Sunset Reach Restoration Project

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

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EXECUTIVE SUMMARY

This report summarizes pre-restoration wildlife monitoring data at Sunset Reach (formerly referred to as Upper Truckee Marsh) and two control sites (Trout Marsh and Upper Truckee Marsh) and illustrates project objectives based on pre-restoration monitoring data. Pre-restoration monitoring occurred in 2006 for all species groups and in 2007 only for songbirds (no nest searching and monitoring).

Restoration Project Goals: Restoration goals for Sunset Reach include (1) improving the natural geomorphic function of the channel (e.g., increase connectivity to the floodplain and sediment filtering and trapping) by raising the bed elevation and (2) potentially increasing stream sinuosity. These goals are supported by the Sierra Nevada Forest Plan Amendment Aquatic Management Strategy (AMS). The AMS defines conditions for aquatic, riparian, and meadow ecosystems. Two AMS goals relevant to this project are:

1. **Floodplains and Water Tables:** Maintain and restore the connections of floodplains, channels, and water tables to distribute flood flows and sustain diverse habitats.
2. **Stream Banks and Shorelines:** Maintain and restore the physical structure and conditions of stream banks and shorelines to minimize erosion and sustain desired habitat diversity.

Riparian conservation objectives relevant to the above stated AMS goals include RCO#2, #5 and #6 (SNFPA 2004).

Associated Wildlife Project Goals: In achieving the above stated process oriented restoration project goals and objectives, the Sunset Reach 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.

Management Recommendations

One year of pre-restoration data has been collected at both Sunset Reach and the associated control sites (Trout Marsh and Upper Truckee Marsh) for all species groups; two years of pre-restoration data have been collected for songbirds. 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 and species preferences. The following management recommendations and restoration actions 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 Sunset Reach restoration project. The monitoring objectives are intended to evaluate project effectiveness relative to the project actions and also to contribute to the validation of wildlife and habitat response to ecosystem restoration projects in the Tahoe Basin.

Butterflies

Recommended restoration actions

1. Based on one year of pre-restoration data, we suggest that restoration seek to mimic conditions found in survey areas 2 and 3 (Appendix 6.1) to improve butterfly richness and abundance.
2. We suggest that restoration efforts seek to maintain or enhance flowering species within meadows and along streamsides, especially those listed as host plants for the desired condition butterfly species (Appendix 6.2), and species observed to be important nectaring plants within the Upper Truckee-Sunset Reach: [western asters (*Aster occidentalis*), wandering daisies (*Erigeron peregrines*), pussypaws (*Calyptridium umbellatum*), yarrow (*Achillea millefolium*), clover (Fabaceae spp.), and bistort (*Polygonum bistortoides*)]. Maintenance of flowering species can be achieved by increasing soil moisture and limiting human access that causes trampling.

Recommended restoration objectives

1. Increase richness and abundance of butterflies and desired condition butterfly species at Sunset Reach.
    - Metric: Richness (number of species) and abundance (number of individuals)
    - Methods: Visual encounter sweep net surveys conducted twice a month from June through August.

Monitoring recommendations

1. 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 more accurately determine if vegetation and hydrological features influence butterfly diversity, abundance, and distribution.
2. Monitor butterflies in 2008 to improve the ability to detect the effect of restoration. Conducting three years of pre-restoration data allows us to assess the natural variability within the system when comparing pre- and post-restoration data

Reptiles and amphibians

Recommended restoration actions

1. Increase amount of wet meadow and areas with ephemeral pools to provide locations for egg laying.
2. We observed common garter snakes and Pacific treefrogs in survey area 2 in areas with standing water; therefore, restoration efforts should focus on replicating conditions found within this area to improve conditions for garter snakes and Pacific treefrogs throughout Sunset Reach.

Recommended restoration objectives

1. Increase distribution of desired condition reptile and amphibian species at Sunset Reach.
    - Metric: Richness (number of species), abundance (number of individuals), and distribution (UTM coordinates).
    - Methods: 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 and 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.

Monitoring recommendations

1. Re-evaluate restoration objectives for reptiles and amphibians.
2. To evaluate changes in distribution of reptiles and amphibians we recommend that survey intensity be increased to include pitfall traps, drift fences, visual encounter surveys, and assessment of hydrological and vegetation features throughout the summer months.
3. Reptile and amphibian surveys should be conducting during the breeding season (late May and June).
4. We suggest intensifying surveys for one or two specific reptiles or amphibians, such as western toads or Pacific treefrogs, to obtain more accurate data or focusing on specific areas within the project site that are likely to affect reptiles and amphibians.

Songbirds

Recommended monitoring actions

1. Maintain snags to provide nesting substrates for cavity-nesting species such as mountain bluebird.
2. 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 focus on improving the structural diversity of the understory plant community to benefit the species listed above. Improving structural diversity can be accomplished by planting species with various growth forms (e.g., Alder and willow) and planting at different times to allow for variation in height.
3. Increase proportion of wet meadow to improve conditions for willow regeneration and to reduce the ability of mammalian predators to access songbird nests.
4. Establish creek-side gravel banks/bars and areas with sandy and firm substrates for foraging and nesting spotted sandpiper (Oring et al. 1997). Create areas with patches of dense vegetation within 100 m of the stream bank for nesting (Oring et al. 1997).
5. To create optimal conditions for belted kingfishers, streams should also support clear and relatively shallow water (Hamas 1994). Kingfishers are often limited by available nesting sites; therefore, restoration efforts should focus on creating areas free of vegetation along the banks of stream channels (Hamas 1994) because areas free of vegetation provide are preferable nesting locations. Overall geomorphic processes that reduce stream incision and channel aggradation may also improve successful reproduction for belted kingfishers (Sullivan et al. 2006).
6. Maintain a variety of snags in different size classes may provide foraging and nesting opportunities for species such as woodpeckers.

Recommended restoration objectives

1. Increase richness and abundance of songbirds and desired condition songbird species at Sunset Reach.

2. Do not increase abundance of waterfowl species of concern to FAA above the threshold level of concern (to be determined) in project areas of concern to the FAA (areas to be specified at a later date).

    - Metric: Richness (number of species) and abundance (number of individuals)
    - Methods: Point-count surveys three times a month during June

Monitoring recommendations

1. Monitor songbirds in 2008 to more accurately detect the effect of restoration. Conducting three years of pre-restoration data allows us to assess the natural variability within the system when comparing pre- and post-restoration data

Songbird productivity

Recommended restoration actions

1. Increase extent and duration of meadow wetness (especially in areas impacted by recreation, as these areas have shown the greatest amount of trampling and are in the greatest need of improvement). Increasing meadow wetness should prove beneficial for songbirds by reducing the ability of mammalian predators to access nests.
2. Increase in total willow cover (> 2 m tall) at Sunset Reach to approximately 60% of the meadow area (Bombay et al. 2003). This recommendation is based on surveys of meadows with willow flycatchers (Bombay et al. 2003). These recommendations should also prove beneficial for yellow warblers, Wilson's warblers, MacGillivray's warblers, warbling vireos, Lincoln's sparrows, and other songbird species that utilize meadows.
3. Increase spatial clumping of willow within meadow (willow patches with an approximate mean size of 375 m^2) (Bombay-Loffland, unpublished data).

Recommended restoration objectives

1. Maintain or increase productivity of focal songbird species (See page 12 in Chapter 1). Expect productivity to increase within meadows due to increased meadow wetness which will reduce the ability of mammalian predators to access nests. Proper restoration of the meadow environment should provide conditions that prevent excessive nest predation; that is, prevent easy access by mammalian predators (e.g., weasels, chipmunks, mice) to nests. Relatively high nest predation would warrant re-evaluation of the success of meadow restoration.
    - Metric: Daily nest survival (Mayfield 1961) and percent parasitism by brown-headed cowbirds
    - Methods: Search for and monitor nests of focal songbird species beginning in late May through early August.

Monitoring recommendations

1. Initiate nest searching if more than five pairs of focal species are detected at Sunset Reach.
2. Initiate nest searching for additional species such as song sparrows, if sufficient numbers can be located.

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 Sunset Reach 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 person hours.

Bats

Recommended restoration actions

1. Maintain tree species and size class diversity to ensure the long-term supply of potential roosting sites.
2. Increase extent and duration of meadow wetness as potential foraging sites.

Recommended restoration objectives

1. Increase species richness and relative frequency of use by desired condition bat species Sunset Reach.
    - Metric: Richness (number of species) and detection frequency (how many times detected)
    - Methods: Three surveys throughout the summer using ultrasonic bat detectors.

Monitoring recommendations

1. Continue current survey methods for bats.
2. We suggest continued monitoring of bat species at Sunset Reach, to determine if activity increases post-restoration. If activity does not increase post-restoration, we recommend that more intensive studies be initiated to locate and quantify roosting and maternity sites, which will require the use of telemetry, to determine if other factors are limiting bat distribution or abundance.

Small mammals

Recommended restoration actions

1. Restoration actions should focus on maintaining open, wet meadows, retaining adequate downed woody debris and snags, and increasing willow cover to encourage the persistence of desired condition small mammal species and other meadow-associated species, and to deter chipmunks from predating bird nests that are located in meadow areas.

Recommended restoration objectives

1. Increase species richness and abundance of desired condition small mammal species at Sunset Reach.
    - Metric: Richness (number of species) and relative abundance (number of individuals)
    - Methods: Trap and mark small mammals
2. Decrease abundance of chipmunk species within the meadow as a result of increased meadow wetness.

