Brown Creeper (*Certhia americana*): A Technical Conservation Assessment

Prepared for the USDA Forest Service, Rocky Mountain Region, Species Conservation Project

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AUTHOR'S BIOGRAPHY

David Wiggins developed an early interest in Ornithology. During his high school years, he worked as a museum assistant under George Sutton and Gary Schnell at the University of Oklahoma. He later earned degrees from the University of Oklahoma (B.Sc. in Zoology), Brock University (M.Sc. – Parental care in Common Terns, under the supervision of Ralph Morris), and Simon Fraser University (Ph.D. – Selection on life history traits in Tree Swallows, under the supervision of Nico Verbeek). This was followed by a U. S. National Science Foundation Post – doctoral fellowship at Uppsala University in Sweden, where he studied life history evolution in Collared Flycatchers, and later a Fulbright Fellowship working on the reproductive ecology of tits (Paridae) in Namibia and Zimbabwe. He currently splits time between ecological research programs in Sweden and North America.

COVER PHOTO CREDIT

Brown Creeper (*Certhia americana*). © Julie Zickefoose. Used with permission of the artist.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF BROWN CREEPERS

The Nature Conservancy has classified the brown creeper (*Certhia americana*) as G5 or "secure" across their North American range. While Breeding Bird Survey (BBS) data show little in the way of population changes since 1960, Christmas Bird Count (CBC) data show a significant rangewide decline from 1960 to 2003. However, brown creepers are not well sampled with BBS or CBC survey techniques, and such data are consequently of questionable value in assessing population trends.

Brown creepers are known to have relatively strict breeding habitat requirements; they prefer to nest in areas with an abundance of mature and old-growth trees and high canopy cover. Additionally, brown creepers are known to be sensitive to forest management practices such as heavy (e.g., clearcut) logging and the habitat-fragmenting effects that it often produces. Consequently, brown creepers may serve as an important indicator of forest health in areas where forest habitats are actively managed.

Studies throughout North America have shown that most types of logging (e.g., clear-cuts, salvage, partial) have negative consequences for local creeper abundance. In some cases, creepers completely abandon logged sites, likely because of the loss of large, mature and old-growth trees that provide both foraging and nesting sites (peeling bark). Logging may also reduce local habitat quality by creating fragmented forest patches and by increasing areas of edge habitat. Brown creepers are a forest interior species, typically nesting far from forest edges. Thus, they are sensitive to fragmentation and consequent increases in edge habitats.

A number of forest management techniques may improve habitat quality for creepers. The single most important factor affecting creeper abundance (and likely reproductive success) is the local density of large snags and mature trees. Under natural conditions, most seral stages retain enough mature trees and snags to support breeding populations of brown creepers. In managed forests, however, the loss of mature trees and the elimination of snags from harvested stands make most regenerating stands unsuitable for brown creepers. Retaining large patches with old-growth characteristics (i.e., large diameter trees and snags, high canopy closure, and old-growth structure) at such sites can significantly improve habitat suitability for creepers.

In order to develop a coherent management strategy for brown creepers in USDA Forest Service Region 2, data are needed on brown creeper demography and responses to habitat manipulations. Data on breeding success, dispersal, and survival under different habitat management scenarios would be particularly valuable. Such data are unavailable from anywhere in the species' range, but they represent a critical need for the implementation of management decisions for this species. In addition, longitudinal (i.e., before/after treatment) studies of the effects of forest management practices (especially logging and forest thinning) are needed for a more statistically robust assessment of how these factors affect local populations.

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EDITOR: Gary Patton, USDA Forest Service, Rocky Mountain Region

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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), USDA Forest Service (USFS). The brown creeper (*Certhia americana*) is the focus of an assessment because it is a Management Indicator Species (MIS) on the Black Hills and Rio Grande national forests within Region 2 (**Figure 1**). Within the National Forest System, a MIS serves as a barometer for species viability at the forest level and can be used to estimate the effects of planning alternatives on fish and wildlife populations [36 CFR 219.19 (a)(1)] and to monitor the effects of management activities on species via changes in population trends [36 CFR 219.19 (a)(6)].

Goal

Species conservation assessments produced as part of the Species Conservation Project are designed to provide managers, biologists, and the public with a thorough discussion of the biology, ecology, conservation, and management of certain species based on existing scientific knowledge. The assessment goals limit the scope of the 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 prescriptive management recommendations. Rather, it provides the ecological background upon which management must be based and focuses on the consequences of changes in the environment

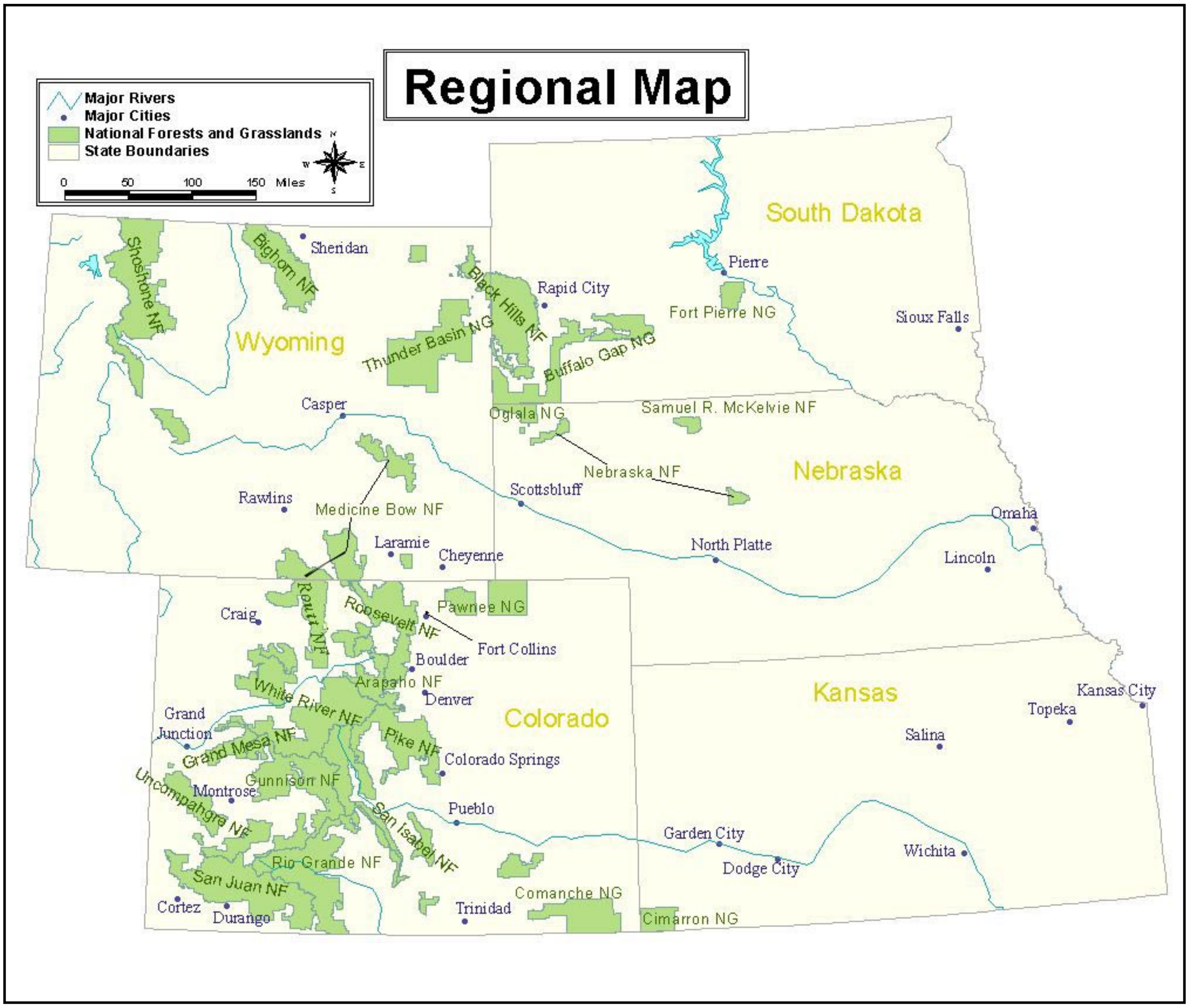

Figure 1. Map of national forests and grasslands within USDA Forest Service Region 2.

that result from management (i.e., management implications). Furthermore, it cites management recommendations proposed elsewhere and examines their success when they have been implemented.

Scope and Limitations of Assessment

This assessment examines the biology, ecology, conservation, and management of the brown creeper with specific reference to the geographic and ecological characteristics of the Rocky Mountain Region. Although most of the literature on the species originates from field investigations outside the region, to the extent possible this document places that literature in the ecological and social context of Region 2. Similarly, this assessment is concerned with reproductive behavior, population dynamics, and other characteristics of brown creepers in the context of the current environment. The evolutionary environment of the species is considered in conducting the synthesis, but placed in current context.

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

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 our 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 evidence for particular ideas, and we describe alternative explanations where appropriate.

Publication of Assessment on the World Wide Web

To facilitate the use of these species conservation assessments, they are being published on the Region 2 World Wide Web site. Placing the documents on the Web makes them available to agency biologists, other agencies, and the public more rapidly than publishing them as reports. More importantly, it will facilitate their revision, 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 their 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 to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

The brown creeper is not federally listed as a threatened species in Canada (Committee on the Status of Endangered Wildlife in Canada 2003). The U.S. Fish and Wildlife Service (2002) does not consider it threatened or endangered or a bird of conservation concern. Within USFS Region 2, the brown creeper is a MIS on the Black Hills and Rio Grande national forests. The Bureau of Land Management State Director's Sensitive Species lists for Colorado (Bureau of Land Management 2000) and Wyoming (Bureau of Land Management 2001) do not include brown creeper. A summary of the management status of brown creepers within state and regional Partners in Flight (PIF) Bird Conservation Plans is presented in **Table 1**. Creepers are listed as a Priority Species in mid-elevation conifer forest in the Wyoming plan (Cervoski et al. 2001), but they are not considered a Priority Species in the Colorado plan. PIF plans for other states within Region 2 have not been published. Just outside Region 2, creepers are also listed as a Priority Species in the Montana and Idaho PIF plans. The Natural Heritage Program has ranked brown creepers as G5, or globally secure, due to the widespread range of the species and

Table 1. Management status of brown creepers according to Partners in Flight Bird Conservation Plans from states within (bolded) and surrounding USDA Forest Service Region 2.

State	Status	Citation
Colorado	Not a Priority Species	Beidleman 2000
Kansas	State PIF plan not published	
Nebraska	State PIF plan not published	
South Dakota	State PIF plan not published	
Wyoming	Priority Species (Level II**, mid-elevation conifer forest)	Cervoski et al. 2001
Arizona	Not a Priority Species	Latta et al. 1999
Idaho	High Priority Species (High elevation mixed-conifer woodlands, Cedar-Hemlock forest)	Ritter 2000
Montana	Priority Species (Level I*; Cedar-Hemlock forest)	Casey 2000
New Mexico	Not a Priority Species	Rustay 2001
Utah	Not a Priority Species	Parrish et al. 2002

* Level I priority species are the highest priority — those for which conservation action is urgently needed.

** Level II priority species are those for which there is sufficient concern to warrant population monitoring.

its apparently secure status in most areas. State and Provincial Natural Heritage Program designations for the brown creeper are shown in **Figure 2**.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

In the United States and Canada, brown creepers are covered under the Migratory Bird Treaty Act, which provides for federal prohibitions against "take" of the species but offers little in the way of management or conservation of the species. Currently, no federal, regional, state, or provincial management plans or conservation strategies cover brown creepers. As noted above, brown creepers have been designated a MIS within the Black Hills and Rio Grande national forests, primarily because they appear to be relatively sensitive to forest management practices that alter and fragment stands with old-growth characteristics. Ideally, MIS are monitored to track changes in population status (density, breeding success) in relation to current or planned forest management activities. Such monitoring has not yet been carried out within Region 2.

Biology and Ecology

Systematics

Brown creeper systematics in North America have largely been carried out using morphological and plumage traits, rather than DNA techniques. As many as 13 subspecies have been recognized, with most of the variation occurring in the western portion of the range (American Ornithologists' Union 1957, Hejl et al. 2002a). *Certhia americana montana* is the resident subspecies in Region 2. *Certhia americana* was only recently (American Ornithologists' Union 1983) split from the Eurasian treecreeper (*C. familiaris*), largely based upon differences in song characteristics (Baptista and Krebs 2000).

Nominate race: *Certhia americana* Linnaeus.

Distribution and abundance

Global distribution

Brown creepers breed throughout the coniferous forest belt in North America, south into the mountains of northern Nicaragua (**Figure 3**). During winter they are more widely distributed (especially at lower elevations) and use a wider variety of habitats (e.g., more deciduous forests). Populations in southwestern New Mexico, southeastern Arizona, Mexico, and Central America are apparently resident (American Ornithologists' Union 1998). During the breeding season, the areas of highest apparent abundance are the Sierra Nevada range in California, along with coastal forests in southern British Columbia (based on Breeding Bird Survey data; **Figure 4**). However, as noted later in this assessment, abundance estimates derived from this data are of questionable accuracy (see Population trends section). During winter, creepers are also relatively abundant in California as well as in deciduous forests along the Ohio and Mississippi River valleys (based on Christmas Bird Count data; **Figure 5**). Few quantitative historical data are available with which to assess trends in abundance.

