of taxa present in stomach contents indicate that olive-sided flycatchers eat a broad diversity of prey species.

Breeding biology

Courtship and pair formation

Pair formation begins with the spring arrival of females in North American breeding grounds (Bent 1942). In Wyoming and Colorado, arrivals peak in mid- to late May (Johnsgard 1986). In Colorado, nest building begins as early as June 5 (Jones 1998), and egg laying occurs between June 16 and July 20, peaking between June 23 and July 3 (Bent 1942, Johnsgard 1986). Latitude, elevation, and weather can influence the exact date of clutch initiation (Altman and Sallabanks 2000).

Limited data indicate that olive-sided flycatchers may exhibit strong site fidelity. In central Alaska, five of nine banded birds returned to the same territory in the subsequent year, and the mean distance between nests used consecutively is 271 m (Wright 1997). In California, two of three recoveries of banded birds were within the same 10-minute block, five and six years later (Altman 1997). In northwestern Oregon, nests were as close as 1 m to the previous year's nest, and occasionally birds re-nested in the same tree (Altman 1999a). There is no evidence that olive-sided flycatchers reuse nests in subsequent years.

Clutch and brood size

Olive-sided flycatchers are typically single brooded, but will frequently re-nest after failing to fledge young (Wright 1997, Altman 1999a). Mean clutch size is typically three eggs (Murphy 1989, Altman 1999a,) but four eggs are frequently observed (Barlow 1901, Dixon 1920, Wright 1997). The largest percentage of four egg clutches occurred in central Alaska (77 percent; Wright 1997). A study in Nova Scotia found that 19 percent of clutches contained four eggs (Altman and Sallabanks 2000). Approximately two-thirds (Oregon; Altman 1999a) to three-fourths (Altman and Sallabanks 2000) of nests had three eggs. All nests with two eggs were second attempts, although some re-nests had more than two eggs (Wright 1997, Altman 1999a).

Parental care and offspring behavior

Females are solely responsible for brooding eggs and nestlings (Altman and Sallabanks 2000). A greater proportion of brooding takes place during the first week after hatching and during inclement weather (Altman and Sallabanks 2000). Although both sexes feed the young, females do so more frequently (Altman and Sallabanks 2000). The incubation period is most commonly reported as 14 to 16 days, and the nestling period is typically 19 to 21 days (Bent 1942, Peterson and Fitchel 1992, Wright 1997, Altman 1999a). In Colorado, fledged young have been reported as early as June 23 and as late as August 4 (Jones 1998). However, it is difficult to assess fledging dates precisely because nestlings frequently perch near the nest before and after fledging (Altman and Sallabanks 2000). Fledglings depend on adults for food up to one week after nest departure, and they may remain within their parents' territory for up to three weeks (Wright 1997, Altman 1999a, Altman and Sallabanks 2000).

Nesting success

There is limited information on nest success for olive-sided flycatchers. In Alaska (1995-1996), five of 13 pairs successfully fledged young (Mayfield estimate of nest success = 26.6 percent; Mayfield 1961), and three of four re-nesting pairs were successful (i.e., total eight of 13 pairs successful; Wright 1997). In a study of burned (severity not described, but presumably included high-severity areas) and logged forests in the Cascade Mountains of Oregon, 79 (52 percent) of 153 nests fledged young (Mayfield estimate = 40 percent; Altman and Sallabanks 2000). Post-fire forests had higher nest success (Mayfield estimate = 62 percent; *n* = 16) compared to thinned or unlogged forests with over 20 percent canopy closure (Mayfield estimate = 49 percent; *n* = 33). Nest success was lowest in logged forests with less than 20 percent canopy closure (Mayfield estimate = 39 percent; *n* = 89) or along the edges of the cuts (Mayfield estimate = 33 percent; *n* = 31). Logged forests ranged in size from approximately 9 to over 40 ha; live trees were retained within the cuts, but the size of burns was not provided (Altman 1998). There are several problems that preclude strong inferences to be made from this study. Meehan and George (2003) suggested that because the burned and logged forests were geographically separated and studied in different years, the study areas may not be directly comparable. Additionally, time since disturbance was not provided for logged or burned forests.

On the Flathead National Forest in Montana, Robertson and Hutto (2007) compared nesting success in a 29,000 ha severe burn (1 year post-fire) and a thinned forest (less than 5 years post-harvest). Daily nest survival (0.988, CL=0.970, 0.995, *n* = 18) was higher in the 4,000 ha burn plot compared to a similar –sized, thinned plot (0.967, CL=0.941, 0.982, *n* = 18). However, males initiated territories, on average, 7.4 days earlier in the thinned plot compared to the burned plot. In addition, food delivery rates to nestlings were higher in the thinned plot (Robertson and Hutto 2007). Although nest predation was not directly observed, the authors concluded that nest failure was primarily a result of nest predation; potential nestling predators (i.e., red squirrels [*Tamiasciurus hudsonicus*], common ravens [*Corvus corax*], gray jays [*Perisoreus canadensis*]) were more abundant in thinned plots than in burned plots (Robertson and Hutto 2007). Another study in thinned forests on the Lolo National Forest found that, overall, 55 percent of nesting pairs (*n* = 20) successfully fledged young; a similar percentage of first and second nesting attempts were successful (Smucker and Smucker 2001).

In contrast, nesting success was lower in a severe burn compared to logged forests in a study in northwestern California. Nesting success of olive-sided flycatchers was measured one to two years following a 20,007 ha burn (30 percent high severity) and compared to a landscape with numerous cuts averaging 14.7 (+/- 7.53) years (Meehan and George 2003). Approximately 24 percent of the landscape had been previously logged or salvage logged and included previous burns that were mostly low or mixed severity. "Relative nest loss" was lowest in the "unburned" landscape (20 percent; *n* = 15) compared to moderate and high-severity portions of the burn (71 percent; *n* = 17) (Meehan and George 2003). In addition, aerial arthropod biomass and peak foraging rates of breeding females were significantly lower in the burned patches, suggesting that food was potentially limiting in the burn (Meehan and George 2003). However, the different ages of burned compared to logged forest, the limited sample size (one burn), the spatial patterning of and the inclusion of burned forest patches in the "unburned landscape," and pre-fire logging in the burned forest make it difficult to draw conclusions about the relative suitability of burned and logged landscapes from this study.

