National Park Service
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Natural Resource Stewardship and Science

Avifauna of Sierra Nevada Network Parks

Assessing Distribution, Abundance, Stressors, and Conservation Opportunities for 145 Bird Species

Natural Resource Report NPS/SIEN/NRR—2012/506

ON THE COVER

Birds of the Sierra Nevada Network parks (clockwise from upper left: Ruby-crowned Kinglet, Western Tanager, Spotted Owl, Dark-eyed Junco nest, Purple Finch, Northern Flickers).

Photographs courtesy of The Institute for Bird Populations

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Assessing Distribution, Abundance, Stressors, and Conservation Opportunities for 145 Bird Species

Natural Resource Report NPS/SIEN/NRR—2012/506

Zachary L. Steel, Monica L. Bond, Rodney B. Siegel, Peter Pyle

The Institute for Bird Populations
P.O. Box 1346
Point Reyes Station, California 94956–1346

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This report is available from the Sierra Nevada Network website (http://science.nature.nps.gov/im/units/sien/index.cfm) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrmp/).

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Abstract

To inform and support the Sierra Nevada Network's long-term bird monitoring program and the Sequoia and Kings Canyon Natural Resource Condition Assessment, we assessed distribution, abundance, ecological stressors, and conservation opportunities for 145 bird species that commonly occur in the national parks of the Sierra Nevada Network. The Network includes Devils Postpile National Monument, Sequoia and Kings Canyon National Parks, and Yosemite National Park. For each species, we drew from published and unpublished information to determine migratory, residency, breeding, and conservation status; significance of the parks to the species' range; distribution and habitat associations within the parks; elevational distribution within the parks; and abundance, population trends and demography within the parks (and, to a lesser degree, across the Sierra Nevada region). We also assessed the likely effects on each bird species of five potential ecological stressors:

- Anthropogenic Climate Change
- Altered Fire Regimes
- Habitat Fragmentation or Loss
- Invasive Species and Disease
- Human Use Impacts

These stressors were identified by NPS staff as the major concerns not just for bird populations, but for park resources in general. In addition to assessing the impacts of these stressors on bird species, we identified and discussed management options and conservation opportunities that park managers might consider for safeguarding the species from the identified stressors.

Despite a wealth of information sources about birds in the Sierra Nevada Network parks, a great deal of uncertainty remains about a) the effects that the identified stressors have already had on individual species, b) how the stressors themselves will change in the future, and c) how bird species will respond to those changes. For many species, conclusions rely heavily on expert opinion and speculation, and remain tentative. Additional monitoring and research on ecological stressors and their effects on bird populations in the Sierra Nevada parks are still needed.

Acknowledgments

This project was made possible by joint funding from Sequoia and Kings Canyon National Parks (for the Natural Resources Condition Assessment) and the Sierra Nevada Network Inventory and Monitoring Program. We thank the following individuals for supporting this project by providing information about SIEN birds and/or helping develop the scope of work and task agreement through the California Cooperative Ecosystem Studies Unit: Alice Chung-MacCoubrey, Angie Evenden, Linda Mutch, Jeanne Panek, Sarah Stock, Charisse Sydoriak, and Harold Werner. We thank Alice Chung-MacCoubrey, Deanna Dulen, Danny Gammons, Bill Kuhn, Rick Standiford, Sarah Stock, Harold Werner, and two anonymous reviewers for providing helpful comments on earlier drafts of the report. This report is Contribution Number 403 of The Institute for Bird Populations (IBP) and was produced by IBP's Sierra Nevada Bird Observatory.

Introduction

Background

Reported declines of many bird species breeding in North America have stimulated interest in avian population trends and mechanisms driving those trends (Robbins et al. 1989, DeSante and George 1994, Peterjohn et al. 1995). Many populations of North American birds and other species are threatened or endangered, or will likely become threatened soon, as a result of anthropogenic climatic and environmental changes (North American Bird Conservation Initiative 2009). Data from the North American Breeding Bird Survey indicate that many bird populations in the Sierra Nevada have declined in recent decades (Siegel and DeSante 1999, Sauer and Hines 2004, Sauer et al. 2011). The improved ability of scientists to document species population trends has spurred long-term monitoring programs to monitor the health and status of populations, and to investigate the causes of observed population changes.

The Sierra Nevada Network Inventory & Monitoring Program (SIEN) and local park staff from SIEN parks – Devils Postpile National Monument (DEPO), Sequoia and Kings Canyon National Parks (SEKI), and Yosemite National Park (YOSE) – identified birds as a high priority for monitoring through the NPS vital signs monitoring program (Mutch et al. 2008). A long-term monitoring protocol (Siegel et al. 2010) has been developed and approved for implementation in 2011. Baseline inventories of birds were completed for all SIEN parks (Siegel and DeSante 2002, Siegel and Wilkerson 2004 and 2005), and the parks have all funded demographic monitoring stations in meadow habitats using the Monitoring Avian Productivity and Survivorship (MAPS) protocol for varying lengths of time (DeSante et al. 2005, Heath 2007, Siegel et al. 2007). While these efforts have provided high-quality information on SIEN birds, there has not been an opportunity to synthesize these datasets along with additional information from research outside the parks to provide a comprehensive assessment of the status of SIEN bird populations.

The specific objectives of this report are to synthesize available data and scientific literature on SIEN birds (distribution, abundance, population trends, and demography for 145 focal species), identify and discuss current and future ecological stressors to SIEN bird populations, and describe management options. The overarching purpose for this report is to inform and support the SIEN long-term bird monitoring program and the SEKI Natural Resource Condition Assessment (NRCA). While this report specifically addresses SIEN and SEKI requirements, the scope of this assessment is network-wide and should serve to inform the concurrent YOSE and DEPO NRCA projects.

General Approach

We assessed 145 bird species of interest for this report, and we present the assessments in individual species accounts in Appendix A, which is published as a separate companion publication to this report (Steel et al. 2012). To assess the condition of each bird species in the SIEN parks, we drew from published and unpublished resources to determine migratory, residency, breeding, and conservation status; significance of SIEN parks to the species' range; distribution and habitat associations within the parks; elevational distribution within the parks; and abundance, population trends and demography within the parks and, to a lesser degree, the Sierra Nevada region. We summarize findings from these species accounts in this report.

In the individual species accounts we summarize existing information about each species within the SIEN, and then assess the likely effects of five potential stressors to bird populations:

- Anthropogenic Climate Change
- Altered Fire Regimes
- Habitat Fragmentation or Loss
- Invasive Species and Disease
- Human Use Impacts

These stressors were identified by NPS staff as the major concerns not just for bird populations, but for park resources in general. In addition to assessing the impacts of these stressors on bird species, we identify and discuss management options and conservation opportunities that park managers might consider for safeguarding the species from identified stressors. As with Conditions and Trends information, we summarize our findings with respect to Stressors and Management Options in the main body of this report.

Major sources of data on bird populations within SIEN parks that we used to assess conditions and trends include the Breeding Bird Survey (BBS), the Monitoring Avian Productivity and Survivorship (MAPS) program, SIEN avian inventory projects conducted by The Institute for Bird Populations as part of the SIEN Inventory and Monitoring Program, multi-year monitoring efforts conducted by PRBO Conservation Science at DEPO, and various park- and species-specific efforts to monitor selected species of management interest. Each of these sources is described below.

The BBS is a network of bird survey routes across North American that provide data on relative abundance and population trends dating back to the program's initiation in 1966. The BBS is an annual, volunteer-based point count survey coordinated by the Biological Resources Division of the USGS and the Canadian Wildlife Service. Droege (1990) and Peterjohn and Sauer (1993) provide detailed descriptions of the survey's methodology and rationale. In brief, the survey consists of a continent-wide array of roadside point count transects, or routes. Each route is 24.5 miles long, and comprises 50 point counts at half-mile intervals. Expert volunteer observers conduct point counts once each year during the peak of the breeding season (which is June in the Sierra), recording numbers of every species detected within a quarter mile radius of each point count station. Data from California routes, including 35 routes within the Sierra Nevada physiographic province and three routes that intersect Yosemite, Sequoia and Kings Canyon National Parks are used in this report.

The MAPS program is a cooperative effort among public agencies, private organizations, and individual bird banders across North America, which operates a network of bird banding stations that provide long-term demographic data on landbirds (DeSante et al. 1995, DeSante et al. 2010). MAPS stations have operated periodically in Kings Canyon NP since 1991 (Siegel et al. 2009), continually in Yosemite since 1991 (though for data consistency reasons here we exclude the 1991 and 1992 data from analyses; Siegel et al. 2010) and in Devils Postpile since 2002 (Heath 2007, Richardson and Moss 2010); no MAPS stations have been established in Sequoia National Park.

The Institute for Bird Populations conducted avian inventory projects for each of the SIEN parks, providing information on distribution, abundance and habitat associations for most species occurring in the parks during the breeding season. The Yosemite inventory (Siegel and DeSante 2002) was conducted during 1998-2000, the Sequoia and Kings Canyon inventory (Siegel and Wilkerson 2005) was conducted during 2003-2004 and the Devils Postpile inventory (Siegel and Wilkerson 2004) was conducted during 2003. At Devils Postpile, PRBO conservation science has conducted point counts every year since 2002, including re-surveying the entire inventory point count grid in 2009 and 2010 (summary results from PRBO's multi-year efforts at DEPO are available in Heath 2007 and Richardson and Moss 2010).

A number of efforts tracking individual species within SIEN parks have also yielded useful information and their findings are included in this report. Among the species where park-specific information is available are Great Gray Owl (Maurer 2004 and 2006, Keane et al. 2010), Spotted Owl (Roberts 2008), Gray-crowned Rosy-Finch (Epanchin et al. 2010), Northern Goshawk (Maurer 2002), Peregrine Falcon (Maurer et al. 2011), and Willow Flycatcher (Siegel et al. 2008).

Despite the existence of these various information sources, a great deal of uncertainty remains about a) the effects that the identified stressors have already had on individual species, b) how the stressors themselves will change in the future, and c) how bird species will respond to those changes. We have assessed the available information holistically and made educated guesses where necessary. For many species, conclusions remain tentative at best. Additional monitoring and research on ecological stressors and their effects on SIEN bird species are still needed.

Methods Used for Producing Species Accounts

Species accounts for the 145 focal species assessed in this report are presented in Appendix A (Steel et al. 2012). These accounts synthesize existing information on each species' status in Sequoia and Kings Canyon National Parks, Yosemite National Park and Devils Postpile National Monument, discuss possible stressors to park populations, and identify management options. The accounts draw from a variety of data and information sources including on-going monitoring projects, published literature and expert opinion. Here we provide detailed explanations of material that is presented in many or all the species accounts.

Acronyms Used in the Accounts

- BBS – Breeding Bird Survey
- DEPO – Devils Postpile National Monument
- MAPS – Monitoring Avian Productivity and Survivorship
- NM – National Monument
- NP – National Park
- SEKI – Sequoia and Kings Canyon National Parks
- SIEN – Sierra Nevada Inventory & Monitoring Network (Includes SEKI, YOSE and DEPO)
- YOSE – Yosemite National Park

Species Name

Common and scientific name of species as defined by The American Ornithologist's Union's Checklist of North American Birds (American Ornithologist's Union 2009).

Migratory Status

The migratory status of the species is defined by the Draft Avian Conservation Plan for the Sierra Nevada Bioregion (Siegel and DeSante 1999). For species not assessed by Siegel and DeSante (1999), Birds of North America (Cornell Lab of Ornithology) species accounts are used to define migratory status.

Migratory Status Definitions:

- Resident – Year-round resident in the Sierra; most populations are sedentary.
- Resident/short-distance migrant – Year-round resident in at least part of the Sierra, but migration to lower levels or movement out of the Sierra is apparent in at least some years.
- Short-distance migrant – Most Sierra populations are migratory but winter at temperate latitudes in the U.S. or northern Mexico.
- Short-distance/Neotropical migrant – Most populations are migratory and winter regularly in both temperate and tropical latitudes. In many cases it is unclear exactly where Sierra populations winter.
- Neotropical migrant – Most Sierra populations winter in tropical latitudes.
- Partial migrant – Populations show disparate patterns of migration across the species' range.