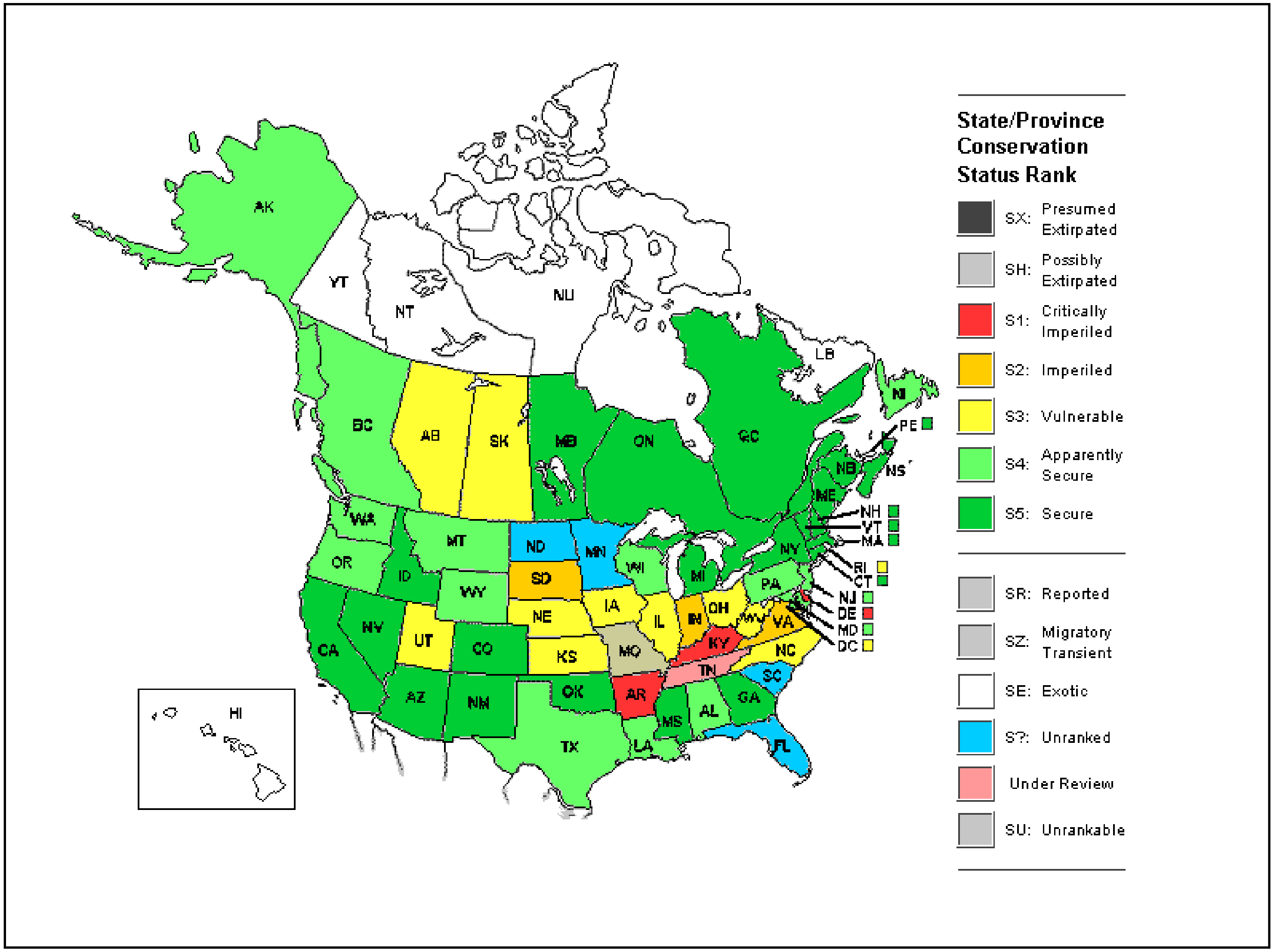

Figure 2. Status of brown creepers in North America based on the Natural Heritage Program database (NatureServe Explorer 2003).

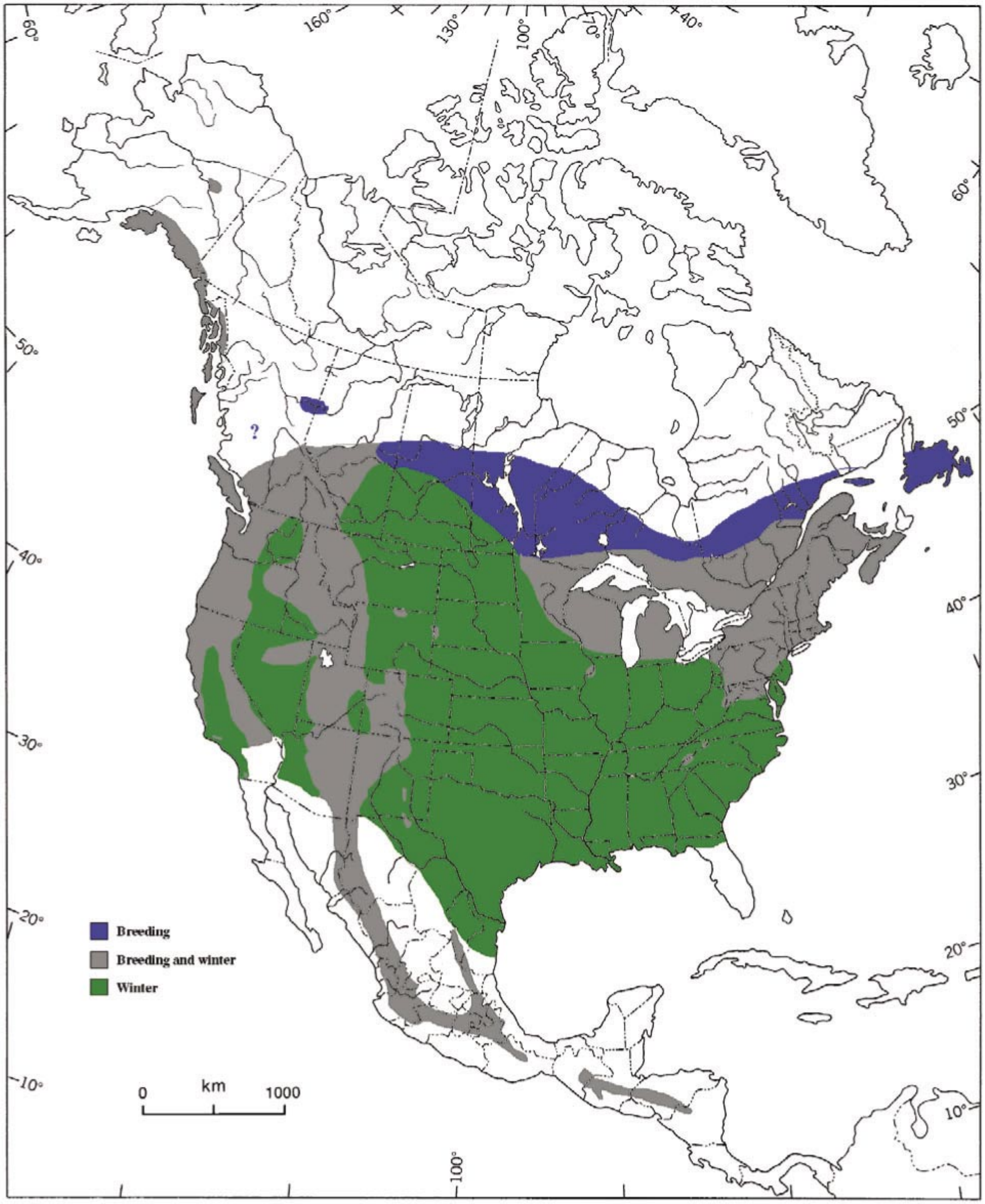

Figure 3. Range of brown creepers in North America. The figure is modified from Hejl et al. (2002a).

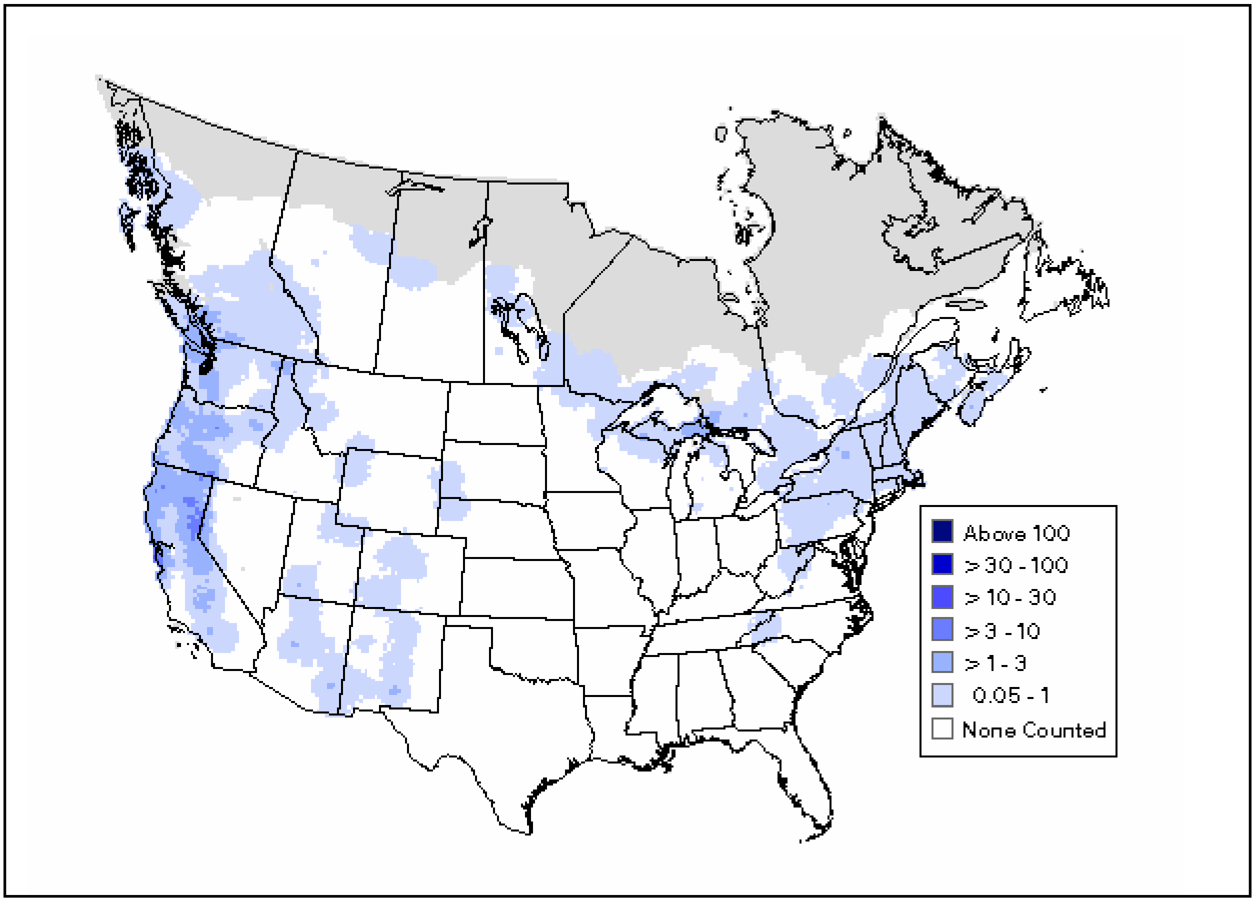

Figure 4. The mean number of brown creepers observed on Breeding Bird Surveys during the years 1994 to 2003 (Sauer et al. 2004).

However, the general concern for this species is that localized loss and degradation (loss of large trees and snags) of old-growth forests have reduced populations in some parts of the breeding range. For example, Raphael et al. (1988) estimated a 35 percent reduction in the number of creepers in northwestern California Douglas-fir (*Pseudotsuga menziesii*) forests due to the loss of mature and old-growth forest (relative to pre-settlement conditions).

Regional distribution and abundance

Within Region 2, brown creepers breed widely in high (ca. 2,700 to 3,500 m) elevation conifer forests in Colorado and Wyoming, with isolated breeding populations in the Bighorn Mountains of Wyoming and in the Black Hills of South Dakota. A few records also exist of pairs breeding in low elevation, floodplain woodlands in eastern Nebraska (Sharpe et al. 2001), and there are scattered summer records (although not confirmed breeding) in eastern South Dakota (Tallman et al. 2002). Breeding Bird Survey data suggest that Region 2 creeper populations occur at low densities relative to those in other areas of the species' range (**Figure 4**).

The historical and current distributions and abundances in Region 2 are as follows:

Colorado: Sclater (1912) described creepers as residents, largely restricted to the foothills and mountains in winter, and generally breeding above 9,000 feet in summer. Bailey and Niedrach (1965) noted it as a resident, breeding in mountain forests from 7,000 feet to timberline. Recent breeding bird atlas work found creepers nesting widely in mountainous areas, with highest densities in the central and southwestern portions of the state (Versaw 1998).

Kansas: Creepers are found in the state as transients and winter residents, but apparently they do not breed there (Goss 1886, Johnston 1965, Thompson and Ely 1992). There is little indication of any historical change. Goss (1886) noted them as common winter residents, while Johnston (1965) considered them "low density" winter residents.