Results from a study of four Colorado burns are consistent with the overall nest success observed elsewhere. In Colorado, 12 of 18 pairs (66.7 percent) nesting 2 to 5 years following prescribed understory (two burns: 200 ha and 1,215 ha) and wildland fires (two burns with over 80 percent tree mortality: 200 ha and 4,450 ha) successfully fledged young (Kotliar and Clouse 2000).

Collectively, the studies of olive-sided flycatcher nest success indicate that nest success for this species can be fairly high and is sometimes higher in burned compared to logged forests. However, there is considerable variation in study design (e.g., size and severity of disturbance, time since disturbance, cover types), which may confound the results, particularly for studies with little or no replication. Thus, it is unclear whether the type of disturbance (e.g., fire, logging) affects habitat suitability *per se*, or if the scaling, severity, or time since disturbance contributes to the differences observed. Additional information on temporal and spatial components of anthropogenic and natural disturbances, better replication, and longer-term studies will be necessary to draw more specific conclusions about the relative suitability of habitat created by different types of disturbances for breeding olive-sided flycatchers.

Demography

Genetic characteristics and concerns

Low densities and the relative isolation of Rocky Mountain populations have the potential to create barriers to gene flow, especially for more southern populations and in some of the isolated areas identified as potential habitat. However, the lack of range-wide population differentiation suggests that isolation is not an important conservation issue for this species. Although the distance separating habitat islands in Wyoming and South Dakota creates the potential for genetic isolation, these isolated areas do not support many breeding birds. Moreover, the ability of this species to colonize recent burns in the region rapidly (N. Kotliar, personal observation) suggests that birds may range widely over large landscapes to exploit relatively ephemeral early successional conditions, providing a mechanism for reducing isolation.

Life history

Olive-sided flycatchers breed their first year after hatching (Altman and Sallabanks 2000). The sex ratio of populations has not been studied, but unpaired males are frequently observed for this monogamous species (Wright 1997, Altman 1999a). Twenty-five percent of 23 males in central Alaska did not maintain territories, and 18 percent of males with territories remained unpaired (Wright 1997). Polygamy has occasionally been observed (Altman 1999a), but it is expected that the occurrence of polygyny is low because territories are large and frequently widely spaced (Altman and Sallabanks 2000). Although non-paired males will seek copulation, there is no genetic evidence that extra-pair copulations are productive (Altman and Sallabanks 2000).

Territoriality and home ranges

Territories are large and variable in size, but typically range from 10 to 26 ha (Altman 1997, Wright 1997). Along drainages, territories often are elongated in shape (Wright 1997). The spatial arrangement of territories can be widely spaced if separated by dense forest or otherwise unsuitable habitat (Altman 1999a), but shared boundaries may occur, for example where forest openings are clustered and territories relatively small (N. Kotliar, personal observation). Olive-sided flycatchers are also territorial on their wintering grounds and only rarely observed in mixed-species flocks (Johnson 1980, Ridgely and Tudor 1994, Altman and Sallabanks 2000).

Factors limiting population growth

The factors limiting population growth in olive-sided flycatchers are poorly understood. The availability of suitable habitat is often suggested to be an important proximate factor limiting olive-sided flycatchers (Marshall 1988, Hutto 1995). Although there is considerable speculation, there is currently insufficient data to evaluate the relative importance of limiting factors on wintering versus breeding grounds. The ephemeral nature of some olive-sided flycatcher habitats (e.g., early successional forests) can affect the spatial and temporal dynamics of habitat availability, and this could result in periods of habitat limitations.

Olive-sided flycatcher have certain life history traits (e.g., relatively low reproductive rate, low breeding densities) that can limit population growth and increase their vulnerability to short-term limitations of habitat and food availability (Altman and Sallabanks 2000). Because of their specialization as aerial insectivores, olive-sided flycatchers are vulnerable to inclement weather during migration and on the breeding grounds (Altman 1997). Indeed, the growth rates of aerial insectivores can be relatively slow compared to those of other types of insectivores because young birds build up fat stores presumably to guard against temporary food shortages (Robertson and Hutto 2007). Consequently, their relatively long nesting cycle, compared to other North American passerines (Altman and Sallabanks 2000), increases the likelihood of nest predation. On their breeding grounds, it appears that food availability (Meehan and George 2003, Robertson and Hutto 2007) and predation rates (Altman 1997, Robertson and Hutto 2007), which can affect nesting success, may vary among forests disturbed by natural and anthropogenic factors.

Community ecology

Predators and competitors

Information on predation and competition is largely unavailable. **Figure 7** shows the theoretical interactions between olive-sided flycatchers and potential predators/competitors. Olive-sided flycatcher use of exposed forest edges and their body size make them vulnerable to predation by accipiters, although only one incidence of such predation has been documented (Cade et al. 1968). Predation on eggs and nestlings by gray jays has been observed (Altman 1999a). Other suspected nest predators include Douglas squirrels (*Tamiasciurus douglasii*), red squirrels, northern flying squirrels (*Glaucomys sabrinus*), Steller's jays (*Cyanocitta stelleri*), and common ravens (Wright 1997, Altman 1999a). Potential competitors include other aerial insectivores, such as western wood-pewees (*Contopus sordidulus*), Townsend's solitaires (*Myadestes townsendi*), and mountain bluebirds (*Sialia currucoides*), which often nest in similar habitats (Kotliar et al. 2002, N. Kotliar unpubl. data). Occurrences of harassment by European starlings (*Sturnus vulgaris*), rufous hummingbirds (*Selasphorus rufous*), and Bohemian waxwings (*Bombycilla garrulus*) have been reported (Altman and Sallabanks 2000).

Brood parasitism

Parasitism from brown-headed cowbirds (*Moluthrus ater*) is rare, with only four cases reported from Alberta, British Columbia, and California (Altman and Sallabanks 2000). Of 214 nests monitored by Cornell University and Altman (1999), none was parasitized (Altman and Sallabanks 2000). Aggressive nest defense and low densities of cowbirds in mountainous areas where olive-sided flycatchers occur limit opportunities for nest parasitism (Altman and Sallabanks 2000).

