CHAPTER VII – BIG MEADOW RESTORATION PROJECT

Written in conjunction with the USDA Forest Service Lake Tahoe Basin Management Unit and

Kathi L. Borgmann[1], Julie Groce[2], and Michael L. Morrison[2]

[1]Arizona Cooperative Fish and Wildlife Research Unit, School of Natural Resources, 325 Biological Sciences East, the University of Arizona, Tucson, AZ, 85721. Email: borgmann@email.arizona.edu
[2]Department of Wildlife and Fisheries Sciences, 210 Nagle Hall, Texas A&M University, College Station, TX 77843-2258. Email: juliegroce@tamu.edu, mlmorrison@ag.tamu.edu

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EXECUTIVE SUMMARY

This report summarizes four years of pre-restoration wildlife monitoring data at Big Meadow and illustrates project objectives based on pre-restoration monitoring data. Pre-restoration monitoring occurred in 2004, 2005, 2006, and 2007; although no reptile or amphibian monitoring occurred in 2007 (with the exception of monitored conducted by the Forest Service in early August 2007). Initially, data collected at Big Meadow were used to make pre- and post-restoration comparisons with Cookhouse Meadow; therefore, we have not selected a control site for Big Meadow. However, pre-restoration monitoring data was collected at Grass Lake; therefore we make comparisons of data collected at Big Meadow with Grass Lake. However, we propose replacing Grass Lake with Fountain Place as a control site for Big Meadow.

Restoration Project Goals

The forest-wide wildlife goal calls for wildlife habitat to be maintained and to preserve and maintain populations of threatened, endangered, and sensitive species. The forest-wide timber goal dictates that healthy forest conditions be maintained through timber management practices designed primarily to achieve benefits of scenery, water quality, recreation, wildlife habitat, vegetative diversity, pest management, and fire protection, rather than for wood fiber production. The timber management proposed for this project is expected to address both of these goals. Additionally, this project is intended to satisfy the fire protection goal to assure that property and resource losses are not excessive. Restoration will include forest thinning of dense second growth conifers, removing ladder fuels and the re-introduction of periodic, low-intensity fires. These goals are supported by the Sierra Nevada Forest Plan Amendment. Six goals relevant to this project are:

Aquatic, Riparian and Meadow Ecosystems

1. Plant and Animal Community Diversity: Maintain and restore the species composition and structural diversity of plant and animal communities in riparian areas, wetlands, and meadows to provide desired habitats and ecological function.
2. Watershed Connectivity: Maintain and restore spatial and temporal connectivity for aquatic and riparian species within and between watersheds to provide physically, chemically, and biologically unobstructed movement for their survival, migration, and reproduction.
3. Watershed Condition: Maintain and restore soils with favorable infiltration characteristics and diverse vegetative cover to absorb and filter precipitation and to sustain favorable conditions of stream flow.

Old Forest Ecosystems

4. Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities.
5. Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape.

Fire and Fuels Management

6. Reduce the threats to communities and wildlife habitat from large, severe wildfires and re-introducing fire into fire-adapted ecosystems.

Associated Wildlife Project Goals

In achieving the above stated process oriented restoration project goals and objectives, the Big Meadows restoration project is also expected to increase diversity and complexity of riparian and meadow communities and enhance wildlife species that rely on these communities (associated with AMS goals for Species Viability, Plant and Animal Community Diversity, and Special Habitats). From these broad wildlife restoration goals specific management actions (i.e., restoration opportunities), associated prescriptions, and monitoring objectives were identified based on existing conditions compared to desired conditions. This project in conjunction with monitoring at High Meadow also provides an opportunity to evaluate the effects of prescribed burning on wildlife species and the effectiveness of burning within meadows as a restoration tool.

Management Recommendations

Four years of pre-restoration data have been collected at both Big Meadow and the associated control site (Grass Lake). Methods for and results of data are presented herein. Data collected thus far provide a baseline of existing conditions for comparing pre- and post-restoration conditions. In addition, these pre-restoration data provide information to guide restoration actions through an analysis of existing conditions compared to desired conditions. The following management recommendations and prescriptions are based on this analysis.

Based on the expected habitat and associated wildlife responses to restoration actions, we recommend the following post-restoration monitoring objectives, associated metrics, and protocols for the Big Meadow restoration project. The monitoring objectives are intended to evaluate project effectiveness relative to the above project actions and also to contribute to the validation of wildlife and habitat response to ecosystem restoration projects in the Tahoe Basin.

<u>Butterflies</u>

Recommended restoration actions

Meadow

1. Within Big Meadow, butterfly richness was highest in survey area 8 (n = 25) and survey area 1 (n = 24). Survey area 8, located in the south west corner of the meadow is typically wet, which may explain the large number of species present there. Restoration actions may want to mimic conditions found in survey area 8 and area 1 to improve butterfly richness across Big Meadow.
2. We recommend utilizing prescribed fire within the meadow as planned to enhance conditions for butterflies. Prescribed fire is expected to increase butterfly richness and abundance because fire can (1) regenerate flowering plants that butterflies rely on and (2) open up the forest canopy, subsequently increasing the amount of sunlight reaching the forest floor, which is important for butterflies.

Recommended restoration objectives

Meadow

1. Increase richness and abundance of butterflies and desired condition butterfly species within the meadow and in meadow areas that are expanded due to restoration actions.

- Metric: Richness (number of species detected within survey areas) and abundance (number of individuals detected within survey areas).
- Methods: Visual encounter sweep net surveys conducted twice a month from June through August.

Monitoring recommendations

1. Because restoration at Big Meadow focuses on burning and removing encroaching conifers, we suggest that additional butterfly surveys take place in areas that will be affected by restoration actions (e.g., the upland forest community that is slated to be thinned) to more accurately compare treatment effects. Currently no survey points exist for butterflies in the upland forest community. Surveys should be conducted within the upland forest areas that are going to be impacted by thinning and conifer removal. Alternatively, impacts of restoration will only be assessed within the larger meadow area where we currently have survey plots.
2. Although we recorded gross vegetation features where butterflies were first detected, additional vegetation and soil moisture data should be collected within each survey area to determine if vegetation and hydrological features influence butterfly diversity, abundance, and distribution. Collecting more specific data such as this will give us a better understanding of ecological features required by butterfly species that will help the Forest Service make better restoration decisions. Additionally, no surveys have been initiated to determine flowering plant composition within survey areas. Thus, we cannot determine if lack of butterflies is due to the absence of host plants or due to other factors. Although no pre-restoration data exist, we suggest that a pilot study be conducted to help determine key ecological requirements of butterflies. The costs to complete such a project are unknown.

Reptiles and amphibians

Recommended restoration actions

Meadow

1. Restoration should attempt to create the following conditions to improve habitat elements for amphibians and reptiles, especially in survey areas 2, 4 and 5: areas of slow moving water, riffles, and ponds, downed logs, deep duff/soil, and vegetative cover.

Recommended restoration objectives

Meadow

1. Do not negatively impact the distribution of desired condition reptile and amphibian species at Big Meadow
    - Metric: Richness (number of species detected) and distribution (location of individuals detected within Big Meadow).
    - Methods: Because reptiles and amphibians can be difficult to locate due, in part, to their cryptic behavior and nocturnal habits, we suggest that survey methods and restoration objectives be re-evaluated. A complete survey of the herpetofauna requires pit fall traps, funnel traps, cover board layouts, night acoustic surveys, and visual encounter surveys (Heyer et al. 1994). However, the cost required to complete such a survey is prohibitive. To obtain distribution data, surveys should

be intensified, locations of individuals should be marked with a GPS, and vegetation associations should be recorded where the individual was detected.

Monitoring recommendations

1. We suggest that survey methods and restoration objectives be re-evaluated; we recommend either discontinuing visual encounter surveys for reptiles and amphibians, or intensifying surveys for one or two specific species, such as western toads or Pacific treefrogs, to obtain more accurate data or focusing on specific areas within a project site to obtain more accurate estimates of amphibian and reptile abundance.
2. Restoration objectives should also consider that natural colonization of reptiles and amphibians following restoration may be dependent on distance of Big Meadow from a source population and ability of reptiles and amphibians to move across the landscape.
3. Reptile and amphibian surveys should be conducted during the breeding season (late May and June)

Songbirds

Recommended restoration actions

Meadow

1. Based on low detections of desired condition songbirds associated with riparian areas, restoration efforts should focus on: 1) improving the willow component and structural diversity of the understory plan community to enhance nesting and foraging opportunities for yellow warblers, calliope hummingbirds, Lincoln's sparrows, willow flycatchers, and red-breasted sapsuckers, and 2) improving meadow wetness and emergent marsh communities to enhance nesting habitat for Wilson's snipes which were infrequently detected at Big Meadow compared to other meadows within the Basin.
2. We recommend utilizing prescribed fire within the meadow as planned, as burning the meadow is expected to increase forb regeneration which may increase vegetation cover at nest sites for songbirds, which may subsequently reduce predation risk and enhance productivity in the long run. Control burns should take place outside the breeding season (May- August), however, to minimize disturbance that could negatively affect nesting success in the short term.

Upland

1. Maintaining snags, improving old-growth conditions in the upland, and improving aspen regeneration to provide habitat elements important to the following desired condition species that were absent or infrequently detected at Big Meadow: olive-sided flycatcher, white-headed woodpecker, red-breasted sapsucker, white-breasted nuthatch, and Williamson's sapsucker.
2. Maintaining snags with cavities during thinning and burning operations, and/or installing nest boxes which should be beneficial for mountain bluebirds, house wrens, white-breasted nuthatch and other secondary cavity nesters which are often limited by insufficient cavities for nesting.
3. Retain snags in the aspen stand to provide habitat for woodpeckers and small owls.

Recommended restoration objectives

Meadow

1. Increase richness and abundance of songbirds and desired condition songbird species that inhabit the meadow/riparian community at Big Meadow
    - Metric: Richness (number of species detected across all survey points per year) and abundance (total number of individuals detected across all survey points per year).
    - Methods: Point-count surveys three times a month during June

Upland

1. Increase richness and abundance of songbirds and desired condition songbird species that inhabit mature forest and aspen communities
    - Metric: Richness (number of species detected across all survey points per year) and abundance (total number of individuals detected across all survey points per year).
    - Methods: Point-count surveys three times a month during June

Monitoring recommendations

1. Continue current survey protocols post-restoration as part of effectiveness monitoring.

<u>Songbird productivity</u>

Recommended restoration actions

Meadow

1. Control burns should take place outside the breeding season (May–August) to minimize disturbance that could negatively affect nesting success.

Upland

1. Maintain a variety of snags in different size classes to provide foraging and nesting opportunities for species such as woodpeckers and small owls.

Recommended restoration objectives

Meadow

1. Maintain or increase productivity of focal songbird species. Expect productivity to increase within meadows due to increased meadow wetness which will reduce the ability of mammalian predators to access nests
    - Metrics: Daily nest survival (Mayfield 1961) and brown-headed cowbird parasitism rate (% of nests parasitized per species)
    - Methods: Search for (daily) and monitor nests of focal songbird species every 3-5 days beginning in late May through early August. Nest searching will take place within the open meadow area and within 150 m of the meadow/forest edge.

Monitoring recommendations

1. Daily nest survival and risk of brood parasitism by brown-headed cowbirds appears stable and are not a cause of concern. However, nest monitoring should continue to ensure that restoration actions do not result in an increase in brood parasitism or a decrease in daily nest survival.

Owls

Recommended restoration actions

Upland

1. Maintain a variety of snags in different size classes to provide nesting opportunities for owls.

Monitoring recommendations

1. If continued monitoring of owl richness is deemed important, we suggest beginning surveys in mid-March or early April and completing them no later than mid-June.
2. If determining the response of cavity-nesting owls to the creation and maintenance of snags in Big Meadow is deemed important, we recommend focusing on the reproductive success of owls in the area. Determining productivity, however, is time-intensive and would require an increase in manpower.

Bats

Recommended restoration actions

Meadow

1. Where possible, preserve riparian habitat corridors, cottonwood, willow and alder woodlands, and areas with open water to provide foraging opportunities for bats.

Upland

1. Because snags are a potential source of roost sites for bats, efforts should be made to determine if the number of snags with cavities is sufficient to meet the needs of bats in the Basin (or specifically at Big Meadow).

Recommended restoration objectives

Meadow

1. Increase species richness and detection frequency of desired condition bat species at Big Meadow
    - Metric: Richness (total number of species detected) and detection frequency (average proportion of detections per visit per species)
    - Methods: Three surveys throughout the summer using ultrasonic bat detectors.

Monitoring recommendations

1. We recommend that more intensive studies be initiated to locate and quantify roosting and maternity sites for bats, which will require the use of telemetry.

Small mammals

Recommended restoration actions

Meadow

1. Restoration actions should focus on maintaining open, wet meadows and increasing willow cover to encourage the persistence of desired condition small mammal species.

Upland

1. Retain adequate downed woody debris and snags to encourage small mammal occurrence.

Recommended restoration objectives

Meadow

1. Increase species richness and abundance of desired condition small mammal species at Big Meadow
    - Metric: Richness (total number of species detected across all visits per year) and relative abundance (number of unique individuals captured per 100 trap nights).
    - Methods: Trap and mark small mammals.

Upland

2. Increase species richness and abundance of desired condition small mammal species at Big Meadow
    - Metric: Richness (total number of species detected across all visits per year) and relative abundance (number of unique individuals captured per 100 trap nights).
    - Methods: Trap and mark small mammals.

Monitoring recommendations

1. Monitoring should continue in the meadow area to determine if change in species composition or abundance occurs during or after restoration activities.
2. Small mammal sampling should be shifted in Big Meadow to encompass areas of expected restoration not currently covered by pre-restoration surveys. Additional traps should be placed in the upland forest community and aspen stands located in the south west corner of the meadow.

Recommended vegetation objectives

1. Increase extent of meadow area within Big Meadow (from aerial photos)
2. Maintain existing willow cover and increase willow cover
    a. Maintain existing willow cover along channel. Burning should not negatively impact the existing willow cover along the channel.
    b. Increase willow along perimeter of meadow in areas where conifers are removed and where there is sufficient wetness to support willow development/recruitment. Conditions that are likely to support willows exist in the in north corner of the meadow near songbird point-count stations M04, M05, and M03 (Appendix 7.1). Planted willows should occupy 60% of the treated area (Bombay et al. 2003).
    c. Planted willows should have an approximate mean size of 375 m^2 (Bombay-Loffland, Unpublished data).
        - Metric: Spatial location (UTM coordinates) and area covered by willow clumps pre- and post-restoration
        - Methods: Record location (UTM coordinates), size (ha occupied), and height (meters) of willows using a global positioning system (GPS).

CHAPTER VII – BIG MEADOW RESTORATION PROJECT

INTRODUCTION

Big Meadow is approximately 30 ha in size and located at 2300 m elevation, south of Highway 89 and the Cookhouse Meadow site (Appendix 7.1). Big Meadow Creek flows through the eastern portion of the meadow. The southwest corner of the meadow contains semi-wet meadow with perennial ponding. Vegetation within the meadow consists of scattered patches of willow (*Salix* spp.) and annual and perennial grasses and forbs. Mixed-conifer species (Jeffrey pine [*Pinus jeffreyi*] and white fir [*Abies concolor*]) are the predominate vegetation in the upland area surrounding the meadow. A small quaking aspen (*Populus tremuloides*) stand is located near the southeast corner of the meadow.

Prior to logging and grazing activities that took place during the Comstock Era, Big Meadow supported a diverse array of native plants shaped, in part, by Washoe Tribe management practices. Plant community distribution in wetlands and meadow habitats was influenced by Washoe Tribe management practices, which included deliberate use of fire to sustain native meadow and forest vegetation. However, in recent times fire suppression has lead to a dense, even-aged monoculture forest which is more susceptible to large-scale fires, insect infestation, and drought. In addition fire suppression has reduced habitat quality for wildlife and plants. For example, encroachment of conifers reduces the amount of foraging habitat available for many species, such as California spotted owl (*Strix occidentalis*), northern goshawk (*Accipiter gentilis*), and mule deer (*Odocoileus hemionus*).

Logging, grazing operations, and fire suppression during the Comstock Era have (1) degraded creek geomorphic processes and function, (2) lowered shallow water tables, (3) degraded riparian corridors, (4) enhanced lodgepole invasion of meadows, and (5) affected wildlife habitat throughout the Big Meadow Creek Watershed. Extended periods of sheep and cattle grazing prevented the natural regeneration of the meadow and riparian vegetation while exposing soils to erosion. As grazers trampled meadow areas, the potential for subsurface water retention was reduced or eliminated. Grazers created gullies that drained the meadows and seeps contributing to soil erosion and disruption of meadow hydrology. Big Meadow does not currently support any grazing activities but the impact of grazing is still evident in the meadow complex.