- Metric: Abundance (number of individuals) and percent community composition (percent of individuals relative to the small mammal community)
- Methods: Trap and mark small mammals

3. Increase abundance of voles, shrews, weasels, and jumping mice within meadows.
    - Metric: Abundance (number of individuals) and percent community composition (percent of individuals relative to the small mammal community)
    - Methods: Trap and mark small mammals

Monitoring recommendations

1. Continue current survey methods for small mammals.
2. Include in future analysis the metric of percent composition (i.e., number of individuals per species), along with relative abundance, as an indication of change in community composition after restoration.

Recommended vegetation restoration objectives

1. Increase meadow wetness (especially in areas impacted by human recreation, as these areas have shown the greatest amount of trampling and are in the greatest need of improvement).
    - Metric: Percent of meadow with standing water and saturated soil throughout summer
    - Methods: Meadow wetness transects
2. Increase in total willow cover (> 2 m tall) at Sunset Reach to approximately 60% of the meadow area (Bombay et al. 2003).
    - 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).
3. Increase spatial clumping of willow within meadow (willow patches with 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).

General monitoring recommendations

1. Discontinue monitoring at Upper Truckee Marsh control site because restoration is being planned for this site in the future. We suggest that monitoring continue at the Trout Marsh control site.
2. Move the northern survey point and relocate at the southern end of Sunset Reach to match the location of restoration actions with survey locations.
3. Record spatial distribution, number, and size of willows at Sunset reach prior to restoration.
4. Record meadow wetness bi-monthly at Sunset reach prior to restoration.

5. We recommend that surveys for songbirds, bats, butterflies, and small mammals continue to more accurately detect the effect of restoration. Conducting three years of pre-restoration data allows us to assess the natural variability within the system when comparing pre- and post-restoration data.

SUNSET REACH RESTORATION PROJECT

INTRODUCTION

Sunset Reach (referred to as Upper Truckee Marsh in Borgmann et al. 2006, unpublished report) encompasses approximately 3.7 km of the Upper Truckee River, including about 150 ha of the stream and surrounding area. The Lake Tahoe Airport borders the marsh on the east while residential areas form the western boundary (Appendix 6.1). The majority of the area is open meadow with annual and perennial grasses and forbs and scattered willow (*Salix* spp.). The surrounding forest is dominated by lodgepole pine (*Pinus contorta*), Jeffrey pine (*Pinus jeffreyi*), and white fir (*Abies concolor*). The stream is currently incised, running deeper and straighter than historically. Incision of the stream has been caused primarily by channelization, grazing, urban development, and the adjacent airport and golf course (ENTRIX 2004). Due to stream incision, the floodplain receives less water during peak flows, resulting in desiccation of the meadow, encroachment of conifer, and overall depletion of wildlife habitat quality. In addition, fire suppression has led to dense conifer stands in areas surrounding the stream.

MONITORING AND ADAPTIVE MANAGEMENT

The restoration approaches and measures of this plan are based principally on SNFPA (2004) and other USFS guidance and policy directives. To continue to meet these restoration goals at Sunset Reach 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 Sunset Reach.

Compliance with the SNFPA 2004 AMS goals is a principle objective of adaptive management at Sunset Reach. 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. Floodplain and wetland functions are essential for a stable channel and natural growth and sustenance of desired riparian and meadow vegetation. Natural erosion and sediment deposition processes are essential to maintain stable banks, healthy substrate, quality aquatic habitat and cover, and positive and functional hydraulic circulation. These attributes should be tracked during and following restoration implementation to assess the effectiveness of these measures and to assist modification of treatment methodologies where warranted.

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

LTBMU and partnering agencies shall coordinate in the development and integration of adaptive management monitoring and assessment plans and analyses to support ecosystem restoration measures at Sunset Reach.

PROJECT GOALS

Restoration goals for Sunset Reach include (1) improving the natural geomorphic function of the channel (e.g., increase connectivity to the floodplain and sediment filtering and trapping) by raising the bed elevation and (2) potentially increasing stream sinuosity. This project will include complete construction of a new channel throughout this reach. The existing channel may be re-shaped to increase sinuosity, which will promote both in-channel sediment storage and pool and riffle formation. The banks of the new channel will be stabilized with sod blocks and willow planting, among other methods. It is anticipated that this project will raise groundwater elevations in the adjacent meadow and increase meadow wetness.

Specific project goals and objectives (not addressed in this report)

The following goals and objectives are taken from Guidelines for Sunset Reach Restoration Project Monitoring (2007, unpublished report).

1. Restore properly functioning geomorphic channel configuration. Objectives include:
    a. Increase frequency of inundation on floodplain to approximate estimated historic flood frequency (about 1.5–2 yr. return interval).
    b. Increase pool and riffle dynamics through restoration of meandering planform.
    c. Increase stability of banks by increasing the elevation of ground water, and associated improvement in riparian vegetation.
    d. Eliminate or reduce the need for maintenance by designing a geomorphically stable channel.
2. Improve aquatic and wildlife habitat/populations. Objectives include:
    a. Increase or enhance aquatic and terrestrial wildlife habitats (fish, birds, small mammals, reptiles, amphibians, macro-invertebrates, etc.).
    b. Add complexity to aquatic habitat by increasing the number of pools and riffles.
    c. Improve stream substrate for fish spawning and aquatic macro-invertebrate habitat through increased sorting of substrate.
    d. Improve habitat for terrestrial wildlife that use riparian habitat.
    e. Decrease peak water temperatures (decreased width to depth ratios and increased channel shading from riparian vegetation).
    f. Protect sensitive wildlife habitat areas from excessive public use by managing public access.
3. Improve functionality of floodplain for improving water quality.
    a. Increase storage of flood flows on and in floodplain (increase contact time with wetland plants).
    b. Raise the level of groundwater and the potential for water quality treatment by wetland plants.
    c. Filter and store suspended sediment on floodplain by restoring the native and historic wet meadow plant communities.
4. Improve riparian, meadow, and upland vegetation.
    a. Increase spatial extent and vigor of native obligate wetland species and wet meadow plant communities.

b. Increase spatial extent, canopy cover, and recruitment of montane riparian scrub vegetation.
c. Increase groundwater elevations and flooding (water availability) throughout the growing season in the floodplain to support wet meadow plant communities.
d. Remove conifer encroachment in aspen stands.
e. Reduce wildfire threat near residential areas.
f. Improve upland forest habitat structure.
g. Eliminate invasive species.

5. Construct projects effectively and efficiently.
    a. High success in project re-vegetation.
    b. Protect existing resources during construction.
    c. High construction efficiency given project constraints.

PLANNED RESTORATION ACTIONS

1. Complete construction of a new channel throughout this reach,
2. Re-shape existing channel and potentially increase sinuosity, which will promote both in-channel sediment storage and pool and riffle formation.
3. Stabilize banks of the new channel with sod blocks and willow planting, among other methods.

DEVELOPMENT OF DESIRED CONDITIONS

Vertebrate species representative of desired ecological conditions were identified based on two fundamental analyses: existing conditions and historic conditions (See below). This analysis was conducted for songbirds, reptiles, amphibians, bats, and small mammals. Species identified through these analyses comprise the *desired condition species*. Species identified through this analysis are species that should be present pending successful restoration. 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 other project sites will also be used to gauge the *progress* of restoration. Final designation of desired condition species is contingent on Forest Service decisions. Selection of desired species should be based on the below analysis as well as site potential.

Desired condition butterfly species were selected based on habitat requirements and life-history traits of butterfly species that occur in the Lake Tahoe Basin because little historic data exists for butterflies. We selected butterfly species that are strongly associated with wet meadow and/or riparian areas and species that have strong host-plant specificity (e.g., nectar or lay eggs on one or two specific plants).

Existing conditions: We used pre-restoration data from the wildlife restoration and monitoring project (Morrison, unpublished data) to assess the existing conditions of wildlife species (songbirds, reptiles, amphibians, small mammals, and bats) at each project site. We also used knowledge of general species distributions in the Basin based on other data sets, to develop the preliminary analysis presented below.

Based on existing pre-restoration data, we developed a list of all species that occurred on meadows throughout the Basin on our other restoration and reference sites (e.g., Big Meadow, Fountain Place, etc). This overall list of species was then ranked by abundance and overall

percent community composition and was compared with the pre-restoration data for each project site. We then identified species from this list that (a) *should* occur at each project site based on location or expected habitat conditions following restoration, but are currently absent; (b) *could* occur at each project site, but were unlikely to do so (e.g., large home range requirements); and (c) were unlikely to occur at a project site due to poor site potential. Species that should occur at each project site will be the focus of monitoring for wildlife responses to restoration. Thus, this subset of species comprises the desired condition species (Appendix 6.2-6.5).

Historic conditions: The current distribution and abundance of species is largely a reflection of past changes in environmental conditions as well as changes in population status (e.g., abundance). Because of past and ongoing management activities (e.g., timber harvest, fire suppression, and grazing), and recreation, the patterns of distribution and habitat use of most species would be expected to differ substantially from that which occurred historically. As such, interpretation of current patterns of habitat use and distribution would be expected to be confounded to an unknown degree.

We compared historic records (Orr 1949, Orr and Moffitt 1971) to recent records (e.g., Watershed Assessment, MSIM, and wildlife restoration and monitoring data) to identify species that have apparently declined in abundance within the Basin. We termed these as *desired condition species* in this document because they are a focus of restoration efforts. Desired condition species might occur on a restoration site such as Sunset Reach, occur on one or more of our other sampling sites, or not occur at all on any sampled site in the Basin. Desired condition species that should occur at each project site were identified and could require special management efforts (e.g., cowbird control) to ensure their occurrence and productivity. These species are not considered indicators of the presence of other more common species, and the presence of common species is not required for restoration to be considered successful. This is because relatively common species are widely distributed throughout the Basin and are not considered at risk of substantial declines at this time. As such, an overall increase in species diversity will not mean that restoration is successful per se. Additionally, the inability to detect a desired conditions species following restoration does not necessarily indicate restoration failure. The presence of desired condition species will; however, be used to gauge restoration progress.

