Coordinated Bird Monitoring in Nevada

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version 1.2

Prepared for the Nevada Steering Committee by:

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Endorsements

The undersigned endorse the Nevada Coordinated Bird Monitoring Plan and agree to participate in it. Specifically:

1. A representative from each agency or organization listed below will attend the annual meeting to review past work and plan future Nevada Coordinated Bird Monitoring projects.

2. The organizations will take reasonable and prudent steps to insure that the program is implemented and remains viable in the long-term and that bird surveys conducted by the partners are coordinated working through the Nevada Coordinated Bird Monitoring Committee.

3. The undersigned will function as a steering committee that oversees the general direction and goals of the Nevada Coordinated Bird Monitoring program in the long-term.

---- *endorsements after final revision here* ----

Executive Summary

The Nevada Coordinated Bird Monitoring Plan was designed to help managers decide which of 286 bird species that regularly occur in Nevada warrant management action due to declines; to identify causes of such declines; and to help managers plan and evaluate land use practices, conservation, and restoration. Further, the program was designed to address specific habitat-related conservation concerns for birds of Nevada: (1) habitat guidelines for managing upland gamebirds (12 species); (2) effects of human activities on riparian areas (136 species); (4) effects of human activities on wetlands and the birds that depend on them (94 species); (5) effects of loss of aspen stands (14 species); (6) effects of sagebrush fires and management on birds (36 species); and (7) effects of pinyon-juniper management on birds (39 species). Identifying species at risk and causes of their declines is a permanent need; the habitat-specific management issues can be addressed with relatively short-term (e.g., 4-7 year) studies after which other short-term priorities will be identified. To identify species at risk, population trend information is needed. Habitat-specific management issues can best be addressed by describing spatial patterns in abundance, identifying habitat relationships, followed by studying productivity to determine quality of available habitats in relation to reference sites or other suitable standards. This report provides quantitative objectives for addressing each of the management issues, identifies the best methods for collecting the needed information, and provides estimated sample size requirements, identifies responsibilities for implementation, and makes recommendations on project management and the next steps toward implementation.

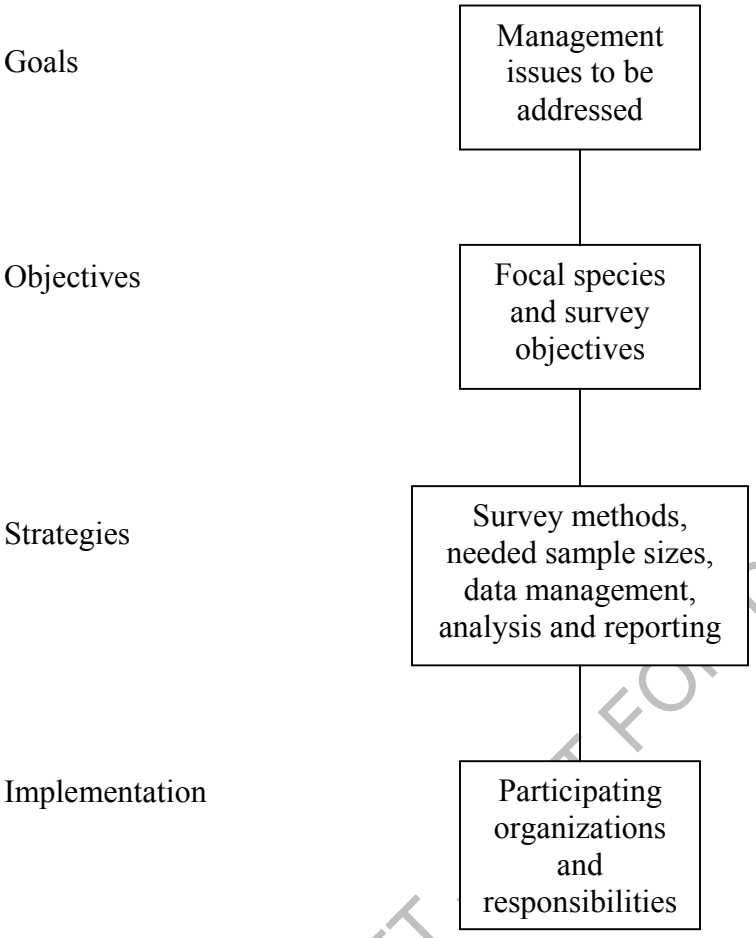
Introduction

Coordinating Bird Monitoring is a joint effort by managers and bird monitoring specialists to improve the success of bird monitoring programs and make the information available to all partners. Its approach focuses on providing information on specific land management issues from reliable monitoring data; describing focal species and quantitative survey objectives for each management issue; choosing survey methods and estimating needed sample sizes; storing all data in permanent, widely available data repositories; analyzing data using methods endorsed by the appropriate professional societies; and using effective methods for communicating results to decision-makers. The model from which this all-bird coordination effort is derived is a long-standing program implemented by the Flyway Councils of tracking waterfowl throughout the nation and continent to set management and harvest strategies for game species (e.g., www.pacificflyway.gov). As with the waterfowl model, coordinated all-bird monitoring is intended as a feedback system that can provide a scientific basis for management and conservation planning for birds of management concern.

Coordinated Bird Monitoring Plans are being developed at the State, regional, and continental scales. Each plan describes existing monitoring programs and then identifies needed improvements and new programs using the following approach (Fig. 1): (1) identify large-scale management issues that the program helps address (goals), (2) identify information that is needed (objectives), (3) select the methods that will be used (strategies), and (4) identify the parties that have primary responsibility for implementing each program component (implementation plan).

Several projects are already in progress at the continental level that will help implement monitoring recommendations at the State, Province, or regional level. For example, a system for conducting peer reviews of survey protocols is currently being developed, data repositories are being constructed, and rapid habitat survey methods are being designed. The Nevada Plan is designed to use these resources and to support the continental programs, where appropriate.

Figure 1. Steps in developing coordinated bird monitoring plans.



Summary of Existing Bird Monitoring and Assessment Projects in Nevada

The Nevada Bird Count

The Nevada Bird Count is a cooperative effort by Nevada agencies and non-governmental organizations to improve coordination among existing bird surveys in Nevada and to implement adequate survey coverage across the state to inform and assist conservation delivery and land management. The program's overall goal is to provide more comprehensive access to scientifically sound information for management agencies concerned with bird conservation needs. The first module of the Nevada Bird Count (NBC) was implemented in 2002 and consists of a breeding landbird monitoring network, thus targeting the largest proportion of species of potential concern to Nevada's resource managers (222 species). NBC's breeding landbird monitoring program was designed based on similar programs in Montana (Hutto and Young 1999) and Colorado (Leukering et al. 2000) and includes statewide coverage by point count surveys in a habitat-stratified, mostly randomly-placed, mostly off-road survey design. The counts are 10 minutes in length (observations recorded separately for 0-3 min, 3-5 min, and 5-10 min intervals). Distances are measured with electronic range finders and recorded in three intervals, 0-50 m, 50-100 m, and > 100 m. Each transect consists of 10 points that are located 300 m apart (in open habitats) or 250 m apart (in forested habitats). About 130 – 180 transects are covered at the current level of effort. In addition, the Nevada Department of Wildlife (NDOW) surveyed 26 point count transects in eastern Nevada for several years prior to the NBC program. Other point count efforts conducted prior to the NBC's implementation include surveys on 9 transects along the Truckee River, surveys by the Bureau of Land Management (BLM) and NDOW of 40 montane streams in Churchill and Humboldt counties, as well as montane riparian surveys by the Forest Service in the Santa Rosa and Mountain City area. Methods used in all of these are compatible with the NBC point-count protocol. Most of the data collected on these surveys are included in the NBC data base.

The second module of the Nevada Bird Count is currently in the planning phase and will consist of completing a network of water/shorebird surveys in the State. Several monitoring efforts, some of them large-scale, that target these bird groups already exist in Nevada. The Nevada Wetland Bird Network will strive to connect monitoring efforts on existing sites and provide additional effort to ensure that all important aquatic sites of the state are included. Other modules, including a migrant landbird monitoring network, a wintering landbird monitoring network, and a special-species survey network will be addressed in later phases of program development.

Nevada Partners-in-Flight (NV PIF) provides the primary oversight function for the Nevada Bird Count, although others are invited to participate. The idea of the program originated as a concept to coordinate monitoring needs for implementation of NV PIF's Bird Conservation Plan (Neel 1999). Participants in the NBC work together on such issues as identifying management issues that warrant monitoring; design of the statewide

program so that it contributes to regional and national efforts; and providing guidance on data management, analysis, interpretation, and reporting of monitoring data. The information network and implementation of statewide monitoring is coordinated by the Great Basin Bird Observatory.

Breeding Bird Survey (BBS)

There are 42 BBS routes in Nevada, but only a small proportion have been surveyed on a regular basis. BBS routes are about 25 miles long, are located along roads, and consist of three-minute unlimited-distance point count at each of 50 stops (for more details see http://www.pwrc.usgs.gov/birds/). As part of the Nevada Bird Count, it is anticipated that BBS coverage in Nevada will increase in future years.

Waterfowl

NDOW has been conducting, at a minimum, four standard fixed-wing aerial surveys of the major waterbodies in Nevada every year. In December, a flight is conducted in northern Nevada for wintering swans. In January, a statewide mid-winter count of all waterfowl is conducted as part of the national winter waterfowl inventory. In March, a flight is conducted to estimate breeding goose pairs in northern Nevada. In May, an aerial survey is conducted to estimate the number of breeding duck pairs. Also, in an expanded survey effort, flights were done on a monthly basis in most of the past twenty years (Norm Saake, pers. comm.). The surveys are largely restricted to northern Nevada, because most significant populations of the targeted species occur in this region rather than in southern Nevada. In addition, brood counts on waterfowl are conducted by several National Wildlife Refuges and Wildlife Management Areas across the entire State.

Upland Gamebirds

Greater Sage Grouse leks are inventoried annually by NDOW using helicopter surveys ("discovery flights"). In addition, a ground crew of NDOW volunteers is deployed annually to count birds on known leks. The main measure of interest in these counts is number of males attending the lek. This information is used in management planning and harvest management. In some areas, NDOW and others also conduct Sage Grouse brood counts. NDOW collects wings from harvested Sage Grouse by placing wing barrels in areas of local hunter congregation (campgrounds etc.). Wings are used to estimate demographic parameters of the hunted populations, particularly sex and age ratios.

Other upland game birds present in Nevada include Wild Turkey, Blue Grouse, Ruffed Grouse, Himalayan Snowcock, Gray (Hungarian) Partridge, Ring-necked Pheasant, Chukar Partridge, California Quail, Gambel's Quail, Mountain Quail, and Mourning Dove. Of these, Blue Grouse, Gambel's Quail, Mountain Quail, and Mourning Dove are considered native to all or most of their current range in Nevada, while the others have been introduced for hunting through much or all of their range. Mourning Doves are assessed annually using coo counts, which are a point count survey with permanent

transects and stops at regular intervals to record Mourning Dove calls for a standard period of time. All upland game birds are monitored by NDOW through a post-season questionnaire that is mailed to 10% of the licensed hunters of a given season. The primary questions included in the request are: which species were hunted, which were harvested, and in which counties did hunting occur.

Nevada Breeding Bird Atlas

During the summers of 1997 – 2000, the Great Basin Bird Observatory surveyed 800 plots across Nevada as part of the Breeding Bird Atlas project. The purpose of the project was to document throughout the State evidence of probable or confirmed breeding for birds that breed in Nevada on a regular basis. The method was a time-unlimited area search of square plots randomly placed within each of 18 landcover (habitat) types. The project led to the first comprehensive maps for Nevada breeding distributions of many species. Field work for the project was largely volunteer-based. The Atlas is expected to be published in the spring of 2005.

Counts on Refuges and Management Areas

Several refuges have long-standing monitoring programs for specific groups of species or for single species. NDOW and Stillwater National Wildlife Refuge (NWR) conducted migratory shorebird surveys in Lahontan Valley since 1988. All birds in the Stillwater and Carson Lake Management areas were counted during aerial and ground surveys during peak migration in spring and fall. Also, Stillwater NWR has been conducting complete colony counts of breeding American White Pelicans on Anaho Island of Pyramid Lake, one of the largest breeding Pelican colonies in North America. Estimates of Pelican reproductive output are also generated annually from nestling counts. Ruby Lake NWR has been conducting surveys of waterfowl, with particular emphasis on a breeding population of Canvasbacks.

Bird Banding

Several monitoring efforts based on bird banding exist in Nevada. At least eleven breeding bird banding stations have been operated intermittently following the Monitoring Avian Productivity and Survivorship (MAPS) protocol, including two banding stations of the National Park Service in the Lake Mead area, Overton (since 1999) and Virgin River delta (2002 only, before burn); four banding stations by the Fish and Wildlife Service, Pahranagat NWR (1995-2001) and Ash Meadows NWR (1997-2001), Ruby Lake NWR (since 1996), and Mary's River (1998-2002); and five banding stations by the Great Basin Bird Observatory along the Truckee and Carson rivers, Numana Wetlands (1998-2002), McCarran Ranch (since 2001), Carson Delta (since 2002), Fort Churchill (since 2002), and Ambrose State Park (since 2002).