There is a need to re-introduce a fire regime to the Big Meadow area to restore the ecological function of the Big Meadow Creek Watershed to conditions that existed prior to grazing, timber management, and fire suppression. Currently, much of the forest consists of dense stands of conifers. Conifers, especially lodgepole pine (*Pinus contorta*), are encroaching into aspen stands. Conifer species tend to draw a significant amount of water away from aspen stands affecting riparian and meadow communities, and ultimately changing the structure of the forest. Prescribed burning in the meadow will aid in the restoration of the ecological structure of meadow plant communities, riparian vegetation, and aspen stands. Thinning and burning in the meadow ecosystem will provide a faster recovery to pre-disturbance conditions. Restoration of the forest ecosystem is also expected to support diverse vegetation communities and increase habitat quality for terrestrial wildlife species.

MONITORING AND ADAPTIVE MANAGEMENT

The restoration approaches and measures of the plan are based principally on SNFPA (2004) and other USFS guidance and policy directives. To continue to meet the restoration goals at Big Meadow in the future, monitoring and site-specific evaluations and management protocols must be outlined and followed. The use of site-specific monitoring, data evaluation, and information-based decision making to manage these resources constitutes the adaptive management approach for Big Meadow.

Compliance with the SNFPA 2004 AMS goals is a principle objective of adaptive management at Big Meadow. The AMS goals of SNFPA 2004 are specifically intended to restore the physical and biological processes to riparian and meadow ecosystems as a means to create self-sustaining riparian-dependent plant and wildlife populations.

The success of restoration at Big Meadow will be assessed in part by the biological integrity of its ecosystem. Measures to assess this integrity may include documenting and assessing wildlife diversity and viability through wildlife surveying, monitoring, and tracking of wildlife assemblages and desired condition wildlife species.

LTBMU shall develop and integrate adaptive management monitoring and assessment plans and analyses to support ecosystem restoration measures at Big Meadow.

PROJECT GOALS

The forest-wide wildlife goal calls for wildlife habitat to be maintained and to preserve and maintain populations of threatened, endangered, and sensitive species. The forest-wide timber goal dictates that healthy forest conditions be maintained through timber management practices designed primarily to achieve benefits of scenery, water quality, recreation, wildlife habitat, vegetative diversity, pest management, and fire protection. The timber management proposed for this project is expected to address both of these goals. Additionally, this project is intended to satisfy the fire protection goal to assure that property and resource losses are not excessive.

Sierra Nevada Forest Plan Amendment goals and objectives (SNFPA 2004)

The SNFPA goals for old forest, aquatic, riparian, and meadow communities, fire and fuels management, and associated species conservation include the following:

Aquatic, Riparian and Meadow Ecosystems

1. Plant and Animal Community Diversity: Maintain and restore the species composition and structural diversity of plant and animal communities in riparian areas, wetlands, and meadows to provide desired habitats and ecological function.
2. Watershed Connectivity: Maintain and restore spatial and temporal connectivity for aquatic and riparian species within and between watersheds to provide physically, chemically, and biologically unobstructed movement for their survival, migration, and reproduction.
3. Watershed Condition: Maintain and restore soils with favorable infiltration characteristics and diverse vegetative cover to absorb and filter precipitation and to sustain favorable conditions of stream flow.

Old Forest Ecosystems

4. Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities.
5. Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape.

Fire and Fuels Management

6. Reduce the threats to communities and wildlife habitat from large, severe wildfires and re-introducing fire into fire-adapted ecosystems.

LTBMU Land and Resource Management Plan goals and objectives

1. Fire protection goal: Provide a level of fire protection to assure that property and resource losses are not excessive (average annual acreage burned less than 50).
2. Timber goal: Maintain healthy, diverse forest conditions through timber management practices designed primarily to achieve scenic, water quality, recreation, wildlife habitat, vegetative diversity, pest, and fire protection benefits.
3. Visual goal: Maintain an attractive forest appearance by meeting or exceeding established visual quality objectives.
4. Wildlife goals: Maintain habitat for the existing wildlife species without preference to game or non-game species. Preserve and enhance populations of threatened, endangered, and sensitive species.

Specific project goals and objectives

Restoring the forest ecosystem will support diverse vegetation communities and lead to an increase in wildlife habitat quality, improve and encourage development of aspen stands, and reduce the risk of wildfires by treating hazardous fuels. Restoration will include forest thinning of dense second growth conifers, removing ladder fuels and the re-introduction of periodic, low-intensity fires. Objectives include:

1. Initiate prescribed burning in the meadow to aid in the restoration of the ecological structure of meadow plant communities, riparian vegetation, and aspen stands.
2. Restore 40 ha of historic, fire-adapted meadow communities in the watershed to conditions approximating pre-European conditions.
3. Increase the diversity and forage quality of the meadow plant community such that it is composed of a diverse assemblage of herbaceous grasses and hardwood shrubs (e.g., willow).
4. Restore approximately 200 ha of historic, fire-adapted old-growth forest community complexes in the Big Meadow watershed to conditions that approximate those that existed prior to the implementation of total fire suppression and other Euro-American land use practices.
5. Reduce the current high risk of destructive, high-intensity fires.
6. Produce a forest composed of a diversity of age classes of conifers and understory vegetation.
7. Improve the health of the old-growth trees.
8. Enhance, improve, and expand habitat for spotted owl, northern goshawk, and mule deer.

9. Improve the health and extent of the aspen communities by re-introducing fire to prevent the encroachment of white firs and lodgepole pine.

PLANNED RESTORATION ACTIONS

Goals and objectives will be met by performing the following project activities:

1. Introduce a mixed severity prescribed burn. Prescribed burning and hand thinning operations will be performed on up to approximately 200 ha of surrounding forest and 40 ha of meadow. Thinned materials will be piled and burned, lopped and scattered, or chipped.
2. Remove lodgepole pines and white firs that have encroached into the meadows and aspen stands.
3. Pile and burn conifer saplings, including an understory burn on the fringes of the aspen stand adjacent to the meadow.
4. Utilize existing trails and features for fire line containment, and potentially realign trails around meadow after project completion.

DEVELOPMENT OF DESIRED SPECIES CONDITIONS

The desired condition for Big Meadow was based on two fundamental analyses (existing conditions – based on pre-restoration data collected from 2004 – 2007 and historical conditions) that are presented in detail in Chapter I (Please see pages 9 – 12 in Chapter I). The analysis was conducted for songbirds, reptiles, amphibians, bats, and small mammals. Due to the lack of historical datasets for reference, desired condition butterfly species were selected as species that rely on montane meadows and riparian areas and those species that have specific host-plant requirements because these are expected to be the most vulnerable and sensitive species. Species identified through these analyses comprise the *desired condition species* for Big Meadow and should be present pending successful restoration (Appendix 7.2-7.5); although the inability to detect a desired conditions species following restoration does not necessarily indicate restoration failure. However, presence of additional species that are relatively common on other meadow sites throughout the Basin (e.g., Wilson's warbler [*Wilsonia pusilla*]) but not at Big Meadow will also be used to gauge the progress of restoration. Final designation of desired species for the Big Meadow restoration project is contingent on Forest Service decisions.

CONTROL SITE DESCRIPTION

Control sites were selected in association with the Big Meadow restoration project to evaluate the effectiveness of restoration actions. Effectiveness monitoring was designed with pre and post comparisons in a Before-After-Control-Impact (BACI) design. The BACI design is ideal and provides the most accurate assessment of the effects of restoration (Morrison 2002). The BACI design requires that monitoring occur at impact sites (i.e., treated or restored sites) and control sites (i.e., not treated or restored) both before and after impact (i.e., treatment or restoration actions). Control sites are used to help determine if changes observed on restoration sites are due to management actions. That is, if there is a difference in the trend of species occurrence, abundance, or other monitoring metric between control sites and a restoration site

before and after restoration then we have support for a conclusion that management actions were responsible for the trend or change observed.

Control sites should be similar in terms of gross vegetation features to the restoration site and be located near the restoration site but far enough away to be considered an independent unit (Block et al. 2001). Initially, data collected at Big Meadow were used to make pre- and post-restoration comparisons with Cookhouse Meadow; therefore, we have not selected a control site specifically for Big Meadow. However, pre-restoration monitoring data was collected at Grass Lake; therefore we make comparisons of data collected at Big Meadow with Grass Lake. However, we propose replacing Grass Lake with Fountain Place as a control site for Big Meadow.

Grass Lake is located at Luther Pass (2300 m elevation) and is approximately 10 ha in size (Appendix 7.8). Our study area is the southern extension of the main Grass Lake; the lake itself is 1 km north of our study site. Much of Grass Lake consists of wet meadow/marsh dominated by grasses and rushes. The outer rim of the wet area consists of sparse willow and grasses and forbs. The upland area consists of mixed-conifer (white fir, lodgepole pine, and red fir (*Abies magnifica*), and quaking aspen).

EFFECTIVENESS MONITORING METHODS

Project effectiveness monitoring will be used to measure the effectiveness in meeting the project objectives. Metric used to assess effectiveness include species (1) richness, (2) abundance, (3) distribution, and (4) productivity. The distribution metric was not used to address any specific objectives from 2005 - 2007, but information on distribution of desired condition species will be used to assist in developing restoration plans. Post-restoration monitoring may want to consider collecting data on distribution. In general, we recommend monitoring changes in species richness and abundance of the following species groups: butterflies, songbirds, and bats due to their high mobility across the landscape; and changes in distribution of reptiles, amphibians and small mammals to determine whether meadow associated communities are being enhanced by restoration actions and whether specific desired species are present or are increasing in abundance due to restoration actions. We also recommend monitoring productivity for focal songbird species to determine whether wildlife productivity is being maintained. Pre-restoration monitoring data was collected at Big Meadow from 2004 to 2007 for all species groups; however reptile and amphibian surveys were not conducted in 2007. Control site pre-restoration data is only available for Grass Lake where monitoring occurred from 2004 to 2007 for all species groups; however, no reptile and amphibian surveys were conducted in 2007 (with the exception of surveys conducted by the Forest Service in August 2007). We recommend that additional pre-restoration monitoring data be collected from an additional control site (Fountain Place).

PRE-RESTORATION OBJECTIVES AND ASSOCIATED WILDLIFE METHODS, METRICS, AND ANALYSIS

Butterflies

Pre-restoration objective 1. Determine richness and relative abundance of butterflies and desired condition butterfly species at Big Meadow pre-restoration.

Methods.—We conducted visual encounter and sweep-net butterfly surveys at Big Meadow and associated control site, Grass Lake, to determine species richness and relative abundance of butterflies. Observers worked in teams of two-to-three and walked slowly in a zigzag pattern through the entire survey area scanning for butterflies. The riparian area was divided into six survey areas to allow us to assess species distribution (Appendix 7.1 and 7.8). Observers recorded the species and the number of individuals detected in each survey area. In addition, we visually assessed vegetation within 5 m of each butterfly detection based on the dominant shrub species and dominant ground cover. We categorized ground cover as either a mixture of grasses and forbs with no soil moisture (grass/forb dry) or as a mixture of grasses and forbs in wet or moist soils (grass/forb wet). Additional ground cover categories were bare soil containing no vegetation or areas covered by rocks. Shrub cover was categorized by the dominant plant species in the mid-story. Categories included alder, willow, flowering shrub, non-flowering shrub, or absence of shrub layer. Only willows and alders were identified in the shrub layer because these species are important nectar sources for many butterflies. If a butterfly species was detected feeding on nectar, we also recorded the plant species the individual butterfly was feeding on. Butterflies that we could not identify from a distance were captured with a sweep net and released after identification. We conducted butterfly surveys twice a month in July 2004 and June to August 2005–2007.

Data analysis.—We calculated richness as the number of species detected across all surveys. We calculated abundance as the total number of individuals observed across all surveys. We chose to report total abundance instead of taking an average across all survey periods because butterflies are short lived and tend to move frequently throughout the landscape.

Reptiles and amphibians

Pre-restoration objective 2. Determine richness of desired condition reptile and amphibian species at Big Meadow pre-restoration.

Methods.—We conducted visual encounter surveys for amphibians and reptiles at Big Meadow and associated control site, Grass Lake, to determine species richness. Observers worked in teams of two-to-three and walked slowly in a zigzag pattern, searching water bodies, and opportunistically turning over rocks and debris in search of reptiles and amphibians. The riparian area was broken into six survey areas that we searched for 30 minutes per person (Appendix 7.1 and 7.8). We conducted visual encounter surveys between mid-to-late morning. We surveyed each site once during June 2004–2006. The amount of time spent searching each site varied by the size of the site, but all meadow areas within each site was thoroughly scanned for reptiles and amphibians.

Data analysis.—We tallied the total number of species detected during each survey for each year. Survey results were used to determine the distribution of species across surveys areas sampled to 1) indicate which areas might benefit from restoration actions, and 2) to generate a spatial metric for tracking changes in distributions before and after project implementation. The distribution metric was calculated as the number of survey areas occupied per species per year, although distribution data is only available for 2006. If the distribution of species expanded due to restoration, this value should increase. Additionally success of the restoration project could also incorporate post-project sampling of newly created habitats (e.g., floodplain depressions, ephemeral ponds) to determine utilization by amphibians and reptiles.

Songbirds

Pre-restoration objective 3. Determine richness and abundance of songbirds and desired condition songbird species at Big Meadow pre-restoration.

Methods.—We established avian point-count stations at Big Meadow and associated control site, Grass Lake, to assess bird species richness and abundance (Appendix 7.1 and 7.8). We established 6 point-count stations 200 m apart surrounding the meadow at Big Meadow and 4 point-count stations surrounding the meadow at Grass Lake. Additional point-count stations were located in the upland communities surrounding the meadow (6 points at Big Meadow and 4 points at Grass Lake). We conducted avian point-counts at each site in June 2004–2007. Each site was surveyed three times separated by one week. Point counts began 15 minutes before sunrise and finished no later than four hours after sunrise. Observers recorded all birds seen or heard within 10 minutes within 50 m of the point-count station. Observers also recorded Douglas squirrels (*Tamiasciurus douglasii*) during point counts. Observers did not conduct point counts during inclement weather (e.g., precipitation or wind >9 km/hr).

Data analysis.—We calculated species richness as the total number of species detected across all surveys. To calculate abundance we averaged the number of individuals detected within 50 m of point-count stations across the three surveys and then divided by the number of points sampled to correct for differences in the number of points surveyed at each site.

Pre-restoration objective 4. Determine productivity of focal bird species pre-restoration.

Methods.—We searched for and monitored nests of six focal species: willow flycatcher, dusky flycatcher (*Empidonax oberholseri*), warbling vireo (*Vireo gilvus*), yellow warbler (*Dendroica petechia*), MacGillivray's warbler (*Oporornis tolmiei*), and Wilson's warbler (*Wilsonia pusilla*) to quantify reproductive success and brown-headed cowbird (*Molothrus ater*) parasitism. We chose to monitor nests of these species because (1) their nests are low in height (nests typically <5 m tall), (2) they are a species of concern (e.g., willow flycatcher), or (3) they are associated with riparian vegetation. At each site, observers searched for nests within 200 m of the main creek. Nests were monitored from May to August 2004–2007. Nests were checked every three to five days until nest outcome could be determined.

Data analysis.—We estimated nesting success by calculating Mayfield estimates of daily survival (Mayfield 1961). Mayfield estimates account for the fact that successful nests are more likely to be found by observers than nests that fail early in the season and hence provide less-biased estimates of nesting success (Mayfield 1961). Daily survival is one minus daily mortality,

which is the total number of nests that fail per species divided by the total number of days all nests of that species were exposed or were active. Nests were considered successful if at least one fledgling was observed. Failed nests were those at which the eggs or nestlings were destroyed or when parental activity ceased prior to the expected fledging date. When calculating Mayfield estimates, we considered parasitized nests that fledged *only* cowbirds as nest failures; we considered nests that were parasitized but fledged at least one host young as successful. Nests at which we could not determine fate with certainty were excluded from analysis. Nests that never received eggs were considered abandoned and were also removed from analysis.

We also calculated the percentage of nests that were parasitized by brown-headed cowbirds. Parasitized nests include all nests in which a brown-headed cowbird egg or nestling was detected, regardless of final nest outcome. Unparasitized nests include nests in which we did not detect the presence of a brown-headed cowbird egg or nestling. At several nests we were unable to determine if a nest was parasitized because we were unable to check nest contents. Nests in which cowbird parasitism could not be accurately determined were removed from analyses.