Residency, Breeding and Abundance Statuses

Table 1 in each account lists the residency, breeding and abundance statuses of the species for each of the Sierra Nevada Network (SIEN) parks, including Sequoia and Kings Canyon National Parks (SEKI), Yosemite National Park (YOSE) and Devils Postpile National Monument (DEPO).

Status classifications were informed by published literature and unpublished reports pertaining to the Sierra Nevada and individual parks, including survey and MAPS programs (Beedy and Granholm (1985), Warner and San Miguel (1991), Gaines (1992), Siegel and DeSante (2002), Siegel and Wilkerson 2005a, Siegel et al. 2009 and 2010, Stock and Espinoza 2009, Richardson and Moss 2010).

Breeding Status Definitions:

- Regular Breeder – Breeds consistently from year to year in the park.
- Occasional Breeder – Breeds in the park during some but not all years.
- Probable Breeder – Evidence of breeding (e.g. territorial behavior), was recorded multiple times during standardized surveys in the same year and/or the species' overall range encompasses the park where breeding habitat exists, but to our knowledge breeding has not been confirmed within the park.
- Possible Breeder – Evidence of breeding was recorded once in suitable habitat within the park and/or the species' overall range encompasses the park where very limited breeding habitat exists, but to our knowledge breeding has not been confirmed within the park.
- Former Breeder – The species was previously known to breed within the park, but current visitors to the park show no signs of breeding.

- Non-breeder – The species was not detected during the breeding season or a species is known to not breed within the park.

Abundance Status Definitions:

- Common – Present in large numbers
- Fairly Common – Present in moderate numbers
- Uncommon – Present in small numbers
- Rare – Present in very small numbers; often highly localized
- Irregular – May be present in a given area one year, rare or absent the next.
- Accidental – Recorded outside of usual season of occurrence.

Abundance Status Modifiers:

- Local – Occurs only in specific locations or uncommon habitat types.
- Extirpated – The species no longer occurs within the park.

Conservation Status

Global, national and state conservation rankings assigned by NatureServe are included in this section with explanations of codes. Any federal or state listings are also included.

Range Significance

The range significance section provides context for the SIEN bird populations within their greater North American range in order to assess the significance of SIEN populations in the conservation of the species. Distributional context was taken from Siegel and DeSante (1999) and Birds of North America Online (Cornell Lab of Ornithology).

Occurrence and Habitat Associations

Known habitat associations for the species across the Sierra Nevada as well as observed habitat use during park inventories are discussed here. Descriptions of general habitat associations were taken from published species accounts. Results from the SEKI (Siegel and Wilkerson 2005) and YOSE (Siegel and DeSante 2002) landbird inventories are presented and interpreted to show park-specific habitat use and abundance of the species.

Data presented include figures illustrating the distribution of survey transects across the parks where the species was and was not detected and a table listing the number of count stations with detections, the total individual birds counted, the most densely occupied habitats of the species, the relative abundance (detections per point) and the estimated density (birds/ha; available for SEKI only). Estimated density is an adjustment of relative abundance based on the estimated detection probability of the species in each habitat type. Habitat associations are ranked according to relative abundance and where this ranking is not consistent with estimated density order, we noted the discrepancy in the account text.

When a species was not detected or was detected only off-survey (i.e., was detected by IBP's survey crew, but not during formal surveys), this was noted in place of habitat associations. Due to the relatively limited diversity of habitat types, only the number of count stations with detections and individual birds counted are presented for DEPO. Finally, it should be noted that habitat associations and distribution data are specific to the breeding season. We do not present any information on winter habitat use.

Elevational Distribution

The elevation of species observations during inventory surveys is presented for SEKI and YOSE. These data provide a quantitative description of the elevational range of each species within the parks during the breeding season. The elevational distribution of observations is displayed visually with elevation means and range noted in the text. A similar analysis was not conducted for DEPO because the limited elevational variation there would make it much less meaningful.

For each species, we collapsed data into detection or non-detection at each survey station and then calculated summary statistics to describe the range of elevations at which the species was detected in each park: the mean detection elevation and its standard deviation, as well as the upper and lower quantiles encompassing 95% of detections. Quantiles were estimated by interpolation using method 7 (the default method) of the quantile function in R (see Hyndman and Fan 1996 for detail).

We graphed the distribution of stations with and without detections of each species using bean plots, which we generated using the 'beanplot' package (Kampstra 2008) in R Version 2.9.2 (R Development Core Team 2009). Bean plots facilitate comparison of distributions of data points by simultaneously displaying the data along with normal density traces of the data. Here we used asymmetrical bean plots to show elevational distributions of point count stations with detections alongside the distributions of point count stations without detections for each park. Individual data points (i.e., point count stations) in the beanplots were represented by short line segments displayed as a one-dimensional scatterplot, or strip chart. Elevations represented by multiple point count stations were displayed as longer lines representing the summed lengths of the line segments of the individual points. The sizes and shapes of density traces in bean plots reflect the distributions of data along the elevation gradients and a bandwidth (smoothing) parameter whose value was determined based on the Shaether-Jones method (Shaether and Jones 1991). The width of the density trace (along the x-axis) is selected by an algorithm that incorporates the sample size and the distribution of values to generate a shape that illustrates relative differences (within a species) in density of detections (or non-detections) at different elevations. Venables and Ripley (2002; pp. 126-129) provide additional detail on density traces and implementation in R.

Abundance, Trends, and Demographic Data

Breeding Bird Survey (BBS) results (Sauer et al. 2008) from California, the Sierra Nevada (BCR 15) and individual transects that intersect Sequoia, Kings Canyon and Yosemite NPs are compiled in this section. These results include mean relative abundance along routes as well as the number of routes in the area of interest with detections, the trend in relative abundance (annual percent change, calculated for multiple routes using the route-regression method (Geissler and Sauer 1990, Link and Sauer 1994), and the p-value associated with the reported trend.

Relative abundance, population trends, and demographic data from park MAPS stations are also presented in this section. Data were used from 12 years of MAPS station operation at Kings Canyon (Siegel et al. 2009), 17 years at Yosemite (Siegel et al. 2010) and five years at Devils Postpile (Richardson and Moss 2010). For MAPS data relative abundance is presented as the number of adults captured per 600 net-hours of operation and population trends are expressed in terms of the percentage annual change in capture rate. Productivity is estimated using a reproductive index (i.e., the number of young captured per number of adults captured) and reproductive index trend is expressed in terms of percent annual change. Finally, apparent annual adult survival rate is presented where sufficient data are available to make estimates.

Stressors

The major stressors to each species are considered in this section. We considered climate change, altered fire regimes, habitat fragmentation or loss, invasive species and disease, human use impacts and air pollution (although air pollution is addressed only in the main body of the report – and generally not in the individual species accounts due to a pervasive lack of species-specific information). The stressors are assessed for each species in the context of both the Sierra Nevada and individual SIEN parks. Our assessment of the impact of each stressor on individual species draws from a number of different sources including published species accounts (e.g. The Birds of North America Online), available datasets (e.g. CDPU 2010) and published literature. To locate relevant literature, we conducted searches in general databases such as Web of Science and Wildlife and Ecology Worldwide. In many cases available information is limited and our assessments of the effects of particular stressors on particularly species by necessity include considerable speculation; we have tried to make areas of substantial uncertainty explicit in the accounts.

Management Options and Conservation Opportunities

Management options and conservation opportunities were drawn from the same sources as our assessment of stressor impacts. Where applicable we summarize current management of the species across its range and/or within SIEN parks. Where species-specific management is not ongoing we identify options for addressing the most prominent stressors outlined in the preceding section.

Listed Species

Among the 145 species assessed, three species or their subspecies are listed as threatened or endangered at the state or federal level, 15 are considered Species of Special Concern (state) or Birds of Conservation Concern (federal) and one species has no state or federal listing, but is considered imperiled (of high risk of extinction or elimination) within the state according to NatureServe’s conservation status ranking system (Table 1).

Table 1. Listed or imperiled bird species of SIEN parks.

Common Name	NatureServe Rank[1]	Federal Status[2]	California Status[3]
Harlequin Duck	S2 – Imperiled	None	Species of Special Concern
Northern Harrier	S3 – Vulnerable	None	Species of Special Concern
Northern Goshawk	S3 – Vulnerable	None	Species of Special Concern
Bald Eagle	S2 – Imperiled	Bird of Conservation Concern[4]	State Endangered
Peregrine Falcon	S2 – Imperiled	Bird of Conservation Concern[4]	None
Flammulated Owl	S4 – Apparently Secure	Bird of Conservation Concern	None
Spotted Owl- CA subsp.	S3 – Vulnerable	Bird of Conservation Concern	Species of Special Concern
Great Gray Owl	S1 – Critically Imperiled	None	State Endangered
Long-eared Owl	S3 – Vulnerable	None	Species of Special Concern
Black Swift	S2 – Imperiled	Bird of Conservation Concern	Species of Special Concern
Vaux's Swift	S3 – Vulnerable	None	Species of Special Concern
Calliope Hummingbird	S4 – Apparently Secure	Bird of Conservation Concern	None
Lewis's Woodpecker[5]	SNR – Not Ranked	Bird of Conservation Concern	None
Williamson's Sapsucker	S3 – Vulnerable	Bird of Conservation Concern	None
Olive-sided Flycatcher	S4 – Apparently Secure	Bird of Conservation Concern	Species of Special Concern
Willow Flycatcher	S1S2 – Critically/Imperiled	Bird of Conservation Concern	State Endangered
American Pipit	S2 – Imperiled	None	None
Yellow Warbler	SNR – Not Ranked	None	Species of Special Concern
Cassin's Finch	SNR – Not Ranked	Bird of Conservation Concern	None

[1] State conservation rankings from NatureServe 2009.
[2] Federal listing statuses from USFWS 2008.
[3] California listing statuses from CDFG 2010, and Shuford and Gardali 2008.
[4] Species has been de-listed from the federal threatened and endangered list.
[5] Species is very rare in SIEN parks and was not assessed for this report.

All of these listed or imperiled species are present within SEKI and YOSE except Harlequin Duck, which has not been observed at SEKI for many decades (although there are historical observations of Harlequin Duck at SEKI, the species was never confirmed to have bred there), but still breeds rarely at YOSE. We did not find records from DEPO for a number of the listed or imperiled species assessed for this report (including Harlequin Duck, Northern Harrier, Peregrine Falcon, Flammulated Owl, Great Gray Owl, Long-eared Owl and American Pipit) but most may occasionally occur there.

Species Lost from SIEN Parks

During the last half-century the SIEN parks have experienced three partial or complete losses of bird species. These species include the loss of the California Condor from the SIEN, the loss of Harlequin Ducks from SEKI (but see above), and the loss of breeding Willow Flycatchers from YOSE (though Willow Flycatchers have been observed during migration in recent years at both YOSE and SEKI).

California Condor was once a wide-ranging carrion feeder whose range encompassed all of the SIEN parks. The species experienced rapid declines during the 20th century and by the 1980s was lost from the wild and existed only in captivity (Snyder and Schmitt 2002). Reintroductions of the species elsewhere in California and Arizona have achieved some success. Individual condors have apparently been observed in or near SEKI twice in recent years (H. Werner, personal communication), but the species cannot be said to have re-colonized any of the SIEN parks.

Harlequin Duck formerly bred at YOSE and was observed at SEKI, but was presumed lost from both parks for many years. One record of a female and four ducklings in Yosemite Valley in 2002 (Beedy 2008) revealed the species to be present and breeding once more, and anecdotal information indicates it has subsequently persisted in small numbers in the park.

Willow Flycatcher has declined during at least the latter half of the 20th century in the Sierra Nevada due to a number of factors, including habitat loss and brood parasitism by the Brown-headed Cowbird (Green et al. 2003). Although a small number of apparently migratory individuals have been observed in YOSE and DEPO in recent years, a recent comprehensive survey of the species in YOSE found no sign of Willow Flycatcher breeding activity within the park (Siegel et al. 2008).

Avifauna Condition and Trends

Breeding Status

Due to their large land area and broad elevational gradient, SEKI and YOSE support a higher number of bird species than does DEPO. In YOSE, all of the 145 bird species assessed for this report occur as either a breeder or non-breeder. Within SEKI, one of the assessed species, Chestnut-backed Chickadee, has never been reported to our knowledge, and the Harlequin Duck no longer occurs (and indeed, it is not clear that it ever bred there in historical times). Willow Flycatcher still occurs rarely in YOSE as a migrant but apparently no longer breeds within any SIEN park. Within DEPO, 49 of the 145 species have not been reported (Table 2).