Also, several efforts exist to monitor landbird fall migration in Nevada. Four mist-net stations have been operated to capture small landbirds, including one by The Nature Conservancy at Torrance Ranch along the Amargosa River (2000-2002), and three by the

Great Basin Bird Observatory: one at Timber Lake along the lower Carson River (Stillwater Wildlife Management Area, 1998-2000), one at Numana Wetlands (1998-2000, and since 2003) and one at McCarran Ranch (since 2003) along the lower Truckee River.

Raptor Surveys

Several efforts are made to assess breeding raptors. The National Park Service and NDOW assess nest sites of raptors throughout the Mojave portion of Nevada using on-the-ground area searches for platform nests. NDOW has extended this effort into the central portion of Nevada through their Tonopah office, and has also done raptor nest surveys by helicopter in the past (C. Mortimore, pers. comm.).

Raptor migration has been monitored annually since 1983 by HawkWatch International in the Goshute Mountains in eastern Nevada. HawkWatch uses a combination of surveys and raptor banding for their monitoring program. NDOW surveys wintering raptors in the greater Elko areas one a three-year interval. This effort is part of a raptor assessment and monitoring plan designed in the 1970's for the entire Great Basin, which also includes several routes in western Nevada that are currently inactive. Also, Alan Hinde of Cambridge, MA, has been surveying and banding winter raptors in north-central and eastern Nevada since for many years. The Great Basin Bird Observatory is currently working with NDOW and Al Hinde to expand the current effort at winter raptor monitoring and to implement a Great Basin wide program.

Other Programs and Research Projects

Several smaller, intensive monitoring efforts also exist in Nevada. For instance, the Lower Colorado regional office of the Bureau of Reclamation (BOR) conducts play-back surveys for Yuma Clapper Rail on the lower Colorado River. These surveys are conducted three times per year by boat during the breeding season. BOR also conducts regular surveys for Western Yellow-billed Cuckoo and Southwestern Willow Flycatcher along the lower Colorado River and its tributaries (Virgin River, lower Muddy River, Meadow Valley Wash). The survey protocols involve repeated visits during which area searches and play-backs are used to determine presence, abundance, and breeding activity of the populations. Specifically, nest searches, territory mapping, habitat assessments, and fledgling banding were used as monitoring and assessment techniques. NDOW has also been conducting Southwestern Willow Flycatcher and Yellow-billed Cuckoo surveys in Pahranagat, Ash Meadows and Moapa since 1999, using the same techniques and protocols as used by BOR. Also, Point Reyes Bird Observatory is conducting a large-scale habitat association study of sagebrush-associated birds in eastern Oregon and some areas in northern Nevada. This study is particularly valuable for management issues of the sagesteppe portions of Nevada, i.e., the far northern part of the state.

Research projects have also been completed, or are in progress, that have relevance to bird monitoring:

- Cali Crampton of University of Nevada, Reno, (UNR) is conducting population and habitat studies of Phainopepla, a focal species of mesquite-catclaw habitats, in southern Clark County and the Virgin River. This effort follows Jeri Krueger's earlier thesis research project on Phainopepla.
- Stanford University and UNR conducted a bird community assessment of Muddy River birds using point counts in 2001.
- The Nature Conservancy and Great Basin Bird Observatory have been monitoring riparian birds along the middle and lower Truckee River using point counts since 1998.
- Stanford University is under contract with the US Forest Service to conduct a bird-habitat association study in the Toiyabe Range where prescribed fires are tested as a management technique for Pinyon-juniper forests.
- The Environmental Resources Department of UNR is under contract with the BLM to provide baseline data on Pinyon-juniper forests in White Pine County that compare and contrast bird communities in stands that have invaded sagebrush with reference areas.
- Great Basin National Park has conducted several studies in White Pine County, including a riparian bird community assessment and Cowbird impact study in the 1990's (Halterman et al.). An elevational bird distribution study was conducted by the Rocky Mountain Forest Experiment Station (RMFES, US Forest Service) in the early 1980's by Medin and cooperators, which was repeated in a collaborative effort of RMFES and NDOW in 2002.

These studies may provide an important head-start on some of the management issues to be addressed in the short-term objectives of the Coordinated Bird Monitoring Program (see sections below).

Integrating Ongoing Surveys into a Coordinated Monitoring Program

Integrating existing monitoring efforts is one of the main motivating factors for Coordinated Bird Monitoring at the state, regional, and continental scales. The purposes of integrating ongoing work into widely accessible databases are:

- Management agencies in need of specific bird conservation data can assess whether or not similar work has already been done
- Resources can be more specifically allocated to obtain information that is still lacking
- Information from local efforts can be utilized beyond the scope of single projects

Existing monitoring programs can contribute to the coordination effort by depositing data sets directly into a data repository, where they can be accessed either by a defined set of users or by the general public, depending on the nature of the data or restrictions set by the provider. Examples of such repositories and the wealth of information they have produced are the Breeding Bird Survey database of USGS' Patuxent Wildlife Research Center, or the Christmas Bird Count program of the National Audubon Society. Repositories that can accommodate all types of bird monitoring data at a continental scale are currently being constructed, and the Patuxent Wildlife Research Center is already at a stage where most monitoring data collected in Nevada can be stored.

In addition, the Great Basin Bird Observatory is currently working with USGS to provide a Nevada version of a data bank that is tailored to facilitate access and use by Nevada partners. This version will be focused on Nevada issues, name places, and applications typical to management questions for this region. To contribute data from ongoing efforts, partners will be asked to provide the following information about their monitoring effort:

- Bird groups targeted
- Location data (coordinates and projection information)
- Type of monitoring data collected (point count, area search, spot mapping, etc.)
- Type of habitat data collected (e.g., vegetation maps, vegetation structure data, floristics, etc.)
- Methods used (point count protocol, specifications for area searches, etc.)
- Year(s) and season(s) of data collection
- Any restrictions on data (e.g., protection of location data on threatened and endangered species, expected publication dates at which data can be released to general use, etc.)
- Contact information for project lead

In cases where major restrictions on data exist, a contributor may make arrangements to only provide these metadata to the general public and to handle requests for raw data through the project's contact person.

Products of Coordinated Bird Monitoring

Conceptually, coordinated bird monitoring can be divided into long-term and short-term objectives. Long-term programs implemented at the state level can be part of the continental program to obtain population trend estimates. Examples include the national Breeding Bird Survey (BBS) program, the national Breeding Pair survey for waterfowl, and national bird banding programs (e.g., MAPS).

Cooperators in state programs also agree to coordinate in carrying out short-term surveys designed for such goals as clarifying habitat relationships, estimating abundance, and evaluating projects. Thus, future revisions of the Nevada plan involve re-evaluating short-term objectives and developing new ones. Short-term surveys are intended to address specific management issues that need to be resolved at a fairly large geographic

scale, often involve multiple species, and thus exceed the data collection capacity of a typical graduate research project. Management issues, survey objectives, methods, roles and responsibilities, and recommendations for implementation are developed during plan revisions (Table 1).

Table 1. Recommended steps for developing new short-term Coordinated Bird Monitoring projects.

Description of the Management Issue
Survey Objectives
Information needed
Study areas
Focal species
Quantitative objectives
Methods
Bird survey methods
Sample size requirements
Habitat variables
Sampling plans
Roles and Responsibilities
Existing and additional surveys needed
Project management
Recommendations for Implementation

Key Variables and Focal Species in Short-term Coordinated Bird Monitoring Projects

Short-term surveys generally have one or more of three applications: regional models, site-based models, and project evaluation (Table 2). All three applications involve a set of one or more independent (predictor) variables and a dependent (response) variable. Sample size estimation procedures for the three applications are described in Appendix B. In most applications, predictor variables will be habitat descriptors, such as basic habitat type (e.g., derived from GAP or other habitat maps) for regional models, and more specific habitat descriptors (e.g., stand density, understory condition, forb cover) for site-based analyses. In project evaluation, the independent variable may be as simple as the presence/absence of a habitat implementation project, but can also include habitat characteristics that are a result of the project (e.g., tree densities after revegetation).

The response variable is typically a descriptor of bird abundance during any period of the year, variables describing demography, or a fitness indicator such as productivity or nutritional status. For most short-term products, we recommend using **total abundance of all focal species** identified for that habitat type as the standard response variable for most analyses. Focal species include all species that are of greatest concern to the management issue. The focal species lists were a combination of priority species named in the following lists: (1) threatened and endangered species; (2) the Partners-in-Flight state chapter's (NV PIF) priority species list; (3) the PIF "Watch List" species as described in the draft PIF Continental Bird Conservation Plan (Rich et al., 2003); (4) NDOW's species of concern matrix (2003 version); (5) USFWS species of concern list; (6) a list of all gamebirds in Nevada, and (7) a list of covered species in Nevada's largest Multi-Species Habitat Conservation Plan, i.e., the Clark County MSHCP. Other bird population or community descriptors can also be used in data analyses, focusing for example on only the abundance or fitness of a single species of interest, or on the proportion of habitat obligates present. However, for the first phase of Coordinated Bird Monitoring in Nevada, we propose to emphasize fairly general analyses before moving into species-specific applications, for which additional statistical considerations will be necessary.

Regional Models

Regional models express the parameter of interest, i.e., here the abundance of a set of focal species, as a function of independent (usually habitat) variables whose values are known throughout a region. The model is applied to the entire region or, more typically, to all of a regional habitat type (e.g., aspen or Mojave lowland riparian). The model may predict the abundance of a group of focal species, or it may be species-specific. The results of these analyses provide an estimate of regionwide species abundance, help managers understand large-scale patterns in abundance, and identify high- and low-quality habitats throughout the region. The models are constructed by obtaining field data from a substantial sample of randomly selected sites (usually using stratified sampling). Broadly defined habitat variables are then identified that are thought to be correlated with bird populations and which are available in regionwide GIS layers.

Site-based Models

Site-specific models also express the bird population parameters as a function of independent (usually habitat) variables. But in addition to variables whose values are known throughout the region, site-based models also include variables that were measured for each surveyed site and that are not available regionwide. These variables are usually habitat measurements that are obtained in the field or from detailed vegetation maps, aerial photos, or other supporting data. Results from these models usually make better predictions of bird population parameters for specific sites, and may reveal more about which habitat variables are correlated with bird population data than the regionwide model can reveal. Site-models cannot be extrapolated statistically to the entire region because, by definition, they include variables whose values are not known regionwide. However, basic habitat management guidelines derived from site-based models can be applied throughout the region in which the habitat characteristics used in the model apply. As a hypothetical example, if a site-based model for aspen were to predict a higher abundance of aspen-associated focal species with increased shrub coverage, then this insight can be applied to aspen management throughout the region in which aspen birds are believed to respond to this effect. Accuracy of site-based models is measured in the same way as for the regional models.

Project Evaluation

Project evaluations involve surveys on a habitat implementation project site before, during, and after the project. These surveys help evaluate and perhaps revise the project and they document effects of the project on birds.

Table 2. Summary of typical products of short-term Coordinated Bird Monitoring projects.

1. Regional model

Description

A model that expresses the parameter of interest (e.g., focal species abundance) as a function of independent variables (e.g., habitat type) whose values are known throughout a region

Uses

Understand large-scale patterns in abundance
Estimate statewide population
Identify low- and high-quality areas throughout the region

Methods

Maps showing distribution of the focal habitat are obtained
Regionwide bird surveys in the habitat, perhaps using stratification to insure samples are obtained from a variety of conditions
Independent variables, suspected to be correlated with bird abundance (or other dependent variables), are obtained (usually from GIS layers) throughout the region
Models are developed using standard regression methods

2. Site-based model

Description

Similar to the regional model but includes independent variables known only for the surveyed areas (e.g., understory type, tree density, burn history, etc.).

Uses

Better understand determinants of habitat quality by including specific habitat variables not measurable statewide
Estimate effects of proposed projects (e.g., habitat conversion/protection/restoration)

Methods

Same methods as for the regional model
In addition, stand-specific variables are collected by fieldwork, examination of aerial photos, or other sources

3. Project evaluation

Description

Estimated value of the parameter (e.g., focal species abundance), within a habitat implementation project area, measured before, during, and after the project.

Uses

Help evaluate habitat implementation projects, and perhaps revise project plans
Document effects of the project on birds

Methods

Surveys on the project area before, during and after the project

[1] The parameter of interest may be bird abundance during any period of the year or a fitness indicator such as productivity or nutritional status.

Management Issues to Be Addressed in Nevada

Extensive discussions were held with managers throughout Nevada to identify major bird conservation and management issues that Coordinated Bird Monitoring should address. Seven issues were identified as the most pressing regional concerns at the time of this document's preparation:

1. Identifying species at risk and causes of declines
2. Habitat associations of upland gamebirds
3. Effects of altering riparian habitats on birds
4. Effects of wetland loss and degradation on birds
5. Aspen habitat and aspen bird management
6. Effects of sagebrush fires and post-fire restoration on birds
7. Management of Pinyon-juniper habitats and their birds

Each of these issues is discussed in more detail below. We describe the management issue and how information collected on bird surveys can help address it, suggest survey goals, assess how well existing programs are providing the needed information, and make recommendations for obtaining any needed additional information.