Conservation

Threats

The indication from BBS trends that olive-sided flycatcher populations may be declining is cause for concern, although considerable uncertainty exists about the validity of range-wide declines for this species. Likewise, the apparently stable populations in Region 2 are based on a very limited number of BBS routes, especially outside of the core range in Colorado. Until the BBS trends can be validated by other data, these patterns should be viewed both with caution and as an impetus for further evaluation (Dunn 2002). Because forest management, including logging and fire management, can affect habitat availability and suitability for olive-sided flycatchers, and potentially population dynamics, it is important to consider the implications of management practices for this species of concern.

Fire management

The characteristics of burns (e.g., size, burn severity, spatial heterogeneity, time since fire) can affect use by nesting olive-sided flycatchers (Altman and Sallabanks 2000, Kotliar et al. 2002). In recent wildland fires in Region 2, olive-sided flycatchers were more abundant in moderate- and high-severity, compared to low-severity, areas (N. Kotliar, unpublished data). This pattern was also observed in burns of the southern Rocky Mountains and Colorado Plateau (N. Kotliar unpublished data) and the Cascade Mountains of Oregon (Sallabanks and McIver 1998). On the Pike National Forest, olive-sided flycatchers also nested in prescribed understory burns, but they were associated with pre-fire snags and forest openings, some of which were created by previous logging (Kotliar and Clouse 2000). Snags, forest openings resulting from tree mortality, and live trees are key habitat components of burns.

In addition to burn severity, temporal and spatial variation in fire effects can affect olive-sided flycatcher use of burns (Kotliar et al. 2002). Because these birds are associated with forest openings resulting form post-fire tree mortality, the proportional edge area of severely burned patches may affect habitat availability. Wind-driven crown fires are often elongated (Agee 1998), such as the Buffalo Creek burn on the Pike National Forest in 1996, with high edge:interior ratios. Remnant live forest within severely burned patches (e.g., along riparian corridors) can also increase the edge:interior ratio, even in exceptionally large crown fires. At the Hayman burn in 2002 (Pike National Forest), for example, a wind-driven crown fire burned over 25,000 ha in one day (Graham 2003), but over 80 percent of severely burned areas are within 200 m of moderately burned forest (N. Kotliar unpubl. data). Initially, portions of crown fire patches much greater than 200 m from live forest may not be readily used by olive-sided flycatchers, due to lack of nearby trees that retain needles. Over longer time frames, however,

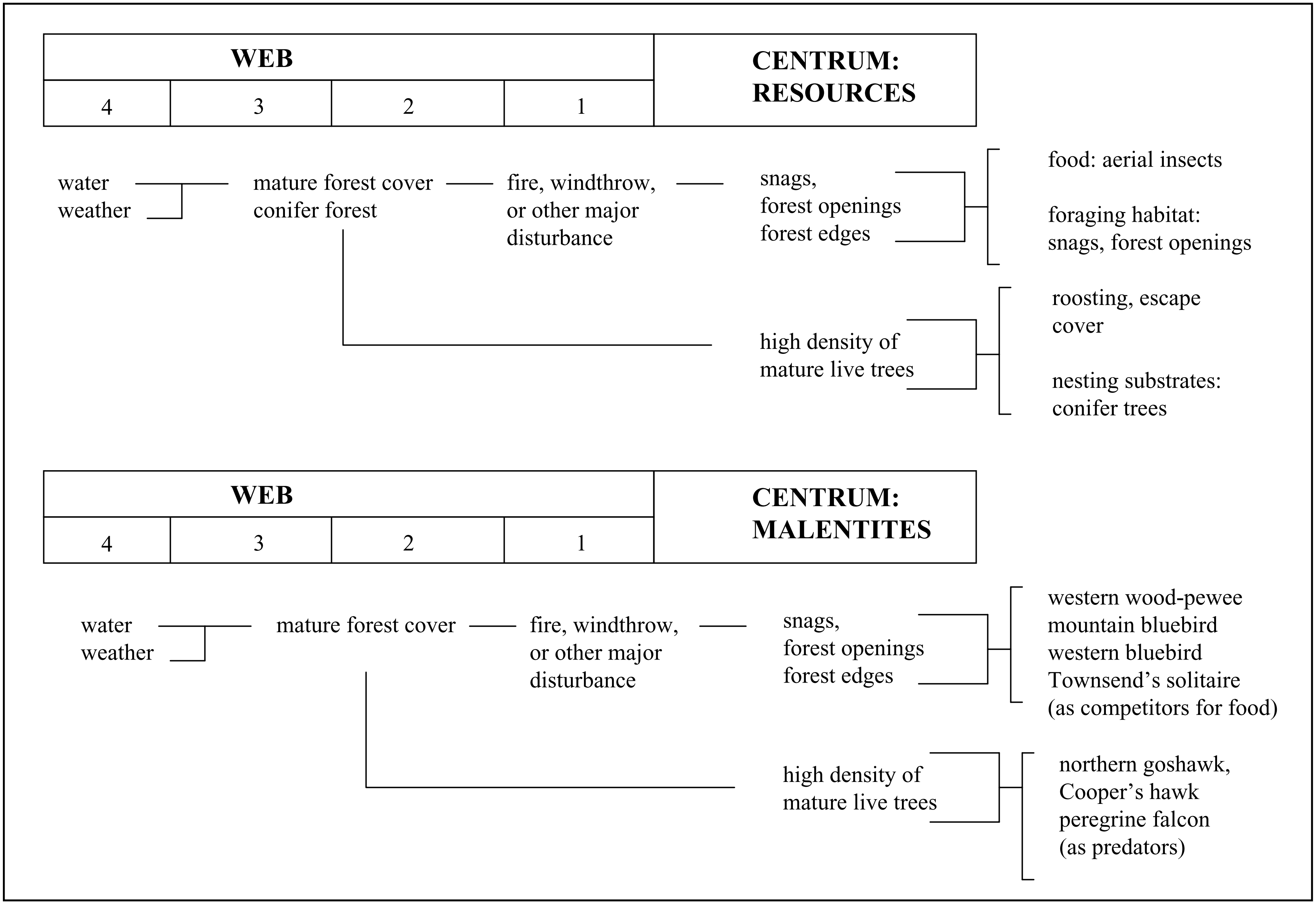

Figure 7. Envirogram representing the web of linkages between olive-sided flycatchers and the ecosystems in which they occur (after Andrewartha and Birch 1984).

delayed forest regeneration within the interior of severely burned patches may prolong occupancy of the burn by olive-sided flycatchers.