Table 2. Summary of breeding status in each park for the 145 bird species we assessed (see species accounts, Appendix A). For summary purposes, breeding status categories have been collapsed in this table. Species considered Regular Breeder, Probable Breeder, Possible Breeder, Occasional Breeder and Irregular Breeder are all included under Breeder; birds considered Former Breeder or Extirpated Breeder are included under Former Breeder.

Breeding Status	Sequoia and Kings Canyon NPs	Yosemite NP	Devils Postpile NM
Breeder	129	133	80
Former Breeder	2	1	0
Non-Breeder	13	11	16
No Records	1	0	49

Population Trends

Breeding Bird Survey (BBS) data provide the most comprehensive source of information regarding population trends of landbirds for North America. Three BBS routes intersect SIEN parks but their localized nature within the parks makes extrapolating route-level population changes to park-wide landscapes difficult. The long-term avian monitoring program that the SIEN parks are initiating in 2011 (Siegel et al. 2010) will address this deficiency and provide park- and network-level assessments of population change over time.

We compiled BBS trend results (Sauer et al. 2008) for all species considered in this report. Trend results are based on the route-regression method (Geissler and Sauer 1990, Link and Sauer 1994) and were retrieved from the BBS web-based interface. The route-regression method defines a species' trend for each survey route as the slope of Poisson regression with covariates to accommodate observer differences (Link and Sauer 1994). Regional trends are then estimated as a weighted average of route-specific regression slopes. We present detailed BBS trend results and associated statistics for each species with available results in the species accounts in Appendix A (Steel et al. 2012). Table 3 summarizes statistically significant ($p < 0.05$) trend results across California and the Sierra Nevada Bird Conservation Region for the period 1966-2007, expressed as annual percent change. Species that were flagged by Sauer et al. (2008) as having non-credible trend results (regardless of statistical significance) due to small sample size or for any other reason have been excluded from the table.

In the Sierra Nevada 13 species exhibited statistically significant declining trends, while 4 species exhibited statistically significant increasing trends (Table 3). Across California as a whole, 24 species showed statistically significant declines, compared with 15 species that showed statistically significant increases (Table 3). Population trends typically vary by geographic extent and time period assessed, but species showing declines across both California as a whole and the Sierra Nevada Bird Conservation Region in particular (Table 3) include Olive-sided Flycatcher, Mountain Chickadee, Golden-crowned Kinglet, Nashville Warbler, Wilson's Warbler, Chipping Sparrow, and Purple Finch. Common Raven is the only species that showed statistically significant increases across both California and the Sierra Nevada Bird Conservation Region (Table 3).

Table 3. Statistically significant ($p < 0.05$) Breeding Bird Survey population trends for California and the Sierra Nevada Bird Conservation Region (BCR) for the period 1966–2007 (Sauer et al. 2008). Population changes are based on the route regression method (Link and Sauer 1994) and are expressed as average annual percent change. SIEN bird species with non-significant trend results, and species that are flagged by Sauer et al. (2008) as having non-credible trend results due to small sample size or any other reason, are excluded.

	Annual Percent Change, 1966-2007	
Common Name	**California**	**Sierra Nevada BCR**
Negative Population Trends		
American Kestrel	-1.4	
Killdeer	-1.8	
Mourning Dove	-0.9	
Belted Kingfisher		-12.3
Olive-sided Flycatcher	-3.5	-2.9
Western Wood-Pewee	-1.8	-1.8
Warbling Vireo	-1.4	
Horned Lark	-3.5	
Violet-green Swallow	-2.2	
Mountain Chickadee	-1.4	-1.6
Chestnut-backed Chickadee	-2.5	
Golden-crowned Kinglet	-2.6	-3.0
American Robin		-1.6
Orange-crowned Warbler		-3.5
Nashville Warbler	-1.7	-2.6
Wilson's Warbler	-1.9	-7.7
Chipping Sparrow	-3.5	-3.5
Black-chinned Sparrow	-6.9	
White-crowned Sparrow	-3.2	
Western Meadowlark	-1.8	
Brewer's Blackbird	-1.9	
Brown-headed Cowbird		-3.0
Bullock's Oriole	-2.0	
Purple Finch	-1.3	-2.5
Cassin's Finch		-3.2
House Finch	-2.0	
Pine Siskin	-6.9	
Northern Flicker	-1.1	
Dark-eyed Junco	-1.3	

Table 3. Statistically significant ($p < 0.05$) Breeding Bird Survey population trends (continued)

	Annual Percent Change, 1966-2007	
Common Name	**California**	**Sierra Nevada BCR**
Positive Population Trends		
Mallard	4.9	
Common Merganser	6.1	
Red-tailed Hawk	1.6	
Turkey Vulture	2.3	
Osprey	6.8	

Table 3. Continued.

	Annual Percent Change, 1966-2007	
Common Name	**California**	**Sierra Nevada BCR**
Red-shouldered Hawk	9.7	
California Quail	1.1	
Anna's Hummingbird		9.7
White-headed Woodpecker	1.9	
Black Phoebe	1.9	
Cassin's Vireo		4.6
Hutton's Vireo		7.4
Common Raven	5.1	9.1
Tree Swallow	3.6	
Townsend's Solitaire	1.7	
Common Yellowthroat	5.8	
Western Tanager	1.2	
Red Crossbill	8.9	

Stressors to Bird Populations

The National Park Service has identified the following stressors as the greatest threats to natural resources (including birds) of the SIEN parks and the central/southern Sierra Nevada: anthropogenic climate change, altered fire regimes, air pollution, habitat fragmentation and loss, non-native species, novel disease paradigms and human use impacts. For the purpose of this report, non-native species, native invasive species, and novel disease paradigms have been combined into a single category – Invasive Species and Disease. For each of the 145 species evaluated in this report, we consider the potential for each stressor to threaten the species and its SIEN populations. Stressor assessments were based on information from reports and monitoring programs specific to SIEN parks, published literature, and expert opinion. Due to a lack of available information regarding effects of air pollution on bird species within the parks, air pollution is not addressed in individual species accounts (Appendix A – Steel et al. 2012). Each stressor, and its potential to threaten SIEN birds, is discussed below.

We classified the observed or expected effect of each stressor on each bird species by holistically assessing the information summarized in the species accounts. Stressor impacts were classified as one of the following:

- Negative, minor – The stressor has caused or is expected to cause harm to the species locally, but without significant long-term effects on population or range.
- Negative, major – The stressor has caused or is expected to cause major population declines or range contractions.
- Positive, minor – The stressor has or is expected to have positive effects on the species locally, but without significant long-term population effects.
- Positive, major – The stressor has or is expected to contribute to a major population increase or range expansion.
- Neutral – The stressor is not expected to have any discernible effect.

We then assessed our own confidence in each of these classifications, as follows:

- Low – Classification is largely based on expert speculation without a body of supporting evidence.
- Medium – Classification is supported by modeled response of the species to the stressor or by studies which provide inconclusive, but defensible evidence indicating a species' response.
- High – Classification is based on conclusive observational or experimental evidence.

We also provide a list of possible management actions or conservation opportunities that could address the stressors. **We emphasize that these are management options, but not necessarily management recommendations. The list includes a broad range of options, from actions that park management is already taking to actions that may not be compatible with other NPS management goals or feasible within the parks. In yet other instances, management options address actions that could be taken by land managers elsewhere in the Sierra, but are not relevant within the parks (e.g., reduce or refrain from post-fire salvage logging).**

Climate Change

Effects of climate change are being observed across the globe (IPCC 2007) and may become the most prominent threats to species in protected areas. Temperatures in California have already risen during the past century due to climate change (Moser et al. 2009). In fact, the Western United States has experienced warming faster than other regions of the country (Moser et al. 2009) and mountain regions such as the Sierra Nevada have experienced above-average warming globally as well (IPCC 2007). Under medium to high emissions scenarios, temperatures in California are expected to rise between 4.7 and 10.5 degrees Fahrenheit over the next century (Franco 2006). Recent assessments of greenhouse gas emissions report that future emissions are likely to exceed even the highest-emission scenarios, making low emissions scenarios highly unlikely and even higher temperature increases possible (Moser et al. 2009).

A growing body of evidence shows that bird species are already responding to climatic changes in a variety of ways. Progressively earlier springs in recent decades have been associated with avian phenological changes such as advanced migration timing, earlier breeding, and changes in clutch size (Crick et al. 1997, Winkler et al. 2002, Parmesan and Yohe 2003, Mills 2005, Parmesan 2006). Historic observations such as those from Grinnell and Storer (1924) in the Sierra Nevada and long-term datasets such as the Christmas Bird Count (CBC) are the most valuable sources of information for assessing realized responses of birds to climate change over the past century. Re-sampling of the Grinnell transects (Tingley et al. 2009) has shown that Sierra Nevada birds have shifted their breeding ranges over the past nine decades, often tracking their climatic niches (i.e., adjusting ranges to remain in climatic conditions similar to those experienced by the species prior to recent climate change). A study of forty years of CBC data suggests that 177 of 305 species (58%) showed significant northern movement toward colder latitudes in North America (Audubon 2009).

The scientific consensus predicts most plant and animal species will shift their ranges poleward and upward in elevation in order to follow their climatic niches (Parmesan 2006). For bird species this shift is likely to be in response to vegetation shifts upward and poleward. In the context of the SIEN parks, bird species currently found in lower elevations may occur more often at higher elevations while species currently limited to the alpine regions of the parks may lose most or all suitable habitat and perhaps cease to occur within the SIEN parks. Likewise, species currently occurring in greater densities south of the SIEN than within park boundaries may move north and become more abundant within SIEN parks. Similarly, frequently observed species within SIEN parks may shift their centers of abundance northward, reducing future park occurrences.

An important characteristic of mountainous regions is the tendency for temperatures to decline rapidly as elevation increases due to a process known as the adiabatic lapse rate. In YOSE and SEKI, with their steep elevation gradients, species may be able to track optimal temperatures by dispersing relatively small distances upslope. In less topographically diverse areas (e.g., the San Joaquin Valley), a northward migration along a gradual elevation gradient would require dispersal of a much greater distance to track shifting average temperatures (Loarie et al. 2009). While species adaptation in the form of range shifts may be more feasible in mountainous regions, this also means that species turnover at any given location will be rapid (Lawler et al. 2009), leading to reshuffling of communities (Stralberg et al. 2009). DEPO may be especially susceptible to species turnover due to its relatively narrow elevation range and small extent.

Known associations between individual species and current habitat and climatic conditions allow for modeling of potential future range shifts. Such modeling exercises can provide some insight into how species may react to increasing global warming and how future bird communities may be structured. Recent efforts to model range shifts for 60 species in California, 44 of which are assessed in this report, suggest that by 2070 avian range shifts will result in 57% of the state being occupied by novel species assemblages (Stralberg et al 2009). We stress, however, that these predictions are still quite speculative – actual changes in bird species' distributions will depend greatly on how plant communities respond to climate change. A full exploration of observed and predicted responses of SIEN plant communities to climate change is beyond the scope of this report. Establishing and sustaining spatially extensive, long-term bird monitoring efforts in the parks (Siegel et al. 2010) will be critical for documenting, understanding, and possibly mitigating, the realized effects of climate change on SIEN birds.

Species that are most likely to be affected negatively by climate change are those limited to the highest elevations in mountainous regions (Loarie et al. 2009) such as the Sierra Nevada. Such alpine-obligate species are most vulnerable because they lack higher altitude habitats to which they can disperse. Habitat-restricted species are already experiencing severe range contraction across the globe (Parmesan 2006). The bird species in the SIEN parks most susceptible to range contraction due to dependence on alpine habitats during the breeding season include White-tailed Ptarmigan (introduced), Horned Lark, American Pipit, and Gray-crowned Rosy-Finch.