CONTROL SITE DESCRIPTION

Control sites were selected in association with the Sunset Reach 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) 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). Trout Marsh (referred to as Truckee-Trout Marsh in Borgmann et al. 2006,

unpublished report) is the control site for Sunset Reach. The marsh extends along Trout Creek southeast of Highway 50 and covers an area of approximately 40 ha (Appendix 6.6). The marsh is situated between Lake Tahoe Community College to the east and a dense residential area to the west. Thin tracts of mixed-conifer surround this willow-dominated wet meadow. Upper Truckee Marsh (referred to as Truckee Marsh in Borgmann et al. 2006, unpublished report) is a second control site for Sunset Reach. Upper Truckee Marsh encompasses approximately 259 ha at the confluence of Trout Creek and Upper Truckee River near the southeast shores of Lake Tahoe (Appendix 6.7). Upper Truckee Marsh consists of dry and semi-wet meadow predominated by willow, annual and perennial grasses and forbs, sedges, and rushes. Urban development and single-family homes encompass the upland portion surrounding the marsh. Because Upper Truckee Marsh is slated for restoration in the near future we recommend that surveys be initiated at Trout Marsh to serve as a control site for post-restoration comparisons.

EFFECTIVENESS MONITORING METHODS

Project effectiveness monitoring will be used to measure the effectiveness in meeting the project objectives. Metrics used to assess effectiveness include (1) richness, (2) abundance, (3) distribution, and (4) productivity. 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. The distribution metric will be used to assess changes in species locations/distribution following restoration for small mammals and herpetofauna. We also recommend monitoring reproductive success for focal bird species to determine whether wildlife productivity is being maintained. Pre-restoration monitoring occurred in 2006 for all species groups and in 2007 only for songbirds (no nest searching and monitoring). To facilitate development of desired condition species and restoration recommendations, we recommend that three years of pre-restoration data be collected if restoration timelines and funding permit.

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 Sunset Reach pre-restoration.

Methods.—We conducted visual encounter and sweep-net butterfly surveys at Sunset Reach and associated control sites, Trout Marsh and Upper Truckee Marsh, to determine species richness and relative abundance. Observers worked in teams of two-to-three and walked slowly in a zigzag pattern through the entire meadow scanning for butterflies. Observers also searched for butterflies within 50 m of the forest-meadow edge. The meadow area was divided into six survey areas to allow us to assess species distribution (Appendices 6.1, 6.6, and 6.7). Observers recorded the species and the number of individuals detected. 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 on dry soil (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 (*Alnus incana* t*enuifolia*), 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 we captured with a sweep net and released after identification. We conducted butterfly surveys twice a month in July 2004 (at Upper Truckee Marsh only) and from June–August 2006 (at all sites).

Data analysis.—We calculated richness as the number of species detected across all surveys in a given year. 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, therefore total summed abundance is likely to be a more accurate measure of the number of individuals detected. Distribution of butterflies is described solely for the purposes of planning restoration actions.

Reptiles and amphibians

Pre-restoration Objective 2. Determine distribution of desired condition reptile and amphibian species at Sunset Reach pre-restoration

Methods.—We conducted visual encounter surveys for amphibians and reptiles at Sunset Reach, Trout Marsh, and Upper Truckee Marsh 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 (Appendices 6.1, 6.6, and 6.7). We conducted visual encounter surveys between mid-to-late morning. We surveyed each site once during June in 2006; Upper Truckee Marsh was also surveyed once in June 2004. No surveys were conducted in 2007. 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.— 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. 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, emphemeral ponds) to determine utilization by amphibians and reptiles.

Songbirds

Pre-restoration Objective 3. Determine richness and abundance of songbirds and desired condition songbirds at Sunset Reach pre-restoration.

Methods.—We established avian point-count stations at Sunset Reach, Trout Marsh, and Upper Truckee Marsh to assess bird species richness and abundance (Appendices 6.1, 6.6, and 6.7). We established point-count stations 250 m apart at each site. The number of point-count stations established at each site varied by the size of the meadow (Appendices 6.1, 6.6, and 6.7). We conducted avian point-counts at all sites in June 2006 and 2007; Upper Truckee Marsh was also surveyed May–June 2004. Each site was surveyed three times, with each visit separated by one week. Point counts began fifteen 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 each 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 songbird species pre-restoration.

We *did not* search for or monitor nests of focal songbird species because only two to three pairs of yellow warblers were detected at Sunset Reach and the control sites. Nest searching was not initiated because the sampling effort required outweighed the data that would have been gathered.

Data analysis.—We estimated nesting success by calculating Mayfield estimates of daily nest 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 nest 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 one cowbird and 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.

Parasitism that exceeds 50% has lead to endangerment in four species (reviewed in Robinson et al. 1995) and other studies suggest that parasitism that exceeds 30% may cause population instability (Laymon 1987), thus we established at threshold of 30% parasitism. If parasitism exceeds 30% we recommend that additional studies be carried out to determine the cause of excessive parasitism or initiate studies to investigate the feasibility of cowbird control.

Owls

Pre-restoration Objective 5. Assess owl richness at Sunset Reach pre-restoration.

Methods.—We conducted nocturnal broadcast surveys for six owl species to determine species presence at Sunset Reach, Trout Marsh, and Upper Truckee Marsh. 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 (Appendices 6.1, 6.6, and 6.7). With each survey separated by at least one week, we conducted two surveys in July 2004 (only at one control site, Upper Truckee Marsh) and three surveys from May to June 2006 (at all sites). 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, 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 detection frequency of desired condition bat species pre-restoration.

Methods.—We conducted acoustic surveys for bats using Pettersson ultrasonic detectors (model D240X) to assess bat species richness in. We placed Pettersson recorders in suitable openings, near habitat transition zones, or in likely movement corridors (Appendices 6.8). Bats were recorded on three different nights separated by at least one week from July to September 2004 (only at one control site, Upper Truckee Marsh) and from June to August 2006 (at all sites). We placed detectors in different locations upon subsequent visits; each location was at least 100 m apart. We did not set up bat detectors during inclement weather.

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. For each visit, we divided the number of recordings of each species by the total number of recordings as an approximation of relative frequency of use.

Small mammals

Pre-restoration Objective 7. Determine species richness and abundance of desired condition small mammal species at Sunset Reach pre-restoration.

Methods.—We conducted small mammal surveys at Sunset Reach, Trout Marsh, and Upper Truckee Marsh using Sherman Live Traps to quantify species richness and abundance in August 2004 (only at one control site, Upper Truckee Marsh) and August 2006 (at all sites). We placed Sherman Live Traps along 250 m transects that ran parallel to the creek and located between songbird point-count stations (Appendices 6.1, 6.6, and 6.7). We placed traps every 25 m along each transect. 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. We marked deer mice (*Peromyscus maniculatus*) and vole (*Microtus* spp.) species by clipping a small amount of fur from their rump.

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, 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.

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.

RESULTS AND DISCUSSION

Butterflies

Pre-restoration Objective 1. Determine richness and relative abundance of butterflies and desired condition butterfly species at Sunset Reach pre-restoration.

Three species were commonly detected at Sunset Reach including greenish blue (50.00 ± 33.34), common checkered skipper (24.83 ± 14.85), and Edith's copper (19.83 ± 9.16) (see Appendix G.10 in Borgmann et al. 2006, unpublished report). All other species detected at Sunset Reach averaged five or fewer individuals per species. Butterfly species within Sunset Reach were equally distributed across the survey areas. We detected 25 species in survey area 1 and 2 and 21 in survey area 3 (Appendix 6.1). However, abundance of desired conditions butterflies was highest in survey areas 2 and 3 (area 1 $n = 3$; area 2 $n = 25$; area 3 $n = 30$; Appendix 6.1). Based on one year of pre-restoration data, we suggest that restoration seek to mimic conditions found in areas 2 and 3.

The desired condition butterfly species identified for montane meadows and riparian areas utilize host plants in the fabaceae, violaceae, primulaceae, and poaceae families (Appendix 6.2). Based on preliminary data collected in 2006 across the Basin, western asters (*Aster occidentalis*), wandering daisies (*Erigeron peregrines*), pussypaws (*Calyptridium umbellatum*), yarrow (*Achillea millefolium*), clover (Fabaceae spp.), and bistort (*Polygonum bistortoides*) appear to be important nectaring plants for a wide variety of butterfly species. We suggest that restoration efforts seek to maintain or enhance flowering species within meadows and along streamsides, especially those listed as host plants for the desired condition species (Appendix 6.2) and also the important nectaring plants listed above. In addition, because the majority of butterfly detections occurred in dry and wet areas containing grasses and forbs, we suggest that restoration focus on creating patches of open grassy areas to provide feeding and reproductive opportunities for butterflies.

Recommended restoration actions

1. Based on one year of pre-restoration data, we suggest that restoration mimic conditions found in survey areas 2 and 3 (Appendix 6.1) to improve butterfly richness and abundance.
2. We suggest that restoration efforts seek to maintain or enhance flowering species within meadows and along streamsides, especially those listed as host plants for the desired condition butterfly species (Appendix 6.2), and species observed to be important nectaring plants within the Upper Truckee-Sunset Reach: [western asters (*Aster occidentalis*), wandering daisies (*Erigeron peregrines*), pussypaws (*Calyptridium umbellatum*), yarrow (*Achillea millefolium*), clover (Fabaceae spp.), and bistort (*Polygonum bistortoides*)]. Maintenance of flowering species can be achieved by increasing soil moisture and limiting human access that causes trampling.