The discussions below frequently mention the number of species affected by a management program or that need to be investigated. These numbers were derived from a comprehensive list of focal species in Nevada. The list was prepared using the general criterion that we should monitor species we would try to conserve if we knew they were declining. It totals 286 species, which includes all game and non-game species that occur regularly in Nevada at any time of year, but it does not include species that are at the very edge of their range in Nevada. Appendix A provides the full species list, along with information about habitats used at the time of occurrence in Nevada, and which specific management issues apply to each species.

1. Identifying Species at Risk and Causes of Declines

Description of the Management Issue

Many bird species are declining, or suspected to be declining, in Nevada and throughout the Intermountain West (Sauer et al. 1997). Unless declines are halted, some species will eventually warrant protection under the Endangered Species Act (ESA), a measure that is generally considered a last resort in species protection. Nearly all natural resource managers therefore recognize the need for a monitoring program designed to serve as an "early-warning" system that identifies declining species and causes of declines.

Identifying species at risk requires information on all 286 species regularly found in Nevada, and information must be collected throughout Nevada. For most nongame species, estimating trends solely for Nevada with sufficient precision is not feasible (Bart et al. 2003). Instead, information from Nevada must be combined with information from surrounding states. Collaboration with other states is thus essential. Increasing sample size - for a particular survey - just within Nevada is inefficient and for many species provides relatively little increase in precision of the regionwide trend estimate. An example from the Pacific Northwest for this phenomenon is provided by Bart et al. (2003).

Information on abundance and productivity in different habitats will also be needed but is much more expensive to obtain. Thus, these efforts should be focused on species and areas where potential threats or, conversely, opportunities to recover populations are most imminent (see management issues 2 – 7).

Survey Objectives

We used an accuracy target for trends proposed by Bart et al. (2003), building on earlier work by Butcher et al. (1993): 80% power to detect a 50% decline, occurring during no more than 20 years, using a significance level of 0.10, a two-tailed test, and incorporating effects of potential bias. Achieving the target for every species is probably not realistic. Bart et al. (2003) suggested achieving the target for 80% of the species that occur regularly in North America as a reasonable goal. It is not expected that the target can be achieved within a single state. Bart et al. (2003) recommended that the target be achieved for each species' entire range or an area one-third the size of the temperate portion of North America, whichever was smaller. The objective for this management issue is 80% power to detect a 20-year decline of 50%, occurring in an area no larger than one-third of the temperate regions of Canada and the US, among 80% of the species that warrant monitoring.

Methods

A panel of experts at the continental level has evaluated which survey methods would best be used to estimate long-term trends in population size, to describe spatial patterns in abundance, and to monitor fitness indicators, for all species regularly occurring in Canada and the United States. The results for Nevada birds are summarized in Table 3.

Table 3. Number of species and dependent variables that would be monitored by each major survey method.

Survey program	Season	Trends	Abundance	Fitness
1. Point counts and related programs	**Breeding**	217	217	41
2. Area-searches for landbirds	**Year-round**	37	193	6
3. Area searches for aquatic birds	**Year round**	51	71	43
4. Migration monitoring programs	**Migration**	51	5	49
5. Nest success programs	**Breeding**	1	4	140
6. Colony counts	**Breeding**	22	10	9
7. Aerial surveys	**Year round**	23	11	0
8. Nocturnal surveys	**Breeding**	9	10	0
9. Upland gamebird surveys	**Breeding**	11	11	11
10. Other surveys	**Year round**	38	40	41

Existing and Needed Information

The Nevada Bird Count and the BBS are primarily designed to sample landbirds. An analysis by Bart et al. (2003) estimated that 80% of the species well suited to monitoring using this approach could be adequately monitored (i.e., would achieve the accuracy target suggested above) if 369 BBS routes were surveyed in Nevada using current methods or 154 routes were surveyed if efforts were also made to reduce potential bias. Conducting counts off roads, as done in the Nevada Bird Count, will reduce bias as will training and evaluation of surveyors, measures the Nevada Bird Count has already implemented or plans to implement. The Nevada Bird Count has also initiated a program of double-sampling to estimate detection rates. Taken together, these measures should reduce potential bias to the level identified by Bart et al. (2003) such that the monitoring target will be achieved by 154 BBS, or other similar, routes. The Nevada Bird Count currently covers 180 routes annually, thus at least 80% of the 216 species suitable for monitoring using this approach are probably already being covered adequately. Thus, no changes are needed in the Nevada Bird Count, other than continuing to implement the measures to reduce potential bias described above, but assurance is needed for long-term support of the Count. Also, to accommodate Nevada representation in the national BBS effort, increased coverage of the currently under-sampled BBS routes in Nevada is a priority.

Trend data on waterfowl is currently derived at the national level through the Duck Breeding Pair Survey. A large number of the ducks that regularly occur in Nevada during migration and winter breed elsewhere and are probably sufficiently covered through these surveys in other regions. The fact that several aerial surveys for waterfowl are already being conducted by NDOW can be used as an opportunity to derive additional trend estimates for other seasons, if this can be coordinated at a regional scale.

Good regional trend data are not currently available for most shorebirds and waterbirds in the Intermountain West, although several local efforts have produced important survey data for some sites (e.g., Stillwater NWR and Ruby Lake NWR in Nevada, Great Salt

Lake in Utah). As part of the Nevada Coordinated Bird Monitoring Program for Nevada, a group of Nevada biologists has collaborated with USGS to conduct an aquatic site assessment that will serve as a basis for population monitoring of shorebirds and waterbirds. Specifically, the sites that need to be included in statewide surveys, the most important areas within these sites, existing survey efforts, and recommended survey methods were identified in the aquatic site assessment. The results of this effort are presented in Appendix C ("Aquatic sites relevant to bird monitoring in Nevada").

Upland game species are currently being monitored by NDOW through post-hunting season questionnaires, coo counts of Mourning Doves, wing barrel data, and lek counts of Sage Grouse. Ways to supplement this information will be explored with NDOW to determine which additional information is desirable to their purposes. An immediately available option would be an information feedback system that would allow NDOW easy access to Nevada Bird Count data on game species.

Raptors are monitored in Nevada through nest searches, some winter surveys, and migration monitoring in the Goshute Range, but statewide coverage is incomplete as of yet. This is also true for colony counts, migration monitoring of landbirds, productivity monitoring of landbirds, and surveys for nocturnal species. Because many of these call for fairly specialized protocols, they are currently done based on local funding opportunities rather than with the intent to achieve comprehensive coverage. The long-term goal of Coordinated Bird Monitoring includes sufficient coverage for these survey types to accommodate regional trend estimates on the parameters measured.

Surveys that cannot be conducted using multi-species protocols will be constructed around existing survey efforts. For instance, BOR and NDOW have intensive survey efforts already in place for breeding population monitoring of Yuma Clapper Rail, Western Yellow-billed Cuckoo, and Southwestern Willow Flycatcher. These efforts cover the majority of these species' breeding distributions in Nevada and may thus be sufficient as a contribution for regional trend estimates. Statewide priorities for other such efforts will be identified and discussed by the Nevada Coordinated Bird Monitoring Steering Committee.

Recommendations

The following steps are recommended to integrate the Nevada effort into regional trend estimation.

- Implement the Nevada Bird Count with long-term goals, objectives, and strategies, including increased coverage of Nevada's BBS routes
- Implement a statewide shorebird/waterbird monitoring plan that estimates year-round bird use of Nevada's most important aquatic sites (Appendix C)
- Coordinate with NDOW to explore the option of using aerial waterfowl surveys also for shorebird counts

- Coordinate with NDOW to determine which if any other upland gamebird surveys are desirable
- Increase coverage of raptor surveys, colony counts, and nocturnal species surveys
- Generate a general data base for existing and new monitoring programs
- Coordinate with other states of the intermountain west to increase effort toward productivity and migrant monitoring in the region

2. Habitat Associations of Upland Gamebirds

Description of the Management Issue

Significant work has been done or is underway, regionwide and in Nevada, to address habitat management for upland gamebirds. For instance, bird-related guidelines for managing sagebrush habitats are provided from research on Sage Grouse (Barrett et al. 2000). However, because information that can guide habitat management for upland game species necessarily comes from single-species assessments, the Sage Grouse guidelines may not be applicable to all other upland game species. For instance, additional information on Blue Grouse or Mountain Quail habitat use in Nevada would be helpful to gamebird managers (C. Mortimore, pers. comm.). A complete list of gamebirds that occur regularly in Nevada is provided in Table 4.

Table 4: List of upland gamebirds that regularly occur in Nevada and primary habitat used. All of them are focal species for this management issue.

Species	Habitat
Chukar	sagebrush
Gray Partridge	agricultural
Ring-necked Pheasant	agricultural
Wild Turkey	lowland riparian, montane shrublands
Himalayan Snowcock	sagebrush
Ruffed Grouse	aspen
Blue Grouse	coniferous forests, montane riparian
Greater Sage Grouse	sagebrush, montane riparian
Gambel's Quail	agricultural, lowland riparian
California Quail	agricultural, lowland riparian
Mountain Quail	montane riparian
Mourning Dove	sagebrush, salt desert, lowland riparian

It is difficult to design a program that encompasses needs for multiple upland game species due to their differences in breeding seasons, habitat use, mating systems, and degree of secrecy. Therefore, the primary objective at the time of this document is to simply make information from multi-species monitoring programs, such as the Nevada Bird Count and BBS, better available to gamebird managers and to explore options of habitat analyses using these data. Future expansion of bird surveys toward additional

coverage of other upland game species will be determined by NDOW based on their information needs.

Recommendations

- Continue coordination with NDOW on the use of multi-species programs, such as the Nevada Bird Count and BBS, to provide additional data and analyses on upland gamebird habitat use
- Explore options for expanding survey coverage for species of particular interest to managers

3. Effects of Altering Riparian Habitats on Birds

Description of the Management Issue

Riparian habitats are here defined to include rivers, lowland springs and streams, and montane streams. Major rivers include the Truckee, Carson, Walker, Mary's, Reese, Virgin, Muddy, Colorado, White and entire Humboldt River system. Lowland springs and streams occur mainly in southern Nevada, for example at Meadow Valley Wash, Ash Meadows, and Warm Springs. Montane streams are widely distributed in northern Nevada but in southern Nevada occur mainly on the Spring and Sheep Mountains.

Riparian areas in Nevada are used by a total of 136 bird species, including 66 focal species for this objective (Table 5, Appendix A). Riparian areas are among the most heavily impacted environments in Nevada. During the past 150 years, riparian habitats have been converted, rivers have been channelized, and substantial amounts of water have been withdrawn for agricultural or municipal uses. Nevada is one of the fastest-growing regions in the country so the pressure to develop riparian bottomlands, remove ground water, and develop other water projects is likely to increase during the coming decades. Concerns about impacts on riparian areas have led to many riparian restoration efforts. In 2002, Nevada passed a $200 million bond issue for acquisition and preservation of open space and wildlife habitats around the state, and much of this money is intended for the protection of riparian resources.

Table 5: List of focal species for riparian management issues. Only species that should be used for modeling and project evaluation are included.

Snowy Egret	**Hummingbird**	**Crissal Thrasher**
White-faced Ibis	**Calliope Hummingbird**	**Phainopepla**
Osprey	**Rufous Hummingbird**	**Orange-crowned Warbler**
Northern Harrier	**White-headed Woodpecker**	**Virginia's Warbler**
Bald Eagle	**Lewis's Woodpecker**	**Lucy's Warbler**
Cooper's Hawk	**Gila Woodpecker**	**Black-throated Gray Warbler**
Northern Goshawk	**Red-breasted Sapsucker**	**Grace's Warbler**
Swainson's Hawk	**Red-naped Sapsucker**	**MacGillivray's Warbler**
Blue Grouse	**Willow Flycatcher**	**Wilson's Warbler**
Greater Sage Grouse	**Black Phoebe**	**Yellow-breasted Chat**
Gambel's Quail	**Vermilion Flycatcher**	**Summer Tanager**
Mountain Quail	**Brown-crested Flycatcher**	**Abert's Towhee**
Clapper Rail	**Ash-throated Flycatcher**	**Black-chinned Sparrow**
Yellow-billed Cuckoo	**Loggerhead Shrike**	**Grasshopper Sparrow**
Short-eared Owl	**Bell's Vireo**	**Black-headed Grosbeak**
Long-eared Owl	**Gray Vireo**	**Blue Grosbeak**
Lesser Nighthawk	**Bank Swallow**	**Indigo Bunting**
White-throated Swift	**Verdin**	**Lazuli Bunting**
Black-chinned Hummingbird	**American Dipper**	**Bobolink**
Costa's Hummingbird	**Black-tailed Gnatcatcher**	**Tricolored Blackbird**
Anna's Hummingbird	**Western Bluebird**	**Hooded Oriole**
Broad-tailed	**Swainson's Thrush**	

Numerous lowland riparian habitat implementation projects have been undertaken, or are being considered, in Nevada. For example, restoration is planned or underway on McCarran, Ferretto, and Mustang Ranches on the Truckee River; on River Fork Ranch on the Carson River; on Rosaci Ranch on the Walker River; and on Torrance and Parker Ranches on the Amargosa River. In each of these projects, studies are needed (and in many cases underway) of effects on birds of planned or occurring activities.