Of the 145 species evaluated in this assessment, the limited available evidence suggests that 18 are likely to benefit from climate change, while a warmer climate is likely to be detrimental to 77 species; the remaining 50 species may be largely unaffected by climate change (Table 4). Discussions of individual species' predicted or observed responses to climate change and each other stressor addressed are provided in the species accounts in Appendix A, and also summarized below (see **Summary of Species Stressor Rankings**). We emphasize that uncertainties associated with climate change impacts on individual species are very large – in many cases our classifications are based on very limited information. Classifications for each species were somewhat subjective, and were made by considering all the information presented in the species account (Appendix A). For discussions on observed and potential responses of individual species' to climate change see species accounts in Appendix A (Steel et al. 2012).

Table 4. The predicted impacts of climate change on all 145 species assessed for this report. A minor impact is defined as affecting the species locally but without significantly altering the species' overall range. A major impact is defined as causing or potentially causing significant changes in a species' population across its range or range contractions. We also note whether climate change is likely to affect a species differently within or beyond SIEN parks. For example, a minor negative impact within SIEN only may indicate the species is expected to move out of the parks, but the species will not be threatened across its range.

	Major Impact	Minor Impact	Total
Negative	**10**	**67**	**77**
Everywhere	9	57	
Primarily outside SIEN	0	2	
Primarily SIEN only	1	8	
Positive	**1**	**17**	**18**
Everywhere	1	16	
Primarily outside SIEN	0	0	
Primarily SIEN only	0	1	
Neutral	n/a	n/a	**50**

Protected areas serve as ideal case studies for the effects of climate change because there are few confounding factors, such as land-use change and other sources of human disturbance (Parmesan and Yohe 2003). SIEN parks can yield valuable insight into how this ubiquitous threat is affecting birds and other parts of the natural system. **In this context we stress that park managers may decide that certain kinds of activities – particularly interventionist activities such as the last three provided below – are not appropriate for national parks. We provide them here to present a full range of options, but not necessarily to endorse their implementation.**

Management Options and Conservation Opportunities

- Develop efforts to educate the public about stressors to park habitats and wildlife posed by climate change, and ways to counteract or reduce them.
- For climate-sensitive species – Monitor range, phenology and population changes to inform adaptive management.
- For meadow-dependent species – Consider restoring hydrology in affected meadows to promote resilience to climate-induced desiccation. This approach poses challenges because of the extensiveness of meadows in the parks, but efforts could focus on locations where restoration projects have the potential to restore particularly large meadows, or meadows that have historically supported particularly sensitive bird species.
- If climate change leads to encroachment of forests on important meadow and alpine habitat – Consider manually removing encroaching trees or performing prescribed burns to prevent new recruitment of woody species.
- If climate change leads to prolonged drought – Consider using wildlife "guzzlers" (artificially maintained water sources) to store and provide supplemental water sources to sensitive species during dry periods.

- For oak woodland-dependent species – Preserve current habitat. Monitor and if possible, promote regeneration of oaks and facilitate climate adaptation in the form of uphill expansion of oaks' ranges.

Altered Fire Regimes

Fire regimes in the Sierra Nevada appear to have undergone two major shifts since European settlement. The first shift occurred with the onset of fire suppression in the early 20th century and a second shift appears to be occurring now due to elevated fuel loads and anthropogenic climate change.

Prior to European settlement of the Sierra Nevada, fire regimes in the range were characterized by common, low and moderate-intensity fires, ignited during the summer months by lightning and Native Americans (McKelvey et al 1996). Less frequent, high-intensity fires also occurred and were likely important determinants of forest structure at a local scale (Stephenson et al. 1991, Odion and Hanson 2006). These frequent fires maintained forest heterogeneity that supported a diverse community of birds and other taxa. However, over the past century a policy of fire suppression has reduced the frequency of low to medium-intensity fire (Miller et al. 2009). The reduction in fire activity during the 20th century, coupled with harvest of large pines by timber operators, led to a transformation of the region's forests. Mid-elevation forests stands are now comprised of denser, smaller trees, with a greater proportion of shade-tolerant White Fir and Incense-cedar (McKelvey et al. 1996, Scholl and Taylor 2010).

While fire suppression successfully reduced land area burned by wildfires for much of the 20th century (Scholl and Taylor 2010), recent trends indicate this is beginning to change. Since the 1980s, large parts of California and western Nevada have experienced increases in the mean and maximum fire size (Miller et al. 2009). Now stand-replacing fires are affecting larger tracts of forest than high-intensity fires seen before fire suppression began (Miller et al. 2009, Pechony and Shindell 2010). Furthermore these trends are likely to be reinforced by accelerated climate change (Liu et al. 2010). If the Sierra Nevada experiences an increasing number of large, stand-replacing fires, forest structure and processes will be affected, leading to impacts on Sierra Nevada birds. The potential impacts on forest structure and processes include reduced connectivity among mature stands, increased extent and connectivity of snag patches, increased or accelerated erosion, stream sedimentation, nutrient cycling, carbon sequestration, and forest regeneration (Miller et al. 2009).

The two shifts in fire regime in the Sierra Nevada have affected bird species in disparate ways. Twentieth century fire suppression was likely detrimental to species adapted to forests with varied age structure such as the Northern Goshawk (Maurer 2000), but may have benefited species associated with dense, late-seral habitat such as Hammond's Flycatcher. Likewise, if the Sierra Nevada experiences more frequent and high-intensity fires in the future, some species will benefit while others will be adversely affected. For example, Hairy and Black-backed Woodpeckers, which strongly select burned habitat for breeding and foraging (Hanson and North 2008), will benefit, as may Lazuli Bunting, which tends to spike in abundance soon after landscapes are transformed by fire (Smucker et al. 2005). Conversely, species such as Hammond's Flycatcher, which is associated with dense forests (Gaines 1992), and Golden-crowned Kinglet, which is rarely found in burned forests, may decline as more frequent stand-replacing fires reduce the extent and increase the fragmentation of mature or unburned forest stands. Especially vulnerable are species such as Great Gray Owl, which rely on old-growth forests and are already rare (Gaines 1992).

Focusing on bird species' expected response to a scenario of increased fire in the Sierra Nevada, we estimated that 67 of the 145 species evaluated in this assessment generally benefit from frequent fires and an increase in fire in the southern Sierra would likely be favorable to them. Such a shift in fire regime is likely to be detrimental to 38 species, which are typically fire-adverse. Forty species are not known to be greatly affected by fire and a shift in fire regime is less likely to impact them substantially (Table 5). Classifications for each species were somewhat subjective, and were made by considering all the information presented in the species account (Appendix A). For discussions on observed and potential responses of individual species' to climate change see the individual species accounts in Appendix A (Steel et al. 2012).

Table 5. The predicted impacts of increased fire activity on all 145 species assessed for this report. A designation of a minor impact is defined as affecting the species locally but without significant long-term effects on population. A designation of a major impact is defined as causing or potentially causing significant changes in a species' population across its range. We also note whether altered fire regimes likely impact a species differently within and beyond SIEN parks.

	Major Impact	Minor Impact	Total
Negative	**2**	**36**	**38**
Everywhere	2	35	
Primarily outside SIEN	0	1	
Primarily SIEN only	0	0	
Positive	**10**	**57**	**67**
Everywhere	10	56	
Primarily outside SIEN	0	0	
Primarily SIEN only	0	1	
Neutral	n/a	n/a	**40**

Prescribed fire, sometimes coupled (or substituted) with mechanical fuel reduction, can be a useful tool in reducing fire hazards while mimicking natural fire regimes that maintain ecosystem functions (Husari and McKelvey 1996). However, prescribed burns can be detrimental to breeding birds if treatments destroy or disrupt nesting sites. Many negative impacts can be reduced if preferred nesting trees are protected or by adjusting the timing of treatments to avoid the primary breeding period (Bagne and Purcell 2009). Likewise, it is important to manage post-fire vegetation characteristics and landscape composition as these factors also influence bird abundance and habitat use (Burnett et al. 2010). Post-fire habitat can be important for some species, such as Black-backed Woodpecker, which is uncommon or rare in unburned forests, but is typically found in recently burned areas (Saracco et al. 2011). Such habitat is especially important for some declining species (e.g. Chipping Sparrow and Western Wood-Pewee, Sauer et al. 2008), which show an affinity to recently burned areas (Siegel and Wilkerson 2004, Burnett et al. 2010)

The restoration of natural fire disturbance is a guiding principal for fire management in the National Parks system (Scholl and Taylor 2010). However, park units vary in how this principle is incorporated into management plans, depending on specific park ecology and management objectives (NPS 2006b). SEKI and YOSE have used prescribed burns over the last twenty-five years (Husari and McKelvey 1996) and approximately 80% of the area within these parks is currently managed for Wildland Fire Use (WFU; Miller et al. 2009). In areas managed for WFU, naturally ignited fires are allowed to burn unsuppressed if conditions are appropriate. These areas tend to be within high-elevation wilderness where fuel loads are low and thus generally result in small fires (Miller et al. 2009). Although the goal is to restore fuel loadings and forest structure to emulate what is considered natural conditions, to achieve this is challenging because of high implementation costs and limitations society places on the use and management of fire.

Management Options and Conservation Opportunities

- To the extent feasible, avoid prescribed fires and forest thinning efforts during spring and early summer when many young birds – particularly ground- and shrub-nesters – are still in their nests and are unable to fly.
- During prescribed burns, provide a buffer around known nesting snags of sensitive species (e.g., Great Gray Owl and California Spotted Owl) to protect them from being destroyed.
- For species dependent on understory vegetation, early-seral habitat or heterogeneous forests with mixed age structure – Promote natural fire regimes, including allowance for fires of varying intensities.
- For species dependent on early-seral habitat – Use prescribed fire to provide favorable conditions.
- For species sensitive to high-intensity fires – Manage fuels through removal or controlled burns in crucial habitats such as old growth forests.
- Engage in public education – especially targeted towards park gateway communities – about the value of burned forests for wildlife.

Air Pollution

Air quality is a significant concern in the region where SIEN parks are located. As a consequence, SIEN parks have among the poorest air quality of any NPS units in the country (Esperanza and van Mantgem 2008). SEKI has elevated levels of ozone and other pollutants transported by prevailing winds from the populous San Joaquin Valley into the Southern Sierra (Mutch et al. 2008).

The effects of ozone and other air-born pollutants on wildlife are not well studied (Mutch et al. 2008), and species-specific field studies are rare. One exception is a study assessing impacts of acid rain on the Wood Thrush in the eastern United States, which showed a strong and significant negative correlation between pollution deposition and thrush population numbers (Hames et al. 2002). In general birds are susceptible to air pollution due to their high respiratory rate and can be used as indicators of poor environmental conditions; the classic example being canaries used as indicators for toxic gases in coal mines (Brown et al. 1997). Controlled laboratory studies have demonstrated the susceptibility of at least some bird species (typically domestic fowl) to air pollution (Brown et al. 1997). Among these studies are assessments of ozone impacts that find young birds are especially susceptible to exposure (Quilligan et al. 1958, Bartov et al. 1981).

One can assume that similar negative effects occur within wild avian populations, but better information is needed to assess air pollution impacts on birds within the SIEN parks. However, in the absence of such studies, we hypothesize that species with particularly high respiratory rates such as hummingbirds may be more susceptible to air pollutants than average. Similarly, piscivorous bird species such as the Belted Kingfisher are likely to accumulate contaminants introduced at lower trophic levels. Finally, bird populations may be negatively affected if air quality degrades bird habitat (e.g. preferred vegetative cover, food or prey availability, etc.). Ponderosa and Jeffrey Pines are among the most sensitive species to ozone and experience chronic levels of injury from prolonged exposure (Miller 1996). Thus, birds associated with these pine species may be indirectly threatened by ozone pollution, especially in SEKI where it is most problematic.

Management Options and Conservation Opportunities

- Develop efforts to educate the public about threats to park habitats and wildlife posed by air pollution, and the actions that might reduce air pollution in the parks.

Habitat Fragmentation and Loss

Destruction and degradation of habitat is one of the greatest stressors to biodiversity around the world and in the United States (Wilcove et al. 2000). Although fragmentation and habitat degradation within SIEN parks is minimal due to a lack of timber harvest, commercial livestock grazing, or extensive development, SIEN bird populations are nevertheless affected by such impacts elsewhere – including adjacent lands within the Sierra and other habitats along migration routes and on wintering grounds.