Fire creates a shifting mosaic of potential olive-sided flycatcher habitat across large landscapes. Because post-fire forests generally remain suitable for use by olive-sided flycatchers less than 20 years, depending on the rate of forest regeneration, continued creation of habitat through the regular occurrence of fires is necessary to offset habitat losses resulting from forest succession. Fire regimes vary in space and time, and the availability of olive-sided flycatcher habitat is likewise expected to vary. However, habitat dynamics may not be in equilibrium at small (e.g., within a national forest) or even larger (e.g., within Region 2) spatial scales (Turner et al. 1993).

By altering frequency, severity, and other fire characteristics, fire management (e.g., wildland fire use, fire suppression, prescribed fire, forest thinning) can affect the availability of olive-sided flycatcher habitat on national forests. Wildland fire use, especially mixed- and high-severity fires, creates olive-sided flycatcher habitat, whereas reduction of fire frequency through suppression activities can reduce habitat availability. In addition, efforts to reduce fire severity by reducing fuel loads (e.g., prescribed fire, mechanical thinning) can decrease post-fire tree mortality, thereby reducing opportunities for the creation of snags and forest gaps. Prescribed fire can also reduce existing snag densities (Horton and Mannan 1988) and may not create forest openings or additional snags if fire severity is low.

Post-fire management has not been well studied, but also has the potential to alter habitat suitability for olive-sided flycatchers. Salvage logging, by reducing snag densities, may diminish site quality particularly if larger snags, which olive-sided flycatchers prefer (Altman and Sallabanks 2000, Brandy 2001), are selectively removed. Recent studies suggest that dead and dying trees can alter microclimate conditions in early post-fire forests (Bonnet et al. 2005, Donato et al. 2006), which could indirectly affect olive-sided flycatchers by affecting insect populations. Indeed, insectivores (including olive-sided flycatchers) were less abundant in salvaged as compared to unsalvaged portions of a burn in Saskatchewan (Morissette et al. 2002). Snag effects on microclimate may be most critical immediately following fires, before vegetation regeneration has progressed. For example, olive-sided flycatchers were observed in a 25-year old burn in Sierra Nevada that had lost 82 percent of snags (Raphael et al. 1987). Post-fire seeding of grasses could cause competition with forbs, which often abound post-fire, and in turn affect prey availability (e.g., hymenopteran pollinators). The degree to which any of these post-fire management activities alters habitat suitability needs further study.

Logging

Although olive-sided flycatchers often breed in logged forests throughout their range, there is conflicting evidence about the relative suitability of these sites. In Colorado, breeding birds were observed using small (less than 5 ha) forest openings that were either natural forest gaps or created by previous logging (as indicated by the presence of stumps) and subsequently burned by prescribed fire. They were also observed in small (1.2 ha) cuts in spruce/fir forests on the Fraser Experimental Forest, but were absent prior to logging and were not observed in adjacent unlogged forests (Scott et al. 1982). The species was generally absent, however, in larger clearcut forests (5 to 40 ha; Kotliar and Melcher 1998), many of which were xeric lodgepole pine with sparse ground cover. In more mesic forests of the northern Rocky Mountains, olive-sided flycatchers readily use a variety of logged forests (Hutto and Young 1999). Size, spatial heterogeneity, proportion of logged/unlogged forest, and local conditions (e.g., cover type, moisture regime) likely affect the suitability of logged forests for olive-sided flycatchers.

The frequency with which olive-sided flycatchers are observed in logged forests, despite apparent population declines in areas of ongoing logging, has caused some to speculate that logged forests may be "ecological traps" (Hutto 1995). An ecological trap is defined as a habitat that is "low in quality for reproduction and survival that cannot sustain a population yet is preferred over other available, high-quality habitats" (Battin 2004). To qualify as an ecological trap, logged forests must be more attractive to olive-sided flycatchers than naturally disturbed forests and function differently such that overall fitness is lower in the logged forests (Robertson and Hutto 2007).

The limited studies comparing nesting success in burned vs. logged forests have found both greater success in burns (Altman and Sallabanks 2000, Robertson and Hutto 2007) and lower reproductive success in burns (Meehan and George 2003). The higher rates of feeding observed in two studies of logged forests compared to burned forests (Meehan and George 2003, Robertson and Hutto 2007), and the propensity for aerial insectivores to build up fat reserves, (Robertson and Hutto 2007) suggests that unmeasured components of fitness (e.g., post-fledgling survival, fecundity) could be higher in logged forests. In addition to lower nesting success, Robertson and Hutto (2007) suggest that higher densities and earlier arrival dates of territorial olive-sided flycatchers in a logged forest compared to a burn are consistent with the hypothesis that logged forests are ecological traps. However, the differences in time since disturbance (and possibly other differences) and lack of replication within treatments confounds their results. In addition, a discrepancy in their calculation of territory densities raises questions about the validity of this pattern. In general, variation in size, age, and spatial heterogeneity in disturbance severity makes it difficult to interpret the conflicting results among studies. However, the evidence for reduced nesting success in logged forests suggests that it may be incorrect to assume that these forests provide suitable alternative habitats for olive-sided flycatchers.

It is not a trivial exercise to document the existence of ecological traps, and evidence for this theory, in general, is limited (Battin 2004). For example, unmeasured fitness trade-offs could account for apparently maladaptive habitat selection (Battin 2004). Even assuming that logged forests are functionally lower in quality (e.g., lower nesting success) compared to burned forests, it is not necessarily also true that population growth rate is negative (i.e., functions as a sink; Pulliam 1988). Battin (2004) discusses additional caveats about the use of ecological trap theory to guide conservation and management efforts. Given these limitations, the suggestion that logged forests could theoretically be made less attractive by removing preferred habitat features (e.g., snags), thereby discouraging olive-sided flycatchers from nesting (Robertson and Hutto 2007), is premature.