Montane streams of particular interest in Nevada include Mahogany Creek (proposed Important Bird Area); streams in the Montana Range, where restoration work is planned; streams in the Selenite Range and other ranges in BLM's Winnemucca District, where effects on birds of a recent change in grazing management is being evaluated; streams in the Santa Rosa Range, the Mountain City area, and the Spring Mountains which support focal species that are otherwise rare in Nevada. Other sites of importance may include Porter Springs in the Seven Troughs Range and streams of the Snowstorm Range which have been studied by NDOW and others.

Managers working in riparian areas primarily need two kinds of information: predicted effects of proposed habitat implementation projects on birds, and actual effects of implemented projects. A site-based model is needed to provide the first kind of information; project evaluations are needed to produce the second kind of information.

See "Products from Coordinated Bird Monitoring" section (above) and Appendix B for more information about site-based models.

Survey Objectives

Needed information: Project evaluations should, at a minimum, document breeding abundance of focal species, but focal species abundance throughout the year and measures of fitness, including productivity during the breeding season and foraging success during migration, would also be highly desirable especially in large projects.

A site-based model should predict focal species abundance relative to a continuum in habitat conditions influenced by fire, grazing, and restoration treatments. The models should be generated for both, breeding and migration, but this draft of the Nevada Plan only discusses abundance during the breeding season. Later revisions will address other needed information. Short-term trends in abundance, as projects are implemented, may also be of interest particularly in large projects.

Quantitative Objectives: Species-specific estimates of abundance are desirable but often cannot be obtained with sufficient precision to be useful. As an alternative, we define the primary parameter of interest as the mean number of individuals of all riparian focal species recorded with a large sample.

The desired accuracy of models to predict abundance, should a proposed project be implemented, must be established independently of specific projects. More experience is needed in developing these models for riparian habitats in Nevada, but we believe that a reasonable initial target is that the CV of the predicted abundance for a single project area should be ≤ 0.25.

Projects affecting riparian habitat often cause major changes in habitat and thus bird abundance so surveys can be designed to detect large, rather than small, changes. As an approximate guideline, it seems reasonable that power to detect a 2-3 - fold change should be at least 80%. The lower precision goal (detecting a 3-fold change) might be appropriate for smaller projects. The higher precision goal might be appropriate for larger projects.

Methods

Bird survey methods: Abundance of landbirds during the breeding season is usually determined using point counts in programs like the Nevada Bird Count.

Sample Size Requirements: Sample sizes for project evaluations were estimated from data collected in the Nevada Bird Count. We used individual points as the primary sampling unit, assuming that points would be distributed evenly across the project area. The Nevada Bird Count uses two-stage sampling (selection of transects, selection of points within transects) so we calculated means and *SD*s within transects and then estimated *CV*s as (mean of the *SD*s/mean of the means). The number of surveys per year

varied from 1 to 3. Our sample included 50 transects surveyed during 2001-2003. There was little variation in CVs with number of surveys indicating that most variation results from change in place, rather than change in time. The grand CV was 1.36 (Table 6). If the level of significance is 0.05 and power is 0.8, then *G*, from Table B3 (Appendix B), is 16 and, using *CV*=1.5 to be conservative, the needed sample is 135 if the change is *R*=2 and is 76 if the change is *R*=3 (Table B4, Appendix B). If surveys are conducted for three years prior to a project and 3 years after a project, then 25-50 points should be surveyed each year depending on whether a two-fold or three-fold change is expected. Note, however, that the parameter is number of individuals of all riparian species of special concern. Much larger sample sizes would be needed for species-specific estimates, and the sample size requirement would vary enormously depending on abundance of the focal species in the project area.

Table 6. CVs ($SD(y_i)/\overline{y}$) for 10-minute point counts in riparian habitat conducted during the Nevada Bird Count[1].

	1 survey	2 surveys	3 surveys	All
N Transects	28	8	14	50
N Points	275	82	139	496
Average SD	1.0	0.5	0.8	0.8
Mean no. birds	0.7	0.4	0.6	0.6
CV(means)	1.37	1.41	1.31	1.36

[1] y_i is the mean number of birds recorded at the i^{th} station; the calculations (see text) exclude two counts >80; the remaining counts were <10 except for two counts of 11 and 21.

Sample sizes required to construct the site-based model are hard to estimate, in part because the number of different models must be specified. At present, we suspect that separate models will be needed for (a) northern rivers, (b) southern rivers and springs, and (c) montane streams. An initial estimate is that the accuracy target for each of these models (*CV*s of 0.50) can be met if data are available from 200 points (20 ten-point transects in the Nevada Bird Count). Three counts per season from each point would be useful (and are being collected at some stations) but a single count might suffice. The sample size target is thus 200 points in each of the three regions: northern rivers, southern rivers and springs, and montane streams.

Habitat survey methods: Habitat data already exist for several projects (e.g., BOR's lower Colorado River surveys, and Truckee and Carson River surveys) and may be supplemented with data from additional sites to increase our knowledge of habitat associations. This information is essential in developing the predictive model since the predictions are based on habitat variables (defined broadly). Habitat variables may include predictors such as width of riparian woodland corridor, total woodland cover, cover by exotic shrubs and trees, measures of foliage height diversity, cover by native understory species, cover by floodplain wetlands, and emergent vegetation cover.

Sampling Plans: Project evaluation surveys should probably employ one-stage systematic sampling, perhaps preceded by stratification, when project areas are small enough for this to be feasible, and should use multi-stage sampling (e.g., clusters of 10

stations as in the Nevada Bird Count) when the strata are too large for this approach. Precision will generally be higher, for a fixed number of stations, with the first approach.

The same general approach will probably work to gather the data for development of the site-based predictive model, though in most cases strata will be large enough that clusters of point count stations will be used. Strata should be delineated to insure that a wide range of habitat types is included. Analysis should acknowledge the stratification and multi-stage nature of the sampling plan.

Finding high-quality sites may be especially difficult. Mary's River may provide the best site for developing the model for northern rivers. Warm Springs may be most useful in developing the model for southern rivers and springs, although better reference sites for Mojave riparian areas may be found outside of Nevada. For montane streams, several exclosure sites could be used as reference sites, for example in Sheldon NWR, at Mahogany Creek, several BLM exclosures in Humboldt County. However, other areas may also provide useful information on reference conditions.

Roles and Responsibilities

Project monitoring surveys: Information about existing projects that will affect riparian birds is summarized in Table 7.

Table 7. Projects that will affect riparian birds in Nevada and information about them.

Name	Location	Size	Status	Bird monitoring done?
McCarran Ranch	Truckee River	5 river miles	currently being implemented	yes
Ferretto Ranch	Truckee River	2 river miles	in planning stage	yes, but needs to be combined with McCarran for evaluation
Mustang Ranch	Truckee River	5 river miles	in planning stage	some, but probably not enough for evaluation
River Fork Ranch	Carson River	3 river miles (?)	in planning stage	some, but probably not enough for evaluation
Rosaci Ranch	Walker River	2 river miles (?)	in planning stage	yes (enough for evaluation?)
Humboldt County streams	about 40 streams	about 100 stream miles total	change in grazing management implemented in late 90's	yes
Torrance Ranch	Amargosa River	2 river miles (?)	partially implemented	some, but long-term uncertain
Parker Ranch	Amargosa River	2 river miles (?)	partially implemented	none currently
Las Vegas Valley Wash		?	in planning stage	?
Meadow Valley Wash		60 river miles	in planning stage	some, but no long-term plans
Virgin River		about 25 river miles	likely projects in the future	some, but coordination needed
Muddy River, Warm Springs		about 6 miles of river	in planning stage	some, but no long-term plans
Ash Meadows spring restoration projects	Ash Meadows NWR	several springs	several have been completed	none currently
Corn Creek	Desert Wildlife Range	1 mile of stream	partially completed	some, but not enough for evaluation

Predictive (site-based) model: Many riparian surveys have been conducted in Nevada. For example, surveys made during the Nevada Bird Count included nine 10-point transects on the middle and lower Truckee River (three visits during each of two breeding seasons); seven 10-point transects along the Carson River (two or four visits during each of two breeding seasons); and 20 or more, 10-point transects located elsewhere in the State surveyed once per season. Other surveys, conducted by NDOW and BLM, covered stretches the Humboldt River and numerous tributaries of the King, Quinn, Reese, and

Humboldt rivers. Habitat information has been recorded in some, but not all, of these surveys and methods have varied. The next steps in developing predictive models are to consolidate this information, record additional habitat data as needed, and develop draft models. This work will clarify what additional field work, if any, is needed.

Project Management: A number of funding partners (Clark County MSHCP, BLM, USFS, NDOW, and USGS) are providing support for the Nevada Bird Count, which is providing much of the currently available data. As part of the Nevada Bird Count program, GBBO takes on responsibility for data management, analysis and reporting. Coordination with other ongoing monitoring efforts is also actively pursued as part of the mission of GBBO's Nevada Bird Count. Information resulting from analyses toward this management issue will be made available online, through reports to funding partners, and through peer-reviewed publications.

Recommendations

- Continue project monitoring that is ongoing until scientific evaluation is possible
- Fill gaps in survey coverage sufficiently to develop riparian site-based models
- Evaluate restoration and other habitat modification projects that are not sufficiently monitored at present
- Provide an information network among managers and scientists that identifies upcoming projects for pre- and post-project bird monitoring.

4. Effects of Wetland Loss and Degradation on Birds

Description of the Management Issue

Wetlands are here defined as including lakes, reservoirs, playas, and marshes. Wetlands of particular importance to birds in Nevada include Walker, Pyramid, and Washoe Lakes; marshes at Stillwater, Ruby Lake, Ash Meadows, and Pahranagat NWRs; and marshes at Carson Lake, Mason Valley, and Overton WMAs, and the lower Colorado River. Playas in the northwestern portion of the state and water storage reservoirs may also be important, especially for migrating birds, but are currently not well investigated.

Wetlands in Nevada are used regularly by 94 bird species including 55 focal species, including 23 species of waterfowl (Table 8, Appendix A). Providing migration stop-over habitat is probably the most important function of Great Basin wetlands for many species of waterfowl, waterbirds and shorebirds. Walker Lake, for example, is a site of regional importance for Common Loons, Clark's Grebes, and American White Pelicans. Lahontan Valley is a major stop-over site for most aquatic species, and especially for shorebirds. Major breeding colonies of Black-necked Stilts and American Avocets, also depend on these habitat types. Many permanent wetlands serve as wintering habitat for waterfowl, for example Tundra Swans.

Table 8: List of focal species for wetland management issues. Only species that should be used for modeling and project evaluation are included.

Common Loon	**Northern Shoveler**	**Snowy Plover**
Clark's Grebe	**Blue-winged Teal**	**American Avocet**
American White Pelican	**Cinnamon Teal**	**Black-necked Stilt**
Least Bittern	**Canvasback**	**Willet**
American Bittern	**Redhead**	**Long-billed Curlew**
Snowy Egret	**Ring-necked Duck**	**Marbled Godwit**
White-faced Ibis	**Greater Scaup**	**Western Sandpiper**
Tundra Swan	**Lesser Scaup**	**Least Sandpiper**
Trumpeter Swan	**Common Goldeneye**	**Long-billed Dowitcher**
Greater White-fronted Goose	**Bufflehead**	**Wilson's Phalarope**
	Common Merganser	**Red-necked Phalarope**
Snow Goose	**Red-breasted Merganser**	**Ring-billed Gull**
Ross's Goose	**Ruddy Duck**	**California Gull**
Canada Goose	**Northern Harrier**	**Caspian Tern**
Mallard	**Bald Eagle**	**Forster's Tern**
Gadwall	**Peregrine Falcon**	**Black Tern**
Green-winged Teal	**Clapper Rail**	**Lesser Nighthawk**
American Wigeon	**Sandhill Crane**	**White-throated Swift**
Northern Pintail	**Black-bellied Plover**	**Tricolored Blackbird**

Loss and degradation of wetlands, particularly due to the withdrawal of water, is recognized as a major threat in the Great Basin and will probably become more severe as consumptive uses of water increase. For example, large-scale dewatering of the Walker River has led to a decrease in the level of Walker Lake and increased salinization. The process is expected to continue and will probably make Walker Lake unsuitable for fish and thus for the fish-eating migrants, such as Common Loon. As a result of stream dewatering, many playa wetlands that used to be permanent have dried up (e.g., Lake Winnemucca) or have become ephemeral. Terminal wetlands in the Great Basin are naturally shallow and relatively saline, amplifying impacts of changes in water delivery on resource availability for wetland birds. Decline of these resources may affect game and nongame bird populations over a wide area.