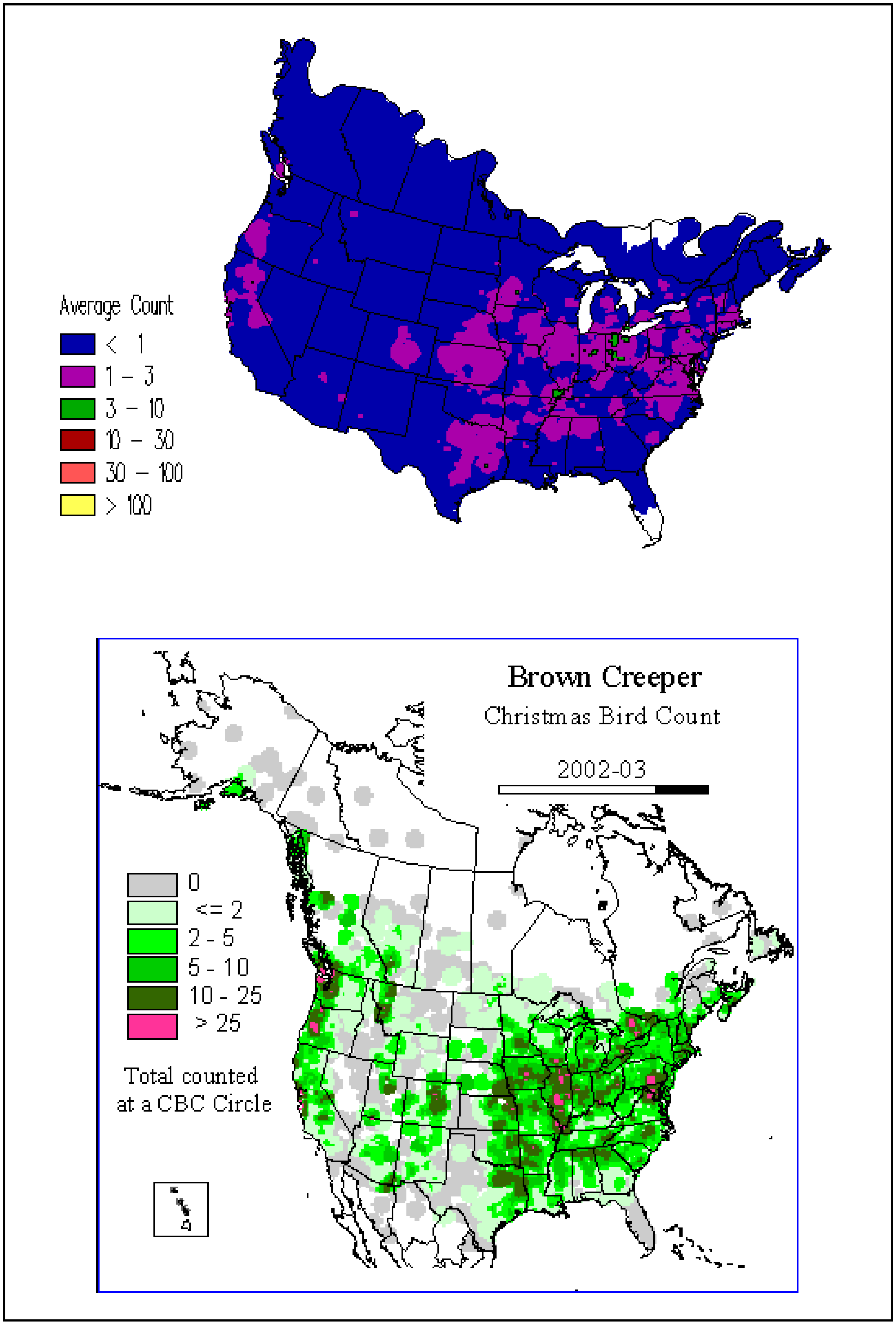

Figure 5. Winter distribution of brown creepers, based on North American Christmas Bird Count (CBC) data. The upper figure represents the average number creepers counted on CBCs for the period 1966 to 1996, while the lower figure represents data from the 2002 to 2003 CBC. Data are from the CBC website (www.audubon.org/bird/cbc).

Nebraska: The breeding status of brown creepers in Nebraska is difficult to assess, but the creeper apparently is a very rare breeder in Nebraska. Based on early historical records, Ducey (2000) considered creepers an uncommon but regular nester in the 1800's along the Missouri River valley. Sharpe et al. (2001) noted summer records in a number of areas across the state, from the Missouri and Niobrara river valleys in the east, to the Pine Ridge area in the northwest. However, the breeding bird atlas in the 1980's did not report the species breeding in the state (Molhoff 2001). In total, there are only two recent, confirmed breeding records, from Brown and Sarpy counties (Sharpe et al. 2001).

South Dakota: Early authors considered brown creepers winter residents in the state (e.g., Over and Thomas 1921). Evidence of breeding in the Black Hills area accumulated during the 1940's, with many birds observed during summer in high altitude conifer forests (Pettingill and Whitney 1965). Tallman et al. (2002) summarized historical records and discounted reported breeding records from southeastern South Dakota in the late 1800's and early 1900's, which were apparently based on the presence of singing birds during summer. More recently, the South Dakota Breeding Bird Atlas (Peterson 1995) found a total of two confirmed breeding attempts, both in the Black Hills (Custer and Pennington counties). All confirmed breeding records have come from the Black Hills area in Custer, Pennington, and Meade counties (Tallman et al. 2002). However, the presence of breeding creepers along the Missouri River valley in Nebraska suggests that creepers may have been regular breeders in eastern South Dakota prior to 1900.

Wyoming: While creepers were considered a summer resident by Knight (1902), Scott (1993) considered brown creepers uncommon residents in most mountain forests, especially in areas with old-growth conifer forests.

According to the available historical data, there has been little apparent change in the overall distribution of brown creepers within Region 2. The only area where creepers once bred and are now absent is along the heavily forested Missouri River valley in eastern Nebraska (Ducey 2000) and, likely, in eastern South Dakota. However, it is important to note that historical comparisons are difficult to make, as early historical accounts were of a general nature and are not directly comparable to more modern quantitative methods such as breeding bird atlas surveys. Historical comparisons of brown creeper abundance in Region 2 are particularly difficult to make, as there are no comparative quantitative data available.

Regional discontinuities in distribution and abundance

Brown creepers breed widely throughout the mountain ranges of Wyoming and Colorado. A relatively isolated breeding population occurs in the Black Hills area of southwestern South Dakota/northeastern Wyoming. Further east, the breeding status is not well known, but there are scattered breeding records from a number of riparian forests in central and eastern Nebraska, and summer records from eastern South Dakota. Thus, it appears that creepers may breed in two distinct habitats in Region 2, primarily in mountainous western conifer forests, but also very rarely in eastern floodplain, deciduous forests.

As creepers are a forest interior species and largely restricted to relatively large patches of mid- to high-elevation conifer (e.g., lodgepole pine [*Pinus contorta*], spruce-fir) forests, their distribution within Region 2 is likely a mosaic, following the distribution of such forests in Colorado and Wyoming. The extent to which populations breeding in relatively isolated habitat patches are linked is not known (see Demography section).

There is little indication of any variance in abundance during the breeding season, as creepers occur at very low densities throughout the region. During winter, creepers are widespread at low altitudes and generally uncommon throughout the region.

Population trend

Available data conflict on the trend of creeper populations. BBS data suggest that brown creeper populations currently are relatively stable in Region 2 (**Table 2**; Sauer et al. 2003). Brown creepers occur at low densities within the Region, and for reasons described below, have not been rigorously sampled during BBS work. For example, note the lack of historical records from 1966 to 1979; this is likely a result of a lack of early surveys at high altitude sites. The lack of earlier BBS data may also be a result of the difficulty in detecting the relatively quiet and unobtrusive creepers, which occur at low densities in forest interiors. All of these factors suggest that BBS data are not a suitable measure of brown creeper population change. Keeping this uncertainty in mind, there is little indication in BBS data of a decline in creeper populations within Region

Table 2. Trends in abundance of brown creepers from North American Breeding Bird Surveys. Data were taken from Sauer et al. (2003) and focus on USDA Forest Service Region 2 and surrounding areas. Trend indicates the percentage change per year. Underlined values represent statistically significant (P <0.05) trends. Region 2 states are in bold.

	1980-2002		
Region	***N***	**Trend**	***P***
Colorado	9	23.6	0.24
Kansas	—	—	—
Nebraska	—	—	—
South Dakota	3	35.7	0.30
Wyoming	2	4.9	0.53
Idaho	11	- 15.2	0.11
Minnesota	6	16.6	0.29
New Mexico	3	7.3	0.13
Utah	7	17.0	0.14
Central Rockies	36	- 9.8	<u>0.00</u>
Southern Rockies	14	21.6	<u>0.03</u>
U.S. Fish and Wildlife Service Region 6	22	18.0	<u>0.00</u>
United States	426	- 0.7	0.45
Canada	83	- 0.7	0.79
Survey-wide	509	- 0.8	0.42

2, with the exception of some areas in northwestern Wyoming (**Figure 6**).

As a measure of recent population change, CBC data (National Audubon Society 2002) may be a better source than are BBS data. The winter distribution of creepers in low altitude deciduous woodlands, as well as their habit of joining mixed-species flocks during the winter makes them much more amenable to detection during surveying. CBC data from the United States and Canada show a strong, statistically significant decline from 1960 through 2003 (**Figure 7**). However, because there are no data available that link wintering and summering populations, it is not clear how the apparent declines in wintering birds are spatially linked to breeding populations.

As with many cryptic forest species, brown creepers were typically mentioned only briefly in early historical accounts, with limited information on nesting and breeding distribution (e.g., Cooke 1897, Knight 1902). More modern studies, especially those employing teams of breeding bird atlassers, have the ability to more accurately assess the distribution and abundance of creepers. Nevertheless, the species' generally quiet behavior and low population density make them particularly difficult to census. As a consequence, historical comparisons of creeper abundance are not possible due to a lack of quantitative information from the late 1800's and early 1900's.

Large-scale movement patterns

Although brown creepers are considered residents in many areas of their range (Hejl et al. 2002a), they are much more widespread during the winter, suggesting substantial migratory movements, or at least elevational changes in the west. There are several reports of banded birds from the northeastern United States and Canada recovered far to the south during the winter, but there are no banding recoveries from western populations (including Region 2). Migration appears to be a slow process, with one individual reported as moving only 8 miles over two days in October (Bartel 1984). In the west, creepers often begin appearing at lower elevations in late September or October, although some populations (e.g., coastal California, southern Arizona, Queen Charlotte Islands in British Columbia) are resident (Hejl et al. 2002a). Campbell et al. (1997) suggested that creepers in British Columbia showed both latitudinal and altitudinal migration, a pattern than may apply throughout the Interior West. In Region 2, creepers are probably largely migratory, moving to low elevation mountains and lowland riparian areas, with only a few birds remaining in mid- and high-elevation conifer forests during the winter (Andrews and Righter

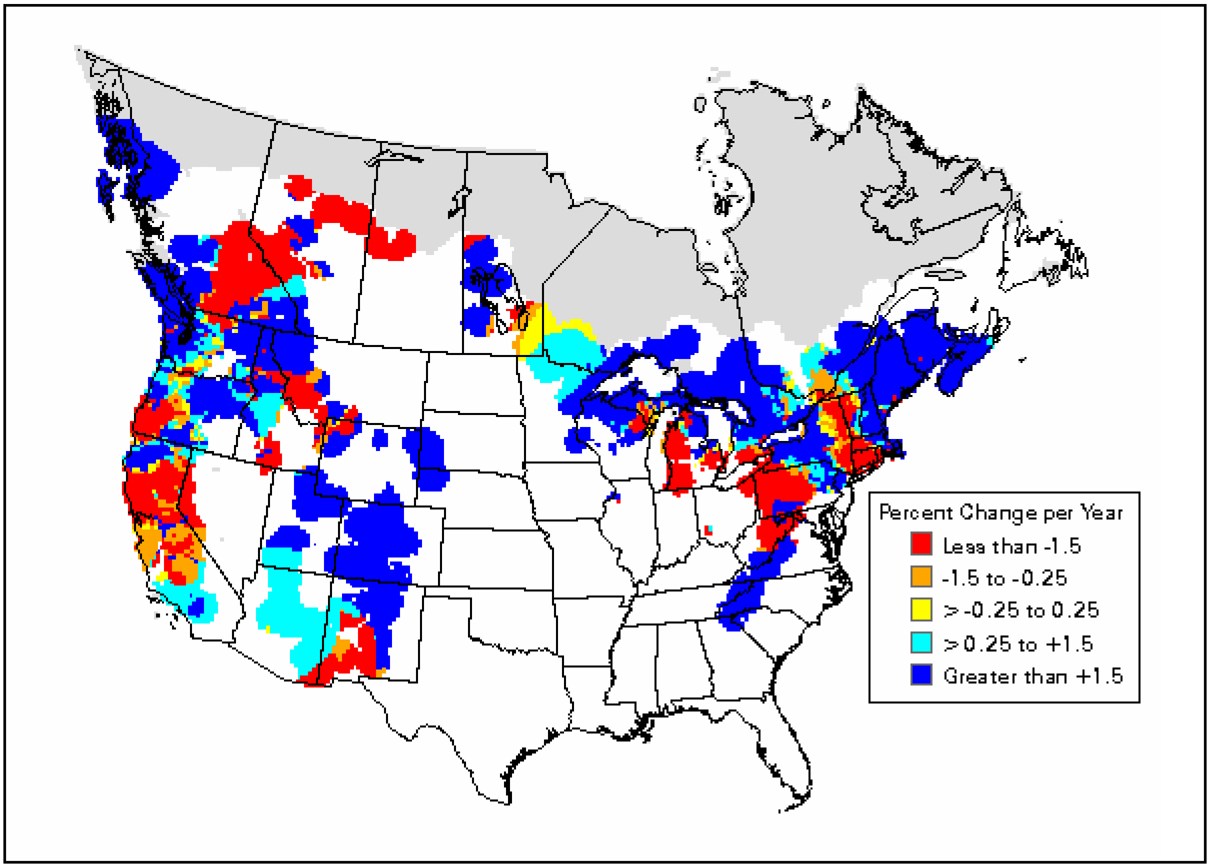

Figure 6. Percent change per year in the number of brown creepers counted on Breeding Bird Surveys from 1966 to 2003 (Sauer et al. 2004).