Rather than discouraging olive-sided flycatchers from nesting in logged forests, the focus should be to improve habitat quality. For example, the practice of leaving isolated residual trees may allow predators to more readily locate olive-sided flycatchers that nest in these trees (Altman 1998). Harvest patterns that are more similar to the spatial patterning created by severe wildland fires (e.g., by clustering residual live trees) may be more appropriate given our limited understanding of the relative suitability of logged forests. Given the higher occurrence of olive-sided flycatchers along forest edges, the differences in edge structure among burned and logged forests may also affect habitat suitability. In post-fire forests, edges are generally very complex and poorly defined compared to logged forests, which often have very pronounced edges. A noteworthy exception is along fire lines, which can create rapid transition zones between burned and unburned forests. Although it has been suggested that olive-sided flycatchers prefer "hard edges" (McGarigal and McComb 1995), others have suggested that more complex edges may be an important habitat attribute (Kotliar and Melcher 1998). For example, if predators focus movements along well-defined edges, this could increase the potential for nest predation. Because none of the studies provided quantitative information on edge structure, this topic needs further study.

Olive-sided flycatchers use both early- and late-successional forests, but not closed-canopy pole or mature stands. Thus, the effects of logging activities have the potential to alter olive-sided flycatcher habitat dynamics over large spatial and temporal scales. Logging old-growth forests can decrease the availability of tree fall gaps, but can also create early successional forests. There are potential differences in the long-term suitability of old-growth vs. logged forests, however. Old-growth forests are more likely to provide continued sources of tree fall gaps, whereas successional changes in forest structure following disturbance decreases habitat suitability unless stands are re-cut on short rotations.

Wintering grounds

In light of the persistent and strong declines indicated by BBS data, the high rates of forest conversion on the wintering grounds and the continued creation of potential habitat by forest logging on breeding grounds have led to speculation that wintering habitat may be limiting for olive-sided flycatchers. Although projections of future forest conversion rates on the wintering areas used by olive-sided flycatchers are cause for concern (e.g., Diamond 1991, Petit et al. 1995), not all logging or burning in neotropical forests (often ambiguously referred to as forest conversion) will necessarily translate into habitat loss or degradation. Because olive-sided flycatchers also use forest edges in the winter (Stiles 1985, Ridgely and Tudor 1994), it has been suggested that they may use forest openings resulting from logging on their wintering grounds (Willis et al. 1993). As with the use of logged forests on the breeding grounds, the characteristics of forest cuts (e.g., size, context, rotation) will affect habitat suitability for olive-sided flycatchers. Because logging practices vary considerably across neotropical forests, the magnitude of conservation threats on wintering grounds needs better quantification.

Conservation of Olive-sided Flycatchers in Region 2

BBS data indicate that olive-sided flycatchers in Region 2 are secure compared to the consistent pattern of declines observed elsewhere, particularly in Pacific Northwest and Southwest. However, the apparent stability of Region 2 populations is based on a relatively small number of routes in Colorado (n = 46) and even fewer in Wyoming (n = 13). In addition, the number of birds per route is low (mean = 2.31 in Colorado; mean = 1.41 survey wide), thereby reducing confidence in the reliability of BBS trends. Consequently, it is difficult to draw strong conclusions about the status of olive-sided flycatchers in this region. The potential long-term declining trends observed range-wide, uncertainty about the adequacy of Region 2 monitoring data, low reproductive rates, and low densities of olive-sided flycatchers raise concerns about their vulnerability to future population declines.

Much of the potential habitat for olive-sided flycatcher in Region 2 occurs on National Forest System lands (**Figure 1**, **Figure 4**, **Figure 5**). Because management activities can alter forest dynamics, such activities can affect the distribution and quality of olive-sided flycatcher habitat. Thus, the USFS has a high level of responsibility for management of the olive-sided flycatcher in this region.

Because olive-sided flycatchers appear sensitive to burn severity and the spatial patterning of burns, alteration of fire regimes may affect habitat availability (Kotliar et al. 2002). Although it is frequently suggested that fire suppression, by reducing fire frequency, may have negatively affected olive-sided flycatchers, the effectiveness of suppression activities varies by cover type and fire regime (Schoennagel et al. 2004). We have a general understanding of historic regimes for many forest types, but considerable uncertainty about spatial and temporal variation in historical regimes remains.

Historically, lower montane ponderosa pine woodlands were often burned by frequent fires. Fire intervals tended to be longer in montane ponderosa pine forests of Region 2 compared to those in the southwestern United States (Shinneman and Baker 1997, Brown and Sieg 1999, Veblen et al. 2000, Baker and Ehle 2001). Upper montane ponderosa pine forests and Douglas-fir forests are characterized by mixed-severity fire regimes, with a complex mix of low-, moderate-, and high-severity (i.e., crown fire) patches (Agee 1998). In times of extreme climatic conditions (e.g., severe drought, high winds) crown fires may result, whereas understory fires occur under conditions that are more moderate (Brown et al. 1999, Veblen et al. 2000). Subalpine forests, including lodgepole pine and spruce-fir, are characterized by infrequent crown fires. Although tree mortality is high in crown fires, low severity burns often occur along edges or create remnant live forest areas comprising significant portions of burns (Turner et al. 1994, Agee 1998). At higher elevations, fuels necessary to support fire spread may take centuries to develop (Romme and Knight 1981), and severe climatic conditions are necessary to dry fuels sufficiently to allow fire spread through mesic subalpine forests. In addition to variation along elevational gradients, fire regimes can vary with other factors such as aspect and climate variability.

Alteration of fire occurrence patterns has been most pronounced in frequent, low-severity fire regimes (Schoennagel et al. 2004). Consequently, many low-elevation ponderosa pine forests throughout the Rocky Mountains exhibit much greater stand densities than that observed prior to fire exclusion (Allen et al. 2002, Keane et al. 2002). Stand densities, however, can vary considerably even under effective fire suppression (e.g., Rocky Mountain National Park; Ehle and Baker 2003). Additionally, there is historical precedence for crown fires in montane systems (Pierce et al. 2004). Consequently, the relatively limited time frame used as a reference for restoration of historical fire regimes may not adequately reflect current climatic conditions (Tiedemann et al. 2000, Wagner et al. 2000, Pierce et al. 2004). Efforts to suppress fires in systems with long fire return intervals appear to have had more limited effects than in systems dominated by surface fires (Romme and Despain 1989).