Due to the restrictions on human activity in parks, contemporary habitat loss and fragmentation is minimal within park boundaries when compared to non-protected areas. However, habitat alteration does occur as a result of high intensity fires that lead to increased fragmentation (or potentially decreased fragmentation for species that specialize on post-fire habitats), or climate change, which has the potential to fragment the ranges of high-elevation species as suitable habitat becomes limited to only the highest, disjunct peaks.

Within the Sierra Nevada as a whole, timber harvest operations alter habitat and fragment the landscape, while exurban development similarly reduces the extent of suitable habitat and introduces additional threats such as domestic predators (i.e., dogs and cats) at the wildland-urban interface (Hansen et al. 2005, Schlesinger et al. 2008). Exurban and agricultural development within the foothills near SEKI and YOSE may affect short-distance migrants – such as Great Gray Owl – that often move from the parks toward lower elevations during the winter. Similarly, forest fragmentation within the Sierra Nevada but outside the parks may affect species that have large home ranges (many raptors for example) and/or frequently cross boundaries between national parks, national forests, and private lands.

Deforestation and habitat degradation on the wintering grounds or along migratory routes of Neotropical migrants (Wilcove et al. 2000) is another indirect, but substantial threat to many of the species which breed within the SIEN parks. Even if ample breeding habitat exists within

SIEN and the Sierra Nevada, annual survivorship may decline as Central and South American habitat is lost.

In addition to direct loss of habitat, land-use changes or human activities that alter the hydrology of waterways or meadows can be deleterious to many species that depend on such habitats (Cain et al. 2003). Some of these activities that have had the most substantial consequences are damming of Sierra rivers, intense livestock grazing and water extraction for agriculture or municipal uses. With notable exceptions (e.g., O'Shaughnessy Dam in YOSE), dramatic alterations of hydrology have not occurred within the SIEN. There is evidence however that historic (prior to park establishment) livestock grazing in park meadows substantially altered hydrology and habitat composition in some locales, with effects that still persist (Cooper et al. 2006).

Habitat changes within and beyond the SIEN parks affect species in disparate ways, with varying consequences. Species that rely on dense, mature forests such as the Pileated Woodpecker and Brown Creeper are adversely affected as the extent of forests becomes smaller and more fragmented through timber harvest or fire (Bull et al. 1995, NatureServe 2009). Conversely, species such as Calliope Hummingbird and Red-tailed Hawk, which rely on open habitats for food sources, benefit from forest clearings created by timber harvests (Calder and Calder 1994, Preston and Beane 2009). Additionally, where human development fragments and degrades habitat for many native birds, synanthropic species such as Brewer's Blackbird, Anna's Hummingbird and House Finch benefit from human presence when additional food sources are provided.

Possibly the most notorious avian beneficiary of habitat fragmentation and human development is the Brown-headed Cowbird, whose North American range has greatly increased as humans have altered the landscape across the continent (Keyser et al. 1998). The Brown-headed Cowbird is an obligate brood parasite, always laying its eggs in the nests of other species to be raised at the expense of the host's offspring (Lowther 1993). Among the favored and more susceptible host species of the Brown-headed Cowbird is the Willow Flycatcher, whose Californian populations are threatened due to a number of factors (Siegel et al. 2008). In fact, the Willow Flycatcher appears to have ceased nesting in SEKI and YOSE, where they bred historically (Beedy and Granholm 1985, Siegel and Wilkerson 2005, Siegel et al. 2008).

Of the 145 species evaluated in this assessment, 19 benefit from fragmentation and human alteration of the landscape, while 100 species are negatively affected. Twenty-six species are not known to be greatly affected by habitat fragmentation and loss (Table 6). Classifications for each species were somewhat subjective, and were made by considering all the information presented in the species account (Appendix A). For discussions on observed and potential responses of individual species' to climate change see species accounts in Appendix A (Steel et al. 2012).

Table 6. The impacts of habitat fragmentation and conversion on all 145 species assessed for this report. A designation of a minor impact is defined as affecting the species locally but without significant long-term effects on population. A designation of a major impact is defined as causing or potentially causing significant changes in a species' population across its range. It is also noted if habitat fragmentation and conversion impacts a species differently within or beyond SIEN parks. For example, a species may be negatively impacted by timber harvest outside of the SIEN, but not within the parks where timber harvest is not permitted.

	Major Impact	Minor Impact	Total
Negative	**25**	**75**	**100**
Everywhere	4	10	
Primarily outside SIEN	21	65	
Primarily SIEN only	0	0	
Positive	**4**	**15**	**19**
Everywhere	2	4	
Primarily outside SIEN	2	11	
Primarily SIEN only	0	0	
Neutral	n/a	n/a	**26**

Management Options and Conservation Opportunities

We emphasize that these are management options, but not necessarily management recommendations. The list includes a broad range of options, from actions that park management is already taking to actions that may not be compatible with other NPS management goals or feasible within the parks.

- Continue to protect park lands from development and other activities that degrade habitat.
- Use active restoration to improve conditions where habitat degradation has occurred.
- For species sensitive to forest fragmentation – Strategize with other land managers in the Southern Sierra to maintain large contiguous blocks of desired forest types and conditions, perhaps limiting timber harvests near park boundaries.
- For species sensitive to grazing – Collaborate with other land managers in the Southern Sierra to limit intensive livestock grazing in habitats surrounding SIEN parks.
- For foothill species – Work with counties and conservation organizations to limit development near SIEN parks.
- For cavity nesters – Maintain snags and downed logs of varying sizes by preventing or limiting their removal during fire treatments.
- To supplement nesting habitat for cavity-limited species – Consider providing nest boxes.

Invasive Species and Disease

The influx of new species and disease can have profound impacts on native bird species across their ranges including within SIEN parks. Invasive bird species compete with native birds for resources, can add additional predation pressure, and contribute to the transmission of disease (Siegel et al. 2010). Here we consider the effects of two species that were deliberately introduced by humans as well as native species that have exhibited range expansions and population increases with increased human development and habitat fragmentation. While all birds are vulnerable to disease to some extent, we focus on two emerging diseases, Avian Influenza and West Nile Virus, which have the potential to threaten SIEN bird populations as well as human health in the region.

Non-native Species
Introduced bird species compete with native species that require similar resources, reducing available nesting sites and food. This competition can result in decreased productivity and survival of native birds. Two of the most widespread invasive birds in North America are the European Starling and the House Sparrow. Both species are strongly associated with human communities and benefit immensely from human activities that provide additional food sources and nesting habitat. Due to limited development within National Parks, these species are not prevalent within the SIEN and do not currently pose a serious risk to park bird populations (although starlings are locally abundant in a few areas within the parks). However, any increase in the European Starling, House Sparrow, or other non-native species within the parks could pose increased threats to some species. For example, the presence of European starlings has been shown to have negative impacts on sapsucker species (Koenig 2003) and could similarly affect SIEN populations.

Two additional non-native bird species, Wild Turkey and White-tailed Ptarmigan, have also become naturalized in SIEN parks (though neither has been reported from DEPO), and their presence may have substantial effects on other species (including birds) in the foothill and alpine regions, respectively. Particularly for White-tailed Ptarmigan and the alpine ecosystem it inhabits, spatially extensive monitoring of bird populations - of the sort slated to be initiated in 2011 as part of the SIEN Inventory & Monitoring Program (Siegel et al. 2010) is needed to accurately assess populations within SIEN parks and to better understand their impact on native flora and fauna.

Evidence is mounting that introduced fish populations may also adversely affect bird populations in the parks and elsewhere in the montane west, through their effects on insect prey populations. Recent studies have demonstrated such effects on aquatic species such as Harlequin Duck (LeBourdais et al. 2009) as well as terrestrial species such as Gray-crowned Rosy-Finch (Epanchin et al. 2010), whose terrestrial insect prey also have an aquatic component to their life-cycle.

Native Invasive Species
In addition to the introduction of non-native species, human development following European settlement has benefited some native species while harming others. Among those native species that benefit from anthropogenic changes to the landscape are birds such as Corvid species (i.e., crows, ravens and jays) that predate other birds’ nests, and the Brown-headed Cowbird, which is an obligate nest parasite.

Densities of Corvids are generally higher near places of high human disturbance such as garbage dumps, highways and agricultural fields (Boarman and Heinrich 1999). Of the Corvid species, the Common Raven is most notable within the SIEN parks where it is fairly common (see Common Raven account, Appendix A – Steel et al. 2012). The raven has exhibited significant population increases across California, in the Sierra Nevada, and along the Kings Canyon NP Breeding Bird Survey route in the past few decades (Sauer et al. 2008).

The Brown-headed Cowbird has expanded its range as the landscape has become more fragmented and supplemental food sources such as livestock feed have become available (Keyser et al. 1998). As a result, the Brown-headed Cowbird has become one of the greatest threats to its Neotropical migrant host species (Halterman et al. 1999) such as the Willow Flycatcher and Yellow Warbler (Heath 2008). However, the Brown-headed Cowbird appears to be a greater threat outside of SIEN parks where human-supplemented food sources are more prevalent. A study of cowbird parasitism in eight western national parks found that parasitism had a significant impact only in parks with substantial livestock populations (Halterman et al. 1999). Included in Halterman et al.'s (1999) study were YOSE and SEKI, which were not found to have significant impacts from cowbirds despite small packstock operations. Those results should be viewed with caution, however, as the study was based on very little data from Yosemite, and in any case may now be badly out of date as cowbirds have become conspicuous breeders at Yosemite's Tuolumne Meadows in the intervening years (S. Stock, personal communication).

Avian Influenza

High-pathogenic avian Influenza (HPAIV), also known as "bird flu", is a major health risk to birds and humans alike where the virus exists (Fuller et al. 2010). To date HPAIV has not yet been reported in North America (though low-pathogenic influenza is present) and is found predominantly among domestic poultry. HPAIV has caused deaths among wild bird species and humans in Africa, Asia, Europe and the Middle East (Fuller et al. 2010). Birds known to be susceptible to HPAIV include waterfowl, raptors, sparrows and corvids and there is concern that HPAIV could spread to California and be transmitted by the state's wild bird species (NPS 2006a). A recent assessment of risk of low-pathogenic avian influenza in wild birds in the U.S. showed that passerines are especially susceptible to the disease, that the Great Plains and the Pacific Northwest are highest-risk areas, and that California shows moderate risk (Fuller et al. 2010). Because North America and California are currently free of HPAIV, the disease is not an immediate threat to the birds of the SIEN parks. However, if HPAIV were to spread to the region in the future, it could potentially threaten the local persistence of rare or particularly vulnerable species.

West Nile Virus

West Nile Virus (WNV) is an infectious disease, transmitted by mosquitoes, and can be contracted by both birds and humans. The disease was first detected in North America in 1999 and quickly spread to California where it arrived in 2003 (Hull et al. 2010). The virus is known to be especially virulent among Corvids (Wheeler et al. 2009) and birds of prey (Hull et al. 2010). However, a number of other species are also found to be at risk within California, including the House Finch, Black-crowned Night-Heron and Yellow-billed Magpie (Wheeler et al. 2009). Of the counties surrounding SIEN parks, bird deaths from West Nile Virus have been reported primarily in Fresno, Tulare and Madera counties in the past three years; across California, the American Crow (224 dead birds), Western Scrub-Jay (94 dead birds), House Finch and House Sparrow (32 dead birds each) tested positive for WNV most often (CDPH 2010). Of the four most affected species in the state, Western Scrub-Jay and House Finch occur regularly within SIEN parks (Table 7).

Table 7. The number of positive West Nile Virus bird deaths for each SIEN relevant species across California in 2009 (CDPH 2010).

Species	Total Positive
American Kestrel	1
American Robin	6
Anna's Hummingbird	1
Black Phoebe	1
Bluebird[1]	1
Brewer's Blackbird	12
Cedar Waxwing	1
Chickadee[1]	1
Common Raven	2
Cooper's Hawk	5
Downy Woodpecker	1
European Starling	7
Finch[1]	3
Flycatcher[1]	2
Goldfinch[1]	3
Great Blue Heron	1
House Finch	32
Hummingbird[1]	1
American Kestrel	1
American Robin	6
Anna's Hummingbird	1
Black Phoebe	1
Bluebird[1]	1
Brewer's Blackbird	12
Cedar Waxwing	1
Chickadee[1]	1
Common Raven	2
Cooper's Hawk	5
Downy Woodpecker	1
European Starling	7
Finch[1]	3
Flycatcher[1]	2
Goldfinch[1]	3
Western Tanager	1
White-crowned Sparrow	4
Yellow Warbler	1

[1]Not identified to species.