Recommended restoration objectives

1. Increase richness and abundance of butterflies and desired condition butterfly species at Sunset Reach.

Monitoring recommendations

1. 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.
2. Monitor butterflies in 2008 to more accurately detect the effect of restoration. Conducting three years of pre-restoration data allows us to assess the natural variability within the system when comparing pre- and post-restoration data.

Reptiles and amphibians

Pre-restoration Objective 2. Determine distribution of desired condition reptile and amphibian species at Sunset Reach pre-restoration.

We detected one desired condition reptile (common garter snake) and one amphibian (Pacific treefrog) at Sunset Reach in 2006. We observed common garter snakes and Pacific treefrogs in survey area 2 (Appendix 6.1) in areas with standing water. Restoration efforts should focus on replicating conditions found within this area to improve conditions for garter snakes and Pacific treefrogs throughout Sunset Reach.

Lack of detection of other species at Sunset Reach does not mean that other reptiles and amphibians do not occur at Sunset Reach. Rather, it is more likely that the visual encounter surveys we conducted were not sufficient to detect additional species. In addition, Sunset Reach was searched only once during June 2006 due to funding limitations. 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 and 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.

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 because the average elevation at Sunset Reach is 1905 m: 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 6.3).

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. Because we detected Pacific treefrogs and common garter snakes in survey area 2, restoration actions should focus on either improving conditions within these areas (e.g., increase amount of standing water in portions of the meadow) or mimic conditions found in these areas in other areas.

Recommended restoration actions

1. Increase amount of wet meadow and areas with ephemeral pools to provide locations for egg laying.
2. We observed common garter snakes and Pacific treefrogs in survey area 2 in areas with standing water; therefore, restoration efforts should focus on replicating conditions found within this area to improve conditions for garter snakes and Pacific treefrogs throughout Sunset Reach.

Recommended restoration objectives

1. Increase distribution of desired condition reptile and amphibian species at Sunset Reach.

Monitoring recommendations

1. Re-evaluate restoration objectives for reptiles and amphibians.
2. To evaluate changes in distribution of reptiles and amphibians we recommend that survey intensity be increased to include pitfall traps, drift fences, visual encounter surveys, and assessment of hydrological and vegetation features throughout the summer months.
3. Reptile and amphibian surveys should be conducting during the breeding season (late May and June).
4. We suggest intensifying surveys for one or two specific reptiles or amphibians, such as western toads or Pacific treefrogs, to obtain more accurate data or focusing on specific areas within the project site that are likely to affect reptiles and amphibians.

Songbirds

Pre-restoration Objective 3. Determine richness and abundance of songbirds and desired condition songbirds at Sunset Reach pre-restoration.

Songbird richness at Sunset Reach was consistent across years and was comparable to species richness observed at one control site (Upper Truckee Marsh) (Fig. 6.1, Appendix 6.9 and 6.10). However, 10 additional species were observed at Sunset Reach when compared to the other control site (Trout Marsh) (Appendix 6.11). Although more species were detected at Sunset Reach, fewer points were surveyed at Trout Marsh.

Desired condition songbird richness was also similar across years at Sunset Reach (Fig. 6.2). Desired condition songbird species detected at Sunset Reach included spotted sandpiper, belted kingfisher, and yellow warbler (Appendix 6.4). More desired condition species were detected at Truckee Marsh, however, the majority of the desired condition songbird species were waterfowl, which are not considered desired species for Sunset Reach due to bird aircraft strike hazards. Abundance of desired condition songbird species was similar across years between the restoration and control sites (Fig. 6.3).

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 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. Decreasing stream incision and improving sinuosity will likely benefit spotted sandpipers, belted kingfishers, common mergansers, and Wilson's snipes (Appendix 6.4). Decreasing stream incision should improve and increase the number of nesting locations for these species. Improving meadow wetness and emergent marsh communities should prove beneficial for yellow-headed blackbird, sora, and Wilson's snipe (Appendix 6.4) as doing so should improve and increase nesting habitat conditions and reduce predation risk by limiting mammalian predator access to nests. Maintaining snags and/or installing nest boxes may be beneficial for mountain bluebird and house wren (Appendix 6.4). Installing nest boxes will provide additional nesting locations for these species.

Recommended monitoring actions

1. Maintain snags to provide nesting substrates for cavity-nesting species such as mountain bluebird.
2. 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 focus on improving the structural diversity of the understory plant community to benefit the species listed above. Improving structural diversity can be accomplished by planting species with various growth forms (e.g., Alder and willow) and planting at different times to allow for variation in height.
3. Increase proportion of wet meadow to improve conditions for willow regeneration and to reduce the ability of mammalian predators to access songbird nests.

4. Establish creek-side gravel banks/bars and areas with sandy and firm substrates for foraging and nesting spotted sandpiper (Oring et al. 1997). Create areas with patches of dense vegetation within 100 m of the stream bank for nesting (Oring et al. 1997).
5. To create optimal conditions for belted kingfishers, streams should also support clear and relatively shallow water (Hamas 1994). Kingfishers are often limited by available nesting sites; therefore, restoration efforts should focus on creating areas free of vegetation along the banks of stream channels (Hamas 1994) because areas free of vegetation provide are preferable nesting locations. Overall geomorphic processes that reduce stream incision and channel aggradation may also improve successful reproduction for belted kingfishers (Sullivan et al. 2006).
6. Maintain a variety of snags in different size classes may provide foraging and nesting opportunities for species such as woodpeckers.

Recommended restoration objectives

1. Increase richness and abundance of songbirds and desired condition songbird species at Sunset Reach.
2. Do not increase abundance of waterfowl species of concern to FAA above the threshold level of concern (to be determined) in project areas of concern to the FAA (areas to be specified at a later date).

Monitoring recommendations

1. Monitor songbirds in 2008 to more accurately detect the effect of restoration. Conducting three years of pre-restoration data allows us to assess the natural variability within the system when comparing pre- and post-restoration data

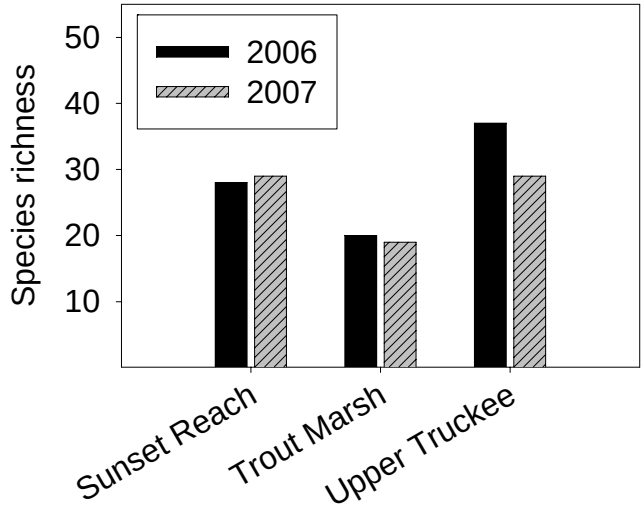

Figure. 6.1. Songbird species richness at Sunset Reach, Trout Marsh (control site), and Upper Truckee Marsh (control site).

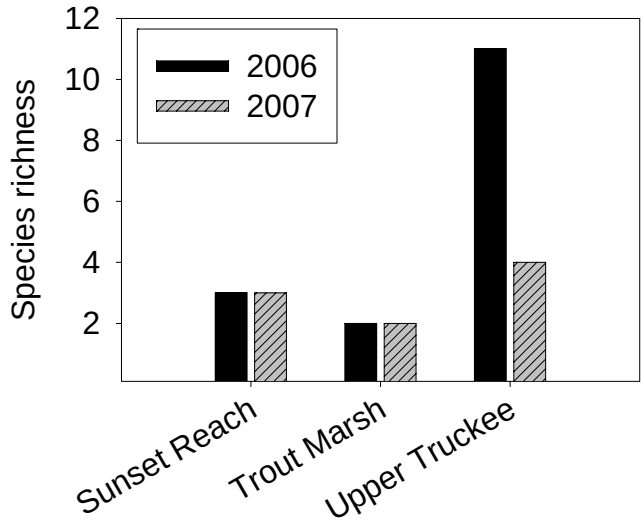

Figure 6.2. Desired condition songbird richness at Sunset Reach, Trout Marsh (control site), and Upper Truckee Marsh (control site).

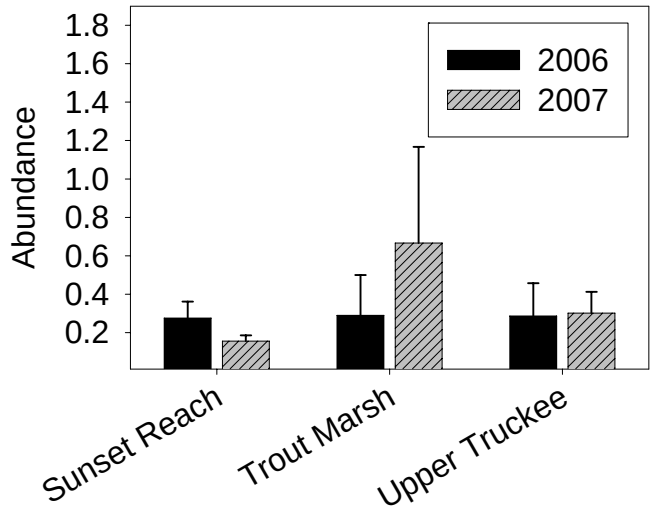

Figure 6.3. Abundance of desired condition songbird species at Sunset Reach, Trout Marsh (control site), and Upper Truckee Marsh (control site).

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

No data were collected to assess objective three because only two to three pairs of one focal songbird species (yellow warbler) were detected at Sunset Reach. Lack of detection was not due to reduced effort, but likely due to limited habitat for yellow warblers.