Other factors can also alter fire frequency across broad landscapes. For example, an increase in forest disturbance (e.g., logging, fires) in many areas of the Rocky Mountains in the later part of the 19th century synchronized forest age over large areas, such that the majority of forests are 70 to 130 years old (Veblen and Lorenz 1991, Smith 2000, Veblen 2000). This has contributed to current high fuel loads across large areas of Region 2. Due to uncertainties about historical regimes and incomplete knowledge of the relative contribution of climate and fuels to variation in fire behavior, the effects of fire exclusion on mixed-severity systems are poorly understood (Veblen et al. 2000, Baker 2003, Ehle and Baker 2003). The relative influence of past forest management on current fuel loads and fire behavior, and in turn the availability of olive-sided flycatcher habitat, is unclear. Because olive-sided flycatcher use of forests burned by low-severity fires is limited, and severe fire regimes have not greatly been altered by suppression, the effects of fire suppression on the availability of olive-sided flycatcher habitat may not have greatly been reduced in lower montane or subalpine forests. In areas where decades of fire suppression have led to more severe fire behavior than has occurred in the recent past, this may have actually benefited olive-sided flycatchers.

Because fire occurrence varies with climate and can vary regionally, the availability of olive-sided flycatcher habitat may vary temporally and spatially across large landscapes (Crist 2002). The dynamics across a broad geographic area are illustrated by variation in annual area burned in several national forests in Region 2 (**Figure 8**). Although there were several years in which two or three forests experienced large fires, in most years there was little correspondence in area burned across all forests. For the same time period, wildland fire burned about 38,000 acres, on average, per year (range about 1,200 – 500,000 acres per year) across Region 2. Even during peak fire years (e.g., 1988 in which 482,000 acres burned), this represents less than 4 percent of the total forested area on national forests in Region 2. The large scales at which potential habitat for olive-sided flycatcher varies dictate that management for olive-sided flycatchers be evaluated at multiple scales.

Forest logging rates in most national forests of Region 2 are currently relatively low. Logging rates are highest in the Black Hills National Forest (**Figure 9**), which is not part of the primary nesting area of olive-sided flycatchers (**Figure 2**). Logging rates on the San Juan National Forest peaked in the late 1970's and currently are similar to rates on other national forests in Region 2, which have remained fairly constant over the past six decades (**Figure 9**). Logging in spruce/fir forests of Region 2 has declined to less than 3,000 acres (less than 0.02 percent of total forested area) per year. Because many forests are thinned, the total volume removed does not reflect the total acreage affected by logging, which represents larger proportions of the landscape.

Despite the current low logging rates, considerable logging has occurred in the past century. Over 50 percent of National Forest System lands in Colorado have origins dating between 1867 and 1927 (Smith 2000). Consequently, only about 10 percent of the national forest area in Colorado and Wyoming is less than 70 years old, and about 15 percent is older than 200 years (Smith 2000). Because olive-sided flycatchers are tied most closely to younger and older forests, logging in the past century has affected current habitat availability across the region.

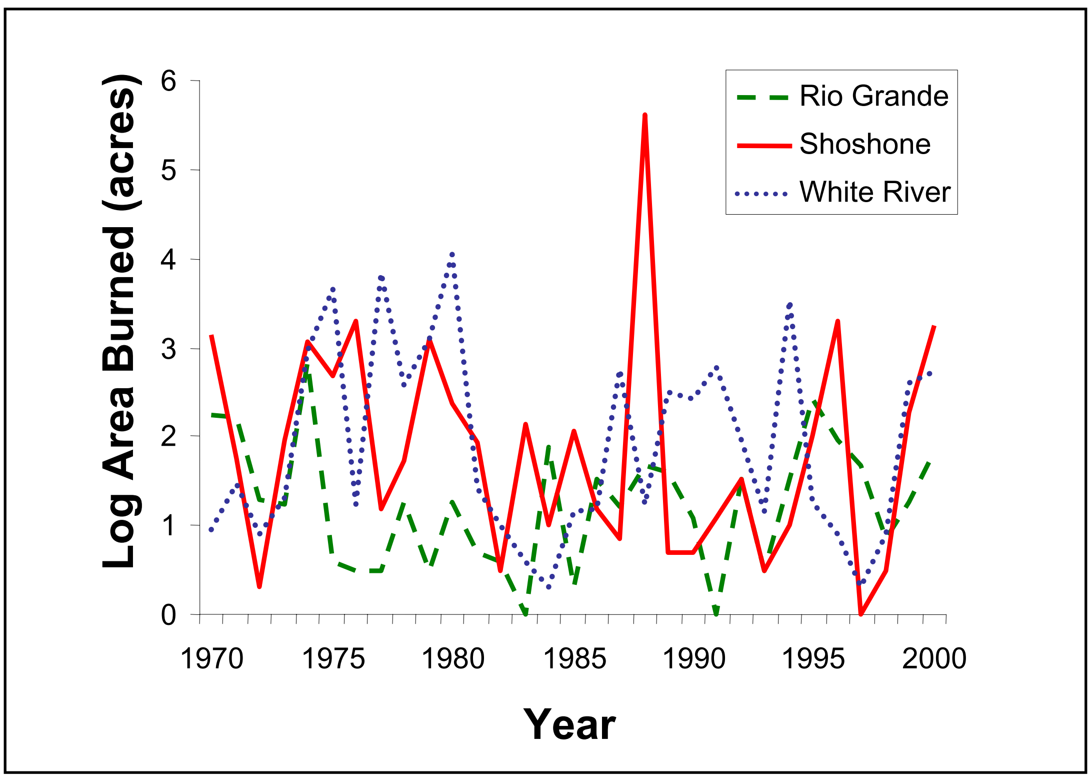

Figure 8. Annual area burned for selected USFS Region 2 national forests (1970-2000).

