APPENDIX F

WILDLIFE INVENTORY AND MONITORING IN THE LAKE TAHOE BASIN, CALIFORNIA: PRE-RESTORATION

WILDLIFE INVENTORY AND MONITORING IN THE LAKE TAHOE BASIN, CALIFORNIA: PRE-RESTORATION

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EXECUTIVE SUMMARY

In an effort to ameliorate past and present disturbances (e.g., logging, recreation impacts, and habitat loss) within the Lake Tahoe Basin, the US Forest Service is embarking on a major restoration effort. Five areas within the Lake Tahoe Basin are slated for restoration aimed at restoring ecosystem function. Development of restoration and associated management activities in the Lake Tahoe Basin will center on achieving a desired ecological condition that approximates as closely as possible those existing prior to major impacts caused by 20th century humans.

We conducted surveys for butterflies, amphibians, reptiles, birds, bats, small mammals, and medium to large mammals to (1) assess relative abundance of wildlife species prior to restoration activities and (2) establish base-line wildlife data to assist with developing desired conditions. Surveys were conducted at five restoration sites and nine reference sites. Reference sites were chosen based on proximity to the restoration site and on vegetation characteristics. Direct comparisons are made between the restoration site and reference site and are presented in separate chapters. Truckee Marsh, Taylor Creek, and Tallac-Spring Creek serve as reference sites for the Taylor-Tallac watershed. Big Meadow and Grass Lake are reference sites for Cookhouse Meadow. General Creek serves a reference site for Meeks Creek, McKinney Creek serves as a reference site for Blackwood Creek, and Burton Creek serves as a reference site for Ward Creek. We also summarize data from all sites monitored within the Basin and present an overall discussion of the status of wildlife in the Lake Tahoe Basin.

We detected 55 butterfly species throughout the Basin. We detected 19 butterfly species in 13 genera at Tallac Marsh, 19 species in 14 genera at Taylor Marsh, and 21 species in 16 genera at Truckee Marsh. The average number of butterflies detected was similar between Tallac Marsh and Taylor Marsh; however, Tallac and Taylor supported >40% more butterflies than Truckee Marsh. The common checkered skipper (*Pyrgus communis*) was the most abundant butterfly species detected at both Tallac and Taylor Marshes and the orange sulphur (*Colias eurytheme*) was the most abundant butterfly species detected at Truckee Marsh. Nearly twice as many butterflies were captured at Meeks Creek (5.98 ± 2.02) than at General Creek (3.03 ± 0.68). We detected 27 butterfly species in 19 genera at Meeks Creek and 24 species in 18 genera at General Creek. The most abundant species observed at Meeks Creek and General Creek were unidentified crescents; however, of the crescent species positively identified, the California crescent (*Phyciodes orseis*) was the most common. We detected 26 butterfly species in 22 genera at Big Meadow, 25 species in 18 genera at Cookhouse Meadow, and 18 species in 12 genera at Grass Lake. Nearly 85% more butterflies were detected at Big Meadow than at either Cookhouse Meadow or Grass Lake. Fritillaries (*Speyeria* spp.) were the most common butterfly species detected at Cookhouse Meadow, Grass Lake, and Big Meadow. We detected 30 butterfly species in 21 genera at Blackwood Creek and 25 species in 18 genera at McKinney Creek. Relative abundance of butterflies was similar between Blackwood and McKinney Creek. The most abundant species observed at Blackwood Creek and McKinney Creek were unidentified crescents; however, of the crescent species positively identified, the California crescent was most common. We detected 16 butterfly species in 13 genera at Ward Creek and 12 species in 9 genera at Burton Creek. Relative abundance of butterflies was 51% higher at Ward Creek (7.00 ± 1.71) than at Burton Creek (4.65 ± 0.88). The most abundant species observed at Ward Creek were unidentified blues; however, of the blue species positively identified, the greenish blue (*Plebeius saepiolus*) was the most common. At Burton Creek, the

most common butterfly detected was the common checkered skipper. Because relatively little information exists on butterflies in the Lake Tahoe Basin, current and subsequent data will be used to determine desired conditions for focal butterflies. Because few butterfly surveys have been conducted in the basin and because butterflies are sensitive to environmental changes, we suggest that surveys continue to better assess their response to restoration activities.

We detected four amphibian species and six reptile species (including incidental observations) throughout the Lake Tahoe Basin. Bullfrogs (*Rana catesbeiana*), pacific treefrogs (*Hyla regilla*), and western terrestrial garter snakes (*Thamnophis elegans*) were detected at Tallac Marsh, Taylor Marsh, and Truckee Marsh. Common garter snakes (*Thamnophis sirtalis*) were detected only at Taylor Marsh and Tallac Marsh, while western aquatic garter snake (*Thamnophis atratus*) was detected only at Tallac Marsh. We detected two reptile species during scheduled surveys at Meeks Creek, western terrestrial garter snake and an unknown garter snake (*Thamnophis* spp.). Outside the survey area at Meeks Creek, we detected pacific treefrog larvae, common garter snake, rubber boa (*Charina bottae*), and western toad (*Bufo boreas*). No reptile or amphibian species were detected at General Creek during scheduled surveys; however, we did detect an adult pacific treefrog. Pacific treefrog larvae were the most common amphibian species detected at Big Meadow and Grass Lake while common garter snakes were the most commonly detected reptile species at both Big Meadow and Grass Lake. Only one reptile species (western terrestrial garter snake) was detected at Cookhouse Meadow during scheduled surveys. Of particular interest were our detections of long-toed salamander (*Ambysyoma macrodactylum*) larvae at Grass Lake. Grass Lake is the only site in the Basin where we detected salamanders. We detected two reptile species and one amphibian at Blackwood Creek. No herpetofauna were detected at McKinney Creek during scheduled surveys, although we did detect a western fence lizard (*Sceloporus occidentalis*) outside the scheduled surveys. We detected one reptile species (western terrestrial garter snake) at Ward Creek. No herpetofauna were detected at Burton Creek during scheduled surveys, although we did detect a western fence lizard and a garter snake outside the scheduled surveys. Western fence lizards were only detected at Blackwood Creek, McKinney Creek, and Burton Creek.

Owl detections throughout the Lake Tahoe Basin were limited. Overall, we detected five species of owls. We detected Great-horned Owls (*Bubo virginianus*) at Big Meadow, Grass Lake, and Meeks Creek, Long-eared Owls (*Asio otus*) at Truckee Marsh and Burton Creek, Northern Saw-whet Owls (*Aegolius acadicus*) at Meeks Creek, Burton Creek, and Cookhouse Meadow, and a California Spotted Owl (*Strix occidentalis*) at General Creek near call point seven. We also tentatively observed a Northern Pygmy Owl (*Glaucidium gnoma*) at Meeks Creek. No owls were detected during surveys at Ward Creek and Tallac Marsh.

We detected 94 bird species during point counts throughout our study sites in 2004. Overall, avian community composition within all watersheds and areas monitored was composed of relatively common species including American Robins (*Turdus migratorius*), Dark-eyed Juncos (*Junco hyemalis*), Mountain Chickadees (*Poecile gambeli*), Brown-headed Cowbirds (*Molothrus ater*), Steller's Jays (*Cyanocitta steller*i), and Warbling Vireos (*Vireo gilvus*). Few individuals associated with wet meadows (e.g., Willow Flycatcher [*Empidonax traillii*]) or riparian vegetation (e.g., Yellow Warbler [*Dendroica petechia*]) were detected at any of the sites. Restoration efforts should seek to improve habitat conditions for marsh and water associated birds as well as birds associated with riparian corridors.