Each year, managers make decisions about how to allocate water among competing uses. In making these decisions, they need better information about how birds will be affected by alternate strategies. The needed information is gathered by surveying birds and recording water levels and their effects on habitat availability for different foraging needs. This data collection process, at least for the waterbird and shorebird component, is not organized throughout the state at present. Therefore, one of the main recommendations will be to assess existing habitat information for aquatic birds in Nevada, and to coordinate collection of additional data as needed. Wildlife biologists whom we consulted in preparing this plan emphasized that models showing habitat relationships of wetland birds will be useful for optimizing water delivery for these groups with limited water available for these purposes. The primary need is thus for site-specific models that predict bird use at the times of year that are most important to the

populations, as a function of water level. Sites where such models may be derived include Stillwater NWR, Ruby Lake NWR, Carson Lake WMA, Overton WMA, Pahranagat NWR, and Mason Valley WMA; and Walker Lake. The development of site-specific models will also greatly facilitate coordinated regional wetland management called for in both the Intermountain West Shorebird Plan and the Intermountain West Water Bird Plan.

As with riparian habitat, numerous projects are under discussion for which predicted effects on wetlands birds would be useful. Examples include Pahranagat NWR, where enhancements for fish are underway and effects on birds are also of interest; McCarran Ranch where oxbow wetlands are being created; and 102 Ranch on the Truckee River, a large former gravel mine where wetland enhancements would be particularly valuable. Thus, in addition to analyses at existing sites, a site-based model is needed to predict effects on birds of proposed projects that will create new habitat or affect existing habitat. See "Products from Coordinated Bird Monitoring Projects" and Appendix B for more information about site-based models.

Survey Objectives

Information Needed: Abundance data for all species groups throughout the year is needed. Waterfowl abundance data may already be sufficient with the existing survey effort, while additional data on waterbirds and shorebirds are likely needed. Surveys during migration are particularly important at many sites. Fitness indicators such as productivity and foraging success are desirable but are not addressed in this version of the Nevada Plan.

Quantitative Objectives: Most aquatic sites can be covered thoroughly by surveys so obtaining species-specific estimates of number present is probably feasible. More experience is needed in developing these models, but we believe that a reasonable initial target is that the CV of the predicted abundance for a single site should be ≤ 0.25.

Methods

Bird survey methods: Abundance of aquatic birds is usually determined using area searches by boat or air plane across all of the site or in a series of randomly selected plots. Careful attention must be paid to estimating detection rates where birds are obscured by vegetation because the vegetation may change between years leading to substantial changes in numbers recorded even if the number of birds present does not change. Site descriptions, including survey protocols, are being drafted for all major aquatic sites in Nevada (Appendix C).

Sample Size Requirements: Sample size requirements are difficult to estimate at present because we do not know how many different models will be required and because existing data have not yet been analyzed. We believe a reasonable approach, given this uncertainty, is to suggest that monthly surveys be made on as many aquatic sites, where birds are influenced by water level manipulations, as possible. During 2004, an analysis

of existing data should be conducted to determine how large a sample is needed to construct models that will achieve the accuracy target above.

Habitat survey methods: An initial list of habitat variables that should be included in a model includes water level data from staff gauges (or water delivery data in managed wetlands) obtained for each bird survey period, topographic data that allow relating water level to water depth, and vegetation maps that reveal wetland vegetation types.

Sampling Plans: Surveys usually cover all of a given site (i.e., there is no sampling in space). When this is not true, stratification is often useful, followed by systematic, or occasionally simple random, selection of plots. Survey times should be selected without regard to number of birds present (i.e., surveyors must avoid the tendency to do a survey *because* large numbers of birds are present).

Roles and Responsibilities

Ongoing efforts should be coordinated in a statewide networking effort that includes NDOW's gamebird biologists, refuges, management areas, and other managers of significant aquatic sites, in order to identify information already available and gaps in data that need to be filled. GBBO has agreed to take the lead in building the network. Initial surveys that include habitat assessments should include all or most actively managed aquatic sites (e.g. refuges and management areas), because detailed information on water delivery and vegetation maps are usually available for these sites. GBBO will be seeking cooperation with site managers to compile the information needed and provide limited logistical support and personnel where possible for additional surveys.

Project Management

The Nevada Important Bird Areas (IBA) program of the National Audubon Society has taken a lead in compiling inventory information for Nevada aquatic sites, including conservation objectives and management issues that are being addressed by NWRs, WMAs and other entities managing large sites. In collaboration with NV-IBA, GBBO and USGS are willing to compile and disseminate monitoring data that are already available and that are obtained in additional survey efforts. Regional analyses and data will be made available online, through reports to management agencies, and through peer-reviewed publications.

Recommendations

- Complete the Nevada aquatic site assessment that has been drafted for the purpose of identifying wetland bird monitoring needs (Appendix C)
- Coordinate with NDOW, FWS , and IBA to determine which additional information on habitat use of aquatic birds would be most useful, given ongoing efforts
- Assess existing bird survey data, and implement new surveys, at focal sites for the modeling effort.

- Assess existing supporting data (aerial photos, topographic maps, staff gauge data, etc.) that can be used in an analyses of geo-referenced count data
- Prepare prototype models from the most important sites, estimate the accuracy of predictions they make, and develop guidelines describing additional data needed.
- Recruit volunteers to conduct surveys at all other Nevada wetlands as frequently as possible; use the results to improve the predictive power of the models, both at the focal sites (listed in Appendix C) and at other sites.

5. Aspen Habitat and Aspen Bird Management

Description of the Management Issue

Quaking aspen (*Populus tremuloides*) are at the southern limit of their range in Nevada and are primarily restricted to montane riparian and snowfield areas. Aspen make up only a minor component of the Nevada landscape but support a significant number of priority and focal species.

Aspen habitats are used by at least 19 bird species; 9 of them are Nevada species of special concern including Northern Goshawk, Cooper's Hawk, Lewis's Woodpecker, Red-breasted Sapsucker, Mountain Bluebird, Swainson's Thrush, and Orange-crowned and MacGillivray's warblers (Table 9, Appendix A). Aspen are heavily used in the breeding season and may be important for migrants though this issue is not well-studied in the Great Basin.

Table 9: List of species that regularly use aspen habitats of Nevada. Focal species for this management issue are in bold.

Cooper's Hawk	Warbling Vireo	**MacGillivray's Warbler**
Northern Goshawk	Black-capped Chickadee	Dark-eyed Junco
Ruffed Grouse	House Wren	**Black-headed Grosbeak**
Lewis's Woodpecker	**Mountain Bluebird**	**Lazuli Bunting**
Northern Flicker	**Swainson's Thrush**	House Finch
Williamson's Sapsucker	Hermit Thrush	
Red-breasted Sapsucker	American Robin	
Dusky Flycatcher	**Orange-crowned Warbler**	

A gradual loss of aspen appears to be occurring in Nevada and elsewhere in the Intermountain West (Wall et al. 2001). The immediate cause appears to be regeneration failure within stands leading to stand loss, and a failure of new stands to develop. Recreational activities, improper grazing practices within stands, and climate change have been identified as possible causes of the decline. Managers need better information on the importance of aspen stands to birds in Nevada. Specific topics of interest include identifying bird species that depend on aspen to reach their highest abundance and/or fitness, and describing the characteristics of aspen stands (e.g., patch size, understory

development, tree size) that determine habitat quality for aspen birds. This information will help managers determine the importance of research on aspen, which habitat elements matter most to birds, and will help identify stands which should be protected.

The greatest need is for a statewide model that describes the overall importance of aspen to birds and that identifies habitat features most strongly correlated with bird abundance and fitness. A few areas, however, are of particular concern and may warrant site-based models and project evaluation. For instance, the US Forest Service is particularly interested in the value of aspen in Mountain City and the Santa Rosas, since concerns for aspen loss have been identified as a primary land management issue of these areas.

Survey Objectives

Information Needed: Models are needed to predict abundance and productivity of birds in aspen during the breeding season and of abundance and fitness of birds in aspen during migration. This draft of the Nevada Plan only discusses abundance during the breeding season. Abundance is here defined as the mean number of birds detected in a 10-minute point count in a circle with 50-m radius. A more biologically relevant definition (e.g., density of territorial males and their mates) may be used in future studies.

Quantitative Objectives: Statewide (regional) and site-based models are needed; project evaluations will likely also be needed, although no specific projects have been identified at the time of this draft. The regional model will permit a statewide evaluation of the importance of aspen to birds and identification of large-scale patterns in aspen use. The site-based model will help reveal which traits of aspen stands (including landscape variables) are most highly correlated with bird abundance in aspen. See "Products from Coordinated Monitoring Projects" and Appendix B for more information about regional and site-based models. We suggest that species-specific and multi-species versions of each model be constructed. More work is needed on reasonable accuracy targets for these models. Interim targets are CV < 0.5 for the species-specific models and CV < 0.25 for the multi-species models.

Methods

Bird survey methods: The Nevada Bird Count protocol (10-minute point counts with a 50-m radius circle) will be used.

Sample Size Requirements: Sample sizes were estimated from data collected in the Nevada Bird Count. Methods are described under the "Riparian" management issue. Our sample included 11 transects surveyed during 2002-2003, conducted once per site per year. The CV was 0.86 (Table 10). If the level of significance is 0.05 and power is 0.8, then *G*, from Table B3 (Appendix B), is 16 and, using *CV* = 1.0 to be conservative, the needed sample is 60 (for *R* = 2; Table B4, Appendix B). Thus, for project evaluations, we suggest a sample of 60 points, evenly distributed across the project area.

Table 10. CVs ($SD(y_i)/\overline{y}$) for 10-minute point counts in riparian habitat conducted during the Nevada Bird Count[1].

N Transects	11
N Points	160
Average SD	1.01
Mean no. birds	1.18
CV(means)	0.86

[1] y_i is the mean number of birds recorded at the i^{th} station.

Sample sizes required to construct the regional models are hard to estimate because little work has been done on these relationships and thus we have little basis for estimating reasonable correlation coefficients between the habitat variables and bird density. For planning purposes, we suggest conducting surveys in 15 additional aspen transects in 2004. Analyses will then be carried out to refine the sample size estimate.

Habitat variables: The habitat variables for the regional model will include stand size and elevation, and may also include measures such as soil type, slope, and aspect that are available from geo-referenced data sources. The habitat variables for the site-based model will include measures of dominant plant taxa, stand density, and height of (a) grass-forbs, (b) shrubs and saplings, (c) understory trees, and (d) overstory trees. Average diameter-at-breast-height of overstory trees should also be used.

Sampling Plans: Most if not all surveys will be conducted using the Nevada Bird Count protocol (one 10-station cluster surveyed once per season). Stratification should be considered to insure that high-quality stands are included in the sampling.

Roles and Responsibilities

Current and Needed Surveys: Approximately 30 ten-point transects have been surveyed during the past two years and additional surveys were conducted by NDOW in the 1980s and 1990s. Approximately 15 additional transects will be surveyed in 2004.

Project Management: A number of funding partners (BLM, USFS, NDOW, and USGS) are currently providing support for the Nevada Bird Count, which is generating much of the currently available data. As part of the Nevada Bird Count program, GBBO takes on responsibility for data management, analysis and reporting. Coordination with other ongoing monitoring efforts is also actively pursued as part of the mission of GBBO's Nevada Bird Count. Information resulting from analyses toward this management issue will be made available online, through reports to funding partners, and through peer-reviewed publications.

Recommendations

- Obtain available information from aspen stand assessments in the Mountain City and Santa Rosa areas from USFS

- Decide on final list of additional habitat variables and how they will be measured for both models
- Obtain additional habitat variables for existing surveys, as needed
- Carry out preliminary analyses for the statewide model (before the 2004 field season).

6. Effects of Sagebrush Fires and Post-Fire Restoration on Birds

Sagebrush habitats, characterized by big sagebrush (*Artemisia tridentata*), cover much of the Great Basin portion of Nevada at elevations above the saltbush-greasewood zone. West (1993) recognizes two sagebrush types: the sagebrush steppe, characterized originally by extensive perennial bunchgrasses co-dominant with sagebrush, occurs in the northern margin of Nevada and throughout the northern Great Basin in Idaho and eastern Oregon. The Great Basin sagebrush zone, characterized originally by much less herbaceous vegetation and taller shrubs than the sagesteppe, occurs largely in central and eastern Nevada and in other eastern parts of the Great Basin.

Sagebrush habitats in Nevada are used by at least 36 bird species, 17 of which are focal species for this habitat type (Table 11). Several species, including Greater Sage Grouse, Sage Thrasher, Brewer's Sparrow, and Sage Sparrow, are sagebrush obligates and Nevada has a major area responsibility for many of the focal species (Carter et al. 2000). Sagebrush habitats are used by birds primarily during the breeding season.

Table 11: List of sagebrush birds of Nevada, including focal species in bold.