Of the 145 species evaluated in this assessment only 4 (excluding invasive bird species themselves) benefit in some form from invasive species or disease. These include Vaux's Swift, which benefits from tree heart rot that improves nesting and roosting habitat, and hummingbird species, which benefit from the introduction of non-native flowering plants that provide additional food sources. Even among hummingbirds, however, invasive plants are not entirely beneficial – anecdotal reports suggest that hummingbirds can be impaled on the spines of the invasive thistle *Cirsium vulgare*, and at least partly for this reason, NPS staff at DEPO strive to remove the plant (D. Duhlen, personal communication). Invasive bird species (e.g., European Starling) are not included in this tally. Eighty-seven species are known to be negatively affected by invasive species or emerging disease while 54 species are not known to be susceptible to West Nile Virus or particularly vulnerable to any other disease or invasive species (Table 8). Classifications for each species were somewhat subjective, and were made by considering all the information presented in the species account (Appendix A). For discussions on observed and potential responses of individual species' to climate change see species accounts in Appendix A (Steel et al. 2012). We stress however that uncertainties associated with emerging diseases are very large – in many cases our classifications are based on very limited information.

Table 8. The predicted impacts of invasive species and disease on all 145 species assessed. A designation of a minor impact is defined as affecting the species locally but without significant long-term effects on population. A designation of a major impact is defined as causing or potentially causing significant changes in a species' population across its range. It is also noted if invasive species and disease impacts a species differently within or beyond SIEN parks.

	Major Impact	Minor Impact	Total
Negative	**5**	**82**	**87**
Everywhere	2	61	
Primarily outside SIEN	3	21	
Primarily SIEN only	0	0	
Positive	**0**	**4**	**4**
Everywhere	0	3	
Primarily outside SIEN	0	1	
Primarily SIEN only	0	0	
Neutral	n/a	n/a	**54**

Management Options and Conservation Opportunities

- For potential invasive birds – Monitor occurrences of Eurasian Collared Dove, European Starling, House Sparrow and Brown-headed Cowbird in and around the parks.
- To reduce abundance of invasive bird species – Control food waste at camp and picnic sites and food sources at packstock stables.
- Periodically assess Brown-headed Cowbird nest parasitism in the parks; the previous assessment was 15 years ago, and a reassessment may already be appropriate.
- If invasive birds become chronic, consider removal programs.
- To track disease occurrence in the parks – Test live and especially dead birds for diseases of concern such as West Nile Virus and Avian Influenza.

- Prevent or, if necessary, control Sudden Oak Death Syndrome, a disease that, if it were to become established in SIEN parks, would not threaten birds directly, but rather would threaten tree species that provide important nesting and foraging substrate to numerous bird species in the middle- and especially lower-elevation regions of the parks.
- For the White-tailed Ptarmigan – Initiate alpine surveys and monitoring to better understand the distribution of this introduced species and its impact on native flora and fauna.
- To conserve the Northern Spotted Owl – If invasive Barred Owls become a problem in SIEN parks, consider removal of Barred Owls.
- To conserve Harlequin Duck, Gray-crowned Rosy-Finch, and perhaps other species – Consider removing non-native trout from a subset of previously fishless alpine lakes.

Human Use Impacts

As compared to non-protected areas, human activities detrimental to bird populations are minimal within the SIEN parks. However, where heavy visitation occurs, especially within sensitive habitats, SIEN bird populations can still be affected. Human activities that have the greatest impact on bird populations are those that result in development or other land-use changes (Wilcove et al. 2000). Such drastic changes are covered in the above section on habitat fragmentation or loss. A few human activities that have the potential to threaten local bird populations are common within SIEN parks. Most notable threats to birds include collisions with cars or structures, disturbance by low-flying aircraft, electrocution, and disturbance associated with recreational activities such as horseback riding and stock use, hiking and camping, rock climbing, and intrusive birding. Additionally, human impacts occurring outside park boundaries such as hunting, collisions with wind turbines, and environmental contamination may affect migratory park birds when they are outside park boundaries.

Collisions and Electrocutions

Collisions between birds and human structures such as buildings and vehicles can be a significant source of mortality for some species. Most prone to collision deaths are carrion feeders such as vultures that are drawn to road kill and low-flying species such as the Great Gray Owl (Kirk and Mossman 1998, Maurer 2006). Over a 15-year period, at least 14 Great Gray Owls were hit by vehicles in YOSE, causing at least 12 owl mortalities (Maurer 2006). Also a concern for large raptors is electrocution from contact with power lines. For example, 25% of recorded Golden Eagle deaths are attributed to electrocution (Kochert et al. 2002). Bird deaths from collisions with structures and electrocution are most prominent where human development and vehicle traffic are widespread. Therefore, the threat is of less concern in SIEN parks than in high-population areas or along major highways. However, avian mortalities still occur along roadways and among the developed areas within the parks (Maurer 2006), and window strikes are common at some park buildings (H. Werner, personal communication).

Low-flying Aircraft

Low-flying aircraft have the potential to disrupt nesting for a small number of species of conservation concern in the parks, and are therefore sometimes subject to airspace closures at some sites (S. Stock, personal communication). Peregrine Falcon eyries on the canyon walls of Yosemite Valley and elsewhere at YOSE are vulnerable to disturbance by helicopters involved with medivac and rescue operations (Maurer et al. 2011); Great Gray Owls, which usually nest near meadow edges, are vulnerable to helicopter activity associated with wildfires because flat, treeless meadows can be attractive landing sites for helicopters (S. Stock, personal communication).

Horseback Riding and Stock Use

A limited number of packstock is permitted within SIEN parks for recreational use. The maintenance of these animals can harm bird species in two ways. First, in the backcountry pack animals graze meadows also used by many bird species. Intensive grazing, especially within sensitive montane meadows and riparian areas, has potential to degrade habitat used by species such as the Willow Flycatcher (Bunn et al. 2007). Currently little data are available on this topic, which merits research and evaluation. Secondly, stables used to house and feed pack animals in the front country provide supplemental food sources for species such as the Brown-headed Cowbird, a nest parasite that is linked with population declines of a number of host species (Halterman et al. 1999). See the section on invasive species and disease for more discussion of the impact of Brown-headed Cowbirds on SIEN parks.

Hiking and Camping

Similar to stables, campgrounds can provide additional food sources and subsequently aid in the artificial expansion of predatory species such as ravens and jays (Halterman et al. 1999, Marzluff and Neatherlin 2006). Additionally, disturbance of nesting sites by hikers or campers can lead to reduced nesting success of many bird species including Northern Goshawk and Belted Kingfisher (Squires and Reynolds 1997, Kelly et al. 2009). Backcountry camping and off-trail hiking can also lead to habitat degradation, but this is likely less of a concern than nest disturbance.

Rock Climbing

By its nature, rock climbing generally occurs on barren cliff faces, which are not readily altered by human activities. However, where climbing routes intersect nesting sites of species such as Black Swift or numerous raptor species, the disturbance caused by climbers could lead to nest failures (Roberson and Collins 2008). Many cliff-nesting species select nesting sites inaccessible even to rock climbing, generally making this a relatively minor threat, although impacts can be significant locally. Temporary closures of rock climbing routes at YOSE that are proximal to Peregrine Falcon eyries have been implemented in recent years and appear successful at preventing nest disturbance (Maurer et al. 2011).

Intrusive Birding

Like rock climbing, intrusive birding is not a widespread threat, but can cause nest failures where excessive disturbance at breeding sites occur. Of greatest concern is disturbance to Great Gray Owls, which are already rare within the SIEN parks (Keane et al. 2011) and across their range (Maurer 2006), and are highly sought after in Yosemite by birders. Great Gray Owls are particularly sensitive to disturbance when actively pursued, rather than just passively observed (Wildman 1992).

Hunting

Hunting has historically caused declines of a number of species such as the Bald Eagle and American Kestrel (Buehler 2000, Smallwood and Bird 2002). Government regulation and public education has led to a decline in killings of many bird species, and while hunting for a number of game species including Morning Dove, Mountain Quail and White-tailed Ptarmigan remains legal and common, harvest levels are set annually to maintain stable populations (CDFG 2010). Hunting is not permitted within SIEN parks, but heavy harvest of game birds outside of the parks could impact park populations, especially among short-distance migrant species.

Environmental Contamination

Perhaps the most well known example of environmental contaminants leading to declines in avian populations is the use of the pesticide DDT in the mid-twentieth century. DDE, a metabolite of DDT, leads to egg-shell thinning and subsequently reproductive failure among a number of species, particularly predator species such as the Bald Eagle (Buehler 2000). However, the ban on DDT in 1972 (EPA 2010) has likely contributed to rebounds of a number of affected species. For example, the Bald Eagle was removed from the federal endangered and threatened species list in 2007 (CDFG 2010) and its numbers continue to improve (Sauer et al. 2008). Despite the successful management of DDT in the United States, the pesticide is still used in many Central and South American countries, exposing many Neotropical migrants that overwinter in these countries, but breed in SIEN parks. Furthermore, many other pesticides and toxins are released into the environment and can be detrimental to the bird community either through direct exposure or through loss of prey species. The lack of agriculture or other sources of environmental contaminants within the SIEN parks limits the exposure of birds to such toxins while within park boundaries. However, short and long-distance migrants are exposed to such contaminants while on their wintering grounds in the California central valley or in Central and South America. Furthermore, the parks – particularly SEKI – are downwind from major air pollution sources; so airborne contaminants are a stressor even within park boundaries.

Of the 145 species evaluated in this assessment, 20 benefit in some form from human use impacts, while 101 species are negatively affected. Twenty-four species are not known to be greatly affected by human activities (Table 9). Classifications for each species were somewhat subjective, and were made by considering all the information presented in the species account (Appendix A). For discussions on observed and potential responses of individual species’ to climate change see species accounts in Appendix A (Steel et al. 2012).

Table 9. The impacts of human use activities on all 145 species assessed for this report. A designation of a minor impact is defined as affecting the species locally but without significant long-term effects on population. A designation of a major impact is defined as causing or potentially causing significant changes in a species' population across its range. It is also noted if human use activities impact a species differently within or beyond SIEN parks.

	Major Impact	Minor Impact	Total
Negative	**12**	**89**	**101**
Everywhere	5	53	
Primarily outside SIEN	6	36	
Primarily SIEN only	1	0	
Positive	**5**	**15**	**20**
Everywhere	2	8	
Primarily outside SIEN	3	7	
Primarily SIEN only	0	0	
Neutral	n/a	n/a	**24**

Management Options and Conservation Opportunities

We emphasize that these are management options, but not necessarily management recommendations. The list includes a broad range of options, from actions that park management is already taking to actions that may not be compatible with other NPS management goals or feasible within the parks.

- To prevent nest failures – Where feasible, identify nesting sites of particularly sensitive or rare species and prevent recreation activities nearby during the breeding season.
- For meadow-dependent species – Limit packstock grazing in meadows, especially during the breeding season.
- To better understand the impact of packstock grazing – Assess changes in vegetation, hydrology and nesting success within grazed meadows.
- To better understand bird mortalities from vehicle collisions – Monitor and record bird deaths along roadways.
- To reduce bird mortalities from vehicle collisions – Strictly enforce speed limits, install speed bumps near owl nesting or foraging sites and/or educate park visitors about the threat.
- For cliff-nesting species – Where nesting sites and rock climbing co-occur, restrict climbing during the breeding season.
- For large raptors – Ensure power lines within SIEN parks are designed to prevent electrocution of perching raptors.

- For Great Gray Owl – Educate visitors of threats to the species and of responsible birding etiquette while limiting information about sensitive breeding sites.

- Consider implementing airspace closures and specific flight paths for aircraft that avoid sensitive species' nests (particularly those of Peregrine Falcon and Great Gray Owl) during the breeding season.