Nearly 1.6 times more individual birds were detected at Taylor Marsh than at either Tallac or Truckee Marshes, due in part, to increased numbers of human commensalist species

(e.g., Brown-headed Cowbird, Steller's Jays, and Common Ravens [*Corvus corax*]). Relative abundance and species richness was 65 % higher along Meeks Creek than at General Creek, although there was no difference within the upland areas at these sites. We detected a total of 50 bird species at Big Meadow, 38 species at Cookhouse Meadow, and 36 species at Grass Lake. Relative abundance of birds detected around the meadow area was similar between sites; however, 36% and 80% more birds were detected in the uplands around Cookhouse Meadow than at either Grass Lake or Big Meadow (respectively). Relative abundance of birds detected along the main creek channel was not significantly different between McKinney Creek and Blackwood Creek; however, species richness was two times higher at Blackwood Creek (n = 44) than at McKinney Creek (n = 21). Relative abundance of birds detected in the uplands also was not significantly different between Blackwood and McKinney Creeks; however, species richness was 1.5 times higher in the uplands at McKinney Creek (n = 38) than in the uplands at Blackwood Creek (n = 26). We detected a total of 56 bird species at Ward Creek and 50 bird species at Burton Creek (includes incidental observations and upland and creek detections). Relative abundance of birds along the main creek and within the uplands did not differ between Ward Creek and Burton Creek; species richness however, was different. Species richness was 21% higher along Burton Creek that along Ward Creek, although the pattern switched in the uplands; species richness in the uplands was 67% higher at Ward Creek than in the uplands at Burton Creek.

The near shore area around Lake Tahoe provides important habitat for waterfowl, wading birds, and raptors; however much of the near shore area is heavily impacted by human recreation. Species richness of birds using the mouth of General Creek, Meeks Creek, Taylor Creek, and Tallac Creek was similar; however, Taylor Creek supported between 25% and 100% more marsh and water associated bird species relative to Tallac Creek, Meeks Creek, and General Creek. Even though Taylor Creek supported the most water bird species, only 10 species were observed and they contributed little to overall abundance.

We searched for and monitored nests of six focal species including Dusky Flycatcher (*Empidonax oberholseri*), Willow Flycatcher (*Empidonax traillii*), Warbling Vireo (*Vireo gilvus*), Yellow Warbler (*Dendroica petechia*), MacGillivray's Warbler (*Oporornis tolmiei*), and Wilson's Warbler (*Wilsonia pusilla*) to quantify nest success and Brown-headed Cowbird (*Molothrus ater*) parasitism. We chose to monitor nests of these species because (1) their nests are easily monitored (nests typically located < 5 m high), (2) are a species of concern (e.g., Willow Flycatcher), and (3) are associated with riparian vegetation. Across the Basin, 45% of the nests monitored failed (n = 205), 37% were parasitized by Brown-headed Cowbirds, and 76% were successful. Nest failure was >50% at Big Meadow, Burton Creek, Cookhouse Meadow, and Ward Creek. General Creek, Meeks Creek, and Truckee Marsh averaged 20-25% nest failure, the lowest in the Basin. Nest parasitism was >30% at General Creek, Tallac Marsh, and Taylor Marsh. High levels of nest parasitism may warrant cowbird control; however, additional data are needed to determine if nest parasitism is negatively affecting populations.

Nest failure was ≥18% higher at Taylor Marsh (n = 15) and Tallac Marsh (n = 23) than at Truckee Marsh (n = 4). Nest parasitism by Brown-headed Cowbirds was ≥25% for Taylor Marsh, Tallac Marsh, and Truckee Marsh. MacGillivray's Warblers, Wilson's Warblers, and Yellow Warblers had particularly high (>50%) nest parasitism at these sites. Nest failures were 5% higher at General Creek (25%; n = 12) than at Meeks Creek (20%; n = 15). Nest parasitism was 37% greater at General Creek than at Meeks Creek and species-specific nest parasitism was >40% at General Creek for all focal species. Nest failure was 11% higher at both Cookhouse

Meadow (*n* = 25, 56%) and Big Meadow (*n* = 20, 55%) than at Grass Lake (*n* = 9, 44%). Parasitism by Brown-headed Cowbirds was 14% higher at Big Meadow than at Grass Lake, while parasitism at Grass Lake was 7% higher than at Cookhouse Meadow. Species-specific parasitism was ≥50% for MacGillivray's Warblers at Grass Lake (*n* = 1) and Big Meadow (*n* = 2). Eleven percent more nests failed at McKinney Creek (*n* = 13) than at Blackwood Creek (*n* = 23). Among the focal species, we found nests of only three species at McKinney Creek. Percent nest failures for Warbling Vireos was 80% higher at McKinney Creek (*n* = 3) than at Blackwood Creek (*n* = 5), while percent nest failures for MacGillivray's Warblers was similar between sites. Percent nest failures for Wilson's Warblers also was higher (25%) at McKinney Creek (*n* = 4). Percent nest failure was similar at Burton Creek (*n* = 22, 55%) and Ward Creek (*n* = 24, 54%). Among the focal species that were found at both sites, nest failures for Warbling Vireos were 7% higher, Wilson's Warblers were 17% higher, and nest failures of Dusky Flycatchers were 40% higher at Burton Creek. Seventeen percent of the Warbling Vireo nests (*n* = 12) detected at Burton Creek were parasitized by Brown-headed Cowbirds and 33% of the Wilson's Warbler nests (*n* = 3) were parasitized. We did not detect any Brown-headed Cowbird parasitism at Ward Creek.

We detected a total of 11 species of bats throughout the Lake Tahoe Basin. Nine of these species were detected across the Taylor-Tallac-Truckee sampling locations, although only 2-3 species were predominate (hoary bat [*Lasiurus cinereus*], little brown bat [*Myotis lucifugus*], and big brown bat [*Eptesicus fuscus*]). Of particular interest, was our detection of the western red bat (*Lasiurus blossevillii*) at Tallac Marsh, a species concern in California. We detected three species of bats at Meeks creek (Big brown bat, little brown bat, and hoary bat) and six species of bats at General Creek, including a western red bat. Big brown bats and hoary bats were the predominate species detected at General Creek. Although species richness differed between sites, overall intensity of use was similar between Meeks Creek and General Creek. Hoary bat and little brown bat were the predominate species detected at Cookhouse Meadow and both reference sites. Long-eared myotis (*Myotis volans*) were detected at Grass Lake and Big Meadow but were absent from Cookhouse Meadow, while fringed myotis (*Myotis thysanodes*) were detected at both Cookhouse Meadow and Grass Lake but not at Big Meadow. Overall, bats were not detected at a high frequency at either Cookhouse Meadow or the reference sites. Bat species composition differed between Blackwood Creek and McKinney Creek; only two species were detected at both sites (big brown bat and little brown bat). Mexican free-tail bats (*Tadarida brasiliensis*) and hoary bats were only detected at Blackwood Creek while pallid bats (*Antrozous pallidus*) were only detected at McKinney Creek. McKinney Creek was the only sampling location throughout the Basin that confirmed the presence of pallid bats in 2004. Although both little brown bats and big brown bats were detected at both sites, the frequency of detection of each species was different at Blackwood Creek (56.3% and 1.3%, respectively) and McKinney Creek (7.5% and 87.5%, respectively). Overall frequency of detection was 3.5 times higher at Blackwood Creek with ~56 bats/tape than at McKinney Creek with ~16 bats/tape. The same three predominate bat species, hoary bat, little brown bat, and big brown bat were detected at both Ward Creek and Burton Creek. Silver-haired bats (*Lasionycteris noctivagans*) were present at both sites but in low frequency. Other species present at low frequencies include the Mexican free-tailed bat and California myotis (*Myotis californicus*) at Burton Creek and the fringed myotis at Ward Creek. Both sites had a moderate detection rate of bats, with ~52 bats/tape at Burton Creek and ~65 bats/tape at Ward Creek. Because bat species use different roosting and

maternity sites, we suggest intensive studies be initiated to locate and quantify roosting and maternity sites.