Recommended restoration actions

1. Increase extent and duration of meadow wetness (especially in areas impacted by recreation, as these areas have shown the greatest amount of trampling and are in the greatest need of improvement). Increasing meadow wetness should prove beneficial for songbirds by reducing the ability of mammalian predators to access nests.
2. Increase in total willow cover (> 2 m tall) at Sunset Reach to approximately 60% of the meadow area (Bombay et al. 2003). This recommendation is based on surveys of meadows with willow flycatchers (Bombay et al. 2003). These recommendations should also prove beneficial for yellow warblers, Wilson's warblers, MacGillivray's warblers, warbling vireos, Lincoln's sparrows, and other songbird species that utilize meadows.
3. Increase spatial clumping of willow within meadow (willow patches with an approximate mean size of 375 m^2) (Bombay-Loffland, unpublished data).

Recommended restoration objectives

1. Maintain or increase productivity of focal songbird species (See page 12 in Chapter 1). Expect productivity to increase within meadows due to increased meadow wetness which will reduce the ability of mammalian predators to access nests. Proper restoration of the meadow environment should provide conditions that prevent excessive nest predation; that is, prevent easy access by mammalian predators (e.g., weasels, chipmunks, mice) to nests. Relatively high nest predation would warrant re-evaluation of the success of meadow restoration.

Monitoring recommendations

1. Initiate nest searching if more than five pairs of focal species are detected at Sunset Reach.
2. Initiate nest searching for additional species such as song sparrows, if sufficient numbers can be located.

Owls

Pre-restoration Objective 5. Assess owl richness at Sunset Reach pre-restoration.

One northern saw-whet owl and a pair of great horned owls were detected at Sunset Reach in 2006 (Table 6.1); no owls were detected at Trout Marsh in 2006 whereas a long-eared owl and a pair of great horned owls were detected in the two years of surveys at Upper Truckee Marsh. The detection of owl species does add to the overall avian species richness at the sites, 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. Starting surveys in March 2007 at other sites in the Basin increased our ability to detect northern saw-whet owls. Based on data collected at all 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 (see Chapter VIII for analysis

details). 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.

Monitoring recommendations

3. 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.
4. If determining the response of cavity-nesting owls to the creation and maintenance of snags in Sunset Reach 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 person hours.

Table 6.1. Number of individual owls detected during nocturnal broadcast surveys at Sunset Reach, Trout Marsh (control site), and Upper Truckee Marsh (control site), 2004 and 2006. The table includes detections of common nighthawks. A "-" indicates no surveys were conducted that year.

Common Name	Scientific Name	Sunset Reach		Trout Marsh		Upper Truckee Marsh	
		2004	2006	2004	2006	2004	2006
Northern saw-whet owl	*Aegolius acadicus*	-	1	-			
Long-eared owl	*Asio otus*	-		-		1	
Great horned owl	*Bubo virginianus*	-	2	-			2
Common nighthawk	*Chordeiles minor*	-	2	-	1		1

Bats

Pre-restoration Objective 6. Determine richness and detection frequency of desired condition bat species pre-restoration.

We detected six bat species at Sunset Reach in 2006 (Table 6.2). Two of the six detected species are currently listed as special concern by various state and federal agencies (Bradley et al. 2006) and are also included as desired condition species for Sunset Reach (Appendix 6.5): long-eared myotis (*Myotis evotis*), and fringed myotis (*Myotis thysanodes*). We detected these species in relatively low frequencies in 2006. We also detected long-eared myotis at Upper Truckee Marsh and fringed myotis at Trout Marsh (Table 6.2).

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. Individuals have been radio tracked to tree hollows, particularly large conifer snags in Oregon and Arizona, and rock crevices in cliff faces in southern California (Bradley et al. 2006). 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. Both 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). Much is still unknown, however, 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

1. Maintain tree species and size class diversity to ensure the long-term supply of potential roosting sites.
2. Increase extent and duration of meadow wetness as potential foraging sites.

Recommended restoration objectives

1. Increase species richness and relative frequency of use by desired condition bat species Sunset Reach.

Monitoring recommendations

1. Continue current survey methods for bats.
2. We suggest continued monitoring of bat species at Sunset Reach, to determine if activity increases post-restoration. If activity does not increase post-restoration, we recommend that more intensive studies be initiated to locate and quantify roosting and maternity sites, which will require the use of telemetry.

Table 6.2. Relative frequency of bat species detected at Sunset Reach, Trout Marsh (control site), and Upper Truckee Marsh (control site) in 2004 and 2006. A "-" indicates no surveys were conducted that year.

Common Name	Scientific Name	Sunset Reach		Trout Marsh		Up. Truckee Marsh	
		2004	2006	2004	2006	2004	2006
Hoary bat	*Lasiurus cinereus*	-	0.5	-	15.6	80.8	6.5
Silver-haired bat	*Lasionycteris noctivagans*	-	68.7	-	74.2		52.1
California myotis	*Myotis californicus*	-	23.4	-			
Long-eared myotis[1]	*Myotis evotis*	-	0.5	-		4.2	
Little brown bat	*Myotis lucifugus*	-	3.5	-	6.3	12.5	40.7
Fringed myotis[1]	*Myotis thysanodes*	-	2.5	-	3.9		
Free-tailed bat	*Tadarida brasiliensis*	-		-		2.5	
Unknown myotis	*Myotis spp.*	-	1.0	-			0.7

[1] Desired condition species (Appendix 6.5)

Small mammals

Pre-restoration Objective 7. Determine species richness and abundance of desired condition small mammal species at Sunset Reach pre-restoration.

We trapped a total of seven small mammal species at Sunset Reach, three species at Trout Marsh, and six species at Upper Truckee Marsh (Appendix 6.12). Seven small mammal species are listed as desired condition species for the Lake Tahoe Basin (Appendix 6.5); of those species, we detected Trowbridge's shrew and vagrant shrew at Sunset Reach (Table 5.3). Species richness and relative abundance of desired condition species were low each year (Tabel 5.3 and Appendix 6.12).

Table 6.3. Relative abundance of desired condition small mammal species trapped at Sunset Reach, Trout Marsh (control site), and Upper Truckee Marsh (control site) during the summers of 2004 and 2006. A "-" indicates no surveys were conducted that year.

Common Name	Scientific Name	Sunset Reach		Trout Marsh		Up. Truckee Marsh	
		2004	2006	2004	2006	2004	2006
Trowbridge's shrew	*Sorex trowbridgii*	-	0.39	-			0.30
Vagrant shrew	*Sorex vagrans*	-	0.39	-		0.32	0.30

Shrews typically occur in montane riparian and wet meadow habitat (e.g., Findley 1999), foraging under moist leaf litter and duff (Gillihan and Foresman 2004). Vagrant shrews are found primarily in patchy, open areas with wet micro-habitats (e.g., wet meadows, streambanks) (Findley 1999). They forage for insects and other invertebrates under moist leaf litter and duff (Gillihan and Foresman 2004). Maintaining open, wet meadows as described herein should encourage the persistence of vagrant shrews at Sunset Reach. Trowbridge's shrews are typically found in coniferous forest with brushy ground cover and uncompacted soils (Terry 1981). Trowbridge's shrews burrow more often than other shrew species and thus need relatively dry, friable soils and associate more with the litter layer of mature forests than open meadows (George 1989). Limiting the extent of soil compaction during the restoration process may encourage the persistence of Trowbridge's shrews at Sunset Reach.

In addition to the desired condition species, we captured several meadow-associated vole and shrew species (Appendix 6.12). Voles and shrews were detected at all sites, with voles being more abundant (Appendix 6.12). Many vole and shrew species occur in or near montane riparian and wet meadow habitat (e.g., Findley 1999), although voles can also be found in nearby forests (e.g., Smolen and Keller 1987). Increasing willow cover at Sunset Reach, along with increasing open, wet meadow, and limiting soil compaction may be beneficial to these species.

Yellow-pine chipmunks were the only chipmunk species detected at Sunset Reach and Upper Truckee Marsh and were relatively abundant compared to other small mammal species (Appendix 6.12). No chipmunks were detected at Trout Marsh. In general, chipmunks are typically found in open canopy forests or in areas with relatively dense shrub cover (e.g., Verner and Boss 1980). Chipmunks are potential predators of several desired condition avian species during the birds' nesting stages; maintaining open, wet meadows may deter chipmunks from predating bird nests that are located in meadow areas (Cain et al. 2003). Maintaining open meadows can be accomplished, in part, by reducing the encroachment of lodgepole pine into the meadows.

Recommended restoration actions

1. Restoration actions should focus on maintaining open, wet meadows, retaining adequate downed woody debris and snags, and increasing willow cover to encourage the persistence of desired condition small mammal species and other meadow-associated species, and to deter chipmunks from predating bird nests that are located in meadow areas.

Recommended restoration objectives

1. Increase species richness and abundance of desired condition small mammal species at Sunset Reach.

2. Decrease abundance of chipmunk species within the meadow as a result of increased meadow wetness.
3. Increase abundance of voles, shrews, weasels, and jumping mice within meadows.

Monitoring recommendations

1. Continue current survey methods for small mammals.
2. Include in future analysis the metric of percent composition (i.e., number of individuals per species), along with relative abundance, as an indication of change in community composition after restoration.

RECOMMENDED VEGETATION OBJECTIVES

1. Increase extent and duration of meadow wetness (especially in areas impacted by recreation, as these areas have shown the greatest amount of trampling and are in the greatest need of improvement). Increasing meadow wetness should prove beneficial for butterflies, songbirds, bats, Belding's ground squirrels, western jumping mice, shrews, and weasels.
2. Increase in total willow cover (> 2 m tall) at Sunset Reach to approximately 60% of the meadow area (Bombay et al. 2003). This recommendation is based on surveys of meadows with willow flycatchers (Bombay et al. 2003). These recommendations should also prove beneficial for yellow warblers, Wilson's warblers, MacGillivray's warblers, warbling vireos, Lincoln's sparrows, and other songbird species that utilize meadows.
3. Increase spatial clumping of willow within meadow (willow patches with an approximate mean size of 375 m^2) (Bombay-Loffland, unpublished data).