Summary of Species Stressor Rankings

In preceding sections, we discussed five major stressors to 145 focal SIEN bird species, described general effects, identified the number of bird species negatively or positively affected, and summarized management options. In Appendix A are individual species accounts that discuss these topics in greater detail for each species and provide supporting evidence of observed or expected impacts (Steel et al. 2012). In Table 10 below, we have summarized the impact of each stressor to each of the 145 species. The availability and quality of evidence to support our assessments varied greatly across the species and stressors. For purposes of rapid reference, we have included our level of certainty along with our stressor rankings (Table 10). For a discussion of the evidence supporting the stressor rankings see the individual species accounts.

Table 10. Species-specific stressor rankings and confidence scores. Stressor impact definitions: - Indicates a minor negative impact on the species. The stressor has or is expected to cause harm to the species locally, but without significant long-term effects on population or range. -- Indicates a major impact on the species. The stressor has or is expected to cause major population declines or range shifts. + Indicates a minor benefit to the species. The stressor has or is expected to have positive effects on the species locally, but without significant long-term population effects. ++ Indicates a major benefit to the species. The stressor has or is expected to contribute to a major population increase or range expansion. Confidence score definitions: • Low confidence – ranking is largely based on expert speculation without a body of supporting evidence. •• Medium – ranking is supported by modeled response of the species to the stressor or by studies which provide inconclusive, but defensible evidence indicating a species' response. ••• High – ranking is based on conclusive observational or experimental evidence. Federal or state listed species (including those of conservation concern) are indicated by bold text.

Common Name	Anthropogenic Climate Change		Altered Fire Regimes*		Habitat Fragmentation or loss		Invasive Species & Disease		Human Use Impacts	
	Rank	Confidence	Rank	Confidence	Rank	Confidence	Rank	Confidence	Rank	Confidence
Mallard	0	••	0	•	-[1]	•••	-	••	-[1]	•••
Common Merganser	-[2]	•	0	•	--[1]	••	0	•	-[1]	•••
Harlequin Duck	-	••	0	•	--[1]	•••	0	•	--	•••
White-tailed Ptarmigan	--	••	0	•••	-[1]	••	0	•	-[1]	•
Sooty Grouse	-[2]	••	-	••	--[1]	•••	0	••	-	•••
Mountain Quail	-	••	+	••	-	••	0	•	-[1]	•••
California Quail	-	••	-	••	-[1]	••	-	•	-[1]	•••
Great Blue Heron	0	••	0	•	-[1]	•••	-	••	--[1]	•••
Turkey Vulture	0	•	0	•	+[1]	••	0	••	-	•••
Osprey	0	•	-	•	-[1]	••	0	•	--[1]	•••
Northern Harrier	0	•	0	•	--[1]	•••	0	•	--[1]	•••
Sharp-shinned Hawk	-[2]	•	0	•	-[1]	•	-	••	--	••
Cooper's Hawk	0	•	0	•	-[1]	•••	-	•••	0	•••
Northern Goshawk	0	•	--	•••	-[1]	•••	-	•	-[1]	•••
Red-shouldered Hawk	-	••	-	•	--[1]	•••	-	•••	-[1]	•••
Red-tailed Hawk	0	•	+	••	++[1]	••	-	•••	-[1]	•••
Golden Eagle	0	•	-	••	-[1]	•••	-	••	--[1]	•••

*Although some accounts contain discussion of species' responses to past changes in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.
[1]The indicated impact of the stressor is primarily relevant outside of SIEN parks only.
[2]The indicated impact of the stressor is primarily relevant to SIEN parks only.

Table 10 (continued).

Common Name	**Anthropogenic Climate Change**		***Altered Fire Regimes**		**Habitat Fragmentation or loss**		**Invasive Species & Disease**		**Human Use Impacts**	
	Rank	Confidence	Rank	Confidence	Rank		Rank	Confidence	Rank	Confidence
Bald Eagle	0	•	-[1]	••	-[1]	•••	-[1]	••	--[1]	•••
American Kestrel	0	•	0	••	0	••	-	••	-[1]	•••
Peregrine Falcon	0	••	0	•	0	•••	0	•••	--[1]	•••
Prairie Falcon	0	••	-	••	-	•••	0	••	-	•••
Killdeer	0	••	0	••	+[1]	••	0	•	-[1]	•••
Spotted Sandpiper	-[2]	•	0	••	-[1]	•	0	•	-[1]	•
Band-tailed Pigeon	-[2]	••	-	•	-	••	-	••	-[1]	••
Mourning Dove	-	••	+	•••	0	••	-	••	-	•••
Flammulated Owl	-	•	+	••	-[1]	•	0	•	-[1]	•
Western Screech-Owl	-	•	+	••	-[1]	•	-[1]	•	-[1]	•
Great Horned Owl	0	•	0	•	0		0	•	0	•
Northern Pygmy-Owl	0	•	+	••	-[1]	••	0	•	-[1]	•
Spotted Owl	-	•	+	••	--[1]	•••	--[1]	••	-[1]	•
Great Gray Owl	-	•	+	•	--[1]	••	0	•	--[2]	•••
Long-eared Owl	-	•	+	•	--[1]	•	0	•	-[1]	•
Northern Saw-whet Owl	-	•	-	•	-[1]	••	0	•	-[1]	•
Common Nighthawk	-	•	++	••	-[1]	••	-[1]	•	-[1]	•
Common Poorwill	+	•	++	••	-[1]	•	0	•	-[1]	•
Black Swift	-	•	0	••	0	••	0	•	+	•
Vaux's Swift	--	••	+	••	--[1]	•••	+	••	-	•••
White-throated Swift	0	•	0	••	0	••	0	•	++[1]	••
Black-chinned Hummingbird	+[2]	•	-	•	-	•	+[1]	••	+[1]	••

*Although some species accounts contain discussion of species responses to past changes in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.
[1]The indicated impact of the stressor is primarily relevant outside of SIEN parks only.
[2]The indicated impact of the stressor is primarily relevant to SIEN parks only.

Table 10 (continued).

Common Name	Anthropogenic Climate Change		*Altered Fire Regimes		Habitat Fragmentation or loss		Invasive Species & Disease		Human Use Impacts	
	Rank	Confidence	Rank	Confidence	Rank		Rank	Confidence	Rank	Confidence
Anna's Hummingbird	0	•	0	•	+[1]	••	--[1]	••	+[1]	•••
Calliope Hummingbird	--	••	+	•	+[1]	••	0	•	+[1]	•••
Rufous Hummingbird	-	•	+	•	0	••	+	••	+[1]	•••
Belted Kingfisher	-[2]	••	0	•	-[1]	••	0	•	-	••
Acorn Woodpecker	+	••	+	••	-[1]	••	-	••	-[1]	••
Williamson's Sapsucker	-	••	-	••	0	•	-	•	0	•
Red-breasted Sapsucker	-	••	-	••	-[1]	•	-	••	-[1]	••
Nuttall's Woodpecker	++	••	+	•	-[1]	•	-	••	-[1]	•
Downy Woodpecker	-[1]	••	+	••	-[1]	••	-	••	0	•
Hairy Woodpecker	-[2]	••	++	•••	--[1]	•••	-[1]	•	0	•
White-headed Woodpecker	0	•	+	••	-[1]	••	0	•	0	•
Black-backed Woodpecker	--	••	++	•••	--[1]	•••	0	•	-[1]	•
Northern Flicker	0	••	++	•••	-[1]	•	-	•	0	•
Pileated Woodpecker	-	••	-	••	--[1]	•••	+	•	+[1]	••
Olive-sided Flycatcher	0	•	-	••	--	•••	0	•	-	•
Western Wood-Pewee	0	••	+	••	-	••	0	•	-[1]	••
Hammond's Flycatcher	-	••	-	••	--	•••	0	••	0	•
Dusky Flycatcher	-[2]	••	0	••	0	••	-[1]	•••	-[1]	•••
Willow Flycatcher	-	••	-	•	--[1]	•••	--	•••	--	•••
Pacific-slope Flycatcher	-	••	-	•	-	••	0	•	+	••
Black Phoebe	0	••	-	•	--	••	0	•	+	••
Say's Phoebe	-	•	-	•	+	••	0	•	0	••
Ash-throated Flycatcher	+	••	0	••	-[1]	••	-[1]	••	-[1]	••

*Although some species accounts contain discussion of species responses to past changes in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.
[1]The indicated impact of the stressor is primarily relevant outside of SIEN parks only.
[2]The indicated impact of the stressor is primarily relevant to SIEN parks only.

Table 10 (continued).

Common Name	Anthropogenic Climate Change		*Altered Fire Regimes		Habitat Fragmentation or loss		Invasive Species & Disease		Human Use Impacts	
	Rank	Confidence	Rank	Confidence	Rank		Rank	Confidence	Rank	Confidence
Western Kingbird	0	•	+	••	+	•••	-	••	-[1]	•
Cassin's Vireo	0	••	-	••	-[1]	•••	-[1]	•••	-[1]	•
Hutton's Vireo	0	••	-	•	--[1]	•••	-[1]	•••	-	••
Warbling Vireo	0	••	-	•••	-[1]	••	-[1]	••	-[1]	••
Steller's Jay	0	••	0	••	+[1]	••	-	••	+	••
Western Scrub-Jay	0	••	-	•	0	••	--	•••	0	••
Clark's Nutcracker	--	••	0	••	0	••	--[1]	•••	+	••
Common Raven	0	••	0	•	-[1]	••	-	•••	++	••
Horned Lark	-	••	+	••	--[1]	••	0	•	-	••
Tree Swallow	-	••	+	••	-[1]	••	-	••	-	•
Violet-green Swallow	0	••	+	••	-[1]	••	-	•	0	•
No. Rough-winged Swallow	0	••	0	••	0	••	-	••	+[1]	•
Cliff Swallow	0	••	0	••	0	••	0	•	+[1]	•
Barn Swallow	-	•	0	•	0	••	-	••	++[1]	•
Mountain Chickadee	0	••	-	••	-[1]	••	-	••	-	•
Chestnut-backed Chickadee	-	••	-	••	-[1]	••	-	••	-	•
Oak Titmouse	+	••	+	••	-[1]	•	-	••	-	•
Bushtit	+	••	+	••	-[1]	•	-	••	-	•
Red-breasted Nuthatch	0	••	-	••	-[1]	••	0	•	0	•
White-breasted Nuthatch	0	••	0	••	-[1]	•	0	•	0	•
Pygmy Nuthatch	-	•	+	••	-[1]	••	-	••	-	••
Brown Creeper	-[1]	••	+	••	--[1]	•••	0	•	-[1]	••

*Although some species accounts contain discussion of species responses to past changes in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.
[1]The indicated impact of the stressor is primarily relevant outside of SIEN parks only.
[2]The indicated impact of the stressor is primarily relevant to SIEN parks only.

Table 10 (continued).

Common Name	Anthropogenic Climate Change		*Altered Fire Regimes		Habitat Fragmentation or loss		Invasive Species & Disease		Human Use Impacts	
	Rank	Confidence	Rank	Confidence	Rank		Rank	Confidence	Rank	Confidence
Rock Wren	0	••	+	••	0	•	0	•	0	•
Canyon Wren	0	••	+	••	0	•	-	••	-	•
Bewick's Wren	0	••	+	••	0	•	-	••	-	•
House Wren	+	••	++	•••	+[1]	••	-	••	0	•
Pacific Wren	-	•	-	••	-	••	-	••	-	•
American Dipper	-	••	0	••	-	•	0	•	0	•
Golden-crowned Kinglet	-	•	--	•••	-[1]	••	-	••	-	•
Ruby-crowned Kinglet	-	•	0	••	--[1]	••	-	••	-	•
Blue-gray Gnatcatcher	+	••	+	••	-[1]	••	-	••	-	•
Western Bluebird	0	••	+	••	0	••	-	••	-	••
Mountain Bluebird	-	•	++	•••	-[1]	••	-	••	-	••
Townsend's Solitaire	-	•	-	••	+[1]	••	-	••	-	•
Hermit Thrush	-	•	-	••	-[1]	••	-	••	-	•
American Robin	-	•	+	••	+[1]	••	-	••	-	•
Swainson's Thrush	--[2]	•	0	••	--	••	-	•••	-[1]	•••
Varied Thrush	-	•	+[2]	••	-[1]	••	0	•	0	•
Wrentit	0	••	+	••	-[1]	•	0	•	-	•
European Starling	+	•	+	••	++[1]	•••	-	•	++[1]	•••
American Pipit	0	••	0	•	0	•	0	•	-	•
Cedar Waxwing	0	•	+	•	+[1]	••	-	••	-	••
Phainopepla	-	•	+	•	-[1]	•	0	•	-[1]	••
Orange-crowned Warbler	0	•	+	••	-[1]	••	-	•	-	•
Nashville Warbler	0	•	-	••	--[1]	•••	-[1]	•••	-	••
Yellow Warbler	-	••	0	••	-[1]	••	-	••	-	••

*Although some species accounts contain discussion of species responses to past changes in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.
[1]The indicated impact of the stressor is primarily relevant outside of SIEN parks only.
[2]The indicated impact of the stressor is primarily relevant to SIEN parks only.