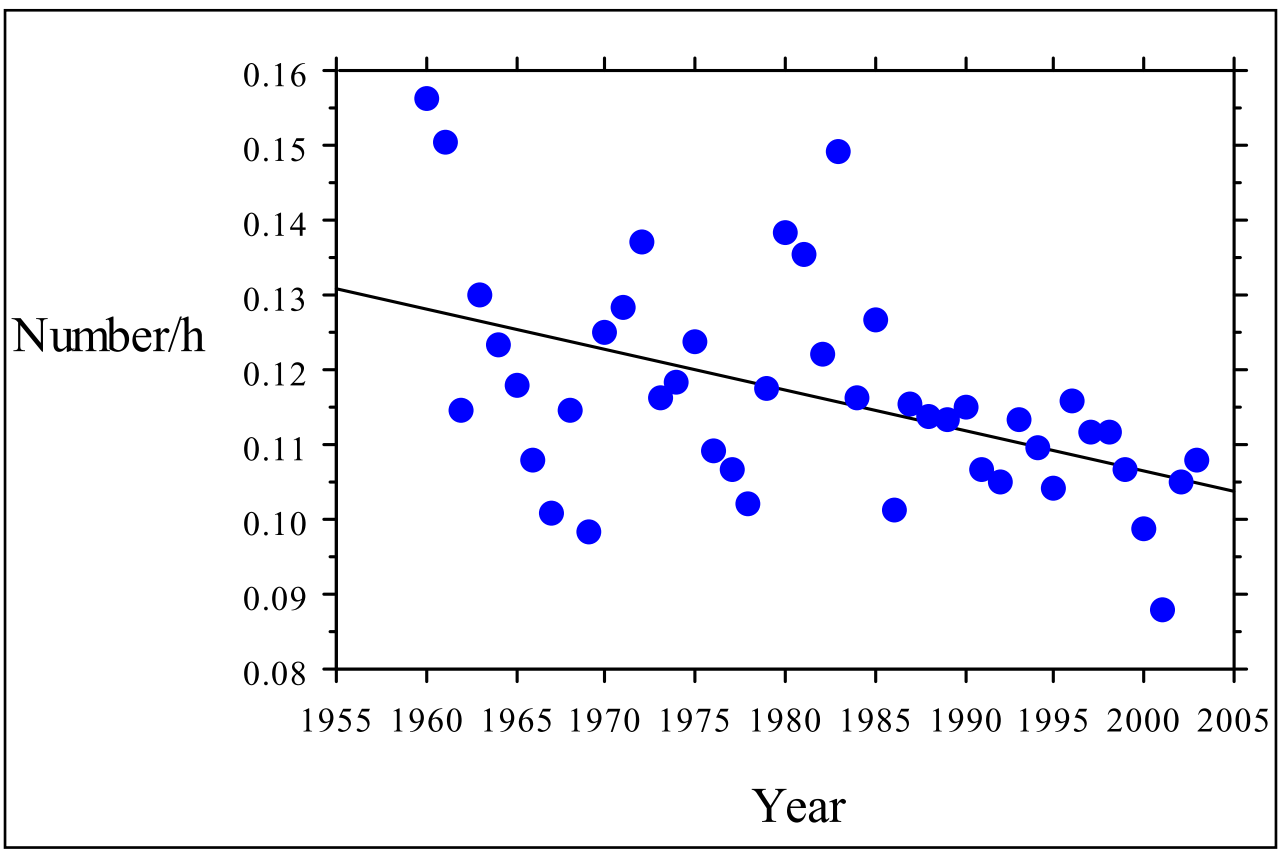

Figure 7. Temporal pattern of abundance of brown creepers on annual Christmas Bird Counts in the United States and Canada from 1960 to 2003. The negative trend was significant (Spearman rank correlation, rs = - 0.50, P = 0.0012). The fitted regression line is for illustrative purposes only. Data were taken from the Christmas Bird Count website http://www.audubon.org/bird/cbc/hr/index.html.

1992). In Colorado, creepers appear in low elevation sites beginning in late September and may remain there until early April (Andrews and Righter 1992).

Brown creepers defend territories during the breeding season, but the extent to which they maintain winter territories is unclear (see Social patterns and spacing section). Although creepers may be highly migratory in the northeastern United States and Canada, there is little information available on seasonal movements in the western portions of the range, aside from altitudinal migration to lower elevations. The degree to which brown creeper populations are linked is not known. To date there have been no studies of dispersal or philopatry in brown creepers. This is unfortunate given the mosaic pattern of habitat within which creepers occur in Region 2. Such a pattern may have significant consequences for population viability, but until data are collected on creeper dispersal patterns, the degree of gene flow among populations will remain unknown.

Habitat

Breeding habitat

Forest characteristics preferred by creepers include large, unfragmented, mature and old-growth stands with high canopy coverage and high densities of large trees and snags (Hejl et al. 2002a). Hejl et al. (2002a) suggested that the most critical feature related to the selection of breeding areas is the presence of large trees and snags, which are the preferred nesting and foraging substrates. **Table 3** summarizes the preferred breeding forest types across the western portion of the breeding range. In Region 2, brown creepers breed primarily in high elevation spruce-fir and lodgepole pine forest and, to a lesser extent, in mid-elevation ponderosa pine (*Pinus ponderosa*) forest (Versaw 1998).

Extensive surveys of breeding birds in the Black Hills National Forest have revealed that well over 90 percent of all observations of brown creepers during the breeding season are in mature or old-growth forests, primarily white spruce (*Picea glauca*) and late-successional ponderosa pine (Panjabi 2001, 2003, 2004). In the Black Hills, white spruce is not heavily harvested and is consequently often found in old-growth stages (A. Panjabi personal communication 2004). Although creepers were also seen in younger stands of ponderosa pine, densities were typically much higher in late-successional stands (**Table 4**).

Creepers may respond positively to cool-season forest fires, at least over the short-term (Apfelbaum and Haney 1981, Kotliar et al. 2002). In general, the response of brown creepers to fire appears to vary within Region 2, with most studies suggesting that creepers prefer unburned forests (Hutto and Young 1995, Kotliar et al. 2002), but others showing creepers utilizing moderately burned forests (Taylor and Barmore 1980). The attraction to moderately burned forests may result from an increase in damaged trees that contain peeling bark (Kotliar et al. 2002), or from an increase

Table 3. Characteristic forest types used by breeding brown creepers in USDA Forest Service Region 2 and the western United States and Canada. Region 2 states are in bold.

Region	Primary breeding forest type	Reference
Colorado	spruce-fir forest, lodgepole pine	Versaw 1998
South Dakota	white spruce (preferred) and ponderosa pine	Pettingill and Whitney 1965; Panjabi personal communication
Wyoming	mixed spruce, lodgepole pine	Dorn and Dorn 1999
Montana-Idaho	mature cedar-hemlock, spruce-fir and mixed conifer	Hutto and Young 1999
Utah	Engelmann spruce, subalpine fir	Smith and McMahon 1981
Arizona	spruce-fir, ponderosa pine, pine-oak (southeast)	Phillips et al. 1964, Cunningham et al. 1980
New Mexico	spruce-fir, ponderosa pine	Bailey 1928, Tatschl 1967
California	Sierra: lodgepole pine, ponderosa pine, red fir Coast: redwood, oak, bay laurel	Hejl et al. 2002a (see references therein)
Oregon	conifer and deciduous woodlands (including oak)	Anderson 1972, Csuti et al. 1997
Washington	mixed-conifer forests, douglas fir	Smith et al. 1997
British Columbia	douglas fir, cedar-hemlock	Campbell et al. 1997
Alberta	spruce-fir, lodgepole pine	Semenchuk 1992

Table 4. Breeding season densities of brown creepers measured during fixed-radius (ca. 50 meters) point counts in different habitat types in the Black Hills National Forest, South Dakota. Data are from Panjabi (2001, 2003, 2004, personal communication). Sample sizes (n) represent the numbers of creepers observed during the approximately 450 point counts in each habitat.

	Density (birds per km^2)					
Habitat type	**n**	**2001**	**n**	**2002**	**n**	**2003**
White spruce	26	8.6	43	14.9	63	7.3
Ponderosa pine (south)	25	—	18	4.4	29	4.2
Ponderosa pine (north)	24	—	26	6.3	33	3.2
Late-successional ponderosa pine	34	20.4	41	10.9	—	—

in insect abundance in such areas. In Douglas-fir and hemlock (*Tsuga* spp.) forests in Washington, brown creepers were one of the most common breeding birds one to three years after fire (Huff et al. 1985). Two studies (Huff et al. 1985, Hobson and Schieck 1999) have shown that the positive response by creepers to fire is short-lived (perhaps due to bark retention times), with later, negative effects apparent in mid-successional burned forests.

An important land management consideration is that salvage and partial logging of burned forests significantly decreases their suitability as brown creeper nesting habitat, likely as a result of the extraction of large diameter trees and snags (Hejl et al. 2002a, b). Data from the Black Hills National Forest fail to show any preference for recently burned areas of forest (Panjabi 2001, 2003, 2004), despite an apparent preference for such areas in other studies (e.g., Apfelbaum and Haney 1981). However, the lack of an observed preference for burned areas in the Black Hills may have been related to the severity and timing of burns (e.g., Hutto 1995), or to logging activity within the burned areas. In addition, at least in some areas, brown creepers are more common in unburned forests relative to nearby burned areas (Kotliar et al. 2002). The degree to which brown creepers utilize burned forests in Region 2 is not yet clear.

This raises another issue that is in need of further study: the degree to which brown creepers show a preference for foraging/nesting in disturbed forests *per se*, including those affected by recent burns, insect and disease outbreaks, and windthrows. All of these forms of disturbance may produce snags and dead and dying trees and may thus provide at least some of the structural requirements that brown creepers prefer. It is likely that the attractiveness of such habitats to brown creepers will depend on the intensity and scale of the disturbance events, with small-scale, low-intensity disturbances being preferred. Data on the abundance and productivity of creepers near such disturbed forests types are clearly needed (see Information Needs section).

Studies in the Pacific Northwest have shown that in unmanaged Douglas-fir forests, brown creeper abundance is not so tightly bound to forest stand age, perhaps because large, decaying snags are prevalent in most successional stages of Douglas-fir forests (Carey et al. 1991). Thus, although old-growth forests likely are the preferred habitat type in most regions, the suitability of other successional stages may depend on the local forest type. Selective logging may reduce the quality of old-growth forests for creepers. Old-growth ponderosa pine (Siegel 1989) and cedar-hemlock forests (Hejl et al. 2002a) that had been selectively logged had lower numbers of creepers than did stands that had not been logged. The preference for old-growth forests appears to be correlated with the abundance of snags, and perhaps with structural (e.g., stand density) and micro-climate (e.g., moisture) components (Siegel 1989, Hejl et al. 2002a).

Brown creepers are a forest interior species throughout their range (Rosenberg and Raphael 1986, Freemark and Collins 1992). Thus, creepers tend to stay far from forest edges and reach highest densities deep within forest patches. In Oregon, creepers nested further away (mean = 252 meters [277 yards]) from forest edges than any other of the cavity nesting species studied (Nelson 1989). In coastal redwood forests in California, creepers were 1.8 times more common in the forest interior (>400 meters [440 yards] from the edge) than in forest edge habitats (Brand and George 2001).

Edge sensitivity may be responsible for the sensitivity of brown creepers to forest fragmentation. On the Medicine Bow National Forest in southeastern Wyoming, Keller and Anderson (1992) found that brown creepers were extremely sensitive to forest fragmentation, never occurring during the breeding season in the fragmented portions of the study woodlands. Forest fragmentation induced stronger declines among brown creepers than among other species that are known to be old-growth specialists (e.g., American three-toed woodpecker [*Picoides tridactylus*] and red-breasted nuthatch [*Sitta canadensis*]).

Models of the distribution of suitable breeding habitat for brown creepers in Wyoming and Colorado, based upon GAP analyses, are presented in **Figure 8** and **Figure 9**, respectively. In the case of the Colorado data, the modeled habitat proved a very good match to the distribution of creepers found during recent Colorado breeding bird atlas surveys (Versaw 1998).

Nest site habitat characteristics

Creepers nest primarily in the niches created by loosening bark, typically on dead or dying trees. Of 248 nests from across the North American range, over 95 percent were placed in dead trees (Hejl et al. 2002a). In British Columbia, Campbell et al. (1997) reported that half of 30 creeper nests were located on dead trees. There are few creeper nest data available from Region 2 states. Two nests in Colorado were situated in Douglas-fir and lodgepole pine (Bailey and Niedrach 1965). In Nebraska, only two nests have been found, one in an American elm (*Ulmus americana*) along the eastern border of the state, and one in a ponderosa pine in the north-central part of the state. Outside Region 2, Bailey (1928) described a nest 35 feet high under the bark of a dead ponderosa pine in New Mexico. Nest site data from a number of studies across the western United States give mean nest heights of 5.3 to 9.5 m (17 to 31 ft), ranging from 0.7 to 22.5 m. (2.3 to 73 ft), and mean nest tree dbh values of 41 to 59 cm (16.4 to 23.6 in) (**Table 5**).