Turkey Vulture	Say's Phoebe	**Brewer's Sparrow**
Golden Eagle	**Loggerhead Shrike**	Lark Sparrow
Rough-legged Hawk	**Northern Shrike**	**Black-throated Sparrow**
Ferruginous Hawk	Common Raven	**Sage Sparrow**
Prairie Falcon	Horned Lark	**Vesper Sparrow**
Chukar	Bushtit	Western Meadowlark
Himalayan Snowcock	Rock Wren	**Gray-crowned Rosy-Finch**
Greater Sage Grouse	**Mountain Bluebird**	**Black Rosy-Finch**
Mourning Dove	**Sage Thrasher**	Purple Finch
Whip-poor-will	Green-tailed Towhee	
Common Poorwill	Spotted Towhee	
Gray Flycatcher	Chipping Sparrow	

Shrubsteppe is widely recognized as one of the most imperiled ecosystems in the United States (e.g., Noss et al. 1995). The Greater Sage Grouse has received recent widespread attention recently due to declines and proposals that the species should be protected under the Endangered Species Act. Sharp-tailed Grouse have also sustained a long-term

decline. Declines are probably not restricted to these species, as Great Basin-wide trends for most shrubsteppe obligate species are negative (Knick et al. *in press*).

Large wildfires have recently become a concern in Nevada and much of the west. Fire was probably infrequent in Nevada prior to settlement (Paige and Ritter 1999), especially in the Great Basin sagebrush zone due to the poorly developed grass-forb understory. In the past few decades, fires have increased in frequency in concert with the spread of cheatgrass (*Bromus tectorum*) throughout the region. In just the past five years, more than three million acres of sagebrush have burned in Nevada. Managers are concerned about the large-scale loss of sagebrush habitat and, specifically, about the loss of tall stands of sagebrush, which are important for several species and may take as much as 30 years to recover.

In response to these concerns, reseeding programs have been initiated in burned sagebrush areas throughout Nevada. Guidelines for these programs have been generated for Greater Sage Grouse (Barrett et al. 2000), but effects on other birds are largely unknown and guidelines have yet to be developed. Resource managers thus need information on short-term and long-term effects of fire and of post-fire restoration efforts on bird communities. More information is also needed about causes of the long-term declines in shrubsteppe species described above.

Survey Objectives

Information Needed: Estimates are needed of abundance and productivity of sagebrush birds in (a) burned and unburned areas, (b) in restoration projects and untreated areas, and (c) in a variety of untreated sites thought to vary in habitat quality. This draft of the Nevada Plan only discusses abundance during the breeding season. Abundance is here defined as the mean number of all focal species detections in a 10-minute point count in a circle with 100-m radius. A more biologically relevant definition (e.g., density of territorial males and their mates) may be used in future studies. This information can best be obtained by developing a site-based, sagebrush model. See "Products from Coordinated Bird Monitoring Projects" and Appendix B for more information about site-based models.

Quantitative Objectives: We suspect that changes in sagebrush bird density resulting from seeding or other treatments may often be modest and therefore suggest that the objective in project evaluations should be 80% power to detect a 2-fold change.

We suggest that species-specific models be constructed for single species (the most abundant ones) and for multiple species that include all focal species. The single-species models will be useful at a large spatial scale where total abundance will be large. The multi-species model will be more useful in predicting effects of treatments on small areas where only a few individuals of many species of interest may be present. More work is needed on reasonable accuracy targets for these models. Interim targets are CV<0.5 for the species-specific models and CV<0.25 for the multi-species models.

Methods

Bird survey methods: The Nevada Bird Count protocol (10-minute point counts with a 100-m radius circle) will be used. Other methods may be needed for Sage Grouse and raptors. If coordinated with ongoing surveys for raptor nests, lek monitoring, and possibly winter raptor surveys, some data gaps in the Nevada Bird Count coverage may be filled without much additional funding.

Sample Size Requirements: Sample sizes were estimated from data collected in the Nevada Bird Count. Methods are described under the "Riparian" management issue. Our sample included 29 transects surveyed during 2002-2003, conducted once per site per year. The CV was 0.77 (Table 12). If the level of significance is 0.05 and power is 0.8, then *G*, from Table B3 (Appendix B), is 16 and, using *CV*=1.0 to be conservative, the needed sample is 60 (for *R*=2; Table B4, Appendix B). Thus, for project evaluations, we suggest a sample of 60 points, evenly distributed across the project area. If sampling during each phase of the evaluation occurred in two years (e.g., two years before, two years after), then 30 points could be surveyed in each year, assuming that 30 new locations were selected in the second year. The same 60 locations should probably be surveyed in different phases of the evaluation (e.g., before, after).

Table 12. CVs ($SD(y_i)/\bar{y}$) for 10-minute point counts in riparian habitat conducted during the Nevada Bird Count[1].

N Transects	29
N Points	344
Average SD	1.13
Mean no. birds	1.47
CV(means)	0.77

[1] y_i is the mean number of birds recorded at the i^{th} station.

Sample sizes required to construct the regional models are hard to estimate because little work has been done on these relationships and thus we have little basis for estimating reasonable correlation coefficients between the habitat variables and bird density. For planning purposes, we suggest conducting surveys in 20 additional sagebrush transects in 2004. Analyses will then be carried out to refine the sample size estimate.

Habitat variables: The habitat variables for the site-based models should include a description of the dominant plant taxa, stand density, and height of (a) the grass-forb layer, (b) the shrub layer, and (c) the sapling and tree layer if one is present (which will be rare). Also, landscape level data should be collected, including presence of cliffs within a set distance, surrounding habitat types within a set distance, and patch size where applicable. Other, project-specific variables may also be needed (e.g., burn history, presence of reseeding efforts).

Sampling Plans: Most if not all surveys will be conducted using the Nevada Bird Count protocol (10-station clusters surveyed once per season). The Nevada Bird Count uses stratification to distribute counts across broad habitat types. Additional stratification may

be needed to insure that generally-considered "high-quality" sagebrush stands are included in the model.

Roles and Responsibilities

Current and Needed Surveys: Approximately xx ten-point transects have been surveyed during the past two years and approximately *xx* additional counts will be made in 2004. These surveys should provide sufficient data for an initial analysis after which the sample size estimates can be reviewed and revised if necessary. (*to be completed in next draft*).

Project Management: A number of funding partners (BLM, USFS, NDOW, and USGS) are currently providing support for the Nevada Bird Count, which is generating much of the currently available data. As part of the Nevada Bird Count program, GBBO takes on responsibility for data management, analysis and reporting. Coordination with other ongoing monitoring efforts is also actively pursued as part of the mission of GBBO's Nevada Bird Count. Information resulting from analyses toward this management issue will be made available online, through reports to funding partners, and through peer-reviewed publications.

Recommendations

- Decide on final list of habitat variables and how they will be measured for both models.
- Obtain habitat variables for existing survey transects.
- Carry out preliminary analyses for the statewide model with existing Nevada Bird Count data (prior to the 2004 field season).

7. Effects of Pinyon-Juniper Management on Birds

Description of the Management Issue

Single-leaf pinyon (*Pinus monophylla*) and juniper (*Juniperus* spp.) are native to mountains throughout Nevada except the northwest corner. Understory plants vary widely and are usually similar to the communities that are found just below and above the elevation of the pinyon-juniper zone. Pinyon-juniper habitats in Nevada are used by at least 41 bird species including 16 focal species (Table 13).

Table 13: List of pinyon juniper birds of Nevada, including focal species in bold.

Turkey Vulture	Steller's Jay	**Grace's Warbler**
Short-eared Owl	Western Scrub-Jay	Hepatic Tanager
Whip-poor-will	**Pinyon Jay**	Western Tanager
Common Poorwill	Common Raven	Green-tailed Towhee
Hairy Woodpecker	**Juniper Titmouse**	Spotted Towhee
Three-toed Woodpecker	Mountain Chickadee	Chipping Sparrow
Gray Flycatcher	Bushtit	Brewer's Sparrow
Cordilleran Flycatcher	White-breasted Nuthatch	Lark Sparrow
Ash-throated Flycatcher	Red-breasted Nuthatch	**Black-chinned Sparrow**
Cassin's Kingbird	Golden-crowned Kinglet	Black-throated Sparrow
Loggerhead Shrike	**Mountain Bluebird**	Dark-eyed Junco
Northern Shrike	Northern Mockingbird	**Scott's Oriole**
Gray Vireo	**Virginia's Warbler**	Cassin's Finch
Plumbeous Vireo	**Black-throated Gray Warbler**	

Fires have recently destroyed large stands of pinyon-juniper in some areas. In other areas, pinyon-juniper appears to be expanding and displacing lower-elevation habitat types. Managers have requested guidance on how bird conservation strategies might be included in pinyon-juniper management, especially for the use of prescribed fire and other methods of tree removal used for preserving sagebrush habitats and for managing stand susceptibility to wildfires. Information is also needed to help identify high-quality stands (e.g., that agencies would try to protect during a wildfire) and to evaluate bird responses to management programs such as thinning or partial removal of a stand. Effects of landscape mosaics will be particularly valuable, since it is assumed that pinyon-juniper associated birds respond at a landscape scale to fires. For example, managers intending to remove part of a large stand need to know whether the remainder of the stand, and other stands nearby, will continue to provide adequate habitat for birds.

Survey Objectives

Information Needed: Models are needed to predict abundance and productivity of birds in pinyon-juniper during the breeding season and of abundance and fitness of birds in pinyon-juniper during migration. This draft of the Nevada Plan only discusses abundance during the breeding season. Abundance is here defined as the mean number of birds of all focal species detected in a 10-minute point count in a circle with 50-m radius. A more biologically relevant definition (e.g., density of territorial males and their mates) may be used in future studies.

Quantitative Objectives: Both statewide (regional) and site-based models are needed. The statewide model will permit a regional evaluation of the importance of pinyon-juniper habitats to birds and identification of large-scale patterns in pinyon-juniper use. The site-based model will help reveal which traits of pinyon-juniper stands (including landscape variables) are most highly correlated with bird abundance. See "Products from

Coordinated Bird Monitoring Projects" and Appendix B for more information about statewide and site-based models. We suggest that species-specific and multi-species versions of each model be constructed. More work is needed on reasonable accuracy targets for these models. Interim targets are CV < 0.5 for the species-specific models and CV < 0.25 for the multi-species models.

Methods

Bird survey methods: The Nevada Bird Count protocol (10-minute point counts with a 50-m radius circle) will be used.

Sample Size Requirements: Sample sizes were estimated from data collected in the Nevada Bird Count. (*to be completed in next draft*).

Habitat variables: The habitat variables we propose to include for the regional model are stand size and elevation, as well as other measures such as soil type, slope, and aspect. The habitat variables for the site-based model will include dominant plant taxa, canopy coverage, and height of (a) grass-forbs, (b) shrubs and saplings, (c) understory trees, and (d) overstory trees. Average dbh of overstory trees should also be recorded. Also, landscape variables may be generated from available supporting data, for example recent aerial photography or vegetation maps that provide data on surrounding habitat types. The burn history, pre-scribed fire treatments, or other fire prevention treatments, need to be included as well. These will likely be available from the BLM and Forest Service as geo-referenced maps.

Sampling Plans: Most if not all surveys will be conducted using the Nevada Bird Count protocol (10-station clusters surveyed once per season). The Nevada Bird count uses stratification to distribute counts across broad habitat types. Additional stratification to insure surveying high-quality pinyon-juniper stands should be considered.

Roles and Responsibilities

Current and Needed Surveys: Approximately xx ten-point transects have been surveyed during the past two years and approximately *xx* additional transects will be surveyed in 2004. These surveys should provide sufficient data for an initial analysis after which the sample size estimates can be reviewed and revised if necessary. (*to be completed in next draft*).

Project Management: A number of funding partners (BLM, USFS, NDOW, and USGS) are currently providing support for the Nevada Bird Count, which is generating much of the currently available data. As part of the Nevada Bird Count program, GBBO takes on responsibility for data management, analysis and reporting. Coordination with other ongoing monitoring efforts is also actively pursued as part of the mission of GBBO's Nevada Bird Count. Information resulting from analyses toward this management issue will be made available online, through reports to funding partners, and through peer-reviewed publications.

Recommendations

- Coordinate with other investigators who have assessed pinyon-juniper birds and their habitats to determine which additional information is still needed.
- Decide on a final list of habitat variables and how they will be measured for both models.
- Obtain these habitat variables for existing survey transects.
- Carry out preliminary analyses for the statewide model with existing Nevada Bird Count data (prior to the 2004 field season).

Summary of Recommendations

The purpose of Coordinated Bird Monitoring is to network existing surveys with each other, to identify important gaps, and to cover these gaps using scientifically sound methods. One desired result of Coordinated Bird Monitoring is that projects that are part of the network will have already undergone significant scientific scrutiny through a peer-review process by the time they may be challenged. Another desired outcome is that access by resource managers to relevant bird data will be improved, thus allowing them to use limited funds for inventory and monitoring most efficiently. Such access to data (or metadata) will be provided through data repositories within Nevada and at national data banks (i.e. Patuxent Wildlife Research Center). In addition, dissemination of monitoring data analyses can occur quickly to Nevada partners through the central network housed at GBBO.