We captured 13 small mammal species at our study sites in the Lake Tahoe Basin. The most abundant species captured throughout the Basin included the deer mouse (*Peromyscus maniculatus*) (40% of the total captures), yellow-pine chipmunk (*Tamias amoenus*) (29% of the total abundance), and shadow chipmunk (*Tamias senex*) (11% of total captures). Deer mice and yellow-pine chipmunks were captured at all 12 sites. Small mammal species richness was similar among Tallac Marsh, Taylor Marsh, and Truckee Marsh, although 60% more individuals were captured at Tallac Marsh and 86% more individuals were captured at Taylor Marsh than at Truckee Marsh. The most abundant species captured at both Taylor and Tallac was the yellow-pine chipmunk (52% and 40% of total captures, respectively), while the montane vole (*Microtus montanus*) was most abundant at Truckee Marsh (51% of total captures). Small mammal species richness was 29% higher at Meeks Creek (n = 9) than at General Creek (n = 7), although the same three species constituted the majority of captures at both sites. Deer mice were the most abundant species captured and were 48% and 67% of the total captures at Meeks and General Creek. Shadow chipmunks were the second most abundant species captured, comprising 19% and 18% of the total captures at Meeks and General Creek, respectively. Small mammal species richness was higher at Cookhouse Meadow (n = 8) than at either Big Meadow (n = 6) or Grass Lake (n = 4). At Big Meadow, 35% of the captures were yellow-pine chipmunks, 25% deer mice, and 15% lodgepole chipmunk (*Tamias speciosus*). The predominate species captured at Cookhouse Meadow include deer mice (33%), lodgepole chipmunks (28%), and montane voles (18%). The most abundant species captured at Grass Lake include lodgepole chipmunk (52%), deer mice (21%), and yellow-pine chipmunk (21%). The shadow chipmunk was only detected at Big Meadow, while the long-eared chipmunk (*Tamias quadrimaculatus*) was detected only at Cookhouse Meadow. The most abundant small mammal species captured at Blackwood Creek was the yellow-pine chipmunk (51% of total captures) and the deer mouse (35% of total captures). The deer mouse (60% of total captures) and the shadow chipmunk (28% of total captures) were the most abundant species captured at McKinney Creek. The remaining species (montane vole, long-eared chipmunk, golden-mantled ground squirrel [*Spermophilus lateralis*], California ground squirrel [*Spermophilus beecheyi*], northern flying squirrel [*Glaucomys sabrinus*], and short-tailed weasel [*Mustela erminea*]) captured made up <10% of the total captures. Small mammal species richness was similar between Burton Creek (n = 9) and Ward Creek (n = 8). Although species richness was similar, 69% more unique individuals were captured at Burton Creek. Two species comprised the majority of captures at both sites, the deer mouse and the yellow-pine chipmunk. Species associated with moist soils and meadows (e.g., Trowbridge's shrew [*Sorex trowbridgii*] and broad-footed mole [*Scapanus latimanus*]) and old-growth conditions (e.g., bushy-tailed woodrats [*Neotoma cinerea*]) were not detected within our survey areas. Restoration efforts should provide dense ground and canopy cover for Trowbridge's shrews, improve moist soils and meadow condition for broad-footed moles and Belding's ground squirrels (*Spermophilus beldingi*), improve riparian vegetation for long-tailed weasels, and improve old-growth conditions for bushy-tailed woodrats, porcupines (*Erethizon dorsatum*), and American Martens (*Martes americana*). Continued monitoring is necessary to determine population status more accurately and to re-assess desired conditions for restoration.

Additional years of data are needed to determine what factors are limiting populations and to determine what restoration activities will likely have the greatest impact. We suggest continued monitoring to (1) determine if temporal variation influences relative abundance of

wildlife species, (2) determine if Brown-headed Cowbird parasitism is limiting bird populations and if so incorporate Brown-headed Cowbird control into restoration design, (3) determine if predation rates on bird nests are excessive and incorporate ways to minimize predation in restoration designs (e.g., increase meadow wetness to limit ground-foraging mammal access), (4) determine movement patterns of bullfrogs prior to any eradication program to assess feasibility of success, (5) determine what species may be used as indicator species to assess the success of restoration efforts, and (6) establish additional base-line data to assist with developing desired conditions and to better assess the effects of restoration.

CHAPTER ONE

PRE-RESTORATION WILDLIFE INVENTORY AND MONITORING IN THE LAKE TAHOE BASIN, CALIFORNIA: AN INTRODUCTION

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INTRODUCTION

The majestic grandeur and rich natural resources of the Lake Tahoe Basin consequently lead to the exploitation of its unique natural resources. Logging during the Comstock Era (1850 - 1900) greatly reduced the proportion of old-growth forest in the Lake Tahoe Basin from approximately 55% to 5% (Murphy and Knopp 2000). Moreover, logging has shifted forest composition and structure from Jeffrey pine (*Pinus jeffreyi*) to fir (*Abies* spp.) and incense cedar (*Calocedrus decurrens*) dominated stands with higher tree densities (Murphy and Knopp 2000). Fire suppression also has altered forest structure and composition, resulting in densely packed trees that are susceptible to insect and disease outbreaks and catastrophic fires as a result of increased fuel loads (Murphy and Knopp 2000). Unregulated cattle and sheep grazing in the 1860s and 1870s resulted in severe overgrazing in several meadows and lake-level areas throughout the Lake Tahoe Basin (Lindstrom 2000). Although grazing was limited to allotments in the 1930s grazing pressure was still heavy and has left a lasting mark in some areas (Lindstrom 2000). Development pressures also have decreased the natural diversity and integrity of ecosystems in the Lake Tahoe Basin. The post Comstock Era (1900 to present) saw rapid development and habitat degradation. For example, by 1905 ten communities were established along the shores of Lake Tahoe and by 1925 a road encircling the lake was built leading to further development and recreation pressures. During the post Comstock Era, non-native species introductions began. Fourteen million non-native fish were introduced into Lake Tahoe from 1944 to 1960 (Manley et al. 2000). Continued urbanization pressure (1990 to present) resulted in further habitat degradation. For example, approximately 75% of the marshes and 50% of the meadows were substantially degraded as a result of development that occurred between 1969 and 1979 (Manley et al. 2000). Housing developments increased from 500 homes in 1960 to 19,000 homes in 1980. Water quality within Lake Tahoe also substantially decreased during this period due to pollution and sewage runoff (Manley et al. 2000). Past disturbances, such as those discussed above, and current pressures are responsible for the degraded state of the Lake Tahoe Basin. In an effort to ameliorate some of these past disturbances, the USFS is embarking on a major restoration effort. Five areas within the Lake Tahoe Basin are slated for restoration aimed at restoring ecosystem function. The Lake Tahoe Basin restoration project is particularly valuable because few studies have conducted pre and post-restoration studies. In addition, few studies undergo pre-restoration data collection using adaptive management to guide restoration decisions. Monitoring wildlife species before and after restoration is critical for evaluating the success of restoration, resulting in invaluable information that will help guide future restoration projects. Moreover, the multi-agency cooperation and careful planning components of the Lake Tahoe watershed restoration project will also serve as a model for other restoration projects.