Owls

Pre-restoration objective 5. Assess owl richness at Big Meadow pre-restoration.

Methods.—We conducted nocturnal broadcast surveys for six owl species to determine species presence. Each call point was 500 m apart to minimize the chance of detecting the same owl at more than one call point (Morrison et al. 2001, Johnsgard 2002); the number of call points depended on site size (Appendix 7.1 and 7.8). With each survey separated by at least one week, we conducted two surveys in July 2004, and three surveys from May to June 2005, May to July 2006, and March to June 2007. Given that most owl species begin courtship and nesting in late winter or early spring (Johnsgard 2002), we believed that starting owl surveys in March would increase the probability of detecting individuals. Surveys commenced 15–30 minutes after sunset and continued until all points at the site were surveyed. Initiating the evening surveys soon after sunset potentially increased the chances of detecting the diurnal northern pygmy-owl (*Glaucidium californicum*). Surveys occasionally occurred before dawn if weather prevented the nocturnal survey from being completed. The order of the call points changed with each visit to the site to decrease the chances of temporal bias (Morrison et al. 2001). At each call point, observers listened for five minutes and recorded all species seen or heard. After the initial five-minute listening period, six species of owls were broadcast using a portable CD player and Foxpro Wildlife Caller® (an amplified speaker). Standard owl calls were used; calls were taken from Peterson Field Guide Audio Series® and Stokes Field Guide to Bird Songs®. Species were broadcast from the smallest to the largest owl species (i.e., flammulated owl [*Otus flammeolus*], northern pygmy-owl, northern saw-whet owl [*Aegolius acadicus*], western screech-owl [*O. kennicottii*], long-eared owl [*Asio otus*], and great horned owls [*Bubo virginianus*]). Each species was broadcast for 30 seconds followed by 30 seconds of silence and repeated twice in succession. At the end of the broadcast series observers listened for five minutes and searched the area for silent owls with a half-million candle-watt spotlight (Nite Tracker 2287) for the first two minutes. Observers recorded the species, interval of the call series during which the owl responded, and the direction and distance of the owl's response. Detections of common nighthawk (*Chordeiles*

minor) and common poorwill (*Phalaenoptilus nuttallii*) were also recorded. Surveys did not take place in heavy rain or winds >20 km/hr.

Data analysis.—We report the presence of owl species detected both during surveys and incidentally. The number of individual owls per site is also noted. If an owl of the same species was detected at the same call point on subsequent visits, it was counted as one individual.

Bats

Pre-restoration objective 6. Determine richness and relative frequency of use of desired condition bat species at Big Meadow, pre-restoration.

Methods.—We conducted acoustic surveys for bats using Pettersson ultrasonic detectors (model D240X) to assess bat species richness. We placed Pettersson recorders in suitable openings, near vegetation transition zones, or in likely movement corridors (Appendix 7.1, 7.8, and 7.9). Due to the high frequency (pitch) with which most bats echolocate, the maximum range at which the detectors can detect bats is about 25–30 m (Fenton 2007). Therefore, in an effort to cover a large proportion of each site, we placed detectors in different locations on subsequent visits, with each location at least 100 m apart. Bats were recorded on three different nights separated by at least one week from July to September 2004 and from June to August 2005 and 2006. To determine if an increase in the number of visits would increase the number of species detected, we recorded bats on six different nights at Big Meadow and Grass Lake from June to August 2007 (Appendix 7.9). Although we did detect two rare species across sites in 2007, the increase in visits did not increase the overall number of species detected compared to previous years. We did not record bats during inclement weather in any year.

Data analysis.—Bat sonograms were analyzed with SonoBat version 2.2 (DNDesign 2004), which facilitates our comparison of sonograms recorded in the field to known species standards. Although it was not possible to determine abundance with this survey method, we calculated relative frequency of use per species; that is, the number of times a particular species (whether the same individual or different individuals) flew past the bat detector. To calculate relative frequency of use, we divided the number of recorded detections of each species by the total number of recorded detections of all bat species.

Small mammals

Pre-restoration objective 7. Determine species richness and abundance small mammals and desired condition small mammal species at Big Meadow pre-restoration.

Methods.—We conducted small mammal surveys at Big Meadow and associated control site, Grass Lake, using Sherman Live Traps to quantify species richness and abundance July–August 2004, June 2005, and July 2006 and 2007. We placed Sherman Live Traps along 250 m transects that ran parallel to the creek and located between songbird point-count stations (Appendix 7.1, 7.7, and 7.8). We placed traps every 25 m along each transect and keeping the traps 25 m from the creek channel. At alternating 25 m, we placed both large and extra-large Sherman Live Traps. At each location, we placed Sherman traps in the nearest appropriate location ensuring that the trap was sufficiently protected from the elements (e.g., sun). We baited traps with a mixture of rolled oats and peanut butter. We checked traps twice daily (morning and

dusk) for three consecutive days. We identified captured animals to species, sexed, and aged if possible. Additionally, we tagged chipmunks and squirrels with numbered aluminum ear tags to allow for individual identification. In 2006, we marked deer mice (*Peromyscus maniculatus*) and vole (*Microtus* spp.) species by clipping a small amount of fur from their rump; neither species were shaved in 2004 or 2005. In 2007, we continued to mark vole species by clipping their fur, whereas deer mice were tagged with ear tags.

In 2007, small mammals were trapped in a relatively small area of Waterhouse (Appendix 7.7). While the purpose of trapping at Waterhouse was not specifically for the restoration inventory and monitoring project, we nevertheless report the results in this chapter as a baseline for future surveys. Trapping occurred at Waterhouse following the methods outlined previously.

Data analysis.— In addition to the number of desired condition species detected in each year, we calculated the number of unique individuals captured by subtracting the number of recaptures and unknown captures from the total number of captures per species. Deer mice were not marked in 2004 or 2005, thus we report the maximum number of mice captured in one visit over the entire trapping session. The maximum number captured in one visit usually underestimates abundance; to allow comparisons of deer mice numbers between years, we also calculated the maximum number of mice captured in one visit over the entire trapping session for 2006 and 2007.

Because the number of traps varied among years and sites, we calculated for each species the number of unique individuals captured per 100 trap nights: we divided the total number of unique individuals per species by the total number of traps available throughout the entire trapping session, multiplied by 100. The number of traps placed varied between years due to conditions within the meadow. If the meadow area was excessively wet we could not place traps in that area, thus affecting the number of traps placed each year. Our analysis adjusts for these differences to allow adequate comparisons.

Throughout the four years of surveys, traps were located in both meadow and upland areas at Big Meadow and Grass Lake. Because of the potential for a different suite of species to occur in each of those areas, we conducted the above analysis not only for all traps total at each site, but also for meadow and upland traps separately.

RESULTS AND DISCUSSION

BUTTERFLIES

Pre-restoration objective 1. Determine richness of butterflies and desired condition butterflies at Big Meadow pre-restoration.

Big Meadow supported more butterflies and desired condition butterflies compared to the control site, Grass Lake (Fig. 7.1 and 7.2 and Appendix 7.10 and 7.11). However, Big Meadow is much larger than Grass Lake and Grass Lake does not contain similar vegetation features. Thus, we recommend that data be compared to pre-restoration data collected at Fountain Place to allow for more appropriate comparisons. Abundance of desired condition butterflies per ha at Big Meadow and the control site (Grass Lake) increased from 2004 to 2007 (Fig. 7.3). Reasons for an increase in abundance are unknown, but what is interesting is that abundance is relatively similar between Big Meadow and the control site and both sites are following a similar pattern.

Within Big Meadow, butterfly richness was highest in survey area 8 (n = 25) and survey area 1 (n = 24; Appendix 7.1). Survey area 8, located in the south west corner of the meadow is typically wet, which may explain the large number of species present there. Restoration actions may want to mimic conditions found in survey area 8 and area 1 to improve butterfly richness across Big Meadow.

Prescribed fire is expected to increase butterfly richness and abundance because fire can (1) regenerate flowering plants that butterflies rely on and (2) open up the forest canopy, subsequently increasing the amount of sunlight reaching the forest floor, which is important for butterflies. In fact, fire management practices riparian systems increased butterfly richness and diversity in Yosemite National Park (Huntzinger 2003). Butterflies are an appropriate species group to examine the effects of prescribed fire because many species have specific host-plant associations. If butterflies respond positively to treatments, this may suggest that treatments resulted in improving the herbaceous community (Harding et al. 1995).

Recommended restoration actions

Meadow

1. Within Big Meadow, butterfly richness was highest in survey area 8 (n = 25) and survey area 1 (n = 24). Survey area 8, located in the south west corner of the meadow is typically wet, which may explain the large number of species present there. Restoration actions may want to mimic conditions found in survey area 8 and area 1 to improve butterfly richness across Big Meadow.
2. We recommend utilizing prescribed fire within the meadow as planned to enhance conditions for butterflies. Prescribed fire is expected to increase butterfly richness and abundance because fire can (1) regenerate flowering plants that butterflies rely on and (2) open up the forest canopy, subsequently increasing the amount of sunlight reaching the forest floor, which is important for butterflies.

Recommended restoration objectives

Meadow

1. Increase richness and abundance of butterflies and desired condition butterfly species within the meadow and in meadow areas that are expanded due to restoration actions.
    - Metric: Richness (number of species detected within survey areas) and abundance (number of individuals detected within survey areas).
    - Methods: Visual encounter sweep net surveys conducted twice a month from June through August.

Monitoring recommendations

1. Because restoration at Big Meadow focuses on burning and removing encroaching conifers, we suggest that additional butterfly surveys take place in areas that will be affected by restoration actions (e.g., the upland forest community that is slated to be thinned) to more accurately compare treatment effects. Currently no survey points exist for butterflies in the upland forest community. Surveys should be conducted within the upland forest areas that are going to be impacted by thinning and conifer removal. Alternatively, impacts of restoration will only be assessed within the larger meadow area where we currently have survey plots.

2. Although we recorded gross vegetation features where butterflies were first detected, additional vegetation and soil moisture data should be collected within each survey area to determine if vegetation and hydrological features influence butterfly diversity, abundance, and distribution. Collecting more specific data such as this will give us a better understanding of ecological features required by butterfly species that will help the Forest Service make better restoration decisions. Additionally, no surveys have been initiated to determine flowering plant composition within survey areas. Thus, we cannot determine if lack of butterflies is due to the absence of host plants or due to other factors. Although no pre-restoration data exist, we suggest that a pilot study be conducted to help determine key ecological requirements of butterflies. The costs to complete such a project are unknown.

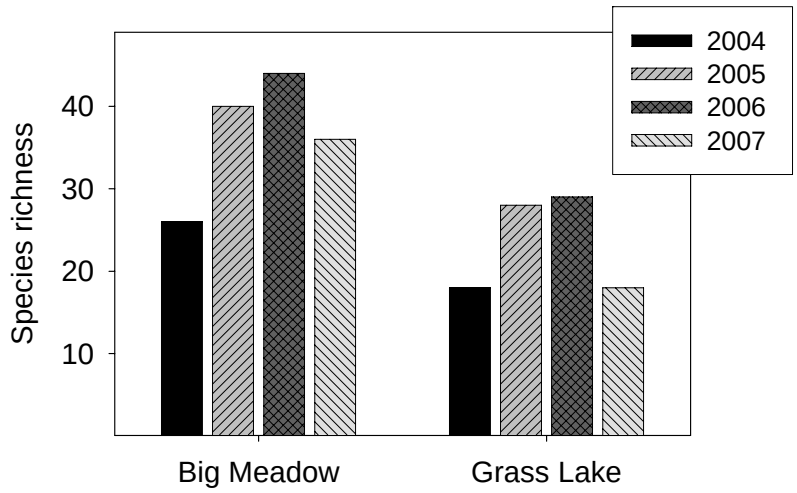

Figure 7.1. Butterfly species richness at Big Meadow and a control site (Grass Lake) from 2004 to 2007.

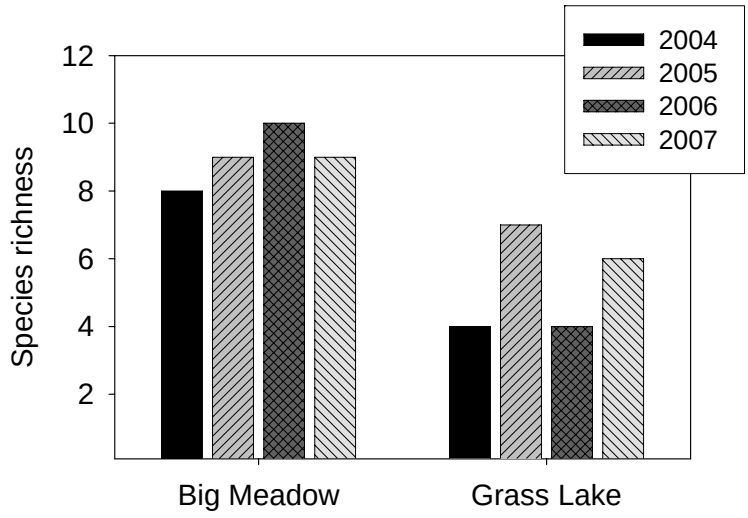

Figure 7.2. Richness of desired condition butterfly species detected at Big Meadow and a control site (Grass Lake).

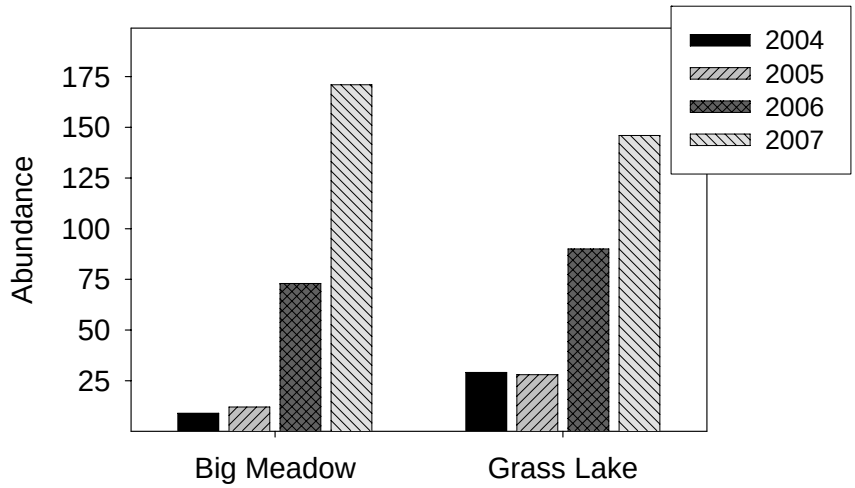

Figure 7.3. Abundance of desired condition butterfly species per ha at Big Meadow and a control site (Grass Lake) from 2004 to 2007.

REPTILES AND AMPHIBIANS

Pre-restoration objective 2. Determine richness and distribution of desired condition reptile and amphibian species at Big Meadow pre-restoration.

Reptile and amphibian surveys were conducted at Big Meadow in 2004, 2005, and 2006 and to a limited extent in 2007 (data from 2007 not reported here because surveys took place in early August). During visual encounter surveys we detected western toads (2005), Pacific

treefrogs (2004–2006), common garter snakes (2004 and 2005), western terrestrial garter snakes (2004–2006), and aquatic garter snakes (2005). Distribution and location data of reptile and amphibian detections was only recorded in 2006. The majority of the Pacific treefrogs we detected were located in survey areas 6, 7, and 8 (Appendix 7.1). Saturated soils with a mix of grasses and forbs in lentic areas or areas with standing water characterized the vegetation surrounding each location where an individual was detected. Garter snakes observed in 2006 were located in all survey areas except areas 2, 4, and 5.

Lack of detection of other species at Big Meadow does not mean that other reptiles and amphibians do not occur at Big Meadow. Rather, it is more likely that the visual encounter surveys we conducted were not sufficient to detect additional species. We recommend that visual encounter surveys be discontinued due to the low numbers of species detected utilizing this method. Because reptiles and amphibians can be difficult to locate due, in part, to their cryptic behavior and nocturnal habits, we suggest that survey methods and restoration objectives be re-evaluated. A complete survey of the herpetofauna requires pit fall traps, funnel traps, cover board layouts, night acoustic surveys, and visual encounter surveys (Heyer et al. 1994). However, the cost required to complete such a survey is prohibitive. We suggest intensifying surveys for one or two specific species, such as western toads or Pacific treefrogs, to obtain more accurate data or focusing on specific areas within a project site to obtain more accurate estimates of amphibian and reptile abundance. Restoration objectives should also consider that natural colonization of reptiles and amphibians following restoration may be dependent on distance of Big Meadow from a source population and ability of reptiles and amphibians to move across the landscape.