As the first step of implementing Coordinated Bird Monitoring, we recommend completing the assessment of ongoing monitoring efforts that may be included in a statewide network. Specifically, we ask our partners to review the list of existing surveys (see "Summary of Existing …." section above) to determine if all surveys that should be listed, are in fact listed. For this, we emphasize efforts that are either already designed for longer-term monitoring (> 4 years) or that should be made part of a longer-term effort, and efforts that are relevant to a short-term objective of this document. Most special research projects will likely fall outside the purview of Coordinated Bird Monitoring; we recommend including only those that address a short-term objective named in this draft document (e.g., site inventories that use standardized methods, habitat-quality studies for single species, etc.).

Secondly, preliminary bird and habitat data already exist for all management issues discussed in this document. We thus recommend to complete preliminary analyses on these data sets to (1) determine how much more sampling needs to be done to answer the questions, and (2) to provide preliminary results from regional and site-based models on

those management questions where fairly comprehensive data are already available (e.g. lowland riparian and montane riparian birds of the Great Basin).

Finally, we recommend implementing the short set of actions listed under each of the management issues (see above) to move forward on each of the short-term goals of the program.

Proposed Action Plan

To implement a Coordinated Bird Monitoring plan in Nevada, we propose a division-in-labor approach that shares the burden of implementation among the program partners. To facilitate further discussion of the implementation process, we provide here a preliminary list of the program elements, the lead agency/organization for it, funding mechanism, and current status of its implementation (Table 14).

Coordination between the plan elements will need to be centralized, and we recommend that this is done through GBBO. The role of GBBO would be to provide a data network that accommodates queries from partners, to help partners identify gaps in monitoring coverage, and where possible, provide additional labor to implement the monitoring work. Technical oversight on GBBO's work will be provided through USGS Snake River Field Station, the University of Nevada, Reno, Biological Resource Research Center (BRRC), and through the formal peer-review process involved in science publications.

Table 14: Summary of Coordinated Bird Monitoring plan elements (divided into long-term and short-term goals), agency/organization offering to be the lead in implementation, funding mechanism, and current status. **Partners in the program are asked to fill in and modify this table during their review**.

Coordinated Bird Monitoring plan element	Agency/ organization offering to take lead in implementation	Funding mechanism	Current status of implementation (fall 2003)
Breeding landbird monitoring (point count network) (**long-term**)	GBBO	Cost-share grants from agency partners and other funding sources (Nevada Bird Count funds)	2 years of Nevada Bird Count data, needs additional coverage of BBS routes and double-sampling effort
Breeding raptor monitoring (**long-term**)	NDOW	??	nest survey and report program in place; may need to be expanded?
Waterfowl monitoring (**long-term**)	NDOW	State funds, hunting licenses (??)	implemented, but would probably benefit from add. funds for increased coverage
Shorebird/water bird monitoring (**long-term**)	??	??	Misc. efforts at NWRs and WMAs; coordination needed with aerial surveys for waterfowl monitoring; need to build up shorebird portion
Upland gamebird monitoring (**long-term**)	NDOW?	State funds, hunting licenses (??)	some elements implemented, but would benefit from add. funds to cover add. species
Winter raptor monitoring (**long-term**)	NDOW/GBBO?	??	Misc. efforts in Great Basin, need increased coverage; plans for pilot volunteer-program for winter 2003/2004
Migrant landbird monitoring (**long-term**)	?? (GBBO?)	??	very spotty coverage in NV; program needs to be built up from scratch
Lowland riparian management (**short-term**)	USGS/GBBO	Cost-share grants from agency partners and other funding sources (Nevada Bird Count funds)	probably enough count data for Great Basin regional model, may need additional data for site-based model; some project evaluation ongoing, but gaps exist; Mojave regional and site-based model will be completed in late 2005 or early 2006

Montane riparian management (**short-term**)	USGS/GBBO	Cost-share grants from agency partners and other funding sources (Nevada Bird Count funds)	probably enough count data for regional model. Need additional habitat data for site-based model. Project evaluation needs to be examined for gaps
Wetland management (**short-term**)	??	??	Misc. ongoing efforts at NWRs and WMAs; need to build up shorebird coverage and examine for other gaps; need to obtain habitat data for site-based model
Sagebrush management (**short-term**)	BLM/GBBO?	Need some additional funds	Probably enough Nevada Bird Count coverage for regional model, need habitat data for site-based model; might need additional coverage in surveys in 2004
Aspen management (**short-term**)	USFS/GBBO?	Cost-share grants from agency partners and other funding sources (Nevada Bird Count funds) + USFS staff in-kind	Probably enough Nevada Bird Count coverage for regional model, USFS has habitat data for site-based model; might need additional coverage in surveys in 2004; preliminary analyses will be done before 2004 season
anything else??			

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Appendix A. Bird Species that Warrant Monitoring in Nevada

Listed are all bird species that regularly occur in Nevada during at least one season.

*Habitat types used during the season a species is found in Nevada are listed as follows:

aq = aquatic, lacustrine sites
wet = palustrine, open wetlands/wet meadows
ag = agricultural
as = aspen
lr = lowland riparian
mr = montane riparian
sg = sagebrush
sd = salt desert
mjs = mojave scrub
mqc = mesquite-catclaw
pj = pinyon-juniper
cf = coniferous forest
ms = montane deciduous shrublands
mtm = mountain mahogany
ur = urban
cl = cliff
alp = alpine

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Common Loon	aq			1			
Horned Grebe	aq			1			
Eared Grebe	aq			1			
Pied-billed Grebe	aq, wet			1			
Clark's Grebe	aq			1			
Western Grebe	aq			1			
American White Pelican	aq			1			
Double-crested Cormorant	aq			1			
Least Bittern	wet			1			
American Bittern	wet			1			
Black-crowned Night-Heron	wet, lr		1	1			
Green Heron	wet			1			
Cattle Egret	wet			1			
Snowy Egret	wet, lr		1	1			
Great Egret	wet, lr		1	1			
Great Blue Heron	wet, lr		1	1			
White-faced Ibis	wet, ag			1			
Tundra Swan	aq			1			
Trumpeter Swan	aq			1			
Greater White-fronted Goose	aq			1			
Snow Goose	aq			1			
Ross's Goose	aq			1			
Canada Goose	aq, wet			1			
Wood Duck	lr		1	1			
Mallard	wet			1			
Gadwall	wet			1			
Green-winged Teal	wet			1			
American Wigeon	aq, wet			1			
Northern Pintail	aq, wet			1			
Northern Shoveler	aq, wet			1			
Blue-winged Teal	aq, wet			1			
Cinnamon Teal	wet			1			
Canvasback	aq, wet			1			
Redhead	aq, wet			1			
Ring-necked Duck	aq, wet			1			
Greater Scaup	aq, wet			1			
Lesser Scaup	aq, wet			1			
Common Goldeneye	aq			1			
Bufflehead	aq			1			

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Common Merganser	aq, lr		1	1			
Red-breasted Merganser	aq			1			
Ruddy Duck	aq, wet			1			
Turkey Vulture	sg, pj, sd				1		1
Osprey	aq, lr		1	1			
Northern Harrier	lr, wet		1	1			
Golden Eagle	sg, cl				1		
Bald Eagle	aq, lr		1	1			
Sharp-shinned Hawk	mr, lr		1				
Cooper's Hawk	mr, lr		1				
Northern Goshawk	mr, as		1			1	
Red-tailed Hawk	ag, lr		1				
Swainson's Hawk	ag, lr		1				
Rough-legged Hawk	sg				1		
Ferruginous Hawk	sg				1		
American Kestrel	ag, lr		1				
Merlin	lr		1				
Prairie Falcon	sg, cl				1		
Peregrine Falcon	wet, cl			1			
Chukar	sg	1			1		
Gray Partridge	sg	1			1		
Ring-necked Pheasant	ag	1					
Wild Turkey	lr, mr	1	1				
Himalayan Snowcock	sg	1			1		
Ruffed Grouse	as	1				1	
Blue Grouse	cf, mr	1	1				
Greater Sage Grouse	sg, mr	1	1		1		
Gambel's Quail	ag, lr	1	1				
California Quail	ag, lr	1	1				
Mountain Quail	mr, cf	1	1				
Clapper Rail	wet			1			
Virginia Rail	wet			1			
Sora	wet			1			
Common Moorhen	wet, aq			1			
American Coot	wet, aq			1			
Sandhill Crane	wet, ag			1			
Snowy Plover	wet, aq			1			
Semipalmated Plover	wet, aq			1			
Killdeer	wet, ag, lr		1	1			
American Avocet	wet, aq			1			
Black-necked Stilt	wet, aq			1			
Willet	wet, aq			1			

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Greater Yellowlegs	wet, aq			1			
Lesser Yellowlegs	wet, aq			1			
Spotted Sandpiper	lr, wet, mr		1	1			
Long-billed Curlew	wet, ag			1			
Marbled Godwit	wet			1			
Dunlin	wet, aq			1			
Western Sandpiper	wet, aq			1			
Least Sandpiper	wet, aq			1			
Long-billed Dowitcher	wet, aq			1			
Wilson's Snipe	wet, ag			1			
Wilson's Phalarope	aq			1			
Red-necked Phalarope	aq			1			
Franklin's Gull	aq			1			
Bonaparte's Gull	aq			1			
Ring-billed Gull	aq			1			
California Gull	aq			1			
Herring Gull	aq			1			
Caspian Tern	aq			1			
Forster's Tern	aq			1			
Common Tern	aq			1			
Black Tern	aq			1			
Band-tailed Pigeon	cf						
Rock Dove	ur, ag						
Mourning Dove	sg, sd, lr	1	1		1		
White-winged Dove	lr		1				
Inca Dove	ur		1				
Yellow-billed Cuckoo	lr		1				
Greater Roadrunner	mjs, sd						
Barn Owl	ag, lr		1				
Short-eared Owl	lr, pj		1				1
Long-eared Owl	lr		1				
Great Horned Owl	lr		1				
Spotted Owl	cf						
Western Screech-Owl	lr		1				
Flammulated Owl	cf						
Northern Pygmy-Owl	cf, mr		1				
Northern Saw-whet Owl	cf, mr		1				
Burrowing Owl	sd, sg, mjs				1		
Lesser Nighthawk	wet, lr		1	1			
Common Nighthawk	wet, lr		1	1			
Whip-poor-will	sg, pj, cf				1		1
Common Poorwill	cf, pj, sg				1		1

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Black Swift	wet, aq			1			
Vaux's Swift	wet, aq			1			
White-throated Swift	cl, mr, wet		1	1			
Black-chinned Hummingbird	lr, mr		1				
Costa's Hummingbird	lr		1				
Anna's Hummingbird	lr		1				
Broad-tailed Hummingbird	mr, lr		1				
Calliope Hummingbird	mr		1				
Rufous Hummingbird	mr, lr		1				
Belted Kingfisher	lr		1				
White-headed Woodpecker	cf, mr		1				
Lewis's Woodpecker	mr, as		1			1	
Gila Woodpecker	lr		1				
Northern Flicker	lr, mr, as		1			1	
Gilded Flicker	mjs						
Williamson's Sapsucker	mr, as		1			1	
Red-breasted Sapsucker	as, mr		1			1	
Red-naped Sapsucker	mr		1				
Ladder-backed Woodpecker	lr		1				
Downy Woodpecker	lr, mr		1				
Hairy Woodpecker	mr, pj, cf		1				1
Three-toed Woodpecker	cf, pj						1
Black-backed Woodpecker	cf						
Pileated Woodpecker	cf						
Olive-sided Flycatcher	cf						
Western Wood-Pewee	lr, mr		1				
Willow Flycatcher	lr		1				
Hammond's Flycatcher	cf						
Gray Flycatcher	sg, pj				1		1
Dusky Flycatcher	mr, as, ms		1			1	
Pacific-slope Flycatcher	lr		1				
Cordilleran Flycatcher	pj, cf						1
Black Phoebe	lr		1				
Say's Phoebe	sg, sd, cl, mjs				1		
Vermilion Flycatcher	lr, ag		1				
Brown-crested Flycatcher	lr, mqc		1				
Ash-throated Flycatcher	mjs, pj, lr		1				1

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Western Kingbird	lr, ag, ur		1				
Cassin's Kingbird	pj, lr		1				1
Eastern Kingbird	lr, ag		1				
Loggerhead Shrike	sg, pj				1		1
Northern Shrike	sg, sd, pj				1		1
Bell's Vireo	lr, mqc		1				
Gray Vireo	pj						1
Plumbeous Vireo	pj, cf, lr		1				1
Cassin's Vireo	cf, mr		1				
Warbling Vireo	lr, mr, as		1			1	
Steller's Jay	cf, pj						1
Clark's Nutcracker	cf						
Western Scrub-Jay	lr, pj		1				1
Pinyon Jay	pj						1
American Magpie	lr, ag, ur		1				
American Crow	lr, ag, ur		1				
Common Raven	sg, cl, pj, sd				1		1
Horned Lark	sd, sg				1		
Tree Swallow	lr		1				
Violet-green Swallow	mr, cl		1				
Bank Swallow	lr		1				
Cliff Swallow	lr, cl		1				
Northern Rough-winged Swallow	lr		1				
Barn Swallow	lr		1				
Juniper Titmouse	pj						1
Black-capped Chickadee	mr, as		1			1	
Mountain Chickadee	pj, cf						1
Verdin	lr, mqc		1				
Bushtit	lr, sg, pj		1		1		1
Brown Creeper	cf						
White-breasted Nuthatch	pj, cf						1
Red-breasted Nuthatch	pj, cf						1
Pygmy Nuthatch	cf						
House Wren	lr, mr, as		1			1	
Winter Wren	lr		1				
Bewick's Wren	lr		1				
Cactus Wren	mjs						
Rock Wren	sg, cl, mjs, sd				1		
Canyon Wren	cl						