Foraging habitat

Brown creeper foraging habitat is similar to nesting habitat (see above). Creepers are bark specialists, moving up tree trunks and probing within bark furrows for insects and small invertebrates. As such, they spend the majority of their foraging time on tree species with furrowed bark, and especially on older, larger trees. The majority of their foraging effort is concentrated between 1 and 9 meters (1.1 to 9.9 yards) above ground (Hejl et al. 2002a). In Douglas-fir/hemlock forests in

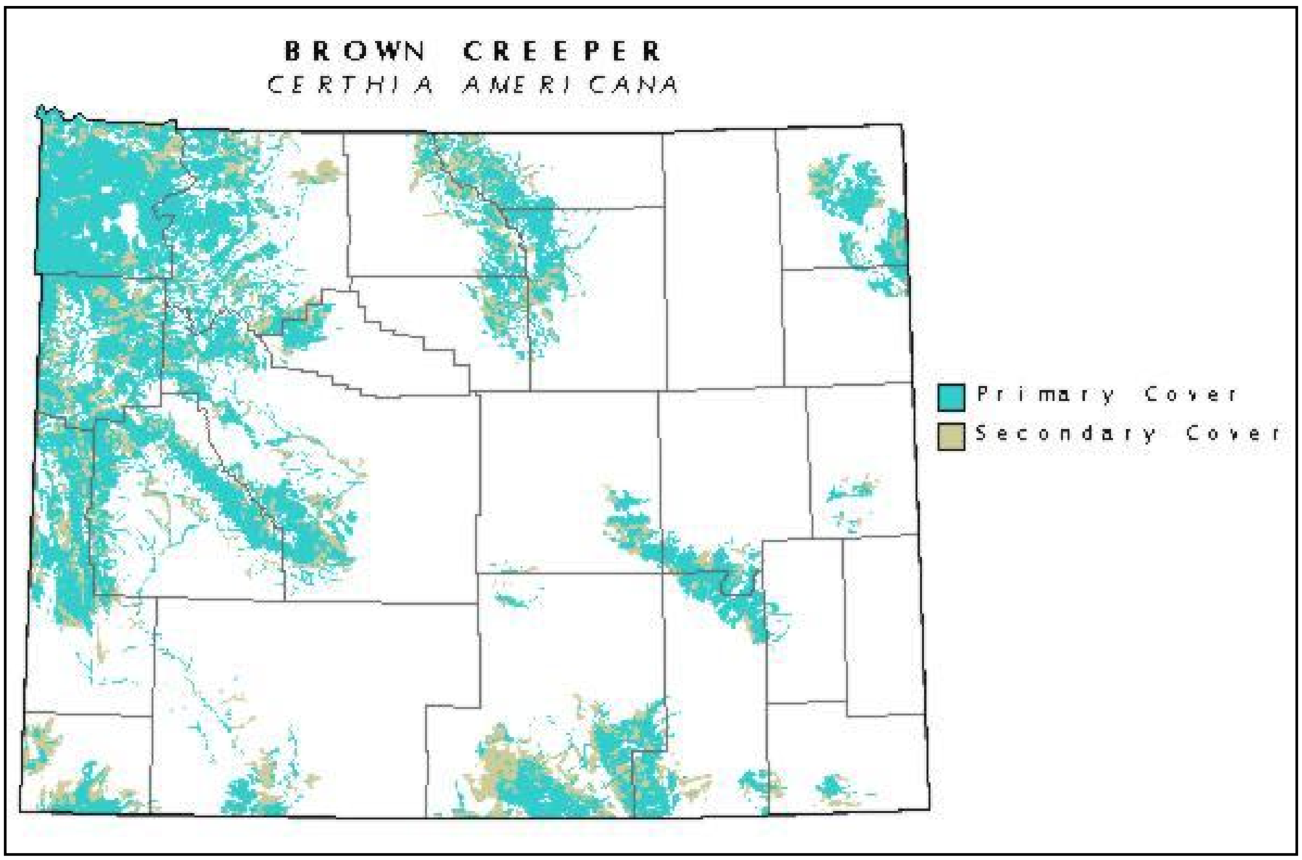

Figure 8. Modeled potential suitable habitat for brown creepers in Wyoming, based upon GAP analysis. Blue and beige shading represent primary and secondary habitat suitability, respectively.

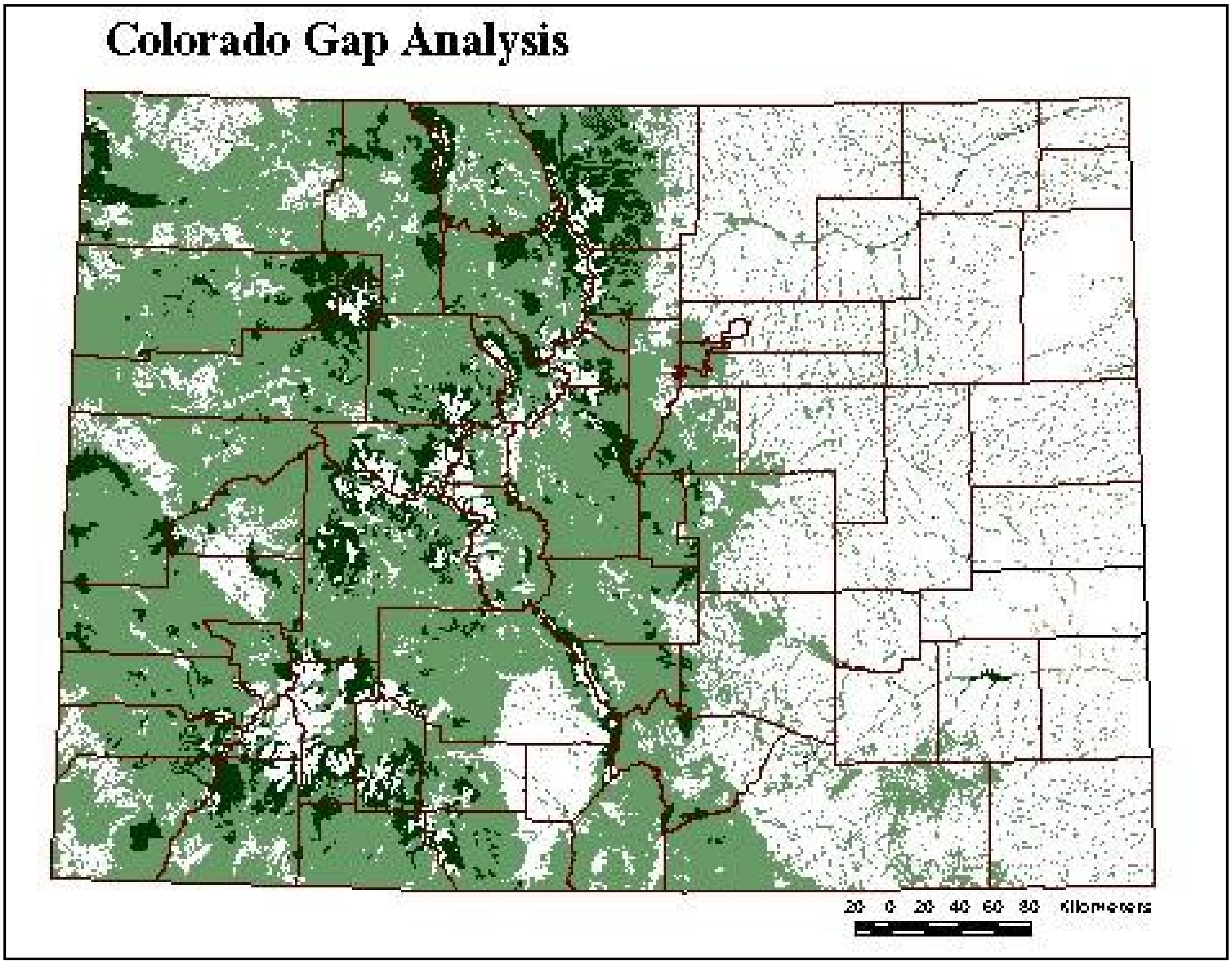

Figure 9. Modeled potential suitable habitat for brown creepers in Colorado, based upon GAP analysis. Dark green shading represents known, suitable habitat, while light green shading represents potentially suitable habitat. During the recent Colorado Bird Atlas project, documented breeding activity was recorded primarily in or near areas of dark green (Versaw 1998).

Table 5. Nest site characteristics of brown creepers in western North America.

Region	n	Nest tree species	Nest tree dbh (cm)	Nest height (m)	Reference
Montana-Idaho	19	subalpine fur (5), Douglas-fir (5), Engelmann spruce (4), lodgepole pine (3), western larch (2)	mean = 47 range = 19 - 94	mean = 5.3 range = 0.7 - 13.7	Hejl et al. 2002a
northern Idaho	34	western white pine (17), western red cedar (9)	mean = 48 range = 19 - 115	mean = 7.9 range = 0.8 - 22.5	Hejl et al. 2002a
Washington	28	Douglas-fir/western hemlock forests (nest trees not specified)	mean = 59	mean = 9.5	Lundquist and Mariani 1991
northern Arizona	30	ponderosa pine (old growth)	mean = 57 range = 19 - 91	range = 2.4 - 19.2	Siegel 1989
central Arizona	102	aspen (57), Douglas-fir/white fir (14), Gambel oak (6)	mean = 41 range = 15 - 90	mean = 6.7 range = 0.9 - 18.3	Hejl et al. 2002a
British Columbia	43	Douglas-fir, western red cedar, western hemlock		range = 0.2 - 15	Cambell et al. 1997

Washington (Lundquist and Manuwal 1990) and in ponderosa pine forests in Arizona (Franzreb 1985, Siegel 1989), creepers foraged mainly on large diameter (>30 cm/12 inches dbh) trunks. In Oregon, creepers foraged primarily on the trunks of live trees that contained large numbers of dead branches (Weikel and Hayes 1999). In the Pacific Northwest, approximately 15 percent of all foraging time is spent on snags (Raphael and White 1984, Morrison et al. 1987). Apfelbaum and Haney (1977) found that creepers used a wider range of foraging heights on trees in young, mature and old-growth forests, foraging progressively higher in trees as stand age increased. During the winter, creepers occupy low elevation deciduous and mixed conifer woodlands (Franzreb 1985), including oak (*Quercus* spp.), cottonwood (*Populus* spp.), and hickory (*Carya* spp.) forests (Hejl et al. 2002a).

Brown creepers spend the majority of their foraging effort on tree trunks and large branches (Adams and Morrison 1993). Several studies have shown that creepers spend a greater proportion of their foraging time on relatively large trees throughout the year (Morrison et al. 1987, Siegel 1989, Lundquist and Manuwal 1990). Tree diameter is positively correlated with a higher density of arthropod prey on the surface, due to the increased surface area associated with deeply furrowed bark (Jackson 1979, Mariani and Manuwal 1990). Using data on arthropod abundance from small and large trees in Washington, Mariani and Manuwal (1990) showed that creepers may increase energy intake by foraging on large trees; one old-growth (112 cm [45 in] dbh) Douglas-fir would provide as much food as 3.3 mature (67 cm [27 in] dbh) trees and as much as 13 small (29 cm [11.6 in] dbh) trees.

Food habits

Brown creepers consume a wide variety of small arthropods including insects, spiders, and pseudoscorpions, and they will occasionally feed on seeds and suet in winter (prey types are summarized in Hejl et al. 2002a). Prey are typically small (<3 mm [1.2 in]) and extracted from crevices in the bark of trees. A quantitative study of creeper stomach contents (by total volume) in California revealed 63 percent beetles, 10 percent pseudoscorpions, 8 percent hemipterans, and 6 percent arachnids (Otvos and Stark 1985). During the breeding season, creepers apparently consume 100 percent animal matter (Dahlsten et al. 1985). Spiders may comprise an important component of the diet, as Mariani and Manuwal (1990) found remains of spiders in all six stomach contents analyzed in Washington during the breeding season. Many species of beetles, including those (e.g., *Ips* spp., *Dendroctonus* spp.) detrimental to a variety of economically important tree species, are consumed during the summer (Otvos and Stark 1985).

During the winter, a large proportion of creepers occupy low elevation deciduous forests, consuming a variety of insects, but also seeds of various types. A winter Illinois study found (by relative frequency) 34 percent homopterans, 23 percent hemipterans, 12 percent coleopterans, 12 percent arachnids, 4 percent hymenoptera, and 6 percent corn and other vegetable matter (Williams and Batzli 1979).

Breeding biology

Courtship and pair formation

In areas where creepers are year-round residents, pairs may remain together throughout the year (Grinnell and Linsdale 1936). Otherwise, pair formation typically takes place early in the spring, apparently before territories are established (Hejl et al. 2002a). Courtship behavior consists of calls by both pair members, followed by short chases around tree trunks (Davis 1978). At some point during such chases, females may wing-flutter and gape in a begging display similar to that of juveniles; they may then be fed by the male (courtship feeding).

Clutch and brood size

Brown creepers are apparently single-brooded throughout their range (Hejl et al. 2002a). Clutch size data for brown creepers are summarized in **Table 6**. Mean clutch size is typically about five eggs, with a North American average of 5.48 eggs. There are no data available on brood size, as few nests have been tracked closely enough to follow the fates of young in nests. Eggs are laid in the early morning, with one egg laid per day (Davis 1978).

The only information on hatching patterns comes from a single study in Michigan (Davis 1978). From Davis' observations at several nests, it appears that all of the eggs in the clutch hatch on the same day. This follows from the observed pattern of incubation, whereby females only begin incubating once the last egg is laid (Davis 1978). There have been no studies of the pattern of nestling loss in creeper broods. Thus, aside from several studies reporting fledging success, there are no data available on how brood size is affected by hatching success, nestling starvation, or other sources of mortality during the nestling period.

Table 6. Mean clutch size and reproductive success of brown creepers in North America.

Study area	Primary habitat	Clutch size (n)	Fledging success[1] (n)	Citation
Idaho	Mixed conifer	5.33 (3)	70 (31)	Hejl et al. 2002a
Montana	Mixed conifer	—	76 (19)	Hejl et al. 2002a
Arizona	Aspen, Douglas-fir	—	83 (150)	Hejl et al. 2002a
British Columbia	Mixed conifer	4.9 (9)	66 (3)	Campbell et al. 1997
Michigan	Elm, balsam fir	6[2] (11)	58 (11)	Davis 1978
Ontario	Elm, mixed conifer	5[2] (33)	—	Peck and James 1987
North America	—	5.48 (166)	60	Hejl et al. 2002a

[1]Percentage of nests that successfully fledged at least one young.

[2]Modal clutch size.