CONCEPTUAL FRAMEWORK

A conceptual model of ecosystem processes and functions is the essential first step in designing a restoration project (Hobbs and Norton 1996). Development of this model involves a process of feedback between the desired ecological condition and what is ultimately feasible to implement and maintain given current environmental conditions, budgetary constraints, and legal mandates. For any restoration project, such a model also must consider the environmental conditions in areas surrounding the overall planning area, because successful restoration is

unlikely if immigration and emigration are impossible, or if predators or competitors cannot be managed either within the project area or on surrounding lands. Developing a sound restoration design and framework is key to the successful implementation of restoration activities that will likely have a positive effect on wildlife species.

An essential component of this framework is incorporation of the ecological requirements of key animal species. While developing and maintaining a functioning ecosystem in the desired condition will provide habitat and niche components for the majority of species, it is unlikely that all key requirements for many species can be achieved in this manner given the degraded environments that exist. For example, unnatural numbers of native predators and exotic species can prevent restoration of essential niche components for many species regardless of the restored condition of the physical habitat (see below). Additionally, because of legal and administrative mandates for conservation of focal species (e.g., legally threatened or endangered species, species of special concern), individual species or small groups of similar species must usually be incorporated into this framework. Thus, in addition to rehabilitation of vegetative structure and hydrologic functions, additional actions must be taken to account for the niche components of animal species in restoration activities and subsequent management actions.

For this project "wildlife" is defined to include all terrestrial invertebrates and vertebrates. This definition expands the more traditional use of "wildlife," which is usually restricted to terrestrial vertebrates. This expanded definition was adopted because it made little sense to separate terrestrial "animals" into different categories, and because of the integral relationship between many vertebrates and invertebrates. Aquatic organisms were not included in this definition because of the substantially different conditions present within aquatic and terrestrial environments, while recognizing the linkages between them in terms of inputs and ecological relationships.

Prior to development of a successful restoration plan, participates must be aware of the distinction between habitat and niche factors, and their relevance to the viability of animals, because failure to recognize wildlife niche requirements can preclude successful restoration (see Morrison et al. 1998 for review). By definition "habitat" is a species-specific concept and should not be confused with "habitat type", which is closely related to vegetative associations. Habitat is simply a description of the physical attributes of the environment in an observer-defined area around an individual animal. Typical habitat variables include the structure and species composition of vegetation (all layers), type and coverage of ground cover (e.g., gravel, bare soil), various special features such as down logs and rocky outcrops, type and coverage of water (e.g., wet depression, pond), and a host of other factors. Habitat factors vary continually as an individual moves through the environment, and over the course of a season. Niche factors relate to the behavioral activities of an individual within the habitat typically determined by where an animal spends its time. Niche factors include various resources, such as the type and size of food required and the constraints on the acquisition of those resources, by the activity of predators and competitors. For example, regardless of the physical appropriateness of vegetation, the presence of Brown-headed Cowbirds (*Molothrus ater*), a nest parasite, usually results in breeding failure of the songbird host (Robinson et al. 1995). Likewise, failing to account for changes in the size distribution and availability of arthropod prey throughout the season will likely result in inadequate food resources for many species. In addition, species interactions also need to be considered in restoration planning. For example, foraging patterns of insectivorous bird were altered by elk browsing on quaking aspen (*Populus tremuloides*) trees. The consumption of aspen shoots by elk reduced the quantities of galls produced by sawflies, the presence of which

had significant and positive effects on the species richness and abundance of other arthropod species. Thus, regardless of the apparent appropriateness of habitat, an animal may be absent from an area because niche factors are inappropriate. Models based solely on habitat factors often result in poor predictions because niche requirements are not met even though the habitat appears suitable. Therefore, it is necessary to incorporate different spatial and temporal habitat and niche models.

Although a thorough evaluation of niche relationships increases time and effort to the front-end planning of a restoration project, such work substantially improves the efficacy of the final restoration plan and drives anticipated post-restoration management activities. For example, if initial analyses indicate that Willow Flycatchers (*Empidonax traillii*) experience high nest parasitism and thus poor breeding success, there would be little reason to attempt to restore habitat (i.e., wet meadows) for Willow Flycatchers unless intensive cowbird management was an integral part of the restoration plan. Of course, resolving all ecological relationships in a restoration project would be a Herculean task, identifying key ecological attributes, in combination with more detailed efforts for focal species, will result in a comprehensive plan that has a higher probability of achieving desired ecological conditions and maintaining biological integrity.

DESIRED ECOLOGICAL CONDITIONS

Development of restoration and associated management activities in the Lake Tahoe Basin will center on achieving a desired ecological condition that approximates as closely as possible those existing prior to major impacts caused by 20th century humans. These conditions, and the types of human-induced activities that caused the changes, were developed in "The Lake Tahoe Watershed Assessment" (Watershed Assessment) (Murphy and Knopp 2000). There have been; however, numerous changes to the environment—both natural and human induced or accelerated—that prevent replication of past conditions. Such changes include global climate change, accumulation of atmospheric CO_2, widespread land-use changes, and human population growth. As such, the restoration goal must be realistic and set within the context of these large-scale changes. Additionally, to be acceptable to a large segment of the public, restoration goals must address the provision of high-quality ecosystem services, such as the provision of clean drinking water, erosion control, availability of recreational activities, enhancement of the view shed, and maintenance of biodiversity. Thus, concentrating on ecosystem functions and services sets the stage for acceptance by the public of restoration activities (e.g., specific management activities such as cutting and burning, restricting access to certain areas, control of certain animal populations). The desired ecological condition, therefore, involves redevelopment of a forest—including riparian community—that approximates ecosystem functions that occurred prior to human involvement.

Historically forest stands were typified by (1) lower montane forests with a 1.5:1 ratio of white fir (*Abies concolor*) to Washoe pine and tree density of ~120-200 per hectare depending on orientation in the Basin, (2) upper montane forests with a 2:1 ratio and tree density of ~120-200 per hectare depending on orientation in the Basin, and (3) a higher proportion of old-growth forest. Current conditions are typified by an increase in white fir and incense cedar that is 2-3 times higher and four times the density in lower montane forests. Upper montane forests currently have doubled in density while species composition has remained relatively stable. The

Lake Tahoe Watershed Assessment (Murphy and Knopp 2000) noted that no consensus was reached on the historic amount of old growth in the Basin, although old growth is thought to have covered ~55% of the Sierra Nevada and currently covers approximately 5%. Other ecologically significant areas including marshes, bogs, fens, aspen groves, riparian areas, and cushion plant communities. Because these areas currently make up a small proportion in the Basin (Murphy and Knopp 2000) and support a disproportionate number of species, restoration plans should seek to increase the proportion of ecologically significant areas. Historically, non-native species were absent from the Basin; however, currently several exotic species (e.g., bullfrogs [*Rana catesbeiana*]) occur in the Basin, thus restoration efforts should seek to control exotic species, particularly if exotic species are negatively impacting native plant and animal communities.

Although we can develop a list of species representative of the desired ecological conditions, it is not possible to specify precise numerical targets for most species. This is because animal numbers vary across time based on a host of environmental factors, which means only a range of abundance can be specified. Additionally, no rigorous data exist for most areas—including the Lake Tahoe Basin—that can be used to specify numerical targets. Orr and Moffitt (1971), for example, reported the status of birds in the Basin in general qualitative categories, such as common or uncommon and thus prevent estimations of target population sizes. For the analyses presented herein, we will report target species of desired ecological condition based on the historical data that is available.