GENERAL MONITORING RECOMMENDATIONS

1. Discontinue monitoring at Upper Truckee Marsh control site because restoration is being planned for this site in the future. We suggest that monitoring continue at the Trout Marsh control site.
2. Move the northern survey point and relocate at the southern end of Sunset Reach to match the location of restoration actions with survey locations.
3. Record spatial distribution, number, and size of willows at Sunset reach prior to restoration.
4. Record meadow wetness bi-monthly at Sunset reach prior to restoration.
5. We recommend that surveys for songbirds, bats, butterflies, and small mammals continue to more accurately detect the effect of restoration. Conducting three years of pre-restoration data allows us to assess the natural variability within the system when comparing pre- and post-restoration data.

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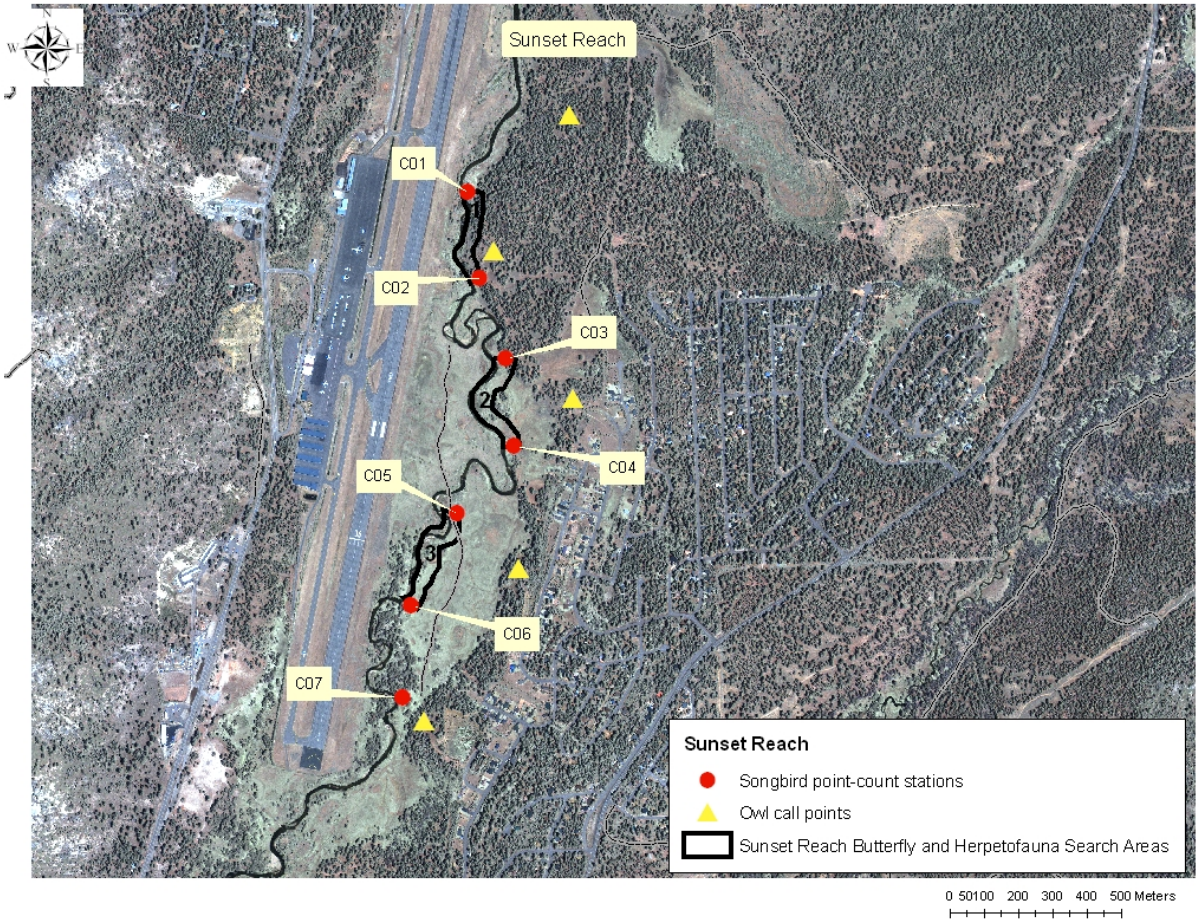
Appendix 6.1. Locations of survey points and survey areas at Sunset Reach. Small mammals trapping transects were located between songbird point-count stations (C01-C02, C03-C04, and C05-C06).



Appendix 6.2. Desired condition butterfly species detected at Sunset Reach and potentially beneficial restoration activities based on habitat preferences. 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 2006	Potentially beneficial restoration activities[1]
Northern Blue (*Lycaeides idas*)		↑*Astragalus* spp., *Lotus* spp., *Lupinus* spp., yarrow (*Achillea millefolium*), flowers in fabaceae family ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Greenish Blue (*Plebejus saepiolus*)	Y	↑ in *Trifolium* spp., clover spp. ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Sierra Nevada Blue (*Agriades podarce*)		↑ in *Dodecatheon* spp., yellow composite spp., bistort (*Polygonum bistortoides*) ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Great Spangled Fritillary (*Speyeria cybele*)		↑ in *Viola* spp., thistle spp. (*Cirsium* spp.), clover spp. ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Pacific Fritillary (*Boloria epithore*)		↑ in *Viola* spp. ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Sonoran Skipper (*Polites sonora*)	Y	↑ in *Festuca* spp., white-flowered thistle spp. (*Cirsium* spp.) ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Western tiger swallowtail (*Papilio rutulus*)	Y	↑ in *Populus* spp., *Salix* spp. ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Purplish copper (*Lycaena helloides*)	Y	↑ in *Polygonum* spp., *Rumex* spp., species in the buckwheat family (Polygonaceae), cinquefoil (*Potentilla* spp.) ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Lilac-bordered copper (*Lycaena nivalis*)		↑ in *Polygonum* spp., *Rumex* spp., species in the buckwheat family (Polygonaceae) ↑ open forest patches
Satyr comma (*Polygonia satyrus*)		↑ in *Urtica* spp., fruiting shrubs ↑ open forest patches and ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies

Appendix 6.2 (Cont.)

Species	Detected in 2006	Potentially beneficial restoration activities[1]
Mourning cloak (*Nymphalis antiopa*)	Y	↑ in *Populus* spp (cottonwood and aspen)., *Salix* spp. ↑ openings along riparian areas ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies
Lorquin's admiral (*Limenitis lorquini*)	Y	↑ in *Prunus* spp., *Populus* spp., *Salix* spp. ↑patches of saturated soil should increase flowering plant diversity and benefit butterflies

[1]Source: http://www.butterfliesandmoths.org/

Appendix 6.3. Reptile and amphibian representative of desired ecological conditions and potentially beneficial restoration activities based on habitat preferences that were detected at Sunset Reach. 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 2006	Community	Potentially beneficial restoration activities[3]	Notes
Long-toed salamander (*Ambystoma macrodactylum*)	X			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*)	X			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*)	X		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*)	X	X		Forest Riparian Meadow	↓ non-native trout, ↑ downed-woody debris, ↑ marsh/wetland vegetation	Species with known population declines (Manley et al. 2000)
W. aquatic garter snake (*Thamnophis couchii*)	X	X		Meadow	↑ number of shallow pools and wetland vegetation	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Common garter snake (*Thamnophis sirtalis*)	X		Y	Forest Riparian Meadow	↑ number of shallow pools and wetland 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 6.4. 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 Sunset Reach. 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 2006	Detected in 2007	Potentially beneficial restoration activities[7]
Sora (*Porzana carolina*)	X					Marsh			↑ shallow water wetlands with emergent vegetation
Spotted Sandpiper (*Actitis macularia*)	X		X			Meadow	Y	Y	↓ stream incision, ↑ gravel bars and sinuosity
Wilson's Snipe (*Gallinago gallinago*)	X					Marsh Meadow			↑ wet willow/alder thickets, ↑ duration of wet conditions, ↓ activities that compact soil
Calliope Hummingbird (*Stellula calliope*)	X			X		Meadow			↑ early successional vegetation, ↑aspen regeneration along streams
Belted Kingfisher (*Ceryle alcyon*)	X	X				Meadow	Y	Y	↑ stream clarity, create streams with riffles, ↓ turbidity, provide areas with earthen banks for nesting cavities
Willow Flycatcher (*Empidonax traillii*)	X	X	X			Meadow			↑ willow, ↓ parasitism risk, ↑ meadow wetness
Warbling Vireo (*Vireo gilvus*)			X			Meadow Riparian	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	Y		↑ streams with low gradient meanders and eroding banks for nesting substrate
House Wren (*Troglodytes aedon*)	X			X		Forest Riparian			Provide nest boxes, ↑ deciduous component along streams

Appendix 6.4 (Cont.)