Parental care and offspring behavior

Davis' (1978) study is the most detailed study of brown creeper parental care and is the source of the information below, except where noted. Only female creepers develop a brood patch and incubate the eggs. During the incubation period, females spend considerable periods of the day incubating (mean 84 percent of day incubating in Arizona; Martin and Ghalambor 1999), while the male provides the female with food. Incubation feeding occurs most frequently in the early morning, with an overall daily rate of 1.59 feeds per hour (Martin and Ghalambor 1999). The average incubation period (the period from laying of last egg to the hatching of the first egg) has been reported at 15 days, with a range of 13 to 16 days in western Montana (Hejl et al. 2002a). Females sit tightly on the eggs, even when disturbed at the nest (Hejl et al. 2002a).

There are no data available on nestling growth. Female creepers do all the brooding of the young, with decreasing frequency as the young age. At one nest in Michigan with 2 day old young, the female brooded 35 minutes per hour, while at another with 12 day old young, only four brief (1 to 2 minutes) brooding periods occurred during a 24-hour period (Davis 1978). Once the nestlings are 10 days old, the female ceases to spend the night on the nest. Both parents forage during the nestling period and provide food for the nestlings, with females apparently providing a majority of the food when the young are 12 days old. Parents may range up to 150 meters from the nest during these foraging bouts (Hejl et al. 2002a). Food deliveries to the nestlings are highest during the morning and evening, and they vary from 16 to 21 deliveries per hour over the course of the day (Davis 1978, Hejl et al. 2002a).

Nestlings fledge when they are 15 to 17 days old, typically within a short period (e.g., 1 hour) during the day (Davis 1978, Hejl et al. 2002a). Once the first young have left the nest, the parents feed the fledglings and continue feeding any young remaining in the nest. After leaving the nest, the fledglings remain in the nest vicinity and are fed by the parents. Parents continue to feed the young up to at least 17 days post-fledging, but the fledglings begin gleaning food themselves nine days after fledging. Observations of primarily single and paired birds in late summer suggest that family groups break up prior to migration.

Timing of breeding and breeding success

Within Region 2, brown creepers typically initiate clutches in May to mid-July in the Black Hills area in South Dakota (Tallman et al. 2002), from May and June in central and eastern Nebraska (where breeding is very rare; Sharpe et al. 2001), and primarily from June to July in Colorado (Bailey and Niedrach 1965). There are no data available on hatching success in brown creepers. Published estimates of nesting success (percent of nests fledging at least one young) are in **Table 6**, and range from 58 to 83 percent. In Arizona, the majority of nest failures were due to depredation (Hejl et al. 2002a).

Demography

Genetic characteristics and concerns

Brown creepers are widely distributed in the coniferous forests of the northern United States, as well as much of Canada, but they are patchily distributed in the western United States and Mexico. In the western United States, creepers breed mainly in mid- to high-elevation coniferous forests, and their distribution is thus somewhat patchy in the Interior West. In Region 2, there are relatively isolated breeding populations in the Black Hills and the Bighorn Mountains, as well as a few occasional nesting pairs in low-elevation forests in central and eastern South Dakota and Nebraska. Even within the core of the Rocky Mountains, creeper nesting habitat is distributed patchily, as they are closely tied to areas of mature or old-growth conifer forest. This patchy distribution, together with a relatively low population density may constrain gene flow. Unfortunately, there are virtually no data on adult dispersal and site fidelity for brown creepers (see Life history characteristics section). Natal dispersal is also critical in determining patterns of gene flow, and it is therefore difficult to assess how much gene flow may be occurring between potentially isolated populations in and around Region 2 (see Information Needs section).

Life history characteristics

Although studies of marked individuals are lacking, brown creepers likely breed first as one-year-olds, as is the pattern in most other passerine birds. Creepers are single-brooded and typically have relatively high reproductive success (Hejl et al. 2002a). Although the available data suggest that pre-fledging survival is relatively high (**Table 6**), there is no information on post-fledging survival of offspring, nor on adult survival. Given the lack of these critical life history data, analyses of lifecycle diagrams and associated demographic matrices (Caswell 1989, McDonald and Caswell 1993) were not carried out in this review. While such analyses can provide valuable insights into which life-history stages may be most critical to population growth, constructing models based on incomplete and/or poor quality data may have little relevance (Reed et al. 2002).

Social patterns and spacing

Brown creepers defend territories during the breeding season, but the extent of territoriality in the winter is unknown. Eurasian treecreepers maintain territories (0.8 to 2.8 hectares) in winter, only joining mixed-species flocks when such flocks enter their territory (Hogstad 1990). In North America, brown creepers often join winter mixed species flocks comprised of kinglets (*Regulus* spp.), nuthatches (*Sitta* spp.), chickadees and titmice (*Parus* spp.), warblers (Paridae), and juncos (*Junco* spp.) (Morse 1970). Within such mixed-species flocks, there may be considerable competition for food resources (Morse 1970). Winter observations in the Sierra Nevadas of California showed that creepers foraged primarily (58 percent of observations) in mixed-species flocks, less often solitarily (22 percent) and in flocks with other creepers (20 percent) (Morrison et al. 1987).

Only two studies in North America have measured the size of brown creeper breeding territories, providing strikingly different results. In Michigan, the size of brown creeper breeding territories varied from 2.3 to 6.4 hectares, with nearest nest distances of 100 and 221 meters (Davis 1978). However, territory size may compress significantly in areas with high food abundance. For example, Apfelbaum and Haney (1977) reported territory sizes ranging from 0.01 to 0.025 hectares in post-fire, mature and old-growth mixed-conifer forests in Minnesota and Ontario. Although food availability was not measured in the above study, such compression of territory size is typical of birds during periods of abundant food resources. The breeding territory is maintained against other creepers, but the extent to which other insectivores are also excluded is unknown.

Factors limiting population growth

The factors limiting population growth in creepers are not well understood, but they are typically assumed from observations of changes in density after human disturbance. The factor most often cited as limiting population growth in creepers is the availability of old-growth and mature woodlands as nesting and foraging sites. Several studies have now shown that creepers abandon sites that have been subjected to even light (e.g., partial-cut) logging activity; such activity is typically focused on large, mature trees (Brawn and Balda 1988, Raphael et al. 1988, Hejl 1994, Hutto and Young 1999).

One of the most detailed studies of logging effects was carried out in western Montana and northern Idaho and included analyses of a large number of bird species on 12 national forests (including areas bordering on Region 2; Hutto and Young 1999). In this study, bird abundances in forests impacted by various logging practices including partial (variable amounts of mature canopy trees removed) and patch (clusters of trees removed, leaving large open areas) cuts, as well as seed-tree (all but a few, mature trees removed) and clear-cuts (nearly all trees removed) were analyzed relative to abundance measures from nearby, unmanaged forests. In their study, Hutto and Young (1999) used 566 10-point transects, conducting a 50 m radius point count at each of the 10 points; they also quantified vegetation cover and forest type at each site. No brown creepers were found at sites with primarily seed-cut or clear-cut forest, and relatively few creepers were detected at sites with partial-cut and patch-cut forests. Hutto and

Young (1999) concluded that old-growth and mature woodlands are a critical resource for creepers, both in providing suitable nest sites (large, scaling bark) and suitable foraging habitat, and that such areas should be a goal of local and regional forest management strategies. Hutto et al. (1993) and Hejl et al. (1995) performed literature surveys on the effects of logging on bird populations in western forests and reached similar conclusions: some large patches of uncut, mature and old-growth conifer forests were necessary to assure brown creeper population maintenance across the local landscape.

Severe winter weather (e.g., cold, precipitation) may also lead to poor over-winter survival and reduced population sizes the following breeding season (Hejl et al. 1988, Peach et al. 1995). In addition, cold, wet weather during breeding has been shown to negatively affect brown creeper breeding success (Davis 1978). However, as weather patterns fluctuate among years, such negative effects on creeper survival and reproductive success are likely to have only short-term effects on local population growth.

Other sources of mortality such as shooting, toxic effects of pesticides, and collisions with vehicles are not thought to be significant problems for brown creepers (Hejl et al. 2002a). However, data suggest that tall structures such as buildings and radio/television towers may be a significant source of mortality during migration. Bohlen (1989) reported a one-day total of 12 dead brown creepers below a television tower in Illinois. During migration, large numbers of individuals also may perish due to collisions with large buildings in metropolitan areas. In Toronto, Ontario, brown creepers are one of the most common species found dead or injured as a result of colliding with tall buildings (http://www.flap.org/new/data.htm).

Community ecology

Interactions between brown creepers and their predators and competitors, and how these factors interact with habitat use are shown in **Figure 10**. The primary factor affecting creeper abundance and breeding success in Region 2 is the availability of old-growth and mature conifer forest. Such habitat provides suitable nesting sites, as well as optimal foraging habitat for creepers. It is unclear whether the loss of mature conifer trees affects creepers by reducing the availability of nest sites, by reducing local food abundance, or both. However, it is likely that both factors contribute to the species' sensitivity to the loss of mature trees. Factors thought to be positively correlated to population viability include small-scale disturbance events (e.g., light to moderate burns, disease, insect outbreaks) that provide improved nesting substrates as well as increased insect abundance.

A number of mammal species, including red squirrel (*Tamiasciurus hudsonicus*), northern flying squirrel (*Glaucomys sabrinus*), golden-mantled ground squirrel (*Spermophilus lateralis*), wood rat (*Neotoma* spp.), and deer mouse (*Peromyscus* spp.) are presumed predators of eggs and nestlings (Davis 1978, Hejl et al. 2002a). Tyler (1948) reported domestic cats (*Felis domesticus*) and northern shrikes (*Lanius excubitor*) preying on adult creepers. Brown creeper nests are apparently only very rarely parasitized by brown-headed cowbirds (*Molothrus ater*), with three known instances (Hejl et al. 2002a). In one case, a pair abandoned their nest after two cowbird eggs were laid (Davis 1978). Given that creepers are a forest interior species, it is likely that cowbird parasitism is rare.

Creepers compete for food with nuthatches, especially with red-breasted nuthatches, as well as woodpeckers, chickadees, and kinglets (Morse 1970). However, whether such competition significantly affects reproductive success or foraging success during winter is unclear.

The only study of brown creeper parasites was carried out by Rausch (1983) who found no helminths (Cestoidea) in nine individuals from the north-central United States.

CONSERVATION

Threats

Brown creepers are an excellent MIS within Region 2, as they breed within all of the Regional forests and appear to be relatively sensitive to a variety of forest management practices (e.g., thinning, logging, prescribed burns). The primary factor linked to local declines in brown creepers has been the loss and degradation of mature and old-growth forests, primarily due to logging (Raphael et al. 1988, Hejl 1994, Hejl et al. 2002a, b). Logging (including clear-cut, partial-cut, and salvage logging), forest thinning, and the consequent fragmentation of forest habitats may affect creepers in the following ways: 1) reducing the overall availability of suitable nesting and foraging habitat; 2) increasing the distance between suitable nesting/foraging habitat patches (i.e., habitat fragmentation); and 3) decreasing reproductive success by lowering prey availability.

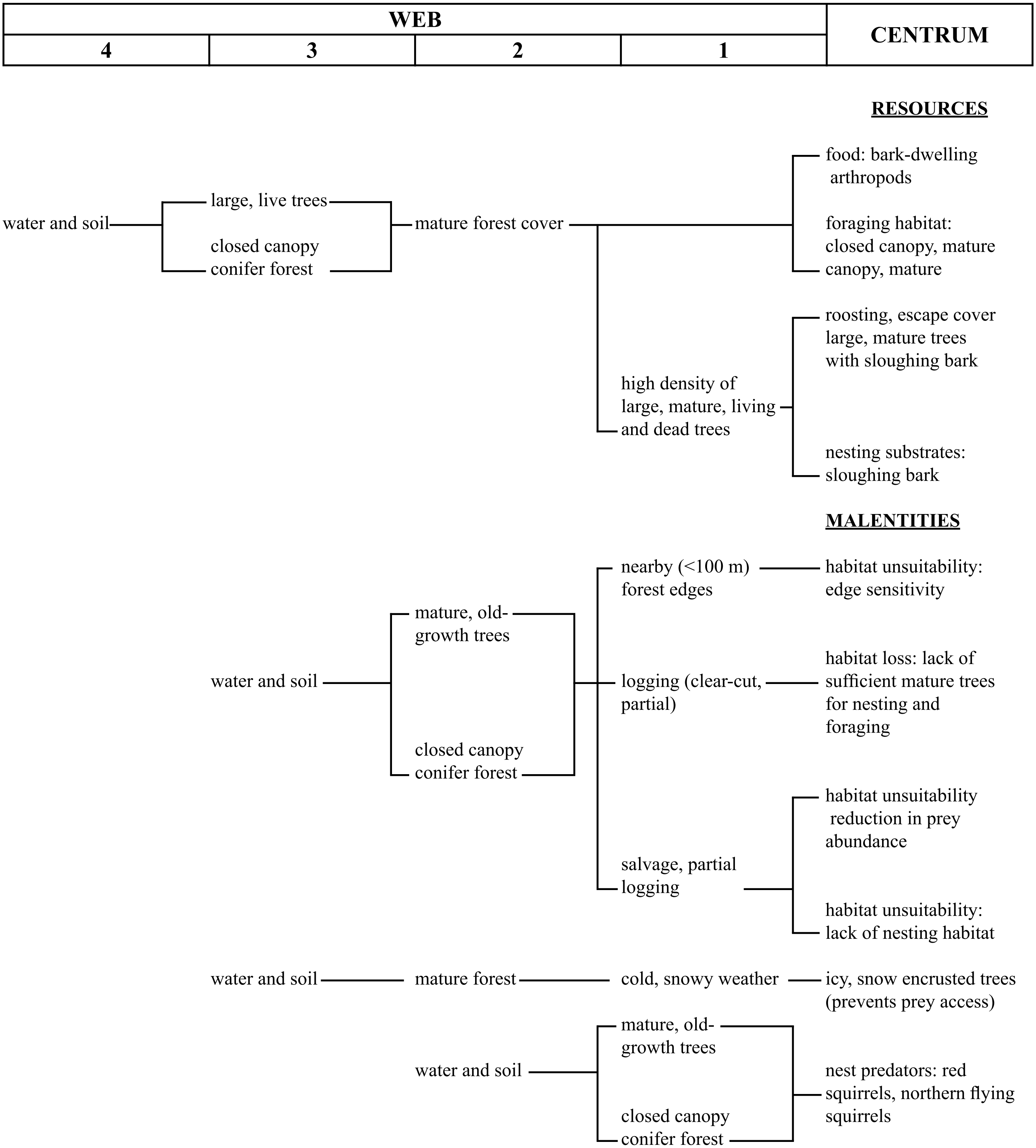

Figure 10. Envirogram representing the web of linkages between brown creepers and the ecosystem in which they occur.