GOALS AND OBJECTIVES

The USFS has established the following overall goals for restoration in the Lake Tahoe Basin (from *Mission Statement: Ecosystem Restoration Program*, USDA Forest Service, Lake Tahoe Basin Management Unit, April 2003):

1. Restore natural processes that sustain healthy ecosystem function
    a. Conduct ecosystem analyses at the hydrologic scale
    b. Develop comprehensive ecosystem restoration plans at the hydrologic scale
    c. Develop monitoring and evaluation plans for each ecosystem restoration project
2. Facilitate an interdisciplinary approach to ecosystem restoration
    a. Design ecosystem restoration projects that integrate all forest programs
3. Promote holistic ecosystem management through collaboration with stakeholders
4. Develop internal and external outreach, environmental education, and information technology transfer
    a. Develop and implement education service-learning programs
    b. Create and maintain a restoration website
    c. Develop partnerships with academic institutions and other agencies and organizations

MONITORING AND IMPLIMENTATION

The success of restoration can be measured by a host of interrelated factors that relate to the desired ecological functions and specific conditions. The success of wildlife restoration in

the Basin will be determined in two primary manners. One, by monitoring the status and trends in wildlife assemblages thought to be typical of the desired ecological condition and two by monitoring the status and trends in focal wildlife species. The wildlife assemblages associated with the desired forest conditions will vary in time and space as the forest varies in structure and composition. That is, within any specific watershed, wildlife will change in composition and abundance as succession proceeds, as catastrophic events occur (e.g., fires, floods), and as other processes occur. Therefore, assessment of restoration success and monitoring changes over time will entail the following sequential steps: (1) identifying the species assemblages associated with various stages of the desired ecological condition of the forest, (2) quantifying the specific forest stages (i.e., seral stages, special elements) present at each monitoring interval (e.g., 5-year interval), (3) determining the proportion of the sampling area (e.g., watershed, multiple watersheds) that contains the desired ecological conditions, and (4) determining how well the expected (desired) species assemblage matches the post-restoration species assemblage. Focal species will be identified to more intensely measure and monitor reproductive success. No attempt at this time will be made to identify a subset of indicator species. Identifying indicators requires that detailed information be obtained on how species respond to environmental perturbations (both natural and human induced); indicators should not be selected without supporting data and analyses (e.g., see review in Morrison et al. 1998). The ongoing "Multispecies Inventory and Monitoring Program" (Manley et al., unpublished) and related efforts in the Tahoe Basin are gathering data that can be used to develop a smaller subset of indicators. As such, this project will only identify species that are characteristic of the desired condition.

Specific application and implementation for wildlife

The following are sequential steps to take in developing the predicted response of wildlife to restoration within a specific watershed or other planning area (where the desired condition of restoration has already been determined), including identification of focal species and specific habitat features that must be provided during the restoration process. This sequence leads to development of wildlife monitoring strategies.

1. List species that are characteristic of the desired conditions.
2. List key natural history traits of each species.
3. Put species into assemblages based on traits.
4. Identify species by area requirements, especially those with large-area requirements.
5. Identify key constraints (e.g., disturbance, predation, and parasitism) that might impact species.
6. Identify species by current abundance categories (e.g., abundant, rare) and evaluate relative to their overall range and range within the Lake Tahoe Basin.
7. Develop list of potential target species that should be emphasized in restoration planning (e.g., focal species).
    a. Determine appropriate response variable for each species (e.g., presence/absence, abundance, productivity).
8. Develop thresholds and triggers within adaptive management context that is based on predicted (and desired) wildlife response to restoration. Note that some species will be expected to decrease in abundance and distribution following restoration (e.g., Brown-headed Cowbirds, European Starlings [(*Sturnus vulgaris*)], and bullfrogs).

a. Species additions and deletions.
b. Changes (increases and decreases) in distribution and abundance.

9. Develop a monitoring plan that is responsive to number eight above.

MANAGEMENT ISSUES AND POTENTIAL SOLUTIONS

Several management issues exist in the Basin that are the target of restoration efforts. Below we provide a general overview of the major management issues and potential management activities that may ameliorate these disturbances (Table 1.1).

Human disturbance

Regardless of the condition of the vegetation community and associated wildlife habitats, excessive human use of an area can result in (1) increased energy expenditures due to excessive movements, (2) temporary or permanent flight from an area, (3) reproductive failure, and (4) increased probability of predation (through distraction). Reducing the impact of human disturbance on wildlife species usually involves establishment of buffer areas between human use areas and areas intended for occupancy by target wildlife species, either on a seasonal (e.g., reproductive period for target species) or permanent basis (Table 1.1).

Loss of ecologically significant areas

Ecologically significant areas, such as wet meadows, often support a disproportionate abundance of species, thus restoration efforts should seek to increase the proportion of these areas throughout the Basin**.** Wet meadow has declined substantially in abundance and quality in the Basin due to road construction (primary and secondary), water diversion, former livestock grazing, and drought. These factors also have created conditions that increase conifer (primarily lodgepole pine [*Pinus contorta*]) and sagebrush encroachment into meadows. Meadow drying allows easier human access to meadow areas, which can negatively impact wildlife species (Table 1.1). Loss of wet meadow also can increase nest predation as ground foraging mammals generally cannot traverse through water. Meadow wetness can be improved by decreasing channel incision allowing overbank flooding, restricting human access, and by artificially adding water to the meadow area.

Aspen occur in patches or groves where proper soil and wetness conditions exist. Because of overall drying in the Basin, aspen is being replaced by conifer species, including lodgepole pine. Aspen regeneration can be improved via conifer removal and introduction of fire into the system. Maintenance of aspen stands in important because aspen stands form an integral part of the overall mosaic of forest vegetation that is needed to support diverse and healthy wildlife populations.

Black cottonwood (*Populus trichocarpa*) stands have limited distribution in the Basin, due degradation of streambed areas that are essential for establishment and recruitment and due to lowered water tables. Cottonwoods are used as nesting and foraging sites by numerous bird species, as den sites by small and meso-mammals, and for roosting by the western red bat (*Lasiurus blossevillii*) (a special interest species that uses deciduous trees for roosting). Establishment and regeneration of black cottonwood can be achieved by reducing stream incision and by planting seedlings in appropriate locations.

Willow (*Salix* spp.) is the primary shrub species of wet meadows and serves as foraging and nesting substrate for numerous sensitive bird species, including the Willow Flycatcher. Alder and other deciduous shrubs, although limited in abundance relative to willow, also serve as important components of meadow and streamside environments (as foraging and nesting locations). Willow regeneration can be improved by increasing water in meadow areas and by planting seedlings. Reducing stream bank incision also will promote vegetation regeneration.

Exotic species

Humans have introduced several species to the west, including the Basin, which negatively impact native species. The bullfrog, native to the eastern United States, preys on native herpetofauna, including larvae and young of the western toad, other native frogs, snakes, and rodents. Bullfrogs also prey on the eggs and nestlings of ground-nesting songbirds. Several birds introduced from Europe, including the European Starling and House Sparrow (*Passer domesticus*), negatively impact certain native bird species, especially secondary cavity nesting species by usurping nest sites (Ingold 1994).

Increased abundance of native species

Certain native species have increased in western environs because of human-related changes to the environment. Notable species in the Basin include Brown-headed Cowbirds, Steller's Jays (*Cyanocitta stelleri*), Common Ravens (*Corvus corax*), raccoons (*Procyon lotor*), and skunks (*Mephitis mephitis*). Removal of Brown-headed Cowbirds has proved successful in increasing reproductive success (Robinson et al. 1995) and may prove to be a viable restoration option if cowbird parasitism is limiting reproductive capacity of songbirds in the Basin.