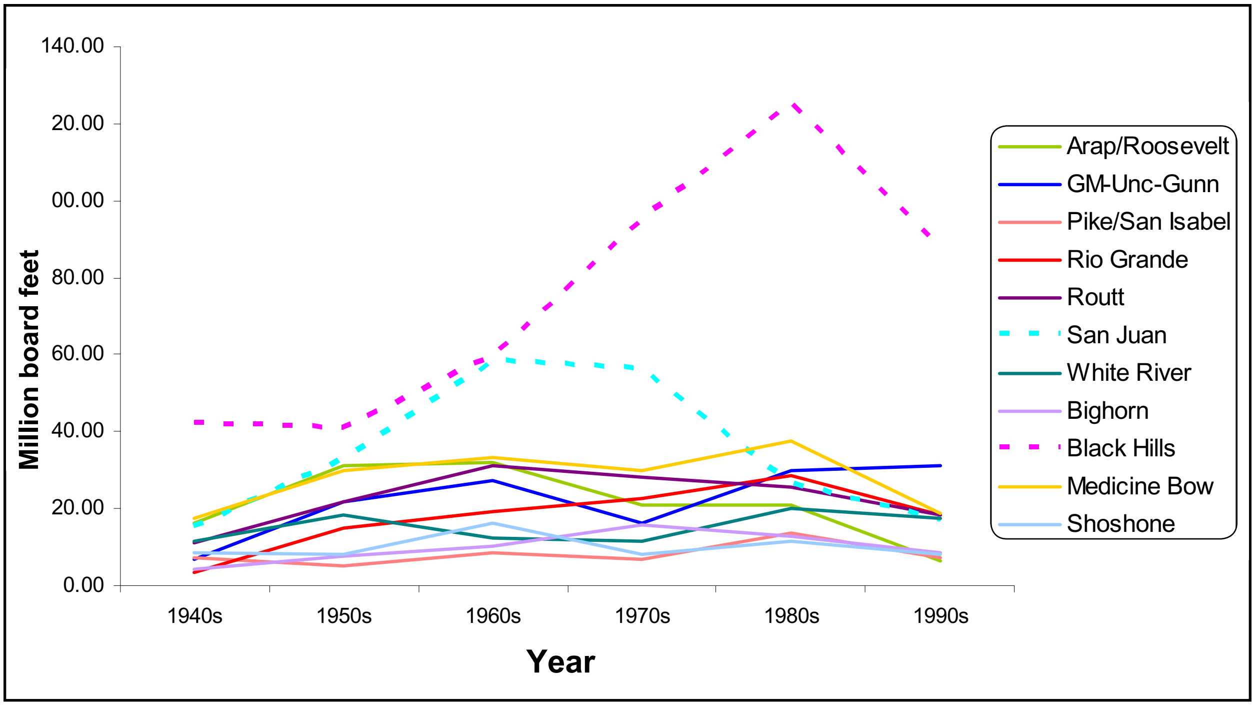

Figure 9. Average volume of timber harvested per decade (1940 – 2000) in USFS Region 2 by national forest.

Logging practices have also changed over the past decades. For example, clearcuts are no longer practiced in spruce/fir forests because of the long regeneration times (Shultz personal communication 1996). Some older (over 30 years) spruce/fir clearcuts, however, are currently used by breeding olive-sided flycatchers (N. Kotliar, personal observation). In the last few years, the Healthy Forest Initiative and National Fire Plan have emphasized reduction of hazardous fuel loads through prescribed fire and mechanical thinning. In Colorado and Wyoming, between approximately 50,000 and 114,000 acres have been treated per year as a result of these programs (http://www.fs.fed.us/projects/hfi); the total area treated annually comprise less than 1 percent of the forested area of national forests in this region. Given the emphasis on reducing fire severity and reducing stand densities, it is unlikely that the goals of these fuels management programs will benefit olive-sided flycatchers.

Management of Olive-sided Flycatchers in Region 2

In light of the importance of National Forest System lands in Region 2 to breeding olive-sided flycatchers, as well as the species' propensity for breeding in burned forests, natural disturbance regimes can provide general guidelines for management until a better understanding of the effects of logging practices on olive-sided flycatchers can be determined. In the absence of better data on olive-sided flycatcher use and nest success in logged forests, characteristics of disturbance regimes (e.g., size, frequency, intensity, spatial and temporal variation) by appropriate cover types and geographic regions may be used cautiously to guide management for olive-sided flycatchers.

Forest conditions created by logging will often differ from those created by severe wildland fires, so it is important to incorporate essential olive-sided flycatcher habitat characteristics (e.g., snags, appropriate scaling of forest openings) where appropriate. In addition, wildland fire use will continue to be an important source of olive-sided flycatcher habitat in Region 2. Although the effects of wildland fire, in particular tree mortality, are often viewed as negative ecologically, such severe fires can create habitats for many species in Region 2 (Kotliar et al. 2002). Other disturbances, such as blow downs and insect outbreaks, likewise may create forest conditions used by olive-sided flycatchers. Because the majority of forested lands under the jurisdiction of USFS Region 2 fall under mixed- and high-severity regimes, undue emphasis on low-severity fires characteristic of southern forests, low elevation, or south facing slopes could diminish the occurrence of conditions created by severe disturbances that are preferred by olive-sided flycatchers. The recent emphasis on reducing fuel loads and reducing fire severity could negatively affect olive-sided flycatchers by creating even-aged forest structures while reducing the risk of severe disturbances that otherwise would create heterogeneous forest conditions (Kotliar et al. 2002). Thus, it is important to apply fuel reduction programs in an ecologically appropriate manner where possible.

Olive-sided flycatchers occur at low densities in Region 2 and are difficult to monitor adequately with BBS surveys or at the national forest level (RMBO unpubl. data). Although research is essential to evaluate the effects of forest management on olive-sided flycatchers, it can be cost-prohibitive to monitor olive-sided flycatchers adequately across broad geographic regions. Alternatively, modeling of potential habitat dynamics, both within national forests and across Region 2, can be used to assess the short- and long-term effects of management activities on the availability of olive-sided flycatcher habitat over multiple scales. Because early successional and late successional forests will primarily provide appropriate habitat conditions, models will need to project habitat dynamics over time. Coupled with local research, such models will be the most cost-effective way to monitor the status of potential olive-sided flycatcher habitat in Region 2.