A total of six amphibian species and eight reptilian species have been reported within the Basin (Schlesinger and Romsos 2000). The northern leopard frog (*Rana pipiens*) is apparently extinct, and the non-native bullfrog has been added to the fauna. Thus, a total of 13 amphibians and reptiles now occur in the Basin. Manley et al. (2002) found all 13 species in the Basin and surrounding national forest, and reported the distribution of these species by elevation. However, five of the species were reported from below 1600 m and thus are unlikely to occur in our study sites: ensatina (*Ensatina eschscholtzii platensis*), California newt (*Taricha torosa*), southern alligator lizard (*Elgaria multicarinata*), California mountain kingsnake (*Lampropeltis zonata*), and gopher snake (*Pituophis catenifer*). Based on historic data and current survey results (Schlesinger and Romsos 2000), the desired herpetofauna includes western aquatic garter snakes (*Thamnophis couchii*), western terrestrial garter snakes (*Thamnophis elegans*), common garter snakes (*Thamnophis sirtalis*), long-toed salamanders (*Ambystoma macrodactylum*), western toads (*Bufo boreas*), and pacific treefrogs (*Hyla regilla*) (Appendix 7.3).

Several human influenced factors can influence herpetofauna within the Lake Tahoe Basin, such as habitat modification and exotic fishes that may negatively affect native frog species (Hayes and Jennings 1986, Adams 1999). For example, non-native fishes (e.g., rainbow trout) are negatively affecting populations of mountain yellow-legged frogs (*Rana muscosa*) in the Sierra Nevada's (Knapp and Matthews 2000). Retention of ephemeral wetland habitat may prove beneficial to native amphibians because non-native fishes are more often associated with permanent open-water bodies (Adams 1999). All of the species listed herein depend on aquatic habitats for part or all of their life stages, which indicate that specific attention should be given to the distribution and condition of egg laying locations and locations suitable for development of sub-adult life stages. These locations usually include relatively slow moving water, riffles, and ponds. Down logs, deep duff/soil, and vegetative cover are also necessary for other life cycle

stages. Thus, restoration actions should focus on creating the above conditions to improve richness and abundance of reptiles and amphibians.

Recommended restoration actions

Meadow

1. Restoration should attempt to create the following conditions to improve habitat elements for amphibians and reptiles, especially in survey areas 2, 4 and 5: areas of slow moving water, riffles, and ponds, downed logs, deep duff/soil, and vegetative cover.

Recommended restoration objectives

Meadow

1. Do not negatively impact the distribution of desired condition reptile and amphibian species at Big Meadow
    - Metric: Richness (number of species detected) and distribution (location of individuals detected within Big Meadow).
    - Methods: Because reptiles and amphibians can be difficult to locate due, in part, to their cryptic behavior and nocturnal habits, we suggest that survey methods and restoration objectives be re-evaluated. A complete survey of the herpetofauna requires pit fall traps, funnel traps, cover board layouts, night acoustic surveys, and visual encounter surveys (Heyer et al. 1994). However, the cost required to complete such a survey is prohibitive. To obtain distribution data, surveys should be intensified, locations of individuals should be marked with a GPS, and vegetation associations should be recorded where the individual was detected.

Monitoring recommendations

1. We suggest that survey methods and restoration objectives be re-evaluated; we recommend either discontinuing visual encounter surveys for reptiles and amphibians, or intensifying surveys for one or two specific species, such as western toads or Pacific treefrogs, to obtain more accurate data or focusing on specific areas within a project site to obtain more accurate estimates of amphibian and reptile abundance.
2. Restoration objectives should also consider that natural colonization of reptiles and amphibians following restoration may be dependent on distance of Big Meadow from a source population and ability of reptiles and amphibians to move across the landscape.
3. Reptile and amphibian surveys should be conducted during the breeding season (late May and June)

SONGBIRDS

Pre-restoration objective 3. Determine richness and abundance of songbirds and desired condition songbirds at Big Meadow pre-restoration.

Total songbird richness in the meadow and upland forest communities was similar across years and sites (Fig. 7.4; Appendices 7.12 and7.13). Of the desired condition species (Appendix 7.4), there was a slight decreasing trend at Big Meadow and the control site for species detected within the meadow (Fig. 7.5b). Within the upland forest community desired condition songbird richness was relatively consistent across years with fewer desired species detected at the control site. Abundance of desired condition species fluctuated across years at Big Meadow (Fig. 7.6),

although the changes in annual abundance were not significant. Richness and abundance of desired songbirds increased from 2006 to 2007. Reasons for this increase is unknown, but could be due to recent changes in meadow hydrology as a result of beaver activity that has increased meadow wetness in the south east corner of the meadow.

Based on low detections of birds associated with riparian areas, restoration efforts should focus on improving the willow component for yellow warblers, calliope hummingbirds, Lincoln's sparrows, and willow flycatchers. Restoration efforts could also focus on improving the structural diversity of the understory plant community to benefit the species listed above. Increasing structural diversity increases the number of available nest sites and increases the amount of foliage concealing the nest site, which may reduce predation risk. In the Sierra Nevada, aspen, willow, snowberry (*Symphoricarpos albus*), number of snags, and herbaceous and grass ground cover have been found to positively influence breeding bird species richness (Riparian Habitat Joint Venture 2004). Increasing the willow component also will benefit red-breasted sapsuckers that rely on the sap from willows during the breeding season. Improving meadow wetness and emergent marsh communities should prove beneficial for Wilson's snipes (Appendix 7.4) which were infrequently detected at Big Meadow compared to other meadows within the Basin. Emergent marsh communities could be created by allowing ponding to occur within portions of Big Meadow.

Other species typically associated with aspen stands or upland forest communities that were infrequently detected at Big Meadow compared to other sites where we sample the upland forest community (Cookhouse, Grass Lake, Fountain Place, and High Meadow) include olive-sided flycatcher, white-headed woodpecker, red-breasted sapsucker, white-breasted nuthatch, and Williamson's sapsucker. Maintaining snags, improving old-growth conditions, and improving aspen regeneration should prove beneficial to these species (Appendix 7.4). Maintaining snags and/or installing nest boxes may also be beneficial for mountain bluebirds and house wrens (Appendix 7.4).

Recommended restoration actions

Meadow

1. Based on low detections of desired condition songbirds associated with riparian areas, restoration efforts should focus on: 1) improving the willow component and structural diversity of the understory plan community to enhance nesting and foraging opportunities for yellow warblers, calliope hummingbirds, Lincoln's sparrows, willow flycatchers, and red-breasted sapsuckers, and 2) improving meadow wetness and emergent marsh communities to enhance nesting habitat for Wilson's snipes which were infrequently detected at Big Meadow compared to other meadows within the Basin.
2. We recommend utilizing prescribed fire within the meadow as planned, as burning the meadow is expected to increase forb regeneration which may increase vegetation cover at nest sites for songbirds, which may subsequently reduce predation risk and enhance productivity in the long run. Control burns should take place outside the breeding season (May- August), however, to minimize disturbance that could negatively affect nesting success in the short term.

Upland

1. Maintaining snags, improving old-growth conditions in the upland, and improving aspen regeneration to provide habitat elements important to the following desired condition species that were absent or infrequently detected at Big Meadow: olive-sided flycatcher,

white-headed woodpecker, red-breasted sapsucker, white-breasted nuthatch, and Williamson's sapsucker.

2. Maintaining snags with cavities during thinning and burning operations, and/or installing nest boxes which should be beneficial for mountain bluebirds, house wrens, white-breasted nuthatch and other secondary cavity nesters which are often limited by insufficient cavities for nesting.
3. Retain snags in the aspen stand to provide habitat for woodpeckers and small owls.

Recommended restoration objectives

Meadow

1. Increase richness and abundance of songbirds and desired condition songbird species that inhabit the meadow/riparian community at Big Meadow.
    - Metric: Richness (number of species detected across all survey points per year) and abundance (total number of individuals detected across all survey points per year).
    - Methods: Point-count surveys three times a month during June.

Upland

1. Increase richness and abundance of songbirds and desired condition songbird species that inhabit mature forest and aspen communities.
    - Metric: Richness (number of species detected across all survey points per year) and abundance (total number of individuals detected across all survey points per year).
    - Methods: Point-count surveys three times a month during June.

Monitoring recommendations

1. Continue current survey protocols post-restoration as part of effectiveness monitoring.

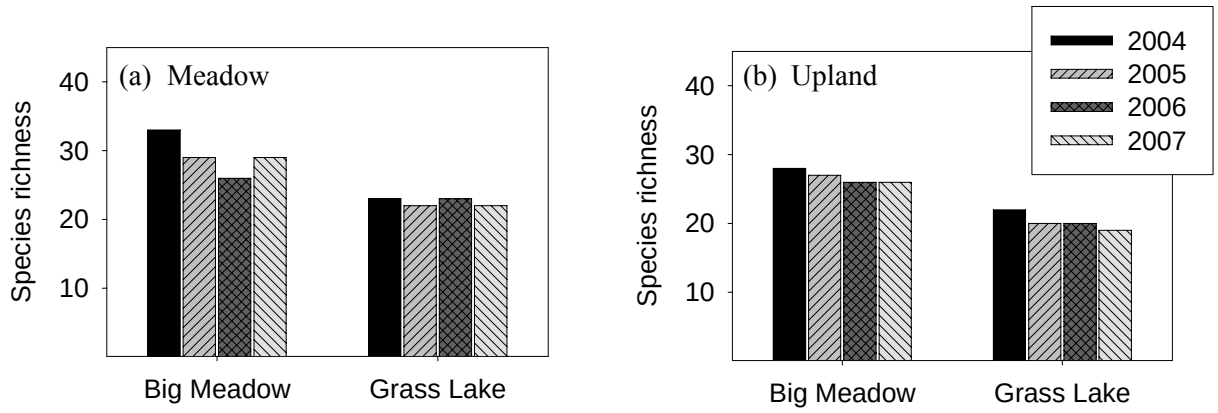

Figure 7.4. Songbird richness within 50 m of point-count stations in the meadow (a) and uplands (b) at Big Meadow and the control site (Grass Lake), 2004–2007.

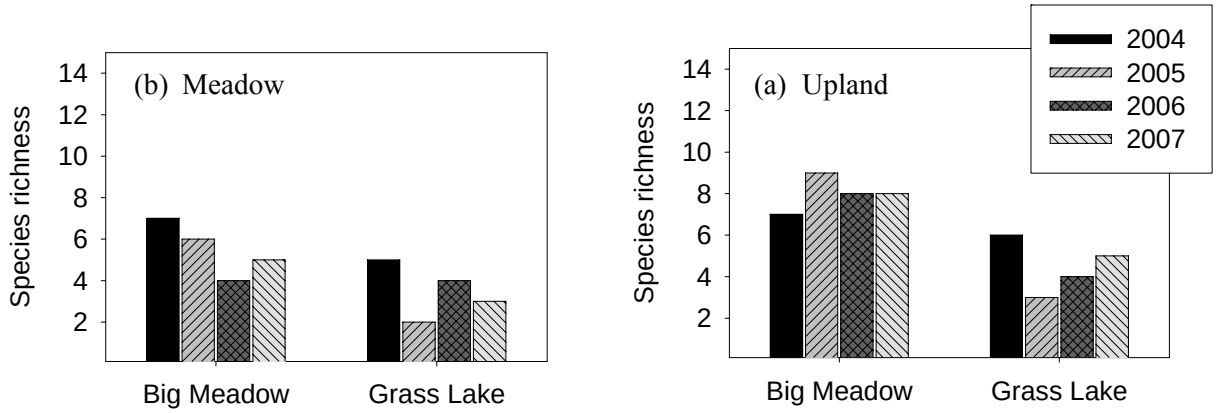

Figure. 7.5. Richness of desired condition songbird species detected within 50 m of point-count stations in the meadow (a) and uplands (b) at Big Meadow and the control site (Grass Lake), 2004–2007.

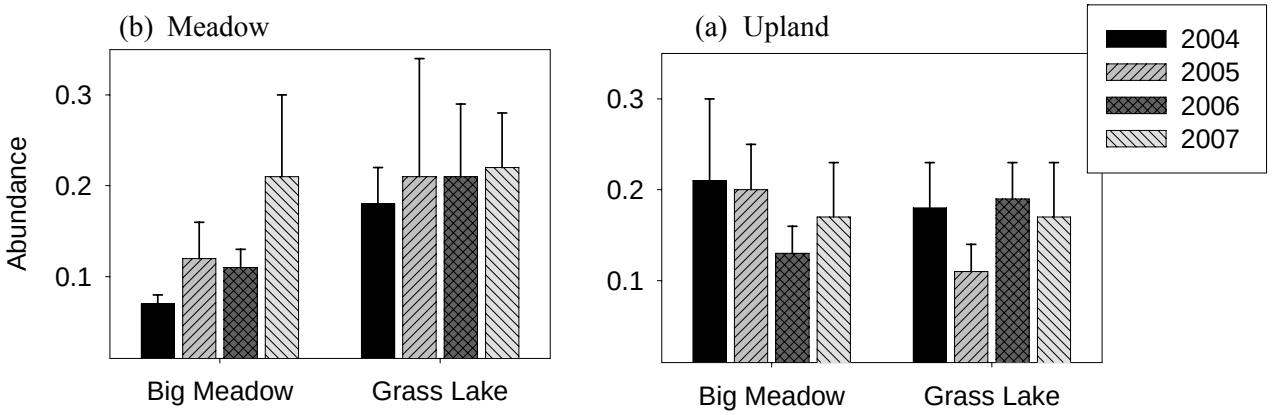

Figure 7.6. Abundance of desired condition songbirds detected within 50 m of point-count stations in the meadow (a) and uplands (b) at Big Meadow and the control site (Grass Lake), 2004–2007.

Pre-restoration objective 4. Determine productivity of focal songbird species pre-restoration.

Daily nest survival of dusky flycatchers, Wilson's warblers, and warbling vireos was consistent across Big Meadow and the control site (Fig. 7.7). Daily survival also remained constant across years. Daily nest survival of the focal species monitored appears stable and is not a cause for concern. Brood parasitism by brown-headed cowbirds at Big Meadow is below the 30% threshold value established (Fig. 7.8), thus no cowbird mitigation or actions are recommended. However, nest monitoring should continue to ensure that restoration actions do not result in an increase in brood parasitism or a decrease in daily nest survival.

It is expected that increasing the willow component and meadow wetness as a result of restoration should maintain or increase daily nest survival. Burning the meadow is expected to increase forb regeneration which may increase vegetation cover at nest sites, which may subsequently reduce predation risk. We recommend that snags with cavities and live trees with cavities be maintained during thinning and burning operations to increase the number of available nest sites for cavity nesting species such as white-breasted nuthatch.

Recommended restoration actions

Meadow

1. Control burns should take place outside the breeding season (May–August) to minimize disturbance that could negatively affect nesting success.

Upland

1. Maintain a variety of snags in different size classes to provide foraging and nesting opportunities for species such as woodpeckers and small owls.

Recommended restoration objectives

Meadow

1. Maintain or increase productivity of focal songbird species. Expect productivity to increase within meadows due to increased meadow wetness which will reduce the ability of mammalian predators to access nests.
    - Metrics: Daily nest survival (Mayfield 1961) and brown-headed cowbird parasitism rate (% of nests parasitized per species).
    - Methods: Search for (daily) and monitor nests of focal songbird species every 3-5 days beginning in late May through early August. Nest searching will take place within the open meadow area and within 150 m of the meadow/forest edge.

Monitoring recommendations

1. Daily nest survival and risk of brood parasitism by brown-headed cowbirds appears stable and are not a cause of concern. However, nest monitoring should continue to ensure that restoration actions do not result in an increase in brood parasitism or a decrease in daily nest survival.