Linkages

To persist locally (e.g., in a planning area) wildlife usually must maintain emigration and immigration with other locations. In the Basin, this involves movements of animals both within a watershed and between watersheds. Most birds, medium and large mammals, and bats can overcome terrestrial barriers. Other assemblages, such as most herpetofauna and small mammals, cannot overcome barriers and must have mostly unobstructed passage. Many species undergo seasonal, elevational movements, often going from lower to higher elevation in the summer, and back downslope in the winter. Failure to make such movements can result in death, and partially obstructed movements can result in lowered survival. Movement up and down (within) watersheds is restricted by highway and other road crossings, campgrounds and other recreational developments, and human use of the landscape, especially stream corridors.

Missing species

There are some species that have a much more limited distribution in the Basin than occurred historically. Because it is usually impossible to know the historic site specific distribution of a species in the Basin, we must usually use knowledge of historic vegetative conditions to hypothesize potential species distributions. Additionally, we can identify locations that currently exist in the Basin that appear potentially suitable—perhaps following restoration—for a species. Relocation of individuals is likely needed to re-establish species with limited mobility, such as small mammals and herpetofauna.

Habitat features

Standing dead wood, or snags, are used by certain birds and mammals as a foraging substrate (embedded arthropods), and for nesting and denning. Trees are usually killed by catastrophic events, such as insect infestations, fire, and flooding, which results in a patchy distribution of snags. As such, retention guidelines call for an average abundance across the landscape, although managers can achieve the required minimum snag abundance in patches (e.g., by 10 acre patches). USFS and Tahoe Regional Planning Agency (TRPA) Snag Retention Guidelines for Eastside Pine and mixed-conifer forest call for an average of three snags per acre, >15 inches diameter at breast height (dbh) in decay class 2-5 within a planning area.

Dead and downed wood is usually created by snags that fall, or by live trees—or parts (limbs, tops) of live trees—falling due to catastrophic events (e.g., wind, fire, flood, lightening). Downed wood is used as a foraging substrate by herpetofauna, birds, and mammals. Certain mammals and most reptiles use downed wood for hiding, denning, and breeding. Although down material, like snags, is often created in a patchy manner, in natural forests there tends to be a somewhat uniform distribution of material across the forest floor. As such, retention guidelines are flexible and can be managed in a patchwork manner. The USFS and TRPA Downed Wood Retention Guidelines for Eastside Pine and mixed-conifer forest call for three logs >12 inches diameter at midpoint per acre.

Lack of fire

The control of fire in the Basin has resulted in changes in plant species composition, build-up of ground (fuel) material, and changes in vegetative communities. In addition, fire suppression has left the Basin extremely vulnerable to crown and stand-replacing fires (Murphy and Knopp 2000). Re-introduction of prescribed fire is recommended to decrease full load and improve stand conditions.

Urban interface

In addition to direct human disturbance in wildlands, the proximity of human developments directly and indirectly impacts wildlife assemblages (Marzluff et al. 1998, 2001). Human developments, including urban, residential, and recreational facilities usually cause a simplification in animal species richness and result in an increased abundance of certain species. Species such as corvids (Stellar's Jay, Clark's Nutcracker [*Nucifraga columbiana*], Common Raven), raccoons, skunks, and domestic and feral dogs (*Canis familiaris*) and cats (*Felix catus*) usually show high abundance in developments relative to the surrounding wildlands (Marzluff et al. 2001). This situation allows urban-enhanced species to move out into wildlands to prey on or otherwise disturb desired wildlife populations. The urban-wildland interface can be improved through education, seasonal recreation closures, and animal control.

Table 1.1. Management issues impacting native animal assemblages and potential remedial actions.

Management issue	Consequences to resource	Management action(s)	Primary species affected
Human disturbance	Leave area Energy expenditure Breeding failure	Buffer zones Closures (permanent or seasonal)	Raptors Waterbirds
Meadow drying	Human access Increased predation Lowered food abundance	Habitat restoration Predator control Artificial addition of water	Marshbirds Songbirds
Exotic species	Breeding failure Increased predation	Predator control Predator exclosures Control domestic/feral animals	Songbirds
Increased cowbirds	Breeding failure	Cowbird control (adult/nestlings)	Songbirds
Linkages (corridors)	Population isolation Local extinctions	Habitat restoration Re-introductions	Meso/large mammals Herpetofauna
Missing species	Lack of corridors	Re-introductions	Meso/large mammals Herpetofauna
Standing dead wood	Loss of secondary cavity nesters Loss of den sites	Creation of snags	Cavity nesting songbirds Small/meso mammals
Dead and down wood	Loss of den sites Loss of foraging locations	Addition of down material	Small/meso mammals Herpetofauna
Lack of fire	Simplification of species richness	Prescribed fire	All species assemblages
Urban interface	Reduced species diversity Increase in exotic species Increase in human disturbance Increased predation of native species	Habitat restoration (complexity) Animal control Closures and education	All species assemblages

ORGANIZATION OF CHAPTERS

Separate chapters were written for each restoration site and their associated reference site. Reference sites were chosen to assess success of restoration. In general, reference sites were chosen based on proximity to the restoration site and on vegetation similarity. Truckee Marsh, Taylor Creek, and Tallac-Spring Creek serve as reference sites for Taylor-Tallac. Big Meadow and Grass Lake are reference sites for Cookhouse Meadow. General Creek is a reference site for Meeks Creek. McKinney Creek serves as a reference site for Blackwood Creek and Burton Creek serves as a reference site for Ward Creek. Direct comparisons between the restoration site and associated reference sites are discussed in separate chapters. Each chapter was written to stand alone for purposes of management and restoration design planning. Chapter two discusses results from Tallac Marsh, Taylor Marsh, and Truckee Marsh. Chapter three examines Meeks Creek and General Creek. Chapter four discusses results from Cookhouse Meadow, Big Meadow, and Grass Lake. Chapter five presents results from surveys conducted within Blackwood Creek and McKinney Creek. Chapter six examines the results from surveys conducted within Ward Creek and Burton Creek. Finally, Chapter seven summarizes data from all sites monitored within the Basin and presents an overall discussion of the status of wildlife in the Basin.

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CHAPTER II

WILDLIFE INVENTORY AND MONITORING IN THE TALLAC CREEK WATERSHED, TAYLOR CREEK WATERSHED, AND TRUCKEE MARSH: PRE-RESTORATION

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EXECUTIVE SUMMARY

We conducted surveys for butterflies, amphibians, reptiles, birds, bats, small mammals, and medium to large mammals to (1) assess relative abundance of wildlife species prior to restoration activities and (2) establish base-line wildlife data to assist with developing desired conditions. Wildlife surveys were conducted at Tallac Marsh, Taylor Marsh, Truckee Marsh, Tallac-Spring Creek, and Taylor Creek. Tallac Marsh and Taylor Marsh are proposed restoration sites and Truckee Marsh serves as a reference site. The upper watershed of Tallac-Spring Creek and Taylor Creek also serve as reference sites for Tallac and Taylor Marshes.

We detected 19 butterfly species in 13 genera at Tallac Marsh, 19 species in 14 genera at Taylor Marsh, and 21 species in 16 genera at Truckee Marsh. The average number of butterflies detected was similar between Tallac Marsh and Taylor Marsh; however, Tallac and Taylor supported >40% more butterflies than Truckee Marsh. The common checkered skipper (*Pyrgus communis*) was the most abundant butterfly species detected at both Tallac and Taylor Marshes and the orange sulphur (*Colias eurytheme*) was the most abundant butterfly species detected at Truckee Marsh. Because relatively little information exists on butterflies in the Lake Tahoe Basin, current and subsequent data will be used to determine desired conditions for focal butterflies.