Species	Desired condition species[1]	PIF[2]	RHJV[3]	MIS[4]	SAR[5]	Community[6]	Detected in 2006	Detected in 2007	Potentially beneficial restoration activities[7]
American Dipper (*Cinclus mexicanus*)	X					Meadow Riparian			Create streams with rocky bottoms, ↑ water clarity, create riffles in streams, ↓ pollution
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	↑ ground and shrub cover along streamsides
Yellow Warbler (*Dendroica petechia*)	X	X	X	X		Meadow	Y	Y	↑ willow, ↓ parasitism risk, ↑ meadow wetness
Wilson's Warbler (*Wilsonia pusilla*)		X	X	X		Meadow Riparian	Y		↑ ground and shrub cover
Song Sparrow (*Melospiza melodia*)			X	X		Meadow Riparian	Y	Y	↑ meadow wetness and duration, ↑ willow and shrub component
White-crowned Sparrow (*Zonotrichia leucophrys*)				X	X	Meadow	Y	Y	↑ patches of open grassy meadow, ↑ density of shrubs
Lincoln's Sparrow (*Melospiza lincolnii*)	X			X		Meadow Riparian			↑ meadow wetness and duration, ↑ density of willow and shrub component,
Black-headed Grosbeak (*Pheucticus melanocephalus*)		X	X			Meadow	Y	Y	↑ willow, ↑ cottonwood along creeks, ↑ aspen regeneration, create habitat type transition zones
Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)	X					Meadow Marsh			↑ meadow wetness, ↑standing water, ↑ emergent vegetation, create deep-water palustrine wetlands

Appendix 6.4 (Cont.)

Species	Desired condition species[1]	PIF[2]	RHJV[3]	MIS[4]	SAR[5]	Community[6]	Detected in 2006	Detected in 2007	Potentially beneficial restoration activities[7]
Brewer's Blackbird (*Euphagus cyanocephalus*)		X				Meadow Marsh	Y	Y	↑ open areas with suitable perches

[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]Sites: Big Meadow (BM), Blackwood (BW), Cookhouse (CH), Sunset Reach (HM), Meeks (MC), Sunset Reach (SR), Tallac Marsh (TLM), Taylor Marsh (TYM), and Ward Creek (WC).
[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 6.5. Mammal species representative of desired ecological conditions and USDA Forest Service Management Indicator Species (MIS) and potentially beneficial restoration activities based on habitat preferences that were detected at Sunset Reach. 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 2006	Community	Potentially beneficial restoration activities[4]	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	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	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			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		Y	Riparian Meadow	↑ old-growth conditions, ↑ ground litter and ground cover	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Vagrant shrew (*Sorex vagrans*)	X	X	Y	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			Forest Riparian Meadow	↑ areas with standing water, ↑ understory shrub density	

Appendix 6.5 (Cont.)

Species	Desired condition species[1]	MIS[2]	Detected in 2004	Community	Potentially beneficial restoration activities[4]	Notes
Belding's ground squirrel (*Spermophilus beldingi*)	X			Meadow	↑ proportion of succulent vegetation, ↑ areas with standing water, create meadow-like openings	Potentially vulnerable terrestrial vertebrate (Manley et al. 2000)
Northern flying squirrel (*Glaucomys sabrinus*)	X	X		Forest	↑ proportion of old-growth conditions	
Western jumping mouse (*Zapus princeps*)	X	X		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		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	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.
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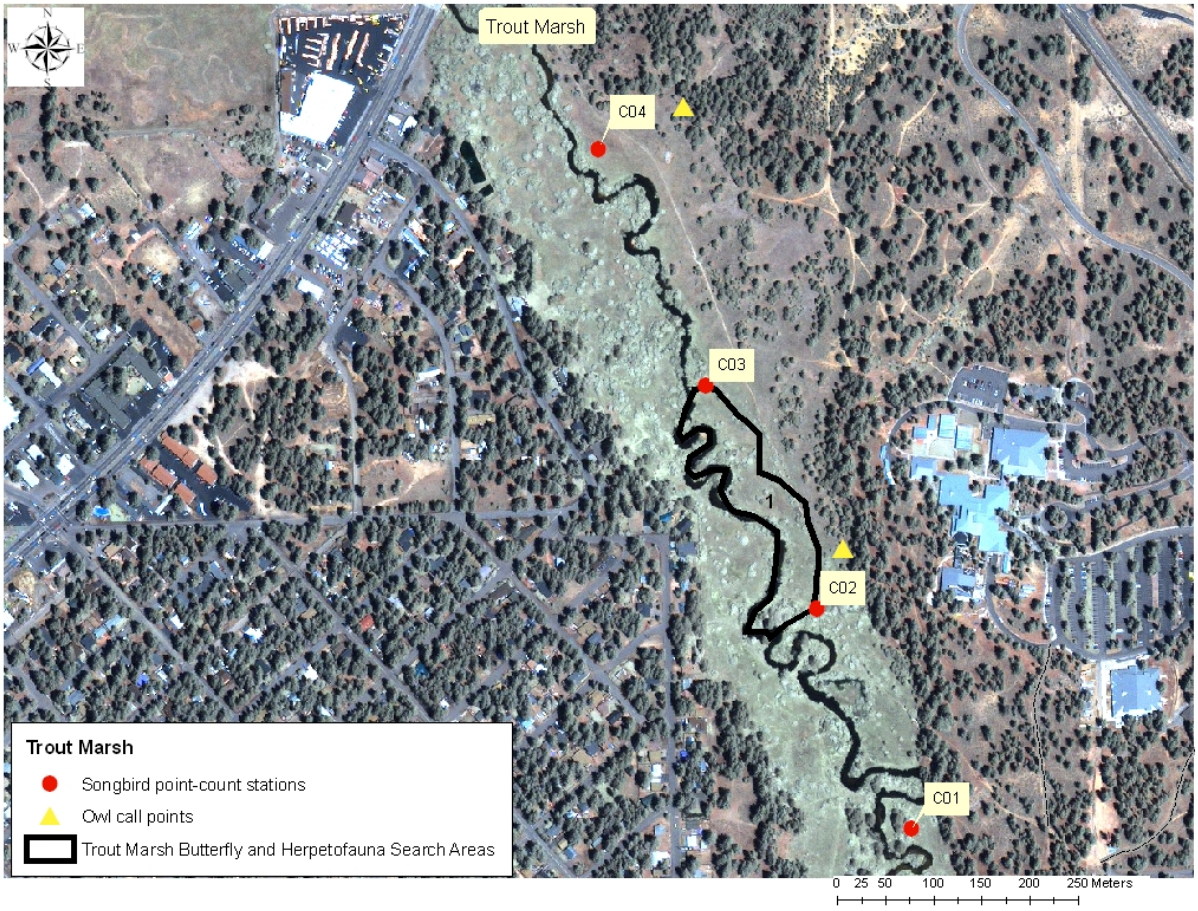
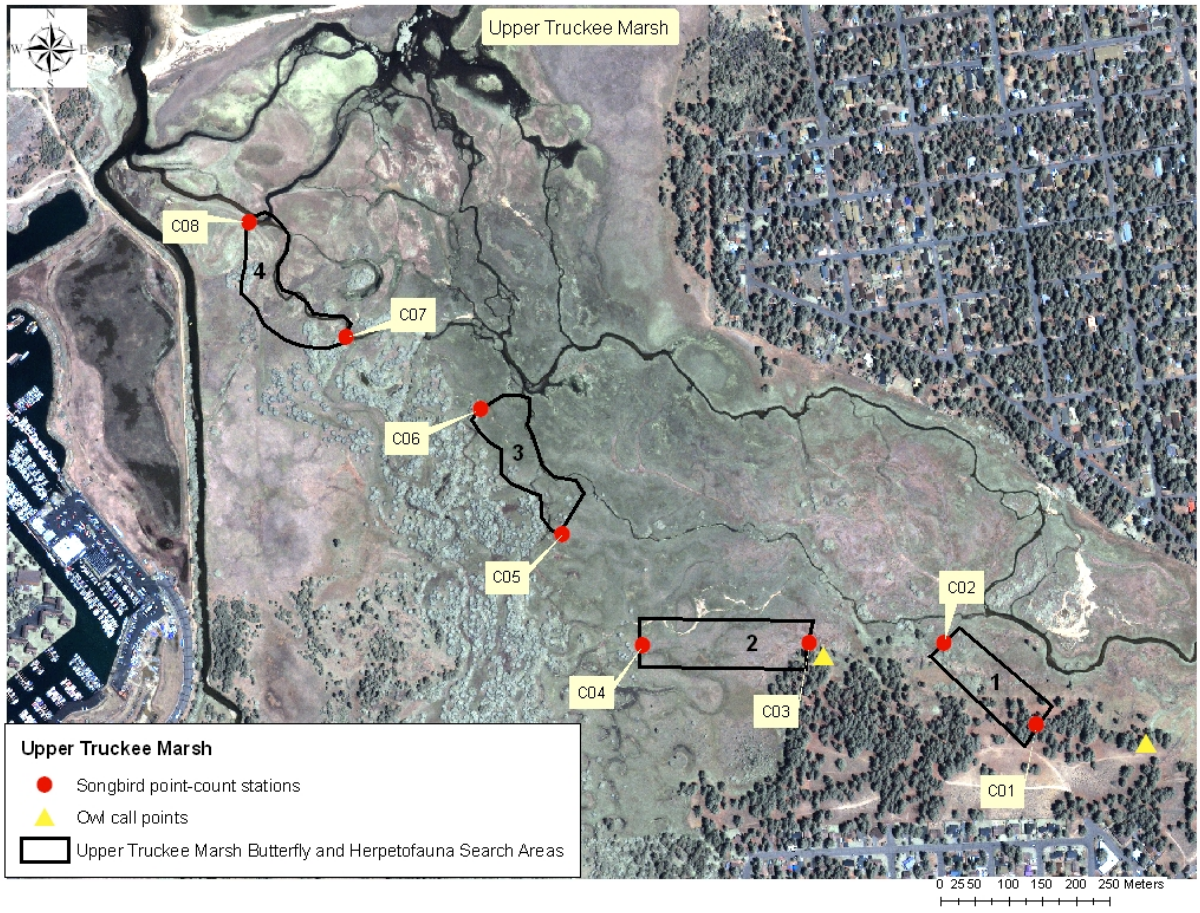
Appendix 6.6. Location of survey points and survey areas at Trout Marsh. Small mammal trapping transects were located between songbird point-count stations C02 and C03.