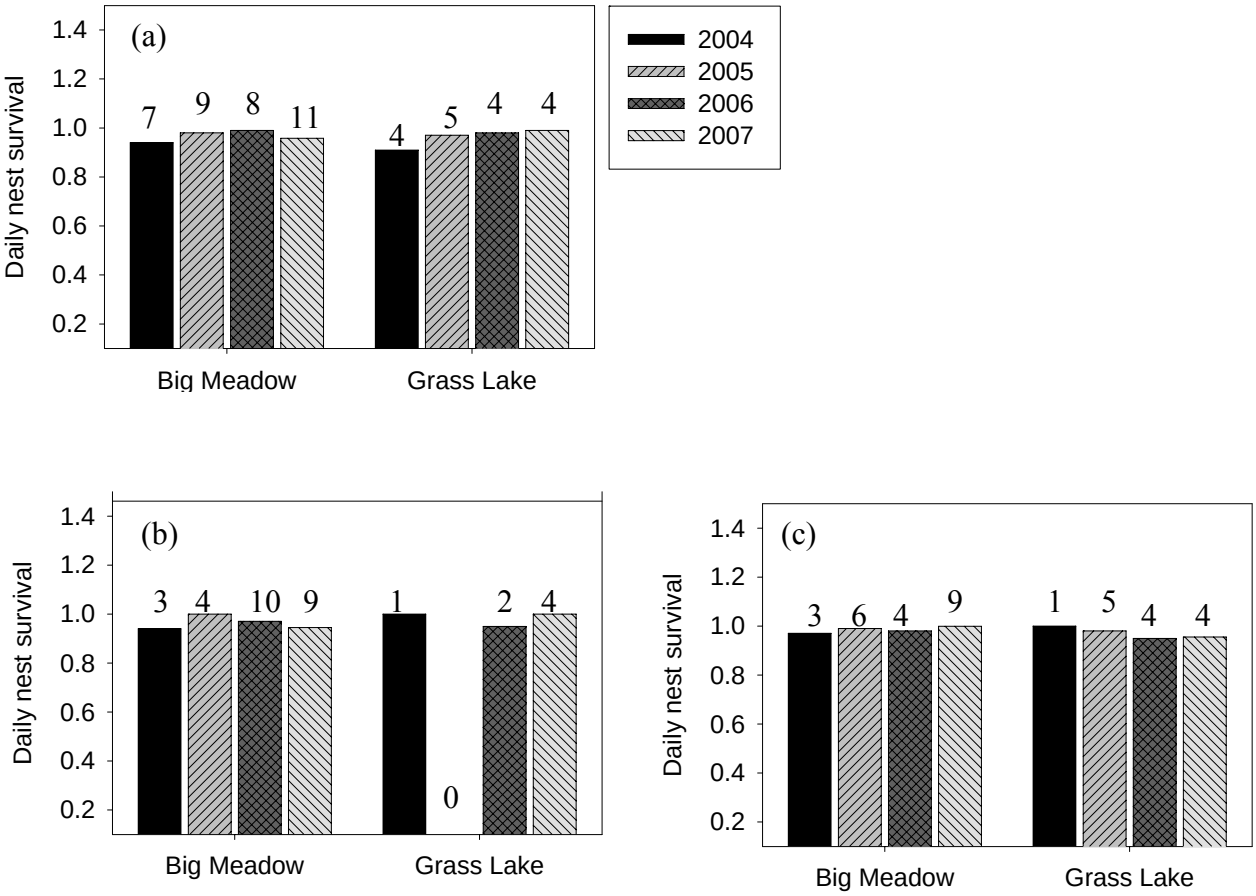

Figure 7.7. Daily nest survival for dusky flycatchers (a), Wilson's warblers (b), and warbling vireos (c) at Big Meadow and the control site, Grass Lake. The number above the bar indicates the number of nests monitored.

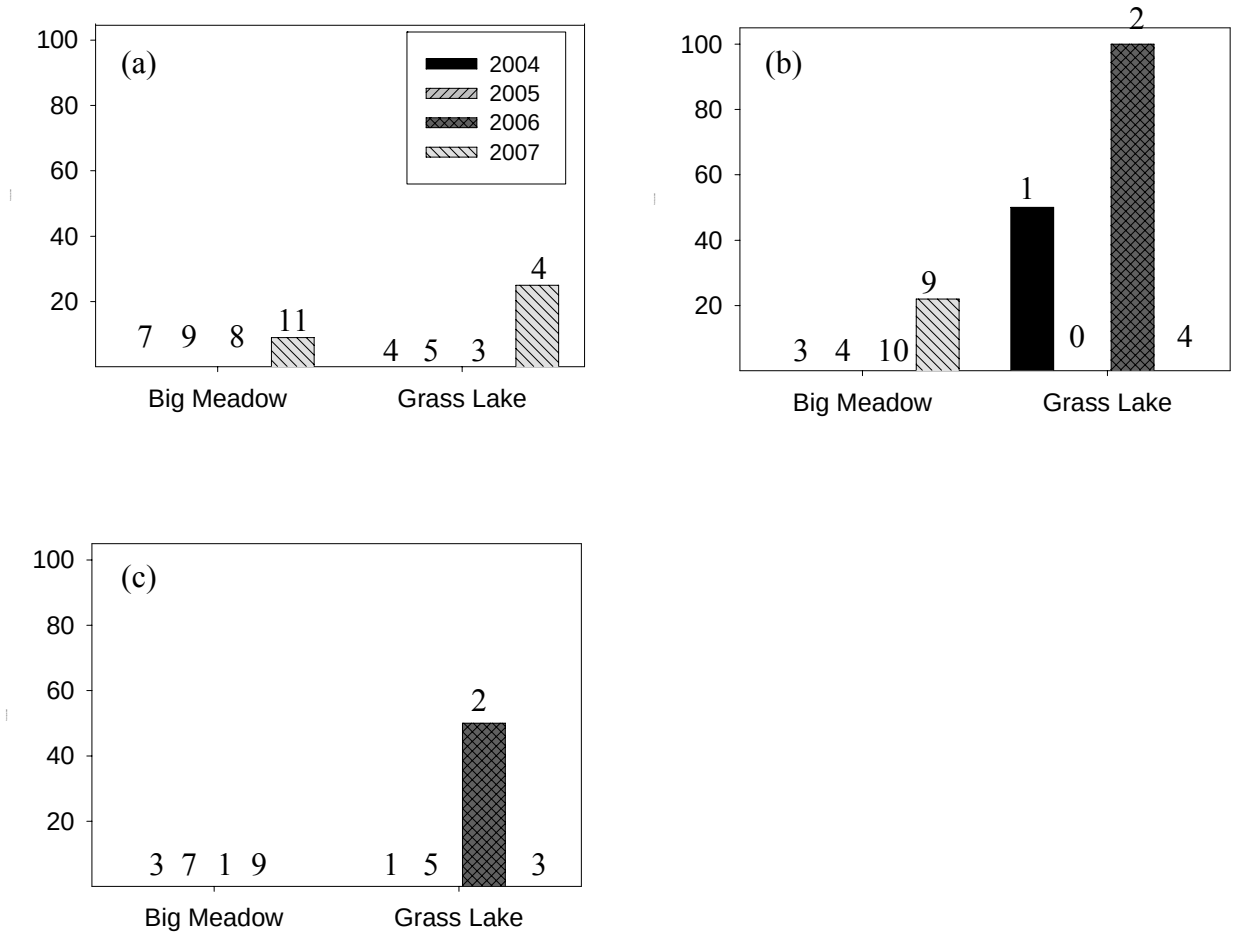

Figure 7.8. Percent of dusky flycatcher (a), Wilson's warblers (b), and warbling vireo (c) nests parasitized by brown-headed cowbirds. The number above the bar indicates the number of nests monitored.

OWLS

Pre-restoration objective 5. Assess owl richness at Big Meadow pre-restoration.

Four owl species were detected at Big Meadow since 2004 (Table 7.1). The detection of owl species does add to the overall avian species richness at Big Meadow, yet the continued inclusion of owl surveys may be of limited benefit when attempting to quantify restoration success. The ability to detect the presence owls both pre- and post-restoration is necessary to understand how restoration efforts may affect owls; however, detection of owl species is low due to the relatively large home ranges that owls inhabit and the difficulty of observing nocturnal species. In addition, detections are hampered by the timing of surveys. For example, starting surveys in March 2007 increased our ability to detect northern saw-whet owls at most sites throughout the basin. Based on data collected at LTBMU restoration and control sites, the

probability of detecting a northern saw-whet owl with six surveys (May–July) in 2006 was 0.04 but increased to 0.16 with six surveys (March–June) in 2007. Maintaining similar detection rates in subsequent years could be difficult because 1) it may be infeasible to begin multi-species owl surveys in the spring (when owls are more responsive), as this time frame has limited overlap with other restoration monitoring surveys, and 2) owls tend to inhabit relatively large home ranges and may be temporarily absent from a specific survey point at any one time, requiring that several surveys be conducted throughout the breeding season. Thus, a relatively large effort would be required to detect the presence of owls.

Recommended restoration actions

Upland

1. Maintain a variety of snags in different size classes to provide nesting opportunities for owls.

Monitoring recommendations

1. If continued monitoring of owl richness is deemed important, we suggest beginning surveys in mid-March or early April and completing them no later than mid-June.
2. If determining the response of cavity-nesting owls to the creation and maintenance of snags in Big Meadow is deemed important, we recommend focusing on the reproductive success of owls in the area. Determining productivity, however, is time-intensive and would require an increase in manpower.

Table 7.1. Number of owls detected during nocturnal broadcast surveys at Big Meadow and associated control site, Grass Lake, 2004–2007. An asterisk indicates the owl was detected incidentally (e.g., during songbird nest searching).

Common Name	Scientific Name	Big Meadow				Grass Lake			
		2004	2005	2006	2007	2004	2005	2006	2007
Flammluated Owl	*Otus flammeolus*		1						
Northern pygmy-owl	*Glaucidium gnoma*								1
Northern saw-whet owl	*Aegolius acadicus*				1		1	1	1
Long-eared owl	*Asio otus*			1*					
Great horned owl	*Bubo virginianus*	1	1*		2	1		2*	
California spotted owl	*Strix occidentalis*							2*	
Unknown owl		1							
Common nighthawk	*Chordeiles minor*			1					
Common poorwill	*Phalaenoptilus Nuttallii*				1				1

BATS

Pre-restoration objective 6. Determine richness and detection frequency of desired condition bat species at Big Meadow, pre-restoration.

A combined total of eight bat species were detected at Big Meadow during the four summers of surveys, with an additional 2 species detected at Grass Lake (Table 7.2). Three of the

eight species detected at Big Meadow are currently listed as special concern by various state and federal agencies (Bradley et al. 2006) and are included as desired condition species (Appendix 7.5): long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), and Yuma myotis (*Myotis yumanensis*). The spotted bat (*Euderma maculatum*), detected only at Grass Lake, is also a species of special concern and desired condition species.

Table 7.2. Relative frequency of use by bat species detected with Pettersson ultrasonic detectors at Big Meadow and associated control site, Grass Lake, 2004–2007.

Common Name	Scientific Name	Big Meadow				Grass Lake			
		2004	2005	2006	2007	2004	2005	2006	2007
Big brown bat	*Eptesicus fuscus*	8.3	9.6	9.8	2.0		2.6		
Spotted bat[1]	*Euderma maculatum*						2.6		0.4
Hoary bat	*Lasiurus cinereus*	28.3	22.9			35.8	45.5	2.0	
Silver-haired bat	*Lasionycteris noctivagans*			48.4	62.5			47.0	43.8
Long-eared myotis[1]	*Myotis evotis*	3.3	7.2		19.6	15.8	2.6	4.5	6.6
Little brown bat	*Myotis lucifugus*	26.7	59.0	32.4	15.1	27.5	10.4	24.7	48.6
Fringed myotis[1]	*Myotis thysanodes*			0.4	0.9	4.2	2.6	2.4	0.3
Hairy-winged myotis	*Myotis volans*						3.9		0.4
Yuma myotis[1]	*Myotis yumanensis*		1.2						
Free-tailed bat	*Tadarida brasiliensis*			9.0			29.9	14.2	
Unknown myotis	*Myotis* spp.							5.3	

[1] Desired condition species

Fringed myotis need caves or tree cavities in which to roost (O'Farrell and Studier 1980). Given the paucity of caves (and mines) in the Basin, it is likely that this species uses tree cavities. Radio-tracked individuals in Oregon and Arizona used tree hollows, particularly large conifer snags (Bradley et al. 2006). Yuma myotis likewise roost in caves or trees, but are also commonly found in man-made structures (Brigham et al. 1992). Long-eared myotis, especially pregnant females, tend to roost near or at ground level (e.g., leaf litter, stumps) (Manning and Jones 1989), indicating that human activities could negatively impact this species. Spotted bats appear to be rare in the basin and tend to be associated with rocky cliffs (Bradley et al. 2006). A study in Texas indicated a distinct lack of use of trees by this species for roosting (Watkins 1977). All four species are insectivorous, often preferring aquatic insects, moths, or beetles, and often forage along or near streams, ponds, and forest edges (Grindal et al. 1999; Bradley et al. 2006). Yet much is still unknown about the habitat needs of many bat species in the Lake Tahoe Basin. We recommend that more intensive studies be initiated to locate and quantify roosting and maternity sites, which will require the use of telemetry. What is known of their habitat preferences suggests that it may prove beneficial to focus on improving or preserving riparian habitat corridors, cottonwood, willow, and alder woodlands, areas with open water, and roost sites such as snags, caves, and rock crevices (Bradley et al. 2006). Because snags are a potential source of roost sites, efforts should be made to determine if the number of snags with cavities is sufficient to meet the needs of bats in the Basin.

Recommended restoration actions

Meadow

1. Where possible, preserve riparian habitat corridors, cottonwood, willow and alder woodlands, and areas with open water to provide foraging opportunities for bats.

Upland

1. Because snags are a potential source of roost sites for bats, efforts should be made to determine if the number of snags with cavities is sufficient to meet the needs of bats in the Basin (or specifically at Big Meadow).

Recommended restoration objectives

Meadow

1. Increase species richness and detection frequency of desired condition bat species at Big Meadow.
    - Metric: Richness (total number of species detected) and detection frequency (average proportion of detections per visit per species).
    - Methods: Three surveys throughout the summer using ultrasonic bat detectors.

Monitoring recommendations

1. We recommend that more intensive studies be initiated to locate and quantify roosting and maternity sites for bats, which will require the use of telemetry.

SMALL MAMMALS

Pre-restoration objective 7. Determine species richness and abundance small mammals and desired condition small mammal species at Big Meadow pre-restoration.

Throughout the four years of surveys, we captured a total of 11 small mammal species at Big Meadow in the meadow and upland areas (Appendix 7.14). Six small mammal species are identified as desired condition species for the Lake Tahoe Basin (Appendix 7.5) and we detected two of those species in the meadow areas at Big Meadow (Table 7.3). No small mammal desired condition species were detected at Grass Lake. Relative abundance of desired condition species was low each year.

Table 7.3. Relative abundance of small mammal desired condition species captured in meadow areas of Big meadow, 2004–2007. No desired condition species were detected at Grass Lake.

Common Name	Scientific Name	Big Meadow			
		2004	2005	2006	2007
Belding's ground squirrel	*Spermophilus beldingi*		0.44	0.45	0.45
Western jumping mouse	*Zapus princeps*			0.45	

Belding's ground squirrels are usually found close to water, in open areas, and require friable soils for burrowing (Verner and Boss 1980, Jenkins and Eshelman 1984). Western jumping mice are typically found in open areas (i.e., without coniferous canopy cover) along margins of montane riparian areas and are usually associated with intermediate to dense

herbaceous cover (Brown 1970, Belk et al. 1988). In the Central Rocky Mountains, this species is most numerous in moist aspen groves, willow-alder thickets, and damp forb-sedge meadows (Brown 1967). Other desired condition species, such as Trowbridge's shrews and long-tailed weasels, are more associated with open coniferous forests and dry ground (George 1989, Sheffield and Thomas 1997). Weasels typically nest in tree cavities, snags, logs, or burrows created by other small mammals (e.g., chipmunks, ground squirrels). Maintaining open, wet meadows, along with retaining adequate downed woody debris and snags, should encourage the presence and persistence of the desired condition small mammal species at Big Meadow. Maintaining open meadows can be accomplished, in part, by reducing the encroachment of lodgepole pine into the meadows.

Recommended restoration actions

Meadow

1. Restoration actions should focus on maintaining open, wet meadows and increasing willow cover to encourage the persistence of desired condition small mammal species.

Upland

1. Retain adequate downed woody debris and snags to encourage small mammal occurrence.

Recommended restoration objectives

Meadow

1. Increase species richness and abundance of desired condition small mammal species at Big Meadow.
    - Metric: Richness (total number of species detected across all visits per year) and relative abundance (number of unique individuals captured per 100 trap nights).
    - Methods: Trap and mark small mammals.

Upland

1. Increase species richness and abundance of desired condition small mammal species at Big Meadow.
    - Metric: Richness (total number of species detected across all visits per year) and relative abundance (number of unique individuals captured per 100 trap nights).
    - Methods: Trap and mark small mammals.

Monitoring recommendations

1. Monitoring should continue in the meadow area to determine if change in species composition or abundance occurs during or after restoration activities.
2. Small mammal sampling should be shifted in Big Meadow to encompass areas of expected restoration not currently covered by pre-restoration surveys. Additional traps should be placed in the upland forest community and aspen stands located in the south west corner of the meadow.