Herpetofauna species richness was highest at Tallac Marsh (n = 5), followed by Taylor Marsh (n = 4) and Truckee Marsh (n = 3). Bullfrogs (*Rana catesbeiana*), pacific treefrogs (*Hyla regilla*), and western terrestrial garter snakes (*Thamnophis elegans*) were detected at all three sites. Common garter snakes (*Thamnophis sirtalis*) were detected only at Taylor Marsh and Tallac Marsh, while western aquatic garter snake (*Thamnophis atratus*) was detected only at Tallac Marsh. Although four times more individuals were detected at Tallac Marsh, nearly half of the detections were of non-native bullfrogs.

No owls were detected at Tallac Marsh during the 2004 surveys. We detected a Long-eared Owl (*Asio otus*) on two occasions at Truckee Marsh and heard a possible Western Screech-Owl (*Otus kennicottii*) at Taylor Marsh. Limited detections may be the result of temporal survey restrictions.

Overall, avian community composition in the Tallac Watershed, Taylor Watershed, and Truckee Marsh was composed of relatively common species including American Robins (*Turdus migratorius*), Dark-eyed Juncos (*Junco hyemalis*), Mountain Chickadees (*Poecile gambeli*), Brown-headed Cowbirds (*Molothrus ater*), Steller's Jays (*Cyanocitta steller*i), and Red-winged Blackbirds (*Agelaius phoeniceus*). Relative abundance was similar across all sites, expect between Taylor Marsh, Tallac Marsh, and Truckee Marsh. Nearly 1.6 times more individuals were detected at Taylor Marsh than at either Tallac or Truckee Marshes, due in part, to increased numbers of human commensalist species (e.g., Brown-headed Cowbird, Steller's Jays, and Common Ravens [*Corvus corax*]). The near shore area provides important habitat for waterfowl, wading birds, and raptors; however much of the near shore area is heavily impacted by human recreation. Species richness of birds using the mouth of General Creek, Meeks Creek, Taylor Creek, and Tallac Creek was similar; however, Taylor Creek supported between 25% and 100% more marsh and water associated bird species relative to Tallac Creek, Meeks Creek, and General Creek. Even though Taylor Creek supported the most water bird species, only 10 species were observed and they contributed little to overall

abundance. Few individuals associated with wet meadows (e.g., Willow Flycatcher [*Empidonax traillii*]) or riparian vegetation (e.g., Yellow Warbler [*Dendroica petechia*]) were detected at any of the sites. Restoration efforts should seek to improve habitat conditions for marsh and water associated birds as well as birds associated with riparian vegetation.

We monitored avian nest success of five focal species at Tallac Marsh, Taylor Marsh, and Truckee Marsh. Nest failure was ≥18% higher at Taylor Marsh (n = 15) and Tallac Marsh (n = 23) than at Truckee Marsh (n = 4). Nest parasitism by Brown-headed Cowbirds was ≥25% for all sites. Yellow Warblers (*Dendroica petechia*), MacGillivray's Warblers (*Oporornis tolmiei*), and Wilson's Warblers had particularly high (>50%) nest parasitism. High levels of nest parasitism may warrant cowbird control; however, additional data are needed to determine if nest parasitism continues to be problematic.

We detected nine species of bats across the Taylor-Tallac-Truckee sampling locations.
Sites were predominated by 2-3 species (hoary bat [*Lasiurus cinereus*], little brown bat [*Myotis lucifugus*], and big brown bat [*Eptesicus fuscus*]) with varying numbers of relatively rare species also occurring. In particular, our detection of the western red bat (*Lasiurus blossevillii*) at Tallac Marsh was significant because of the widespread concern over the status of this species.

Small mammal species richness was similar among all sites, although 60% more individuals were captured at Tallac Marsh and 86% more individuals were captured at Taylor Marsh than Truckee Marsh. The most abundant species captured at both Taylor and Tallac was the yellow-pine chipmunk (*Tamias amoenus*) (52% and 40% of total captures, respectively), while the montane vole (*Microtus montanus*) was most abundant at Truckee Marsh (51% of total captures).

Additional years of data are needed to determine what factors are affecting populations and to determine what restoration activities will likely have the greatest impact. We suggest continued monitoring to (1) determine if temporal variation influences relative abundance of wildlife species, (2) determine if Brown-headed Cowbird parasitism is limiting bird populations and if so incorporate Brown-headed Cowbird control into restoration design, (3) determine if predation rates on bird nests are excessive and incorporate ways to minimize predation in restoration designs (e.g., increase meadow wetness to limit ground-foraging mammal access), (4) determine movement patterns of bullfrogs prior to any eradication program to assess feasibility of success, (5) determine what species may be used as indicator species to assess the success of restoration efforts, and (6) establish additional base-line data to assist with developing desired conditions and to better assess the effects of restoration.

INTRODUCTION

Several disturbances within the Taylor/Tallac watershed impede ecological function and are the target of restoration efforts. These include (1) paved access and parking lots for recreational use that reduce infiltration and water flow, (2) improperly constructed and maintained culverts that restrict surface water flow between swales and that increase meadow drying, (3) trampling and erosion associated with human use, (4) grazing by pack station livestock, (5) disconnected flows in near shore swales due to a maintenance road that also increases meadow drying, (6) sedimentation of swales that reduces water levels and connectivity between the marshes, and (7) increased human use that disrupts wildlife breeding and wintering activities. Many of these disturbances can affect wildlife via changes in vegetation structure, reduced critical habitat (e.g., marsh), and increased disturbance associated with human recreation.

Restoration aims in the Taylor-Tallac Watershed focus on increasing surface water flows, reducing sedimentation, and enhancing riparian vegetation. Other goals include increasing the proportion of wet meadow and old-growth conditions within the watershed. The ultimate restoration goal is to enhance the ecological condition of these areas and to increase the abundance of desired wildlife species. Development of restoration and associated management activities in the Lake Tahoe Basin will center on achieving a desired ecological condition that approximates as closely as possible conditions existing prior to major impacts caused by 20th century humans. The desired ecological condition involves redevelopment of a forest—including riparian community—that approximates ecosystem functions that occurred prior to human involvement with certain exceptions that prevent replication of past conditions such as human population growth. We developed a list of species representative of the desired ecological conditions, composed of species that are relatively common throughout the Basin and thus should be present and those that are relatively rare throughout the Basin and should be enhanced by restoration activities (i.e., rare and focal species).

We conducted surveys for butterflies, amphibians, reptiles, birds, bats, small mammals, and medium to large mammals to (1) assess relative abundance of wildlife species prior to restoration activities and (2) establish base-line wildlife data to assist with developing desired conditions. We conducted wildlife surveys at Tallac Marsh, Taylor Marsh, Truckee Marsh, Tallac-Spring Creek, and Taylor Creek. Tallac Marsh and Taylor Marsh are restoration sites and Truckee Marsh serves as a reference site. The upper watershed of Tallac-Spring Creek and Taylor Creek also serve as reference sites for Tallac and Taylor Marshes.