Appendix.6.7. Location of survey points and survey areas at Upper Truckee Marsh. Small mammal trapping transects were located between songbird point-count stations (C01-C02, C03-C04, C05-C06, and C07-C08).



Appendix 6.8. UTM locations of bat ultrasonic detectors placed at Sunset Reach, Trout Marsh (control site) and Upper Truckee Marsh (control site) in 2006.

Site	Year	Visit	Zone	Easting	Northing
Sunset Reach	2006	1	11	240620	4308557
Sunset Reach	2006	1	11	240586	4308370
Sunset Reach	2006	2	11	240275	4308204
Sunset Reach	2006	2	11	240279	4308006
Sunset Reach	2006	3	11	240563	4308895
Sunset Reach	2006	3	11	240518	4309146
Trout Marsh	2006	1	11	242099	4313100
Trout Marsh	2006	2	11	242109	4312869
Trout Marsh	2006	3	11	242313	4312417
Upper Truckee Marsh	2006	1	11	241251	4313319
Upper Truckee Marsh	2006	2	11	241082	4313325
Upper Truckee Marsh	2006	3	11	240837	4313337

Appendix 6.9. Average number of birds detected per point within 50 m of point-count stations (± SE) at Sunset Reach (previously referred to as Upper Truckee) and the percentage of the avian community each species comprises. Data from 2007.

Common name	Scientific name	Average number detected per point	SE	Percent composition
California Quail	*Callipepla californica*	0.05	0.05	<1
Spotted Sandpiper	*Actitis macularia*	0.48	0.05	5
Mourning Dove	*Zenaida macroura*	0.05	0.05	<1
Belted Kingfisher	*Ceryle alcyon*	0.10	0.10	1
Northern Flicker	*Colaptes auratus*	0.05	0.05	<1
Western Wood-Pewee	*Contopus sordidulus*	0.52	0.05	5
Steller's Jay	*Cyanocitta stelleri*	0.48	0.13	5
Tree Swallow	*Tachycineta bicolor*	0.33	0.17	3
Cliff Swallow	*Petrochelidon pyrrhonota*	0.33	0.21	3
Mountain Chickadee	*Poecile gambeli*	0.67	0.05	6
White-breasted Nuthatch	*Sitta carolinensis*	0.05	0.05	<1
Pygmy Nuthatch	*Sitta pygmaea*	0.14	0.08	1
Brown Creeper	*Certhia americana*	0.10	0.10	1
American Robin	*Turdus migratorius*	0.76	0.31	7
Orange-crowned Warbler	*Vermivora celata*	0.10	0.10	1
Nashville Warbler	*Vermivora ruficapilla*	0.05	0.05	<1
Yellow Warbler	*Dendroica petechia*	0.33	0.13	3
Yellow-rumped Warbler	*Dendroica coronata*	0.19	0.05	2
Western Tanager	*Piranga ludoviciana*	0.19	0.13	2
Chipping Sparrow	*Spizella passerina*	0.14	0.08	1
Savannah Sparrow	*Passerculus sandwichensis*	0.33	0.13	3
Song Sparrow	*Melospiza melodia*	0.62	0.17	6
White-crowned Sparrow	*Zonotrichia leucophrys*	0.10	0.05	1
Dark-eyed Junco	*Junco hyemalis*	0.14	0.08	1
Black-headed Grosbeak	*Pheucticus melanocephalus*	0.57	0.08	6
Brewer's Blackbird	*Euphagus cyanocephalus*	2.48	0.53	24
Brown-headed Cowbird	*Molothrus ater*	0.81	0.17	8
Cassin's Finch	*Carpodacus cassinii*	0.05	0.05	<1
Pine Siskin	*Carduelis pinus*	0.10	0.10	1

Appendix 6.10. Average number of birds detected per point within 50 m of point-count stations (± SE) at Upper Truckee Marsh (previously referred to as Truckee Marsh) and the percentage of the avian community each species comprises. Data from 2007.

Common name	Scientific name	Average number detected per point	SE	Percent composition
Great Blue Heron	*Ardea herodias*	0.13	0.00	1
Mallard	*Anas platyrhynchos*	0.21	0.04	2
Cinnamon Teal	*Anas cyanoptera*	0.04	0.04	<1
Green-winged Teal	*Anas crecca*	0.38	0.00	4
Spotted Sandpiper	*Actitis macularia*	0.13	0.00	1
Wilson's Snipe	*Gallinago gallinago*	0.13	0.07	1
Hairy Woodpecker	*Picoides villosus*	0.13	0.00	1
White-headed Woodpecker	*Picoides albolarvatus*	0.25	0.00	3
Western Wood-Pewee	*Contopus sordidulus*	0.04	0.04	<1
Steller's Jay	*Cyanocitta stelleri*	0.13	0.13	1
Tree Swallow	*Tachycineta bicolor*	0.25	0.00	3
Mountain Chickadee	*Poecile gambeli*	0.17	0.17	2
Pygmy Nuthatch	*Sitta pygmaea*	0.46	0.04	5
Western Bluebird	*Sialia mexicana*	0.25	0.00	3
American Robin	*Turdus migratorius*	0.29	0.11	3
Orange-crowned Warbler	*Vermivora celata*	0.13	0.00	1
Yellow Warbler	*Dendroica petechia*	0.25	0.13	3
Wilson's Warbler	*Wilsonia pusilla*	0.25	0.00	3
Savannah Sparrow	*Passerculus sandwichensis*	0.29	0.11	3
Song Sparrow	*Melospiza melodia*	0.54	0.11	6
White-crowned Sparrow	*Zonotrichia leucophrys*	0.13	0.00	1
Dark-eyed Junco	*Junco hyemalis*	0.25	0.00	3
Black-headed Grosbeak	*Pheucticus melanocephalus*	0.17	0.04	2
Red-winged Blackbird	*Agelaius phoeniceus*	2.21	0.23	23
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	0.13	0.07	1
Brewer's Blackbird	*Euphagus cyanocephalus*	1.25	0.29	13
Brown-headed Cowbird	*Molothrus ater*	0.33	0.22	4
Pine Siskin	*Carduelis pinus*	0.31	0.06	3
Lesser Goldfinch	*Carduelis psaltria*	0.25	0.00	3

Appendix 6.11. Average number of birds detected per point within 50 m of point-count stations (± SE) at Trout Marsh (previously referred to as Truckee-Trout Marsh) and the percentage of the avian community each species comprises. Data from 2007.

Common name	Scientific name	Average number detected per point	SE	Percent composition
Mallard	*Anas platyrhynchos*	0.33	0.17	2
Killdeer	*Charadrius vociferus*	0.17	0.17	1
Spotted Sandpiper	*Actitis macularia*	0.17	0.08	1
Mourning Dove	*Zenaida macroura*	1.17	1.17	7
Northern Flicker	*Colaptes auratus*	0.08	0.08	<1
Steller's Jay	*Cyanocitta stelleri*	0.50	0.14	3
Barn Swallow	*Hirundo rustica*	0.08	0.08	<1
Cliff Swallow	*Petrochelidon pyrrhonota*	1.25	0.72	7
Mountain Chickadee	*Poecile gambeli*	0.25	0.25	1
Pygmy Nuthatch	*Sitta pygmaea*	0.33	0.33	2
American Robin	*Turdus migratorius*	1.08	0.46	6
Orange-crowned Warbler	*Vermivora celata*	0.08	0.08	0
Yellow Warbler	*Dendroica petechia*	1.17	0.33	7
Song Sparrow	*Melospiza melodia*	0.92	0.08	5
Dark-eyed Junco	*Junco hyemalis*	0.08	0.08	<1
Black-headed Grosbeak	*Pheucticus melanocephalus*	0.58	0.08	3
Red-winged Blackbird	*Agelaius phoeniceus*	1.50	0.38	8
Brewer's Blackbird	*Euphagus cyanocephalus*	7.08	0.79	40
Brown-headed Cowbird	*Molothrus ater*	0.92	0.33	5

Appendix 6.12. Number of small mammals trapped per 100 trap nights (i.e., relative abundance) trapped at Sunset Reach, Trout Marsh (control site), and Upper Truckee Marsh (control site) during the summers of 2004 and 2006. A "-" indicates no surveys were conducted that year. An asterisk indicates a desired condition species.

Common Name	Scientific Name	Sunset Reach		Trout Marsh		Up. Truckee Marsh	
		2004	2006	2004	2006	2004	2006
Long-tailed vole	*Microtus longicaudus*	-	0.39	-			
Montane vole	*Microtus montanus*	-	1.17	-	10.34	7.67	0.91
Unknown vole	*Microtus* spp.	-	0.78	-	2.30		1.22
Deer mouse	*Peromyscus maniculatus*	-	12.50	-	5.75	0.32[1]	0.91
Trowbridge's shrew*	*Sorex trowbridgii*	-	0.39	-			0.30
Vagrant shrew*	*Sorex vagrans*	-	0.39	-		0.32[1]	0.30
Unknown shrew	*Sorex spp.*	-	0.78	-	1.15		0.91
California ground squirrel	*Spermophilus beecheyi*	-		-		0.32[1]	0.91
Yellow-pine chipmunk	*Tamias amoenus*	-	4.69	-		6.71	9.15
Douglas squirrel	*Tamiasciurus douglasii*	-	0.39	-			

[1] Individuals were not marked, therefore this number represents maximum number of individuals trapped in one visit and is an underestimate of abundance.