Logging

Evidence supporting the negative effects of logging on brown creeper presence and abundance is extensive in mountainous areas of western North America (see reviews in Hejl et al. 1995, Hejl et al. 2002b). Creepers depend on large patches of old-growth or mature conifer forests for both nesting and foraging. A number of studies have shown decreased creeper abundance with decreased canopy cover (Beedy 1981, Hejl and Verner 1988), with a lower density of large, mature trees (Mannan et al. 1980, Mariani and Manuwal 1990, Carey et al. 1991, Hansen et al. 1995a) and with a lower density of snags (Lundquist and Mariani 1991). Most types of logging have negative effects on all three of these factors and are thus likely to have negative impacts on brown creeper abundance. Paired comparisons of creeper abundance/presence in logged vs. nearby unlogged forests have shown strong, negative effects (complete absence or significantly lower abundance) of logging (Hagar 1960, Franzreb and Ohmart 1978, Franzreb 1985, Zarnowitz and Manuwal 1985, Hansen et al. 1995a, Hejl et al. 1995, Anthony et al. 1996, DellaSala et al. 1996, Norton and Hannon 1997, Beese and Bryant 1999, Hutto and Young 1999, Schieck et al. 2000), with no exceptions (Hejl et al. 2002b).

The type of logging appears to have some effect on the probability of creepers breeding in the plot. As mentioned earlier, Hutto and Young (1999) found that creepers were only rarely found in partial- and patch-cut forest stands, and they were totally absent from seed-cut and clear-cut forests in Idaho and Montana. Hansen et al. (1995a) found either none or very few brown creepers in clear-cut stands during the summer in Oregon. Imbeau et al. (1999) reported no creepers breeding in recently clear-cut black spruce forests in Quebec. Even when selective logging is carried out with snag retention, there may be negative effects on creepers (e.g., in ponderosa pine, Scott 1979), although this effect may depend on the species composition within the forest (Stribling et al. 1990). In the northern Rocky Mountains, salvage logging of recently burned forests results in decreased breeding habitat suitability for brown creepers (Hejl et al. 2002a).

Data from conifer forests in Region 2 suggest that the level of various forms of logging has decreased significantly in recent years (**Figure 11**). However, stand thinning has increased significantly in recent years in response to drought and the increased risk of large-scale fires (J. Burke personal communication 2004). Thus, although current levels of logging do not appear to pose a threat to spruce-fir and lodgepole pine forests in Region 2, the effects of forest thinning measures remain unknown.

Studies of the relationships of creepers to logging in the eastern portions of the United States have found similar results to those in the west (Hejl et al. 2002a, b). The present pattern of distribution of creepers in the eastern United States is thought to have resulted from the pattern of logging there in the late 1800's and early 1900's (C. Haney, cited in Hejl et al. 2002a). In the southeastern-most portion of their range (Blue Ridge and Allegheny mountains), creepers are present as a breeding species largely within old-growth, spruce-fir forests at high elevations, and they are absent from many small old-growth patches at lower elevations.

Lack of old-age forest stands

Hutto and Young (1999) found that breeding brown creepers were twice as abundant in old-growth forests as in mature forests, and they were rare in young forests in the northern Rocky Mountains. Similar results have been found rangewide, with creepers typically more abundant in older forest stands during the breeding season. Hejl et al. (1995) concluded that such forests contain the necessary structural characteristics to support breeding creepers. Mannan and Meslow (1984) found fewer breeding creepers in second-growth Oregon mixed-conifer forests, relative to old-growth. A strong positive correlation between creeper abundance during the breeding season and the proportion of mature and old-growth forests has been found in black spruce habitats in Quebec (Imbeau et al. 1999), in conifer forests on Vancouver Island (Bryant et al. 1993), in Douglas-fir forests in Washington (Mariani and Manuwal 1990) and in Oregon (Mannan et al. 1980, Hansen et al. 1995a, Hagar 1999), and in conifer forests in the Appalachian Mountains (Haney 1999). Thus, the available evidence points to a clear preference by creepers for old-growth or mature forest during the breeding season.

Habitat fragmentation

Forest fragmentation is known to have several negative consequences on the viability of local and regional bird populations (Robinson et al. 1995). Such effects are likely strongest for species that breed within the forest interior, like the brown creeper. The fragmentation of mature and old-growth forests due to logging, road-building, and other sources of habitat partitioning likely has a multitude of negative effects on brown creeper populations. For example, habitat fragmentation may hamper adult and juvenile

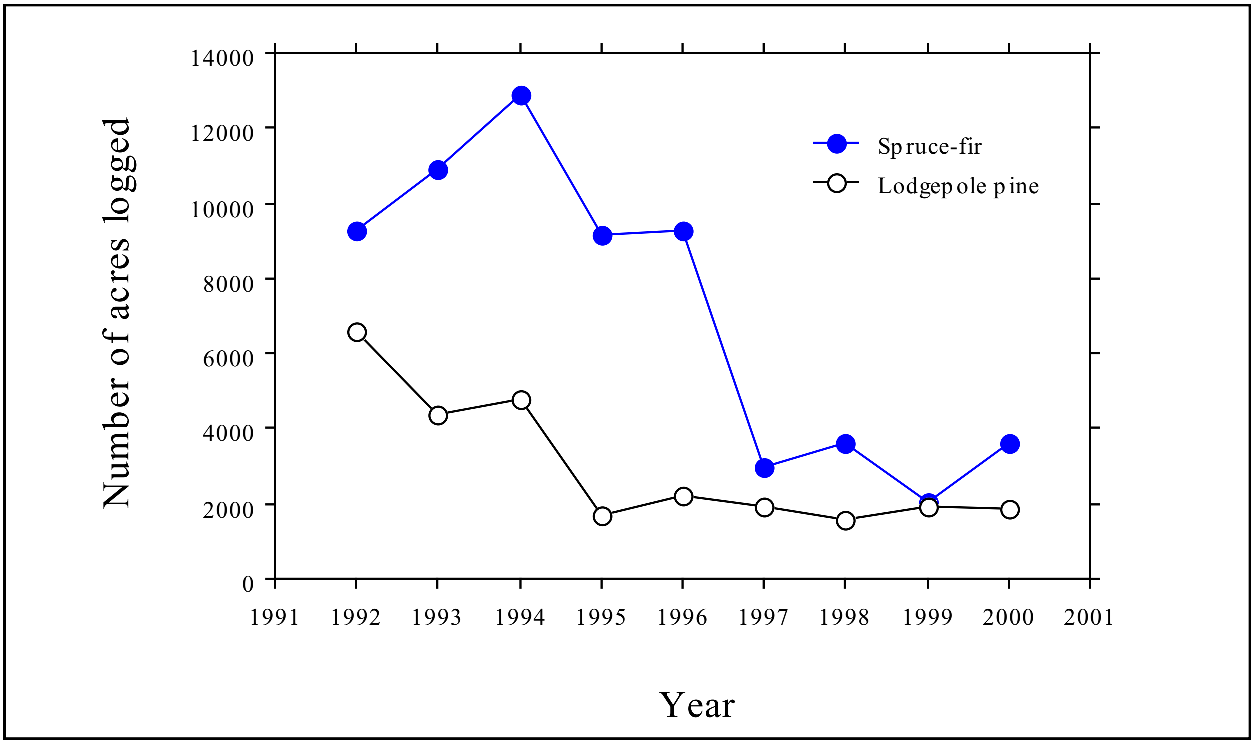

Figure 11. The total number of acres of spruce-fir and lodgepole pine forest logged from 1992 to 2000 in USDA Forest Service Region 2. Data were taken from Region 2 Silva databases.

dispersal among neighboring forest patches. However, the primary effect of forest fragmentation is that brown creepers may simply avoid breeding in small forest fragments.

In Region 2, there are no data available to assess how forest patch size affects brown creeper occupancy. However, in a study in north-central Saskatchewan, Hobson and Bayne (2000) found that brown creepers were one of only two forest species that never bred in fragmented (0.2 to 123 hectare) plots. Dobkin and Wilcox (1986) found that wintering brown creepers in Nevada only occurred in forests that were at least 1000 hectares in size. In coastal forests in Oregon and California, brown creepers nest relatively far from forest edges (Nelson 1989, Brand and George 2001). The Eurasian treecreeper has been shown to be relatively sensitive to forest fragment size; it avoids breeding in small, open woodlots (Hinsley et al. 1995). The extent to which brown creepers will avoid nesting in fragmented forest blocks likely depends on local habitat conditions such as canopy closure, snag abundance, and other factors that determine habitat suitability for this species.

Brown creepers breeding in forest fragments may also realize relatively poor reproductive success, but this needs further study (see Information Needs section below). Hejl et al. (2002b) found a trend of lower nesting success among creepers breeding in fragmented forests in Idaho. Although the reasons for poor success in fragmented woodlands are not clear, several factors may play a role, including reduced availability of large trees, fewer snags, and overall reduced food availability. In addition, birds breeding in smaller forest fragments may suffer from high nest predation rates and from increased brood parasitism from brown-headed cowbirds. Although brown creepers are thought to be rare hosts for cowbirds, no studies have assessed the effects of cowbird parasitism or nest predation on creeper breeding success in fragmented forests. Finally, fragmentation may hamper dispersal if wooded corridors are not present.

The minimum size of forest fragments used by brown creepers varies widely among different areas. Studies in eastern forests have shown that the minimum size of patches occupied by creepers is 50 hectares in Connecticut (Askins et al. 1987) and 100 hectares in Wisconsin (Fowler and Howe 1987). However, as noted by Hejl et al. (2002a), a broad-scale analysis in the Mid-Atlantic States found that area was not a significant predictor of creeper presence/absence (Robbins et al. 1989). On the Medicine Bow National

Forest in Wyoming, Keller and Anderson (1992) found that brown creepers never bred in fragmented, 45-hectare forest patches, but they did breed in nearby 100 hectare patches.

One potential problem with many studies of the effects of habitat fragmentation is controlling for variation in the structural and vegetative composition of fragmented versus continuous forests. Ideally, forest patches should differ only in size, but they should be similar in composition and structure. For brown creepers, fragmented and continuous plots should ideally be matched for canopy closure, snag availability, and the proportion of mature trees available. However, the only variable typically considered when carrying out such studies is the proximity of sites, as well as the general vegetative composition. If fragmented patches contain, on average, fewer snags, fewer mature trees, and more open canopy, such differences could explain the observed sensitivity of brown creepers to fragmented forests.

Other variables that may be related to the suitability of forest fragments include the composition and configuration of the forest patch and surrounding habitats (Freemark et al. 1995). For example, forest "edges" may be comprised of open clearcut areas, roads, riparian buffer zones, and other habitat types, but the effect of variation in edge type on brown creeper habitat suitability has not been investigated. Similarly, the isolation of forest patches may play a significant role in determining occupancy by creepers (e.g., Hinsley et al. 1995). A better understanding of how forest fragmentation may be affecting creepers should consider a broader range of landscape structural details (Freemark et al. 1995, Hejl et al. 2002a).

Other potential habitat influences

There are no data on the effects on brown creepers of livestock grazing, human disturbance, pesticides, or loss of winter habitat. However, grazing is likely to have little effect on breeding populations in western North America, as brown creepers typically nest in interior old-growth stands and at relatively high elevations, where cattle grazing is not common.

Conservation Status of Brown Creepers in Region 2

With the exception of northwestern Wyoming (**Figure 6**), there is no compelling data that brown creepers are decreasing in Region 2 as a breeding species. Recent breeding bird atlas work in Colorado (Versaw 1998) found creepers breeding widely in central and western Colorado mountain forests, including areas where they were previously not known to breed. However, there remains a degree of uncertainty over the status of creepers in Region 2 (and elsewhere) as creepers are relatively poorly sampled with BBS and breeding bird atlas methodologies. In addition, nests are difficult to locate, making confirmation of breeding status problematical.

Still, the significant decline in brown creepers observed on CBCs (**Figure 7**) suggests that the species may be of conservation concern. However, the data in **Figure 7** are from the entire United States and Canada, and thus the degree to which the observed decline pertains to populations in Region 2 is unclear. There are no data on the seasonal movements of brown creepers breeding in the Rocky Mountain Region, and thus the status of the Region 2 breeding population during winter is difficult to assess.

Two other factors suggest that creeper populations in Region 2 should be closely monitored. First, concern for the population viability of creepers has resulted from the presence of relatively isolated breeding populations in the Black Hills and Bighorn national forests. Although there is a lack of data on adult and juvenile dispersal (and hence, an unknown pattern of gene flow), the presence of these isolated populations in areas subjected to widespread forest management activities is cause for concern. In addition, brown creepers have been shown to be relatively sensitive to logging activity and forest fragmentation, factors that are likely acting to further subdivide populations within Region 2. However, to date there are no reliable data available with which to assess long-term population trends in Region 2. Consequently, the extent to which brown creeper populations are being negatively impacted by forest management practices in Region 2 is uncertain.

Rates of logging of Region 2 lodgepole pine and spruce-fir forests have declined in recent years (**Figure 11**). However, as logging is typically focused on mature and old-growth forests, even low harvest levels may pose a threat to local brown creeper populations. This is especially true in the Black Hills where creepers are most common in relatively rare late seral-stage forests (R. Panjabi personal communication 2004).