RECOMMENDED VEGETATION OBJECTIVES

1. Increase extent of meadow area within Big Meadow (from aerial photos).
2. Maintain existing willow cover and increase willow cover.

a. Maintain existing willow cover along channel. Burning should not negatively impact the existing willow cover along the channel.
b. Increase willow along perimeter of meadow in areas where conifers are removed and where there is sufficient wetness to support willow development/recruitment. Conditions that are likely to support willows exist in the in north corner of the meadow near songbird point-count stations M04, M05, and M03 (Appendix 7.1). Planted willows should occupy 60% of the treated area (Bombay et al. 2003).
c. Planted willows should have an approximate mean size of 375 m^2 (Bombay-Loffland, Unpublished data).
    - Metric: Spatial location (UTM coordinates) and area covered by willow clumps pre- and post-restoration
    - Methods: Record location (UTM coordinates), size (ha occupied), and height (meters) of willows using a global positioning system (GPS).

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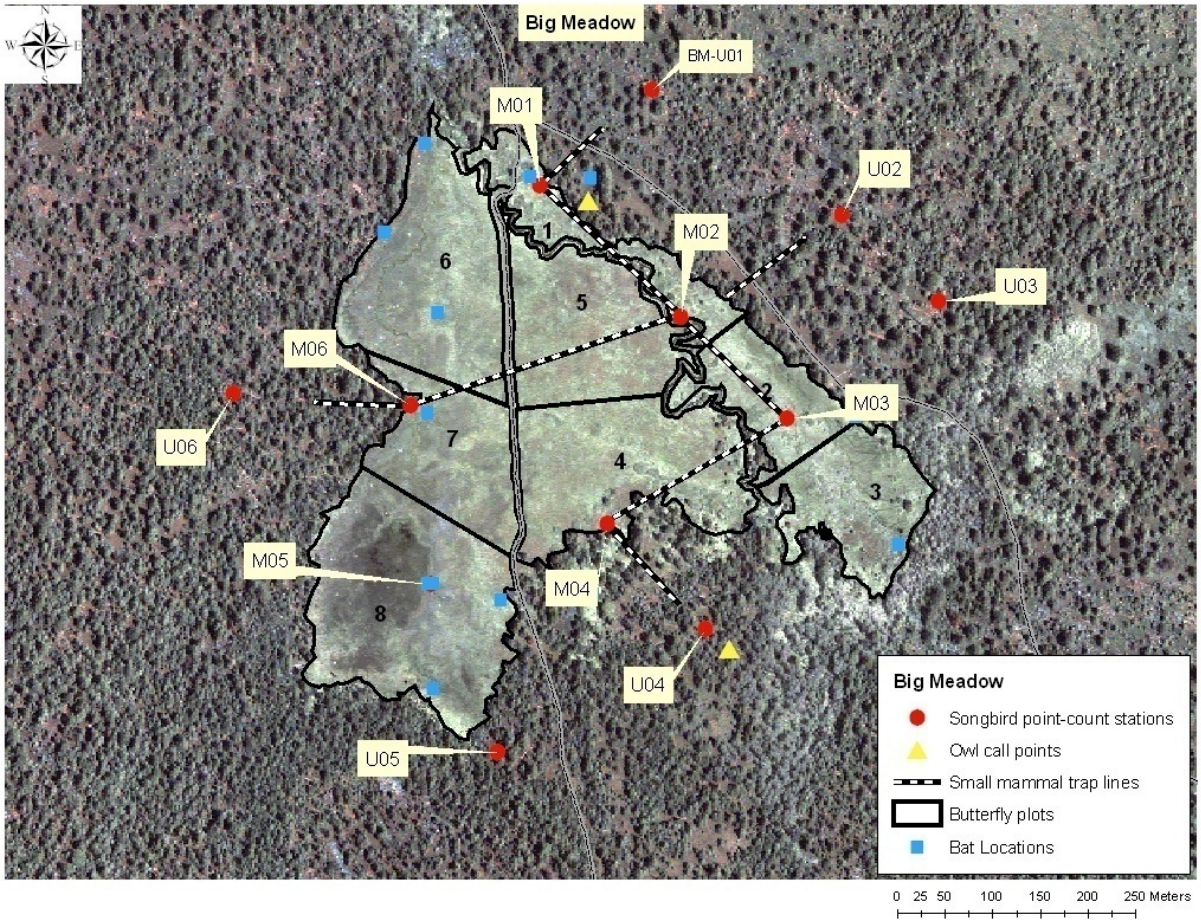
Appendix 7.1. Locations of survey points in Big Meadow. Bat detector locations as indicated are for 2007 only.



Appendix 7.2. Desired condition butterfly species and potentially beneficial restoration activities based on habitat preferences that were detected during visual encounter and sweep-net surveys at Big Meadow from 2004-2006. Up arrows suggest that restoration could focus on increasing the abundance of host plants. Species were selected based those that have specific host-plant preferences and are generally restricted to wet meadow and riparian communities.

Species	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Community[1]	Potentially beneficial restoration activities[2]
Northern Blue (*Lycaeides idas*)			Y		Meadow	↑flowers in the pea family (Fabaceae – *Lotus, Astragalus*, and *Lupinus* spp.) and yarrow (*Achillea millefolium*). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Greenish Blue (*Plebejus saepiolus*)	Y	Y	Y	Y	Meadow Riparian	↑ in clover species (Fabacea family - *Trifolium* spp.). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Sierra Nevada Blue (*Agriades podarce*)	Y	Y	Y	Y	Meadow	↑ in shooting star (*Dodecatheon* spp.), yellow composite species in the Asteraceae family, bistort (*Polygonum bistortoides*). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Great Spangled Fritillary (*Speyeria cybele*)		Y	Y		Meadow Riparian	↑ in violets (*Viola* spp.), thistle species (*Cirsium* spp.) and clover species (Fabaceae family – *Trifolium* spp.). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Pacific Fritillary (*Boloria epithore*)		Y	Y	Y	Meadow	↑ in violets (*Viola* spp.). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Sonoran Skipper (*Polites sonora*)		Y	Y	Y	Meadow	↑ in grass species in the Poaceae family *(Festuca* spp.) and white-flowered thistle species (*Cirsium* spp.). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Western tiger swallowtail (*Papilio rutulus*)	Y	Y	Y	Y	Riparian	↑ in cottonwood and aspens (*Populus* spp.) and willows (*Salix* spp.). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.

Appendix 7.2 (cont.)

Species	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Community[1]	Potentially beneficial restoration activities[2]
Purplish copper (*Lycaena helloides*)			Y		Riparian	↑ in species in the buckwheat family including smartweeds (*Polygonum* spp.), buckwheats (*Eriogonum* spp.), and docks (*Rumex* spp.). ↑ in cinquefoil species (*Potentilla* spp.) ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Lilac-bordered copper (*Lycaena nivalis*)		Y	Y	Y	Riparian	↑ in species in the buckwheat family including smartweeds (*Polygonum* spp.), buckwheats (*Eriogonum* spp.), and docks (*Rumex* spp.). ↑ open forest patches.
Satyr comma (*Polygonia satyrus*)		Y		Y	Riparian	↑ in nettle species (*Urtica* spp.), fruiting shrubs. ↑ open forest patches. ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.
Mourning cloak (*Nymphalis antiopa*)	Y	Y	Y	Y	Riparian	↑ in cottonwood and aspens (*Populus* spp.) and willows (*Salix* spp.). ↑ openings along riparian areas ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Lorquin's admiral (*Limenitis lorquini*)	Y	Y	Y	Y	Riparian	↑ in Bitter cherry *(Prunus emarginata*), cottonwood and aspens (*Populus* spp.), and willows (*Salix* spp.). ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies.

[1]Community types: Meadow – includes within-meadow streams; Forest – mixed-conifer forest; Riparian – aspen and cottonwood forests along riparian corridors; Marsh – wetland and open-water areas.
[2]Source: http://www.butterfliesandmoths.org/

Appendix 7.3. Reptile and amphibian representative of desired ecological conditions and potentially beneficial restoration activities based on habitat preferences that were detected at Big Meadow during surveys conducted from 2004-2006. Up arrows suggest that restoration could focus on increasing or creating specified condition and down arrows suggest that restoration could focus on decreasing specified condition.

Species	Detected in 2004	Detected in 2005	Detected in 2006	Community	Potentially beneficial restoration activities[1]	Notes
Long-toed salamander (*Ambystoma macrodactylum*)				Forest Riparian Meadow	↓ non-native trout, ↑ habitat near breeding ponds, ↓ bullfrogs, ↑ number of temporary pools of water for breeding sites, ↑ downed woody debris	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Western toad (*Bufo boreas*)		Y		Riparian Meadow	↑ number of temporary pools, ↑ vegetative cover around pools to decrease UV radiation, ↓ non-native trout	Species with known population declines (Manley et al. 2000). Potentially vulnerable terrestrial vertebrate (Manley et al. 2000).
Pacific treefrog (*Hyla regilla*)	Y	Y	Y	Forest Riparian Meadow	↓ non-native trout, ↓ bullfrogs, ↑ shallow-water pools	Species with known population declines (Manley et al. 2000). Potentially vulnerable terrestrial vertebrate (Manley et al. 2000).
W. terrestrial garter snake (*Thamnophis elegans*)	Y	Y	Y	Forest Riparian Meadow	↓ non-native trout, ↑ downed-woody debris, ↑ number of shallow pools and wetland vegetation	Species with known population declines (Manley et al. 2000)
W. aquatic garter snake (*Thamnophis couchii*)		Y		Meadow	↑ number of shallow pools and wetland vegetation	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Common garter snake (*Thamnophis sirtalis*)	Y	Y		Forest Riparian Meadow	↑ number of shallow pools and wetland vegetation	

[1]Sources:
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Appendix 7.4. Potentially beneficial management and restoration activities for bird species representative of desired ecological condition, Partners in Flight (PIF), riparian habitat joint venture focal bird species (RHJV), USDA Forest Service Management Indicator Species (MIS), and USDA Forest Service Species At Risk (SAR), that were detected at Big Meadow. Up arrows suggest that restoration could focus on increasing or creating specified condition and down arrows suggest that restoration could focus on decreasing specified condition.

Species	**Desired condition species[1]**	**PIF[2]**	**RHJV[3]**	**MIS[4]**	**SAR[5]**	**Community[6]**	**Detected in 2004**	**Detected in 2005**	**Detected in 2006**	**Detected in 2007**	**Potentially beneficial restoration activities[7]**
Northern Goshawk (*Accipter gentilis*)	X					Forest					↑ mature forest trees, ↓ disturbance during the breeding season
Blue Grouse (*Dendragapus obscurus*)	X			X		Forest					↑ proportion of early successional vegetation, ↑ aspen regeneration, ↓ OHV use in areas with Blue Grouse
Mountain Quail (*Oreortyx pictus*)				X		Forest					↑ shrubby vegetation
Spotted Sandpiper (*Actitis macularia*)	X		X			Meadow		Y			↓ stream incision, ↑ gravel bars and sinuosity
Wilson's Snipe (*Gallinago gallinago*)	X					Marsh Meadow				Y	↑ wet willow/alder thickets, ↑ duration of wet conditions, ↓ activities that compact soil
Calliope Hummingbird (*Stellula calliope*)	X			X		Meadow	Y	Y	Y	Y	↑ early successional vegetation, ↑aspen regeneration along streams
Belted Kingfisher (*Ceryle alcyon*)	X	X				Meadow					↑ stream clarity, create streams with riffles, ↓ turbidity, provide areas with earthen banks for nesting cavities

Appendix 7.4 (Cont.)

Species	Desired condition species[1]	PIF[2]	RHJV[3]	MIS[4]	SAR[5]	Community[6]	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Potentially beneficial restoration activities[7]
Red-breasted Sapsucker (*Sphyrapicus ruber*)	X			X		Riparian	Y	Y	Y	Y	↑ snags (112 snags/100 ha to support 28 pairs within 100 ha)
Williamson's Sapsucker (*Sphyrapicus thyroideus*)	X			X		Riparian	Y	Y	Y	Y	↑ aspen regeneration, ↑ snags in groups
Black-backed Woodpecker (*Picoides arcticus*)				X		Forest					↑ snags
Hairy Woodpecker (*Picoides villosus*)				X		Forest	Y	Y		Y	↑ snags
Downy Woodpecker (*Picoides pubescens*)				X		Forest					↑ snags
White-headed Woodpecker (*Picoides albolarvatus*)	X	X		X		Forest	Y	Y		Y	↑ snags, ↑ areas with 50-50% open canopy with sparse understory in coniferous forests
Northern Flicker (*Colaptes auratus*)		X		X		Forest	Y	Y	Y		↑ snags (93 snags/100 ha), ↑ aspen regeneration, ↑ cottonwood density along creeks
Pileated Woodpecker (*Dryocopus pileatus*)				X		Forest	Y	Y			↑ snags, ↑ old-growth conditions, ↑ canopy closure >60%

Appendix 7.4 (Cont.)

Species	Desired condition species[1]	PIF[2]	RHJV[3]	MIS[4]	SAR[5]	Community[6]	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Potentially beneficial restoration activities[7]
Olive-sided Flycatcher (*Contopus cooperi*)	X	X				Forest	Y	Y	Y	Y	↑ proportion of late successional forests with <50% canopy cover, ↑ snags, ↑ use of prescribed fire
Western Wood-Pewee (*Contopus sordidulus*)		X				Forest	Y	Y	Y	Y	↓ densely vegetated understories, ↑ standing dead trees, ↑ habitat type transition zones
Willow Flycatcher (*Empidonax traillii*)	X	X	X			Meadow					↑ willow, ↓ parasitism risk, ↑ meadow wetness
Hammond's Flycatcher (*Empidonax hammondii*)				X		Forest	Y		Y		↑old-growth conditions, dense fir and aspen
Warbling Vireo (*Vireo gilvus*)			X			Meadow Riparian	Y	Y	Y	Y	↓ parasitism risk, ↑ deciduous component
Violet-green Swallow (*Tachycineta thalassina*)		X	X	X		Meadow Riparian					↓ tree density, ↑ snags
Bank Swallow (*Riparia riparia*)			X			Meadow Riparian					↑ streams with low gradient meanders and eroding banks for nesting substrate
Mountain Chickadee (*Poecile gambeli*)		X				Forest	Y	Y	Y	Y	↑ aspen, ↑ snags, maintain incense cedar for wintering forage, ↑ conifer diversity

Appendix 7.4 (Cont.)

Species	Desired condition species[1]	PIF[2]	RHJV[3]	MIS[4]	SAR[5]	Community[6]	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Potentially beneficial restoration activities[7]
White-breasted Nuthatch (*Sitta carolinensis*)	X			X		Forest		Y	Y		↑ snags 30-38 cm dbh, ↑ mature forest with diverse conifer species
Red-breasted Nuthatch (*Sitta canadensis*)	X	X		X		Forest	Y	Y	Y	Y	↑ snags with existing cavities, ↑ mature deciduous forest
Pygmy Nuthatch (*Sitta pygmaea*)	X					Forest	Y				↓ stand density in Jeffery pine forests, ↑ snags, ↓ forest disturbances, ↑ heterogeneous mix of well-spaced pines of various ages
Brown Creeper (*Certhia americana*)	X	X		X		Forest	Y	Y	Y	Y	↑ proportion of old-growth forest conditions, ↑ snags (>40 cm dhb), preserve large trees (>100 cm dhb),
House Wren (*Troglodytes aedon*)	X			X		Forest Riparian		Y			Provide nest boxes, ↑ deciduous component along streams
Golden-crowned Kinglet (*Regulus strapa*)	X			X		Forest	Y	Y	Y	Y	↓ logging, ↑ old-growth forest conditions
Ruby-crowned Kinglet (*Regulus calendula*)		X				Forest	Y	Y			Minimize thinning and logging

Appendix 7.4 (Cont.)