Table 10 (continued).

Common Name	Anthropogenic Climate Change		*Altered Fire Regimes		Habitat Fragmentation or loss		Invasive Species & Disease		Human Use Impacts	
	Rank	Confidence	Rank	Confidence	Rank		Rank	Confidence	Rank	Confidence
Yellow-rumped Warbler	0	••	-	••	-[1]	••	-	••	-	••
Black-throated Gray Warbler	+	••	-	••	-[1]	••	-	••	-	•
Townsend's Warbler	-	•	-	••	-[1]	•	0	•	0	•
Hermit Warbler	0	•	-	••	--[1]	••	-	••	-	••
MacGillivray's Warbler	--	••	-	••	--[1]	•••	-[1]	•••	-	••
Common Yellowthroat	-	••	+	•	0	••	-	••	-	••
Wilson's Warbler	-	••	+	••	-[1]	••	-	••	-	••
Green-tailed Towhee	0	•	++	•••	0	••	-	•	-	••
Spotted Towhee	-	••	+	••	0	•	0	•	-[1]	•
California Towhee	-	•	+	••	0	•	0	•	-	•
Rufous-crowned Sparrow	+	••	+	••	-[1]	••	-	••	-	•
Chipping Sparrow	0	••	+	••	+[1]	••	-	••	-	•
Black-chinned Sparrow	+	•	+	••	-[1]	••	0	•	0	•
Fox Sparrow	-	••	+	••	+[1]	••	-	••	-	•
Song Sparrow	-	••	+	••	-	••	-	••	-	•
Lincoln's Sparrow	-	••	0	••	--[1]	••	-[1]	••	-	••
White-crowned Sparrow	-	••	+	••	-	•	-	••	-	•
Golden-crowned Sparrow	-	••	0	•	-[1]	•	0	•	-	•
Dark-eyed Junco	-	••	+	••	-[1]	••	-	••	-	••
Western Tanager	-	••	-	••	0	••	-	••	-	••
Black-headed Grosbeak	0	•	0	••	0	••	0	•	-	•
Lazuli Bunting	-	•	++	•••	-[1]	•	-[1]	••	--	••

*Although some species accounts contain discussion of species responses to past changes in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.
[1]The indicated impact of the stressor is primarily relevant outside of SIEN parks only.
[2]The indicated impact of the stressor is primarily relevant to SIEN parks only.

Table 10 (continued).

Common Name	Anthropogenic Climate Change		*Altered Fire Regimes		Habitat Fragmentation or loss		Invasive Species & Disease		Human Use Impacts	
	Rank	Confidence	Rank	Confidence	Rank		Rank	Confidence	Rank	Confidence
Red-winged Blackbird	-	•	0	•	+	•••	-[1]	••	--	••
Western Meadowlark	+	•	+	•	-[1]	••	0	•	0	•
Brewer's Blackbird	-	••	0	••	++	••	-[1]	••	-	••
Brown-headed Cowbird	+	•	0	••	++	•••	0	•	++	•••
Bullock's Oriole	-	•	+	•	-[1]	••	-[1]	••	-	•
Gray-crowned Rosy-Finch	-	••	0	•	0	•	-	••	-[1]	••
Pine Grosbeak	--	••	+	••	-[1]	••	0	•	0	•
Purple Finch	-	••	+	••	-[1]	•	0	•	0	•
Cassin's Finch	--	••	+	••	-[1]	•	0	•	+	••
House Finch	+	•	+	••	+	••	-[1]	••	+	••
Red Crossbill	--	•	0	••	-[1]	••	0	•	0	•
Pine Siskin	-	••	++	••	-[1]	••	-[1]	••	0	•
Lesser Goldfinch	+	•	+	•	-[1]	•	-[1]	••	-	••
Lawrence's Goldfinch	+	•	+	••	-[1]	••	-[1]	•••	+	••
Evening Grosbeak	-	••	+	••	-[1]	•	-[1]	••	-[1]	••

*Although some species accounts contain discussion of species responses to past changes in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.
[1]The indicated impact of the stressor is primarily relevant outside of SIEN parks only.
[2]The indicated impact of the stressor is primarily relevant to SIEN parks only.

Conclusions

The species assessed for this report are highly diverse, with varying habitat needs and life histories. Due to this variation, the major stressors of climate change, altered fire regimes, habitat fragmentation and loss, invasive species and disease, and human use impacts affect different species in disparate ways. Our review of the 145 focal species and their stressors suggests that human use impacts and habitat fragmentation and loss are the greatest stressors for the highest number of species across their ranges (Table 11). However, because SIEN parks are protected from extensive development, timber harvest, grazing, pesticide use etc., SIEN bird populations are often not directly affected, and finding solutions to the stressors outside of park boundaries may be largely beyond the purview of National Park managers.

When species facing stressors completely external to the SIEN parks are excluded from our tally, climate change becomes the greatest potential stressor. We suggest that climate change is a major stressor to 10 of the assessed species (i.e., there is potential to cause substantial population declines or range contractions) and a minor stressor to 67 of the assessed species (i.e., there is potential to cause minor or local population declines or slight range contraction) (Table 11). Climate change and altered fire regimes generally impact species in the same way within and beyond SIEN park boundaries, while the stressors of invasive species and disease, human use impacts, and especially habitat fragmentation and loss were often more influential elsewhere in a species' range. Interestingly, an increase in fire frequency and intensity would appear to benefit more species (67 species) than it would harm (38 species) (Table 11).

Table 11. Summary of assessed or predicted impacts of each stressor on the 145 bird species assessed for the SIEN. Range-wide stressors are those that impact the species anywhere within the species' range and includes stressors not directly relevant to the National Parks assessed. SIEN stressors are those that impact park populations either within park boundaries or on presumed wintering grounds or migration routes of park birds. This category excludes stressors not directly relevant to park populations (e.g., loss of habitat due to timber harvest elsewhere in the Sierra Nevada). A minor impact is defined as affecting or potentially affecting the species locally but without significant long-term changes in population or range. A major impact is defined as causing or potentially causing significant changes in a species' population across its range or range contractions/expansions.

	Climate Change		**Altered Fire Regimes**[1]		**Fragmentation & Loss**		**Invasive Species & Disease**		**Human Use Impacts**	
	Range-wide	SIEN	Range-wide	SIEN	Range-wide	SIEN	Range-wide	SIEN	Range-wide	SIEN
Total Negative	**77**	**75**	**38**	**37**	**100**	**14**	**87**	**63**	**101**	**59**
Major Impact	*10*	*10*	*2*	*2*	*25*	*4*	*5*	*2*	*12*	*6*
Minor Impact	*67*	*65*	*36*	*35*	*75*	*10*	*82*	*61*	*89*	*53*
Total Positive	**18**	**18**	**67**	**67**	**19**	**6**	**4**	**3**	**20**	**10**
Major Impact	*1*	*1*	*10*	*10*	*4*	*2*	*0*	*0*	*5*	*2*
Minor Impact	*17*	*17*	*57*	*57*	*15*	*4*	*4*	*3*	*15*	*8*
Total Neutral	**50**		**40**		**26**		**54**		**24**	

[1]Although some species accounts contain discussion of responses to past shifts in fire regimes, stressor impacts here refer to the species' expected response to a scenario of increased fire in the Sierra Nevada.

Our assessments of the 145 focal species revealed multiple species that are of concern for various reasons – including declining population tends and expected negative responses to stressors that may be worsening (see above). However, aside from on-going programs, none of these species appear to warrant immediate intervention and species-specific management within SIEN parks. Instead of managing for the most threatened species, we suggest that measures targeting sensitive habitats and specific stressors are the best way to conserve bird species within the SIEN parks. For example, to protect meadow-dependent birds from climate change, restoration of meadow hydrology, particularly for meadows that historically supported sensitive species, may be the best approach for building up resilience within the habitat and buffering sensitive species from future disturbances associated with the stressor. Specific management options are listed in the stressor section above.

In addition to habitat-based management, we suggest continued and augmented bird monitoring within the SIEN parks. Monitoring is especially needed for high-elevation species (e.g., Gray-crowned Rosy-Finch) and other species that are poorly surveyed by existing programs such as the BBS and MAPS. Continued and augmented monitoring will help management adapt to changing stressors and changing needs of bird populations. Adaptive management, made possible by monitoring, is especially crucial for responding to poorly understood stressors such as climate change.

Addressing the Major Stressors

Climate Change

Exactly how climate change will impact bird species and the habitats on which they depend is unclear. Thus management actions designed to prevent some of the greatest harm to bird species and help them adapt to the stressor must necessarily be adaptive, incorporating monitoring and periodic review of the latest climate science to ensure effectiveness. Unlike less vagile taxa, translocation of threatened individuals or populations to help a species adapt to climate change is unlikely to be necessary for birds. The best approach for aiding bird species resist and/or adapt to climate change will likely be to build up resilience in their habitats and/or help their habitats "migrate" upslope to follow favorable conditions. For many of the meadow-dependent species discussed here, restoration of the natural hydrology of altered meadows would aid breeding success as summers become warmer and dryer into the future. Because current and future responses of birds to climate change are uncertain, new or continued study of the most threatened species is urgently needed. This is especially true for alpine species such as the Gray-crowned Rosy-Finch whose population trends and demographics are completely unknown.

Altered Fire Regimes

Fire suppression over the past century has been detrimental to a number of Sierra bird species. Increased fire frequency in the future may benefit many species that respond positively to post-fire conditions. Many species would also benefit from a reduction in fire suppression across the Sierra. When prescribed burns and manual removal of fuels are necessary, treatment should occur outside of the breeding season to prevent nesting failures among many species.

Habitat Fragmentation and Loss

As discussed above, habitat fragmentation and loss is a significant problem, but one that occurs outside of SIEN parks. Because this stressor is detrimental to bird populations outside the parks, park managers can best combat effects of this stressor by collaborating with neighboring land managers and promoting research on habitat loss and fragmentation on wintering grounds and migratory routes.

Invasive Species or Disease

Many of the specific stressors encompassed by this category such as highly pathogenic avian influenza (which has not yet been detected in California) and the Barred Owl (which has been detected once at SEKI but has not established a foothold; Steger et al. 2006) are not yet problems within SIEN parks. However, unlike habitat fragmentation and loss, invasive species and disease can spread into protected areas and become greater stressors to sensitive species in the future. Testing of dead birds for diseases such as West Nile Virus and Avian Influenza coupled with rapid response by managers in cases of outbreak might help prevent the spread of diseases, at least where there were some obvious action managers could take. While there do not appear to be any major current threats from invasive species, monitoring their potential expansion into SIEN parks, limiting artificial food sources for species such as the Brown-headed Cowbird, and if needed, establishing programs to remove invasive species can all be used to prevent a worsening of this stressor.

Human Use Impacts

Human use impacts negatively impact sensitive bird species in a variety of ways, both within and beyond SIEN parks. Among the most damaging impacts on hawk and owl species is mortality due to collisions with cars. Park managers can minimize this stressor by strictly enforcing speed limits, installing speed bumps in sensitive areas and educating park visitors. For species susceptible to human disturbance, restricting human activities near known nesting sites during breeding may be helpful in preventing unnecessary nest failures. Perhaps the SIEN species most susceptible to human use impacts is the Great Gray Owl, whose nesting efforts can be disrupted by aggressive birding – particularly when it involves broadcasting Great Gray Owl recordings. In addition to or instead of restricting visitor access, public education about responsible birding could be very helpful.

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