Tools and practices

Olive-sided flycatchers are not the focus of conservation efforts. Other than addressing the creation of key habitat features through fire and logging practices outlined above, no specific tools are available that address olive-sided flycatcher conservation.

Inventory and monitoring

As noted above, species that occur at low densities, such as olive-sided flycatcher, are challenging to survey adequately. In general, olive-sided flycatchers are currently not surveyed adequately by BBS routes, particularly in Wyoming. RMBO surveys initiated in 1998 on National Forest System lands in Colorado, Wyoming and the Black Hills, detected olive-sided flycatchers on about 200 routes; the number of olive-sided flycatchers per route ranged from one to six (RMBO unpubl. data; 1998-2005). The number of RMBO transects with olive-sided flycatcher detections far exceeds the number of BBS routes in this region (Colorado: ~150 RMBO vs. 45 BBS; Wyoming: ~50 RMBO vs. 13 BBS). Thus, local or regional monitoring programs, such as those developed by RMBO, may be an important supplementary source of data on olive-sided flycatcher trends in Region 2.

Nesting success has received scant attention in Region 2 and has not been adequately monitored. Because population densities may be highest in large severe burns due to the creation of habitat, these sites may provide an excellent and cost-effective opportunity to evaluate nest success of olive-sided flycatchers. Coupled with studies of other fire and logging management activities, this type of intensive local monitoring will help to improve our understanding of the consequences of forest management on olive-sided flycatchers in Region 2. Optical fiber video monitoring systems can be used to monitor nest contents while minimizing disturbance to the nests.

Population or habitat management approaches

Given the uncertainty in Region 2 regarding the status of olive-sided flycatcher populations and the effects of particular logging practices or fire management on breeding olive-sided flycatchers, specific management recommendations will be difficult to establish. As noted above, habitat management plans that are based on natural disturbance regimes are assumed to provide the best opportunity for ensuring the continued availability of habitat for this species.

Both general and specific recommendations have been proposed in Bird Conservation Plans for several state and regional PIF programs. Some conservation recommendations are general: 1) use of prescribed fire and understory thinning to create patchy mosaics, 2) increase wildland fire and prescribed fire use to create post-fire habitats, 3) limit post-fire salvage logging, 4) minimize removal of large snags in fuel wood permit areas and elsewhere, 4) minimize pesticide spraying near nesting birds, 5) create snags, 6) retain large live trees or snags in areas of selective logging (Altman 2000a, b, Beidleman 2000, Nicholoff 2003).

Additionally, specific recommendations were developed for the Pacific Northwest including: retain over 2 percent of landscape as post-fire habitat, and over 40 percent of post-fire landscape as unsalvaged. In burns, salvage less than 50 percent of standing and down dead in small (over 40 ha) burns, retain all trees/snags over 51 cm diameter at breast height (dbh) and over 50 percent of trees/snags between 30 and 51 cm dbh, retain patches with mix of live trees and snags (Altman 2000b).

The PIF recommendations variously address the severity of disturbances, in particular the use of wildland fire, the mixture of live trees and snags, the creation of snags, and limitation of post-fire salvage logging. However, the recommendations are not based on particular disturbance regimes, and it is unlikely that prescribed low-severity fire by itself will create "patchy mosaics." Thus, more specific recommendations associated with particular forest types and historical variation in fire regimes (e.g., severity, frequency, spatial patterning), and under the constraints of legacies of past disturbances (both anthropogenic and natural) should be developed for Region 2. Appropriate spatial and temporal variation in disturbance regimes within forest types should also be incorporated into the management plans (Landres et al. 1999).

Information Needs

The primary information need for olive-sided flycatchers in Region 2 is a better understanding of the long-term population trends of this species. Improved statistical techniques and monitoring designs for quantifying population trends for species that occur at low densities are needed. Better local monitoring is crucial for validation of BBS trends. Because forests (and habitat patches) may vary over long time spans relative to the duration of the BBS data, several more decades of monitoring may be necessary to accurately quantify population trends. Correlational studies of quantitative information on long-term forest dynamics (e.g., forest cover, successional age, burn size and severity, logging practices) may help to evaluate how forest dynamics may contribute to variation in BBS trend data. In addition, regional- and landscape-level analysis of habitat dynamics and predictive modeling of olive-sided flycatcher population dynamics are necessary to evaluate population dynamics over time scales relevant to forest dynamics and changes in land use practices. The relative importance of habitat alteration on the breeding vs. wintering grounds is also crucial to setting priorities and assessing long-term threats to this species. Remotely sensed imagery coupled with habitat modeling can be used to assess the validity of concerns about the loss of habitat on the wintering grounds.

Another critical information need is how various forest management practices affect olive-sided flycatcher (e.g., densities, reproductive success). Previous research has provided equivocal results. In particular, research should include an evaluation of the severity and spatial patterning of the management practices in comparison to natural disturbances in the same cover type and geographical context. Some of examples of research topics include:

- ❖ the effects of wildland vs. prescribed fire
- ❖ fire effects in ponderosa pine vs. Douglas-fir fir stands
- ❖ forest thinning vs. group selection and other harvesting treatments
- ❖ prescribed fire vs. mechanical treatment
- ❖ effects of post-fire management (e.g., salvage logging, seeding)
- ❖ how the relative suitability of various disturbances (e.g., wildland fire, prescribed fire, harvesting treatments) varies over time.

Because disturbance severity is scale-dependent, ideally severity should be quantified at multiple scales (Kotliar et al. in press).

Finally, quantification of habitat used by olive-sided flycatcher (e.g., the density of snags, forest gaps, live trees; insect availability; predation rates; forest edge; and gap structures) across a broad range of forest conditions can provide insight into the range of conditions and constraints that characterize olive-sided flycatcher habitats in Region 2. This information will be especially valuable if nest density and nesting success are also quantified. Additionally, information on the movements of individual birds (e.g., via radio telemetry, stable isotopes; Clegg et al. 2003), both on the home range and year round (migratory and winter range) would help to address the relative importance of threats to olive-sided flycatcher populations in the United States as compared to threats in Central and South America.

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