It is interesting to note that despite numerous studies showing a significant negative effect of logging/fragmentation on brown creeper abundance (e.g., Hejl et al. 1995), the reasons behind the sensitivity of creepers to logging remain unknown. There are a number of factors that may drive this effect, including a lack of suitable nesting sites, insufficient food supplies in logged/fragmented areas, or increased predation rate on adults (in more open forests) or at nests. Detailed longitudinal (i.e., before/after) studies of breeding ecology in areas undergoing forest management (logging, fragmentation) would greatly help to clarify the reasons for the sensitivity of brown creepers to logging (see the Information Needs section below).

Data from the Black Hills National Forest (**Table 4**) clearly show that creepers reach higher breeding densities in forest types (white spruce, late-successional ponderosa pine) that are primarily composed of mature and old-growth trees (Panjabi 2001, 2003, 2004). Both of these forest types are relatively rare within the Black Hills National Forest (A. Panjabi personal communication 2004). Information on the reproductive success and survival of creepers in such habitats, relative to those breeding in disturbed and managed (e.g., thinned, partially cut) forests, would allow land managers to assess how the local landscape structure may be affecting brown creeper population viability.

Management of Brown Creepers in Region 2

Implications and potential conservation elements

The primary factor affecting the abundance and reproductive success of brown creepers in Region 2 is likely the availability and size of old-growth, mid- and high-elevation conifer forest. Creepers prefer large, continuous forest tracts comprised of mature and old-growth forest, with a high density of snags and mature trees. Some current forest management practices (e.g., logging, thinning) may have significant negative effects on creeper habitat suitability. However, there are various techniques available that have been shown to improve post-treatment forest habitat for brown creepers. These include retaining large snags following logging or burns (Zarnowitz and Manuwal 1985, Hansen et al. 1995a), as well as maximizing structural and tree species diversity within logged areas (Adams and Morrison 1993).

Data summarized by Hejl et al. (2002a) suggest that in the absence of forest management (i.e., within naturally regenerating forest stands), the tight correlation between creeper abundance and the degree of forest maturity breaks down to some extent. This may reflect the higher degree of structural and species composition complexity within natural forests, with a number of large snags available in most seral stages (Carey et al. 1991). If this pattern also pertains to Region 2, it implies that an important component of regional forest management should be to set aside permanent large blocks of unlogged forest. Such blocks may serve as population source areas for brown creepers (and other snag-dependent species), although data are needed to support this idea.

It is important to point out that no studies have attempted to measure the effects of forest management practices on creeper reproductive success. That is, although it is clear that many forms of logging typically result in lower densities of breeding brown creepers, it is not known whether reproductive success or adult/juvenile survival are negatively affected by logging (see Information Needs section). This is an important point as it is often implies that declines in abundance are due to habitat degradation, which in turn may be reflected in reproductive success and survival as well.

Published recommendations for forest management practices that may aid brown creepers are in **Table 7**. Most of these recommendations have come from the Wyoming PIF bird conservation plan (Cervoski et al. 2001). The recommendations include maintaining large, continuous stands of mixed conifer forest, with high numbers of large snags and decaying trees, implementing long logging rotations within managed forests, and studying the effects of forest management practices on creepers (as most effects have been studied outside the Region). The Montana PIF plan (Casey 2000) also stressed the importance of maintaining/retaining large snags, and this recommendation is likely the single most important management technique available for improving nesting and foraging habitat for brown creepers (see also Hejl et al. 2002a).

Studies of foraging behavior (outside of Region 2) have suggested that creepers typically utilize snags for approximately 15 percent of their foraging time, with the bulk (>70 percent) of foraging spent on large, live trees (Raphael and White 1984, Franzreb 1985). If so, this suggests that in addition to snag retention (for nesting, and secondarily for foraging), large, mature and old-growth trees should be retained within managed plots, as they serve as the primary foraging substrate for brown creepers.

In summary, the optimal habitat elements that may act to maintain local brown creeper populations in Region 2 include:

- mature and old-growth spruce, spruce-fir, lodgepole pine, and ponderosa pine forests

Table 7. A summary of published management recommendations for brown creepers within state Partners in Flight Bird Conservation Plans.

State	Recommendations	Presumed benefits	Citation(s)
Wyoming	Provide large, continuous stands of mixed coniferous forests	Maintain preferred breeding habitat	Cervoski et al. 2001
	Preserve snags with broken tops, >20 cm dbh, and >40 percent of the original bark intact	Maintain nesting substrate	
	Implement long (>100 year) harvest rotations	Buffer against loss of habitat	
	Retain large snags in clearcuts, create snags from living trees in areas where large snags are absent	Improve foraging habitat; potential nest sites	
	Retain old timber in riparian buffer zones	Improve foraging habitat; potential nest sites	
	Avoid or minimize insecticide use in forests	Increase food abundance	
	Study effects of forest management on creeper site use, nesting, and survivorship in Wyoming	Improved knowledge of local forestry effects	
Montana	Maintain dead and dying trees in high elevation, old growth conifer forests	Increased availability of nest sites	Casey 2000

- ❖ conifer forests recently (1 to 3 years) affected by light to moderately severe fires
- ❖ large (>100 hectares), unbroken forest patches that reduce the amount of edge habitat

Tools and practices

Brown creepers are not currently the focus of conservation efforts in North America. Consequently, aside from the recognition of habitat management techniques (e.g., snag retention) that may help to improve nesting and foraging habitat for creepers, there has been little development of tools and practices that may aid in brown creeper conservation.

Inventory and monitoring

The primary problem in assessing the conservation status of brown creepers has been in accurately censusing local populations. As noted elsewhere in this report, there are concerns that BBS, CBC, and breeding bird atlas data collection methods may not provide an accurate assessment of brown creeper density. Inaccuracies may result from overlooking birds (because they are small and relatively quiet), but also from misclassifying migrant and post-breeding birds as local breeders. Thus, a more accurate censusing method, incorporating a better idea of the timing of local reproduction (and thus the status of observed birds), is badly needed for this species (see Information Needs section).

In Region 2, census methods to detect breeding brown creepers could include presence/absence surveys and nest searches carried out during the early breeding season (in Region 2, typically mid-May to mid-June) when both sexes should be most responsive to calls and songs. Particular care should be taken to listen for calls used by the male and by the female; these occur most frequently at or near the nest site. Censuses and searches should be concentrated in forest interiors, at least 100 meters from forest edges and in relatively large (>100 hectare) forest patches that contain large diameter, mature and old-growth trees as well as snags. Locating nests can be simplified by concentrating search effort on large diameter trees with peeling bark.

Another important component of brown creeper population monitoring is tracking reproductive success. One problem in assessing the breeding success and demography of brown creepers is the difficulty in finding nests. Creepers are a relatively cryptic species and build nests in small niches behind pieces of peeling bark. Consequently, many studies that have measured the abundance of breeding creepers have failed to track nesting success. This represents an important methodological hurdle that is hampering our knowledge of the relationship between forest management practices and brown creeper population dynamics. Dedicated efforts to locate creeper nests should be more successful when carried out in the interior regions of forests and when using the behavior of adults as a clue to nest proximity. Once found, nests should be handled very carefully as they can be easily damaged. Optical fiber video monitoring systems may provide a convenient method of assessing nest contents while minimizing potential damage to the nest structure.

Species and habitat management tools

Previous studies of the response of brown creepers to forest management activities suggest a number of potential habitat management tools that may improve conditions for brown creepers. In situations where nesting microhabitat (i.e., peeling bark) may be limiting, low intensity prescribed burns may increase the number of suitable nest sites by inducing bark peeling. Although it has not been studied in detail, foraging success may also benefit from low-intensity burns as such burns may increase the short-term availability of insects. It should be noted, however, that although several studies (e.g., Apfelbaum and Haney 1981, Kotliar et al. 2002) have noted short-term positive effects of forest fires on creeper abundance, this point is in need of further study: at least one study (Bock and Bock 1983) found no effect of fire on creeper abundance in ponderosa pine habitat in the Black Hills.

In general, brown creepers will respond positively to management actions that preserve large blocks of undisturbed forest. Consequently, management activities that avoid forest fragmentation will positively affect local brown creeper populations. Road building, clear-cut logging, and other forms of forest-edge habitat creation may reduce the local abundance of brown creepers.

The most critical factor in regulating local populations of brown creepers is the proportion of mature and old-growth forest stages. Consequently, increasing the length of logging rotations, modifying logging/thinning practices to preserve as many snags and old-growth trees as possible, as well as (at the landscape level) preserving large, core patches of mature forest will all contribute to improved brown creeper population viability.

Information Needs

Table 8 summarizes the main information needs for brown creepers in Region 2, which are outlined more fully below. Although there has been considerable interest and research on the effects of forest management practices on brown creepers, the majority of this work has concentrated on presence/absence data or on variation in abundance *after* forest treatments. While such studies are clearly important, forest management practices may have more subtle, indirect effects on birds, including increased predation at nests, decreased food abundance (and therefore decreased reproductive success), decreased availability of dispersal corridors, and decreased adult survival. Such data are critical for an improved understanding of the role of forest management on brown creeper population viability. Ideally, local-scale studies of brown creeper abundance and reproductive success should be carried out before and after forest

Table 8. A summary of proposed information needs necessary for a better understanding of the conservation of brown creepers in Region 2.

Information Needed	Technique/Methodology	Benefits
Demographic data (survival, dispersal, age-related reproductive success)	Local-scale studies of reproductive success and banding of adults and nestlings	Demographic data will be useful for modeling population viability, as well as for clarifying the effects of habitat treatments
Longitudinal studies of the effects of forest management (logging, thinning fragmentation, fire) and natural forest disturbances (fire, windthrow, disease)	Between-year studies of creeper abundance and reproductive success; before/after studies	Clearer understanding of how treatments and disturbances affect creeper population biology
Improved population censusing methods	Develop improved methods (e.g., use of song playbacks, forest interior point counts) for accurately assessing creeper population size	Improved population size and trend information
Effects of forest isolation on creeper survival and dispersal	Multi-year effort to band adults and nestlings at isolated sites such as the Black Hills and Bighorn national forests	Clarification of how isolation affects creeper survival and dispersal

management (e.g., logging, thinning) to assess how such treatments affect creeper population dynamics.

Habitat fragmentation may be particularly detrimental to brown creepers as they are known to be a forest interior species. Only a single study has assessed the effects of forest management practices on creeper reproductive success: Hejl et al. (2002b) found a trend of lower breeding success among creepers breeding in fragmented forests (relative to those in continuous forests) in Idaho. However, the reason for the relatively poor success in fragmented forests was not clear. Further studies on the effects of forestry practices on reproductive success are needed. These should include studies of creeper reproductive success relative to:

- the proximity of nests to forest "edge"
- selective and salvage logging
- forest thinning treatments
- prescribed burns (of varying severity)
- continuous versus fragmented forests in a variety of forest types (e.g., cedar-hemlock, spruce-fir, ponderosa pine).

In addition, local studies of adult and natal dispersal, as well as survival, relative to forestry practices would provide data critical to understanding creeper demography in forested landscapes.

Keller and Anderson (1992) showed that brown creepers were absent from fragmented conifer woodlands on the Medicine Bow National Forest in Wyoming. As mentioned earlier in this report, it would be very helpful to know the causes for this effect. That is, there are a number of possible reasons why creepers avoid fragmented and logged sites, but the exact causes remain unknown. Analyses of reproductive success, predation rates, and survival within control and fragmented/logged sites would provide data critical to understanding how such habitat treatments are affecting brown creeper populations. For example, it may be that predation rates at nests are higher in fragmented/logged sites, that food abundance is not sufficient for reproduction, or that snag abundance (and thus nest sites or food abundance) is too low to support a breeding effort. Understanding the nature of this relationship is critical to developing better habitat management plans for brown creepers in Region 2.

A longitudinal study design (i.e., before/after treatments) would help to strengthen the analytical power of studies assessing the effects of forest management. To date, most studies have utilized comparisons of treated vs. untreated plots, which may introduce various forms of bias to the analyses. Longitudinal studies would be particularly useful in assessing any changes in creeper abundance and reproductive success *before and after* selective/salvage logging, as well as forest fragmentation.

An attempt should be made to carry out a demographic study of creepers. Data on reproductive success, adult and juvenile dispersal, and survival are all critical to modeling population viability. There are currently no such data available for brown creepers in Region 2, and only limited data elsewhere on reproductive success. One potential problem with such a study is the difficulty in finding and monitoring creeper nests. However, as noted earlier in this assessment, attempts to locate creeper nests may be more successful when focused on forest interior areas and when using parental behavior (e.g., food carrying) as a cue to nest proximity.

There is relatively little information available on how fire affects the occurrence and breeding success of brown creepers. Especially in situations where prescribed, cool-season burns are scheduled, assessing creeper abundance/breeding success before and after the burn would provide an ideal experimental set-up. Such studies should be carried out in different forest types (e.g., stand ages, species composition), as well as with different fire characteristics (e.g., stand-replacement vs. understory fires). Similarly, the recent proliferation of fuel-reduction (forest thinning) activities in western forests could be used as an experimental manipulation to test (before/after) how such activities affect creeper abundance and reproductive success.

Relationships between forest stand history (e.g., logging frequency, stand age) and brown creeper reproductive success would be extremely valuable when assessing Region 2 land management impacts on creepers. The majority of studies to date have been carried in relatively moist forests in the Pacific Northwest, with few studies available from Region 2 (but see Keller and Anderson 1992). There are suggestions from modeling studies (e.g., Hansen et al. 1995b) that the suitability of different stand types changes as the stands age, but conditions may be different in Region 2 where habitat treatments and brown creeper ecology likely differ significantly from the situation in the Pacific Northwest.

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