Species	Desired condition species[1]	PIF[2]	RHJV[3]	MIS[4]	SAR[5]	Community[6]	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Potentially beneficial restoration activities[7]
Swainson's Thrush (*Catharus ustulatus*)	X		X		X	Meadow Riparian					↑ ground and shrub cover along streams, ↑ meadow wetness, ↑ aspen regeneration, ↑ forest tree density and canopy closure
Mountain Bluebird (*Sialia currucoides*)	X			X		Meadow Riparian					↑ snags >38 cm dbh
Orange-crowned Warbler (*Vermivora celata*)		X				Meadow		Y		Y	↑ ground and shrub cover along streamsides
Yellow Warbler (*Dendroica petechia*)	X	X	X	X		Meadow					↑ willow, ↓ parasitism risk, ↑ meadow wetness
Hermit Warbler (*Dendroica occidentalis*)	X	X				Forest					↑ old-growth conditions with high canopy volume
Wilson's Warbler (*Wilsonia pusilla*)		X	X	X		Meadow Riparian	Y	Y	Y	Y	↑ ground and shrub cover
Western Tanager (*Piranga ludoviciana*)		X				Forest	Y	Y	Y	Y	↑ aspen regeneration, ↑ deciduous component along streams, create habitat type transition zones
Chipping Sparrow (*Spizella passerina*)		X				Forest					Provide open grassy areas in conifer forests, ↑ early succession community

Appendix 7.4 (Cont.)

Species	Desired condition species[1]	PIF[2]	RHJV[3]	MIS[4]	SAR[5]	Community[6]	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Potentially beneficial restoration activities[7]
Song Sparrow (*Melospiza melodia*)			X	X		Meadow Riparian	Y	Y	Y	Y	↑ meadow wetness and duration, ↑ willow and shrub component
Fox Sparrow (*Passerella iliaca*)				X		Forest Riparian	Y	Y	Y	Y	Prefers shrubby component
White-crowned Sparrow (*Zonotrichia leucophrys*)				X	X	Meadow	Y	Y	Y	Y	↑ patches of open grassy meadow, ↑ density of shrubs
Lincoln's Sparrow (*Melospiza lincolnii*)	X			X		Meadow Riparian	Y	Y	Y	Y	↑ meadow wetness and duration, ↑ density of willow and shrub component,
Black-headed Grosbeak (*Pheucticus melanocephalus*)		X	X			Meadow					↑ willow, ↑ cottonwood along creeks, ↑ aspen regeneration, create habitat type transition zones
Brewer's Blackbird (*Euphagus cyanocephalus*)		X				Meadow Marsh	Y	Y	Y	Y	↑ open areas with suitable perches
Cassin's Finch (*Carpodacus cassinii*)		X		X		Forest	Y	Y	Y	Y	↓ tree density in coniferous forests
Evening Grosbeak (*Coccothraustes vespertinus*)		X				Forest					↓ mixed conifer density to provide more open canopy

[1]Desired condition species are species that should be present following restoration data based on historic and current data.

[2]Based on Partners in Flight assessment scores (PIF 2005). Species selected as priority species if they met any of the following criteria, (1) in need of management attention to reduce long-term population declines, (2) severe deterioration in the future of breeding conditions is expected due to vulnerability to human activities, habitat fragmentation or loss, or high levels of nest depredation or parasitism, (3) population trend exhibits a >15% decline, (4) regional stewardship is required to maintain or improve population, or (5) percent of the breeding population is >10% in the Sierras.
[3] Focal riparian area species selection based on (1) the use of riparian vegetation during the breeding season, (2) species status (e. g., threatened), the reduction in historical breeding range, (3) abundance of the species to allow for adequate sample sizes, and (4) species that represent all successional stages within riparian areas (Riparian Habitat Joint Venture 2004).
[4]USDA Forest Service Management Indicator Species (MIS) identified in the Sierra Nevada Forest Plan Amendment – Final Supplemental Environmental Impact Statement.
[5]USDA Forest Service Species At Risk (SAR) identified in the Sierra Nevada Forest Plan Amendment FEIS Appendix E.
[6]Community types: Meadow – includes within-meadow streams; Forest – mixed-conifer forest; Riparian – aspen and cottonwood forests along riparian corridors; Marsh – wetland and open-water areas.
[7]Sources:

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Appendix 7.5. Mammal species representative of desired conditions and USDA Forest Service Management Indicator Species (MIS) and potentially beneficial restoration activities based on habitat preferences that were detected at Big Meadow during trapping sessions, 2004–2007. A "Y" indicates that this species was detected during surveys. Up arrows suggest that restoration could focus on increasing or creating specified condition and down arrows suggest that restoration could focus on decreasing specified condition.

Species	Desired condition species[1]	MIS[2]	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Community	Potentially beneficial restoration activities[3]	Notes
Bats									
Spotted bat (*Euderma maculatum*)	X						Forest Riparian Meadow	↓ human disturbance near roost sites, ↑ duration of meadow wetness	Federal species of special concern (Bradley et al. 2006)
Townsend's big-eared bat (*Corynorhinus townsendii*)	X						Forest Riparian Meadow	↓ human disturbance near roost sites, ↑ duration of meadow wetness	Federal species of special concern (Bradley et al. 2006)
Long-eared myotis (*Myotis evotis*)	X		Y	Y		Y	Forest Riparian Meadow	↑ duration of meadow wetness, ↑ willows along streams, ↑ tree cavities for roost sites	Federal species of special concern (Manley et al. 2000)
Fringed myotis (*Myotis thysanodes*)	X				Y	Y	Forest Riparian Meadow	↓ human disturbance near roost sites, ↑ duration of meadow wetness	Federal species of special concern (Manley et al. 2000)
Yuma myotis (*Myotis yumanensis*)	X			Y			Forest Riparian Meadow	↑ number of tree cavities near streams, ↑ tree cavities for roost sites	Federal and state species of special concern (Manley et al. 2000)
Small mammals									
Trowbridge's shrew (*Sorex trowbridgii*)	X						Riparian Meadow	↑ old-growth conditions, ↑ ground litter and ground cover	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Vagrant shrew (*Sorex vagrans*)		X					Riparian Meadow	↑ old-growth conditions, ↑ ground litter and ground cover	
Broad-footed mole (*Scapanus latimanus*)	X						Forest Riparian Meadow	↑ moisture level in soils, ↑ duration of moist soil conditions	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Long-tailed weasel (*Mustela frenata*)	X			Y			Forest Riparian Meadow	↑ areas with standing water, ↑ understory shrub density	

Appendix 2.8 (cont.)

Species	Desired condition species[1]	MIS[2]	Detected in 2004	Detected in 2005	Detected in 2006	Detected in 2007	Community	Potentially beneficial restoration activities[3]	Notes
Belding's ground squirrel (*Spermophilus beldingi*)	X			Y	Y	Y	Meadow	↑ proportion of succulent vegetation, ↑ areas with standing water, create meadow-like openings	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Western jumping mouse (*Zapus princeps*)	X	X			Y		Forest Riparian Meadow	↑ and maintain meadow wetness, ↑ herbaceous cover near water	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Medium/Large Mammals									
American marten (*Martes americana*)	X						Forest Riparian	↑ proportion of mature coniferous forest with 30-50% crown density, ↑ downed-woody debris and dense understory shrub and forb component	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Mountain beaver (*Aplontia rufa*)	X	X			Y		Meadow	↑ early successional vegetation along streams, ↓ soil compaction	Federal and state species of special concern (Manley et al. 2000)
Porcupine (*Erethizon dorsatum*)	X						Forest Riparian Meadow	↑ pine, ↓ coyotes	
Coyote (*Canis latrans*)	X			Y		Y	Forest Riparian Meadow	↑ early successional vegetation	
Mule deer (*Odocoileus hemionus*)	X	X					Forest Riparian Meadow	↑ availability of succulent forage, ↑ early successional vegetation	

[1]Desired condition species are species that should be present following restoration data based on historic and current data.
[2]USDA Forest Service Management Indicator Species (MIS) identified in the Sierra Nevada Forest Plan Amendment – Final Supplemental Environmental Impact Statement
[3]Sources:

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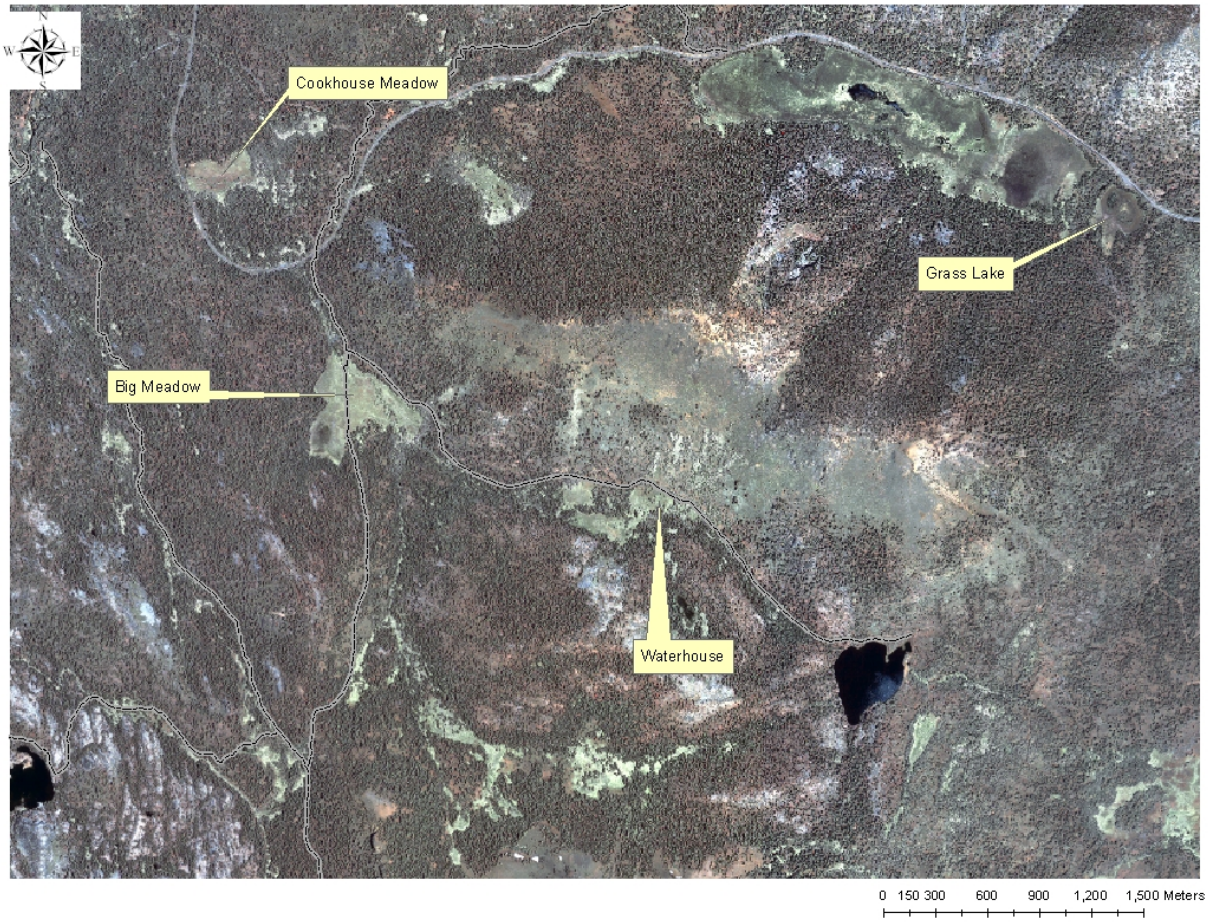
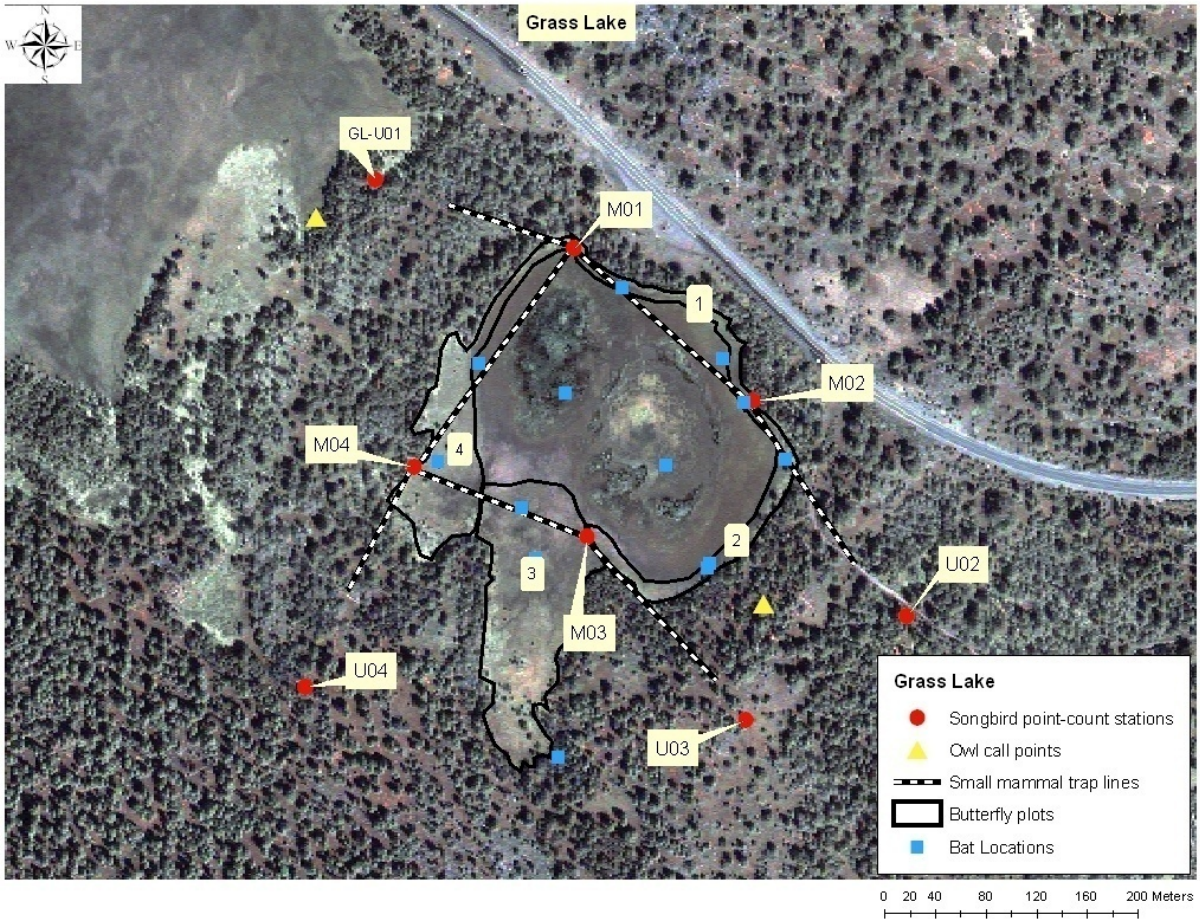
.Appendix 7.6. Location of Big Meadow in relation to the control site (Grass Lake).



Appendix 7.7. Locations of sampling points at Grass Lake. Bat detector locations as indicated are for 2007 only.



Appendix 7.8. UTM locations of bat ultrasonic detectors placed at Big Meadow and General Creek in 2007.

Site	Year	Visit	Zone	Easting	Northing
Big Meadow	2007	1	11	239503	4296570
Big Meadow	2007	1	11	239565	4296564
Big Meadow	2007	2	10	760603	4296612
Big Meadow	2007	2	10	760561	4296518
Big Meadow	2007	3	11	239395	4296433
Big Meadow	2007	3	11	239395	4296433
Big Meadow	2007	3	10	760605	4296328
Big Meadow	2007	4	10	760612	4296038
Big Meadow	2007	4	10	760607	4296149
Big Meadow	2007	4	10	760612	4296149
Big Meadow	2007	5	11	239539	4296127
Big Meadow	2007	5	11	239441	4296127
Big Meadow	2007	6	11	239827	4296295
Big Meadow	2007	6	11	239862	4296158
Big Meadow	2007	6	10	760612	4296149
Grass Lake	2007	1	11	244085	4297159
Grass Lake	2007	1	11	244050	4297034
Grass Lake	2007	2	11	244115	4297113
Grass Lake	2007	2	11	244047	4297030
Grass Lake	2007	3	11	244070	4297195
Grass Lake	2007	3	11	243995	4297256
Grass Lake	2007	4	11	243877	4297203
Grass Lake	2007	4	11	243841	4297129
Grass Lake	2007	5	11	243912	4297047
Grass Lake	2007	5	11	243920	4296889
Grass Lake	2007	5	11	243904	4297087
Grass Lake	2007	6	11	244020	4297114
Grass Lake	2007	6	11	243945	4297176

Appendix 7.9. Total number of individual butterflies detected at Big Meadow during visual encounter and sweep-net surveys in 2007. Number of individuals detected is also corrected for the amount of area surveyed at Big Meadow (Number/19 ha).