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Marsh Wren	wet						
American Dipper	mr						
Golden-crowned Kinglet	mr, lr		1				
Ruby-crowned Kinglet	cf						
Blue-gray Gnatcatcher	lr, sg		1		1		
Black-tailed Gnatcatcher	lr		1				
Western Bluebird	lr		1				
Mountain Bluebird	pj, sg				1		1
Townsend's Solitaire	cf, al						
Swainson's Thrush	mr, lr		1				
Hermit Thrush	as, ms, mr		1			1	
Varied Thrush	lr		1				
American Robin	lr, mr, as, cf		1			1	
Northern Mockingbird	lr, ur, ag, mjs, pj		1				
Sage Thrasher	sg				1		
Bendire's Thrasher	mjs						
Crissal Thrasher	lr, mqc		1				
Le Conte's Thrasher	sd, mjs						
European Starling	ag, ur, lr		1				
American Pipit	alp						
Cedar Waxwing	ur, ag		1				
Phainopepla	mqc, lr		1				
Orange-crowned Warbler	mr, lr		1				
Nashville Warbler	mr, cf		1				
Virginia's Warbler	pj						1
Lucy's Warbler	lr, mqc		1				
Yellow-rumped Warbler	cf, mr, lr		1				
Black-throated Gray Warbler	pj, mtm						1
Townsend's Warbler	mr		1				
Hermit Warbler	cf						
Grace's Warbler	cf, pj						1
Yellow Warbler	lr, mr		1				
MacGillivray's Warbler	mr, as		1			1	
Wilson's Warbler	mr, lr		1				
Common Yellowthroat	wet, lr		1	1			
Yellow-breasted Chat	lr, mr		1				
American Redstart	lr		1				
Summer Tanager	lr		1				
Hepatic Tanager	cf, pj						1

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Western Tanager	lr, mr, pj		1				1
Green-tailed Towhee	sg, pj				1		1
Abert's Towhee	lr		1				
Spotted Towhee	sg, lr, pj		1		1		1
American Tree Sparrow	lr, ag		1				
Chipping Sparrow	pj, sg, mr, cf		1		1		1
Brewer's Sparrow	sg, pj, mtm				1		1
Lark Sparrow	sg, pj, mtm				1		1
Black-chinned Sparrow	pj, lr		1				1
Black-throated Sparrow	sg, pj, sd				1		1
Sage Sparrow	sg				1		
Grasshopper Sparrow	ag						
Fox Sparrow	mr, ms						
Savannah Sparrow	wet, ag			1			
Lincoln's Sparrow	mr, lr		1				
Song Sparrow	lr, wet		1	1			
Vesper Sparrow	sg				1		
White-crowned Sparrow	lr, ur, ag		1				
Golden-crowned Sparrow	lr, ur, ag		1				
Dark-eyed Junco	mr, as, pj, cf		1			1	1
Lapland Longspur	sd, wet			1			
Black-headed Grosbeak	mr, lr		1				
Blue Grosbeak	lr, mqc		1				
Indigo Bunting	lr		1				
Lazuli Bunting	lr, ms, mr		1				
Bobolink	ag, lr		1				
Western Meadowlark	sg, sd, ag				1		
Yellow-headed Blackbird	wet			1			
Red-winged Blackbird	wet			1			
Tricolored Blackbird	wet			1			
Great-tailed Grackle	lr, ag, ur		1				
Brewer's Blackbird	wet, ag, lr		1	1			
Brown-headed Cowbird	lr, ag, ur		1				
Hooded Oriole	ag, ur, lr		1				
Bullock's Oriole	lr, ag		1				
Scott's Oriole	mjs, pj, lr		1				1
Gray-crowned Rosy-Finch	al, sg, sd				1		
Black Rosy-Finch	al, sg, sd				1		
Purple Finch	wet, sg, sd			1	1		

Common Name	Primary Habitat Types Used in NV	Management Issue					
		Upland Game-bird	Ripa-rian	Wet-land	Sage	Aspen	P-J
Cassin's Finch	cf, pj						1
House Finch	lr, ag, ur		1				
Red Crossbill	cf						
Pine Grosbeak	cf						
Pine Siskin	cf						
American Goldfinch	lr, mr, ur		1				
Lesser Goldfinch	ag, ur, lr		1				
Evening Grosbeak	cf						
House Sparrow	ur, ag						

Appendix B. Sample size estimation procedure for products of Coordinated Bird Monitoring in Nevada.

This Appendix presents sample size formulas for regional models, site-based models, and project evaluations.

Regional and Site-based Models

Standard regession (or other) methods are used to construct the models. Mixed effects models (e.g., Agresti 2002) are often needed to acknowledge the stratification, multi-stage sampling (e.g., surveying clusters of points) or both. The three most common predictions, and their measures of accuracy, are (a) the estimated regionwide total or mean, (b) the estimated parameter value for a single site that has not been surveyed, typically because the habitat of interest is part of a proposed project and does not yet exist on the ground, (c) the estimated change in parameter value with each unit increase in one of the independent variables. CVs provide useful measures of accuracy for all three estimates. As an example of the third estimate, suppose that a model predicted abundance/ha, y, as $y = b_o + 0.5$(stand size in ha) + (other terms). The equation predicts that the average number of birds per ha increases by 0.5 for each 1-ha increase in stand size (if other variables do not change). If the CV for the coefficient (0.5) was 0.25, it would mean that the 95% CI for the increase was ±50% of the coefficient or (0.25, 0.75).

Pilot study data are needed for reliable estimation of the sample sizes needed to construct regression models but the following approach may be of some use for planning. In estimating a regional mean we hope that the regression model will improve precision compared to the simple mean. But performance of the regression model cannot be worse than the simple mean, so we might estimate sample sizes for the simple mean as a conservative initial estimate. With simple random sampling, the sample size for any desired CV($\bar{y}$) may be expressed as

$$n = \left(\frac{CV(y_i)}{CV(\bar{y})} \right)^2$$

where y_i is the mean from the i^{th} primary unit (e.g., transect or point). Table B1 gives some typical values. For example, if the desired $CV(\bar{y})$ is 0.20 (95% CI ≈ mean ±40% of the mean) and $CV(y_i)$ =2, then the needed sample size is 100.

Table B1. Sample size for estimating a mean expressed

Desired CV($\bar{y}$)	CV(y_i)			
	1	1.5	2	2.5
0.15	44	100	178	278
0.20	25	56	100	156
0.25	16	36	64	100
0.30	11	25	44	69

An advance estimate of the sample size needed to achieve a specified *CV* for the regression coefficient can also obtained if we can estimate the correlation coefficient between the independent and dependent variables, or perhaps more reasonably, if we assume that variables are only interesting if they have a fairly high correlation with the dependent variable. Table B2 gives some values. For example, suppose (a) we trying to predict abundance, (b) the desired *CV* of the regression coefficient, b_k, is 0.15 and (c) we are mainly interested in independent variables whose correlation with abundance is at least 0.6 (on the basis that variables with lower correlations have little capacity for helping us predict abundance or understand what determines it). In this case, from Table B2, the needed sample size is 81. These analyses suggest that a sample size of 100 points seems reasonable for initial efforts to develop regression models that can be used to estimate regional means or help elucidate factors correlated with the parameter (e.g., abundance, a fitness indicator).

Table B2. Sample size for estimating regression coefficients, b_k.

Desired CV(b_k)	Correlation coefficient of x_k and y_k				
	0.4	0.5	0.6	0.8	0.9
0.10	527	302	180	58	25
0.15	235	135	81	27	12
0.20	133	77	46	16	8
0.25	86	50	30	11	6

Project Evaluations

Sample sizes required in project evaluations to detect a given change, *R*, may be estimated if an estimate of the *CV* of the measurements is available from a pilot study or from surveys in other areas. The procedure should be based on results per "primary sampling units". If clusters of points are surveyed, then the cluster is the primary sampling unit. If points are evenly (or randomly) distributed across a study area, then the individual point is the primary unit. The sample size also depends on the level of significance, the change expected or that we wish to detect, and the probability (power) we wish to have of detecting the change (i.e., of obtaining a significant result in a statistical test). The change, *R*, is defined as (larger value)/(smaller value) and is thus always >1. A two-step procedure is given here. First, choose the level of significance and power and read the corresponding value of "*G*" in Table B3. Then read the sample size from Table B4. For example, suppose the level of significance will be 0.05 and the desired power is 80% power. *G*, from Table B3, is 16. Suppose further that points are going to be evenly distributed across a study area, the *CV* ($SD(y_i)/\bar{y}$) of numbers recorded per point (or mean numbers if >1 survey is made) is 1.5, and the change of interest is a three-fold increase (*R*=3). The needed sample size, in each period is approximately 76. Conducting the surveys in >1 year is often worthwhile. If surveys were made in three years before the project and in three years after it, then about 25 points should be surveyed per year (in new locations each year).

Table B3. Values of *G*, used in Table B4 to obtain sample sizes.

Level of significance	Power		
	0.6	0.8	0.9
0.05	10	16	21
0.10	7	12	17
0.15	6	10	15

Table B4. Sample sizes as a function of the *G* (from Table B3), the estimated $CV(y_i)$, and the change of interest, *R*.

		R		
G	*CV*	1.5	2	3
5	0.5	11	5	3
5	1.0	45	20	11
5	1.5	101	45	25
5	2.0	180	80	45
10	0.5	23	10	6
10	1.0	90	40	23
10	1.5	203	90	51
10	2.0	360	160	90
15	0.5	34	15	8
15	1.0	135	60	34
15	1.5	304	135	76
15	2.0	540	240	135
20	0.5	45	20	11
20	1.0	180	80	45
20	1.5	405	180	101
20	2.0	720	320	180

Project Evaluation

Project evaluations involve surveys on a project site before, during, and after the project. These surveys help evaluate and perhaps revise the project and they document effects of the project on birds. Accuracy targets for these estimates also may be expressed using the *CV*. A *CV* of 0.25, for example, means that the 95% confidence interval (CI) is approximately the mean ±50% of the mean. Thus, if the estimate was 50 and the *CV* was 0.25, then the 95% CI would be approximately (25, 75).

Sample sizes required in project evaluations to detect a given change, *R*, may be estimated if an estimate of the *CV* of the measurements is available from a pilot study or from surveys in other areas. The procedure should be based on results per "primary sampling unit". If clusters of points are surveyed, then the cluster is the primary sampling unit. If points are evenly (or randomly) distributed across a study area, then the individual point is the primary unit. The sample size also depends on the level of

significance, the change expected or that we wish to detect, and the probability (power) we wish to have of detecting the change (i.e., of obtaining a significant result in a statistical test). The change, *R*, is defined as (larger value)/(smaller value) and is thus always >1. A two-step procedure is given here. First, choose the level of significance and power and read the corresponding value of "*G*" in Table B1. Then read the sample size from Table 4. For example, suppose the level of significance will be 0.05 and the desired power is 80% power. *G*, from Table 3, is 16. Suppose further that points are going to be evenly distributed across a study area, the *CV* ($SD(y_i)/\bar{y}$) of numbers recorded per point (or mean numbers if >1 survey is made) is 1.5, and the change of interest is a three-fold increase (*R*=3). The needed sample size, in each period is approximately 76. Conducting the surveys in >1 year is often worthwhile. If surveys were made in three years before the project and in three years after it, then about 25 points should be surveyed per year (in new locations each year).

Pilot study data are needed for reliable estimation of the sample sizes needed to construct regression models but the following approach may be of some use for planning. In estimating a regional mean we hope that the regression model will improve precision compared to the simple mean. But performance of the regression model cannot be worse than the simple mean, so we might estimate sample sizes for the simple mean as a conservative initial estimate. With simple random sampling, the sample size for any desired $CV(\bar{y})$ may be expressed as

$$n = \left(\frac{CV(y_i)}{CV(\bar{y})} \right)^2$$

where y_i is the mean from the i^{th} primary unit (e.g., transect or point). Table 4a gives some typical values. For example, if the desired $CV(\bar{y})$ is 0.20 (95% CI ≈ mean ±40% of the mean) and $CV(y_i)$ =2, then the needed sample size is 100.

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	1	1.5	2	2.5
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helping us predict abundance or understand what determines it). In this case, from Table 4b, the needed sample size is 81.

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These analyses suggest that a sample size of 100 points seems reasonable for initial efforts to develop regression models that can be used to estimate regional means or help elucidate factors correlated with the parameter (e.g., abundance, a fitness indicator).

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Appendix C. Aquatic Sites Relevant to Bird Monitoring in Nevada