Common name	Scientific name	Total number of individuals detected	Number of individuals detected corrected for area surveyed (19 ha)
Clodius parnassian	*Parnassius clodius*	7	0.37
Anise swallowtail	*Papilio zelicaon*	4	0.21
Western tiger swallowtail	*Papilio rutulus*	32	1.68
Pale swallowtail	*Papilio eurymedon*	28	1.47
Pine white	*Neophasia menapia*	2	0.11
Spring white	*Pontia sisymbrii*	1	0.05
Cabbage white	*Pieris rapae*	3	0.16
Unknown white	*Subfamily Pierinae*	9	0.47
Stella orangetip	*Anthocharis stella*	12	0.63
Orange sulphur	*Colias eurytheme*	65	3.42
Unknown sulphur	*Colias spp.*	20	1.05
Tailed copper	*Lycaena arota*	19	1.00
Edith's copper	*Lycaena editha*	2	0.11
Lilac-bordered copper	*Lycaena nivalis*	10	0.53
Mariposa copper	*Lycaena mariposa*	7	0.37
Unknown copper	*Lycaena spp.*	12	0.63
Hedgerow hairstreak	*Satyrium saepium*	1	0.05
Western pine elfin	*Callophrys eryphon*	3	0.16
Spring azure	*Celastrina ladon*	11	0.58
Unknown dotted-blue	*Euphilotes spp*	4	0.21
Greenish blue	*Plebejus saepiolus*	2615	137.63
Boisduval's blue	*Icaricia icarioides*	71	3.74
Sierra Nevada blue	*Agriades podarce*	125	6.58
Unknown blue	*Subfamily Polyommatinae*	45	2.37
Plebejus spp	*Plebejus spp*	9	0.47
Unknown Speyeria spp.	*Speyeria spp.*	2427	127.74
Pacific fritillary	*Boloria epithore*	21	1.11
Unknown fritillary	*Genus Speyeria*	34	1.79
Northern checkerspot	*Chlosyne palla*	149	7.84
Hoffmann's checkerspot	*Chlosyne hoffmanni*	3	0.16
Unknown checkerspot	*Chlosyne spp.*	5	0.26
Field crescent	*Phyciodes pratensis*	355	18.68
Unknown crescent	*Phyciodes spp.*	48	2.53
Satyr comma	*Polygonia satyrus*	21	1.11
Hoary comma	*Polygonia gracilis zephyrus*	10	0.53
Unknown comma	*Polygonia spp.*	1	0.05
California tortoiseshell	*Nymphalis californica*	6	0.32

Appendix 7.9 (Cont.)

Common name	Scientific name	Total number of individuals detected	Number of individuals detected corrected for area surveyed (19 ha)
Mourning cloak	*Nymphalis antiopa*	7	0.37
American lady	*Vanessa virginiensis*	1	0.05
Unknown lady	*Vanessa spp.*	2	0.11
Lorquin's admiral	*Limenitis lorquini*	19	1.00
Great Basin wood-nymph	*Cercyonis sthenele*	1	0.05
Monarch	*Danaus plexippus*	3	0.16
Mexican cloudywing	*Thorybes mexicanus*	1	0.05
Unknown cloudywing	*Thorybes spp*	6	0.32
Unknown duskywing	*Erynnis spp.*	21	1.11
Two-banded skipper	*Pyrgus ruralis*	3	0.16
Common checkered skipper	*Pyrgus communis*	8	0.42
Juba skipper	*Hesperia juba*	4	0.21
Sonoran skipper	*Polites sonora*	391	20.58
Unknown skipper	*Subfamily Hesperioidea*	46	2.42

Appendix 7.10. Total number of individual butterflies detected at Grass Lake during visual encounter and sweep-net surveys in 2007. Number of individuals detected is also corrected for the amount of area surveyed at Grass Lake (Number/2.75 ha).

Common name	Scientific name	Total number of individuals detected	Number of individuals detected corrected for area surveyed (2.75 ha)
Western tiger swallowtail	*Papilio rutulus*	14	5.09
Pale swallowtail	*Papilio eurymedon*	10	3.64
Cabbage white	*Pieris rapae*	1	0.36
Unknown white	*Subfamily Pierinae*	1	0.36
Orange sulphur	*Colias eurytheme*	4	1.45
Mariposa copper	*Lycaena mariposa*	2	0.73
Unknown copper	*Lycaena spp.*	1	0.36
Spring azure	*Celastrina ladon*	2	0.73
Unknown dotted-blue	*Euphilotes spp*	1	0.36
Silvery blue	*Glaucopsyche lygdamus*	3	1.09
Greenish blue	*Plebejus saepiolus*	302	109.82
Boisduval's blue	*Icaricia icarioides*	20	7.27
Sierra Nevada blue	*Agriades podarce*	80	29.09
Unknown blue	*Subfamily Polyommatinae*	1	0.36
Zerene fritillary	*Speyeria zerene*	2	0.73
Unknown Speyeria spp.	*Speyeria spp.*	36	13.09
Northern checkerspot	*Chlosyne palla*	17	6.18
Unknown checkerspot	*Chlosyne spp.*	1	0.36
Field crescent	*Phyciodes pratensis*	102	37.09
Unknown crescent	*Phyciodes spp.*	5	1.82
California tortoiseshell	*Nymphalis californica*	1	0.36
Mourning cloak	*Nymphalis antiopa*	1	0.36
Lorquin's admiral	*Limenitis lorquini*	2	0.73
California sister	*Adelpha bredowii*	1	0.36
Sonoran skipper	*Polites sonora*	3	1.09
Unknown skipper	*Subfamily Hesperioidea*	1	0.36

Appendix 7.11. Average number of birds detected per point within 50 m of point-count stations (± SE) at Big Meadow and the percentage of the avian community each species comprises. Data from 2007.

Community	Common name	Scientific name	Average number detected per point	SE	Percent composition
Meadow	Mallard	*Anas platyrhynchos*	0.06	0.06	1
Meadow	Wilson's Snipe	*Gallinago gallinago*	0.06	0.06	1
Meadow	Calliope Hummingbird	*Stellula calliope*	0.50	0.00	8
Meadow	Hairy Woodpecker	*Picoides villosus*	0.06	0.06	1
Meadow	Western Wood-Pewee	*Contopus sordidulus*	0.33	0.10	5
Meadow	Dusky Flycatcher	*Empidonax oberholseri*	0.94	0.24	15
Meadow	Warbling Vireo	*Vireo gilvus*	0.67	0.25	10
Meadow	Steller's Jay	*Cyanocitta stelleri*	0.28	0.06	4
Meadow	Tree Swallow	*Tachycineta bicolor*	0.11	0.06	2
Meadow	Mountain Chickadee	*Poecile gambeli*	0.22	0.06	3
Meadow	Red-breasted Nuthatch	*Sitta canadensis*	0.06	0.06	1
Meadow	Brown Creeper	*Certhia americana*	0.11	0.06	2
Meadow	American Robin	*Turdus migratorius*	0.78	0.11	12
Meadow	Orange-crowned Warbler	*Vermivora celata*	0.06	0.06	1
Meadow	Yellow-rumped Warbler	*Dendroica coronata*	0.22	0.11	3
Meadow	MacGillivray's Warbler	*Oporornis tolmiei*	0.39	0.06	6
Meadow	Common Yellowthroat	*Geothlypis trichas*	0.06	0.06	1
Meadow	Wilson's Warbler	*Wilsonia pusilla*	0.44	0.15	7
Meadow	Western Tanager	*Piranga ludoviciana*	0.22	0.06	3
Meadow	Savannah Sparrow	*Passerculus sandwichensis*	0.06	0.06	1
Meadow	Song Sparrow	*Melospiza melodia*	0.56	0.06	9
Meadow	Lincoln's Sparrow	*Melospiza lincolnii*	0.33	0.17	5
Meadow	White-crowned Sparrow	*Zonotrichia leucophrys*	0.28	0.06	4
Meadow	Dark-eyed Junco	*Junco hyemalis*	0.22	0.06	3
Meadow	Red-winged Blackbird	*Agelaius phoeniceus*	1.22	0.40	19
Meadow	Brewer's Blackbird	*Euphagus cyanocephalus*	0.22	0.06	3
Meadow	Brown-headed Cowbird	*Molothrus ater*	0.44	0.11	7
Meadow	Cassin's Finch	*Carpodacus cassinii*	0.33	0.10	5
Meadow	Pine Siskin	*Carduelis pinus*	0.67	0.38	10
Upland	Red-breasted Sapsucker	*Sphyrapicus ruber*	0.17	0.10	3
Upland	Williamson's Sapsucker	*Sphyrapicus thyroideus*	0.06	0.06	1
Upland	Hairy Woodpecker	*Picoides villosus*	0.06	0.06	1
Upland	White-headed Woodpecker	*Picoides albolarvatus*	0.06	0.06	1
Upland	Olive-sided Flycatcher	*Contopus cooperi*	0.06	0.06	1

Appendix 7.11 (Cont.)

Community	Common name	Scientific name	Average number detected per point	SE	Percent composition
Upland	Western Wood-Pewee	*Contopus sordidulus*	0.33	0.10	5
Upland	Dusky Flycatcher	*Empidonax oberholseri*	0.61	0.20	10
Upland	Cassin's Vireo	*Vireo cassinii*	0.06	0.06	1
Upland	Warbling Vireo	*Vireo gilvus*	0.22	0.15	3
Upland	Steller's Jay	*Cyanocitta stelleri*	0.28	0.06	4
Upland	Clark's Nutcracker	*Nucifraga columbiana*	0.06	0.06	1
Upland	Mountain Chickadee	*Poecile gambeli*	0.61	0.29	10
Upland	Red-breasted Nuthatch	*Sitta canadensis*	0.17	0.10	3
Upland	Brown Creeper	*Certhia americana*	0.56	0.15	9
Upland	Golden-crowned Kinglet	*Regulus satrapa*	0.22	0.11	3
Upland	Hermit Thrush	*Catharus guttatus*	0.11	0.06	2
Upland	American Robin	*Turdus migratorius*	0.11	0.06	2
Upland	Yellow-rumped Warbler	*Dendroica coronata*	0.50	0.00	8
Upland	Western Tanager	*Piranga ludoviciana*	0.28	0.15	4
Upland	Fox Sparrow	*Passerella iliaca*	0.17	0.00	3
Upland	Lincoln's Sparrow	*Melospiza lincolnii*	0.06	0.06	1
Upland	Dark-eyed Junco	*Junco hyemalis*	0.94	0.11	15
Upland	Red-winged Blackbird	*Agelaius phoeniceus*	0.06	0.06	1
Upland	Brown-headed Cowbird	*Molothrus ater*	0.06	0.06	1
Upland	Cassin's Finch	*Carpodacus cassinii*	0.17	0.10	3
Upland	Pine Siskin	*Carduelis pinus*	0.44	0.29	7

Appendix 7.12. Average number of birds detected per point within 50 m of point-count stations (± SE) at Grass Lake and the percentage of the avian community each species comprises. Data from 2007.

Community	Common name	Scientific name	Average number detected per point	SE	Percent composition
Meadow	Common Nighthawk	*Chordeiles minor*	0.08	0.08	1
Meadow	Hairy Woodpecker	*Picoides villosus*	0.17	0.08	2
Meadow	Western Wood-Pewee	*Contopus sordidulus*	0.50	0.25	7
Meadow	Dusky Flycatcher	*Empidonax oberholseri*	0.42	0.30	6
Meadow	Warbling Vireo	*Vireo gilvus*	0.75	0.43	10
Meadow	Steller's Jay	*Cyanocitta stelleri*	0.25	0.25	3
Meadow	Tree Swallow	*Tachycineta bicolor*	0.08	0.08	1
Meadow	Mountain Chickadee	*Poecile gambeli*	0.75	0.38	10
Meadow	Brown Creeper	*Certhia americana*	0.17	0.17	2
Meadow	House Wren	*Troglodytes aedon*	0.17	0.08	2
Meadow	Ruby-crowned Kinglet	*Regulus calendula*	0.08	0.08	1
Meadow	American Robin	*Turdus migratorius*	0.50	0.14	7
Meadow	MacGillivray's Warbler	*Oporornis tolmiei*	0.33	0.08	4
Meadow	Wilson's Warbler	*Wilsonia pusilla*	0.08	0.08	1
Meadow	Western Tanager	*Piranga ludoviciana*	0.17	0.17	2
Meadow	Lincoln's Sparrow	*Melospiza lincolnii*	0.33	0.08	4
Meadow	White-crowned Sparrow	*Zonotrichia leucophrys*	0.08	0.08	1
Meadow	Dark-eyed Junco	*Junco hyemalis*	1.08	0.22	14
Meadow	Red-winged Blackbird	*Agelaius phoeniceus*	1.17	0.17	16
Meadow	Brown-headed Cowbird	*Molothrus ater*	0.17	0.08	2
Meadow	Cassin's Finch	*Carpodacus cassinii*	0.42	0.22	6
Meadow	Pine Siskin	*Carduelis pinus*	0.42	0.22	6
Upland	Calliope Hummingbird	*Stellula calliope*	0.08	0.08	1
Upland	Western Wood-Pewee	*Contopus sordidulus*	0.50	0.25	7
Upland	Dusky Flycatcher	*Empidonax oberholseri*	0.83	0.33	11
Upland	Warbling Vireo	*Vireo gilvus*	0.50	0.25	7
Upland	Steller's Jay	*Cyanocitta stelleri*	0.08	0.08	1
Upland	Mountain Chickadee	*Poecile gambeli*	0.75	0.14	10
Upland	Brown Creeper	*Certhia americana*	0.17	0.08	2
Upland	Golden-crowned Kinglet	*Regulus satrapa*	0.42	0.17	6
Upland	Swainson's Thrush	*Catharus ustulatus*	0.08	0.08	1
Upland	American Robin	*Turdus migratorius*	0.67	0.30	9
Upland	Yellow-rumped Warbler	*Dendroica coronata*	0.50	0.14	7
Upland	Western Tanager	*Piranga ludoviciana*	0.08	0.08	1
Upland	Green-tailed Towhee	*Pipilo chlorurus*	0.08	0.08	1
Upland	Chipping Sparrow	*Spizella passerina*	0.08	0.08	1

Appendix 7.12 (Cont.)

Community	Common name	Scientific name	Average number detected per point	SE	Percent composition
Upland	Fox Sparrow	*Passerella iliaca*	0.08	0.08	1
Upland	Lincoln's Sparrow	*Melospiza lincolnii*	0.08	0.08	1
Upland	Dark-eyed Junco	*Junco hyemalis*	1.33	0.22	18
Upland	Cassin's Finch	*Carpodacus cassinii*	0.50	0.38	7
Upland	Pine Siskin	*Carduelis pinus*	0.67	0.22	9

Appendix 7.13. Number of small mammals trapped per 100 trap nights (i.e., relative abundance) in meadow and upland areas at Big Meadow and Grass Lake, 2004–2007. An asterisk indicates a desired condition species. See Appendix 7.14 for scientific names.

Meadow:

Common Name	Big Meadow				Grass Lake			
	2004	2005	2006	2007	2004	2005	2006	2007
Long-tailed vole		0.37	0.63				0.43	1.35
Montane vole	2.82	0.37	0.63	2.60	1.30			
Unknown vole				0.32				1.35
Deer mouse	2.46		0.94	0.32	0.87		3.03	1.79
Belding's ground squirrel*		0.75	0.63	0.65				
Unknown shrew				2.27			0.43	0.45
Golden-mantled ground squirrel	0.70	0.37						
Yellow-pine chipmunk	0.35	1.49	1.57	2.92	0.43	4.03	0.87	2.24
Long-eared chipmunk						1.34		
Shadow chipmunk			0.31				0.43	
Lodgepole chipmunk	0.35	0.37	1.57		1.74		1.30	
Unknown chipmunk			1.26					
Mountain pocket gopher			0.31					
Western jumping mouse*			0.63					

Upland:

Common Name	Big Meadow				Grass Lake			
	2004	2005	2006	2007	2004	2005	2006	2007
Long-tailed vole			1.52					
Montane vole	0.94		0.76		0.43			
Unknown vole				0.76				
Deer mouse	5.19		3.79	5.30	6.07		3.25	5.43
Golden-mantled ground squirrel	1.89	0.55	0.76	1.52				0.54
Yellow-pine chipmunk	11.32	2.21	4.55	15.15	5.64	4.08	3.90	4.35
Long-eared chipmunk						2.72	1.95	
Shadow chipmunk	0.94		0.76			1.36	1.95	
Lodgepole chipmunk	4.72	1.10	13.64	11.36	15.18	0.68	16.88	0.54
Unknown chipmunk			3.79	6.82	0.43	0.68	3.90	0.54
Douglas squirrel			0.76					0.54