METHODS

Study sites

Tallac, Spring, and Taylor Creek Watersheds total approximately 1450 ha located on the south shore of Lake Tahoe, California. The drainage area for Tallac-Spring Creek is approximately 1165 ha with a channel length of approximately 6 km. Elevation ranges from 2000 m at the mouth of Tallac creek to 2600 m at the headwaters of Spring Creek. Taylor Creek is parallel to and approximately 1.5 km east of Tallac Creek. Taylor Creek

is approximately 2.4 km in length, ranging in elevation from 2000 m to 2600 m. Tallac-Spring Creek and Taylor Creek contain a mix of conifer species with sparse mountain alder (*Alnus incana*) and willow (*Salix* spp.) lining the creek.

Tallac Marsh and Taylor Marsh contain several different vegetation types including semi-wet meadows, dry meadows, and ponded areas created by over bank flooding and beaver (*Castor candadensis*) activity. Willow, mountain alder, quaking aspen (*Populus tremuloides*), annual and perennial grasses and forbs, sedges, and rushes dominate these areas. Tahoe yellow cress (*Rorippa subumbellata*), a threatened species, also occurs near the mouth of Taylor Creek. Jeffrey pine (*Pinus jeffreyi*), white fir (*Abies concolor*), lodgepole pine (*Pinus contorta*), quaking aspen, and deciduous shrubs are the predominate species in the upland area surrounding both Tallac and Taylor Marshes.

Truckee Marsh encompasses approximately 259 ha at the confluence of Trout Creek and Upper Truckee River near the southeast shores of Lake Tahoe. 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 Truckee Marsh.

Butterflies

We conducted butterfly surveys within specified survey areas at Tallac Marsh, Taylor Marsh, and Truckee Marsh to determine species composition and relative abundance. Four butterfly survey areas (200 m × 25 m) were established between point count stations at each site (Appendices A-2). Observers worked in teams of two and walked slowly in a zigzag pattern through each survey area scanning for butterflies. Observers recorded species and the number of individuals detected in different vegetation classes. Butterflies that could not be identified from a distance were captured with a sweep net and released after identification. At each visit, observers searched each survey area for 30 minutes, stopping the timer to record observations. Butterfly surveys were conducted four times within each survey area in July 2004.

Herpetofauna

Visual encounter surveys.—We conducted visual encounter surveys for amphibians and reptiles at Tallac Marsh, Taylor Marsh, and Truckee Marsh to determine species composition and relative abundance. Observers worked in teams of two and walked slowly in a zigzag pattern, searching water bodies, and opportunistically turning over rocks and debris in search of reptiles and amphibians. At each visit, observers searched the marsh/meadow area for a total of 60 minutes, stopping the timer to record observations. Visual encounter surveys were conducted in June between mid to late morning. We surveyed each site multiple times until the entire marsh area was searched thoroughly once.

Avifauna

Owl surveys.—We conducted multi-species call-playback owl surveys at Tallac Marsh, Taylor Marsh, and Truckee Marsh during July 2004 to determine species presence. Call playback surveys were conducted at two of the avian point count stations (C01 and C03, Appendix B-2). We established an additional point in the upland habitat between Tallac Marsh and Taylor Marsh. Two surveys were conducted at each site

separated by one week. Surveys commenced a half-hour after dusk and continued for four hours. 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 tape player (Sony TCM-200DV) and amplified speaker. Species were broadcast from the smallest to the largest owl species (e.g., Flammulated Owl [*Otus flammeolus*], Northern Pygmy Owl [*Glaucidium gnoma*], Northern Saw-whet Owl [*Aegolius acadicus*], Western Screech Owl [*Otus kennicottii*], Long-Eared Owl [*Asio otus*], and California Spotted Owl [*Strix occidentalis*]). Each species was broadcast for 20 seconds followed by 30 seconds of silence. At the end of the call-playback series observers listened for five minutes. During the last two minutes of the five-minute listening period, observers searched the area for silent owls with a half-million candle-watt spotlight (Nite Tracker 2287). Observers recorded owl species detected, noted the species the owl responded to if any, and the distance and direction of the owl from the call point.

Avian point counts.—Avian point count stations were established at Tallac Marsh, Taylor Marsh, Truckee Marsh, Tallac-Spring Creek, and Taylor Creek to assess bird species composition and relative abundance. We established point count stations 200 m apart following the main creek channel at the marsh sites (Appendix B-2). Additional point count stations at the marsh sites were placed 200 m apart in the uplands surrounding the marsh (Appendix B-2). Point count stations at Tallac-Spring Creek and Taylor Creek were established in the upper watershed of Tallac Creek and Taylor creek (south of US Hwy 89). Points were located 25 m from the edge of the creek and were placed 250 m apart. The number of point count stations established at each site varied by the length of the watershed and time constraints (Appendix B-2).

Avian point counts were conducted from late May through June 2004. Each site was surveyed three times 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 at each point in two distance intervals, 0-50 m and >50 m. Observers also recorded Douglas squirrels (*Tamiasciurus douglasii*) during point counts. Point counts were not conducted during inclement weather (e.g., precipitation or wind >9 kmph).

We also conducted half-hour observations at the mouths of Tallac Creek, Taylor Creek, Meeks Creek, and General Creek to quantify the use of the shoreline areas by birds. Each site was visited four times at variable times of the day in June 2004. Observers recorded all birds seen or heard around the mouth of each creek for a half-hour. Additional bird species not recorded during scheduled surveys were recorded as incidental sightings (Appendices C-2 - G-2).

Nest searching and monitoring.—We searched for and monitored nests of five focal species including Willow Flycatcher (*Empidonax traillii*), Warbling Vireo (*Vireo gilvus*), Yellow Warbler (*Dendroica petechia*), MacGillivray's Warbler (*Oporornis tolmiei*), and Wilson's Warbler (*Wilsonia pusilla*) to quantify nest success, and Brown-headed Cowbird (*Molothrus ater*) parasitism. We chose to monitor nests of these species because (1) their nests are easily monitored (nests typically located < 5 m high), (2) are a species of concern (e.g., Willow Flycatcher), and (3) are associated with riparian vegetation. Nests of other species were monitored when encountered. Nest searching and monitoring was conducted only at Tallac, Taylor, and Truckee Marshes. At each

site, observers searched for nests throughout the marsh and within a 200 m buffer zone surrounding the marsh. Nests were monitored every three to five days until nest outcome could be determined.

Mammals

Acoustic bat sampling.—We conducted acoustic surveys for bats using Pettersson ultrasonic detectors (model D240X) at Tallac Marsh, Taylor Marsh, and Truckee Marsh to assess bat species composition. At each site, Pettersson recorders were placed in the nearest suitable opening, near habitat transition zones, or in likely movement corridors (Appendix H-2). Bats were recorded on three different nights separated by at least one week beginning in July and ending in September 2004. Detectors were placed in different locations upon subsequent visits.

Small mammal surveys.—We conducted small mammal surveys at Tallac Marsh, Taylor Marsh, and Truckee Marsh using Sherman Live Traps from August to September 2004 to quantify species composition and relative abundance. Sherman Live Traps were placed every 25 m between avian point count stations (Appendix I-2). At alternating 25 m, both large and extra-large Sherman Live Traps were placed. At each location, Sherman traps were placed in the nearest appropriate location ensuring that the trap was sufficiently protected from the elements (e.g., sun). Traps were baited with a mixture of rolled oats and peanut butter. Traps were checked three times daily (morning, mid-day, and dusk) for three consecutive days. Captured animals were identified to species, sexed, and aged if possible. Additionally, we removed a small amount of fur from the rump of all captured animals to determine the number of unique individuals captured. Deer mice (*Peromyscus maniculatus*) were not handled or marked due to the risk of hanta virus.

Medium to large mammals.—We surveyed medium to large mammals using track plates to determine species presence. Each track plate consisted of an aluminum plate (20 × 76.2 × 0.1 cm) with half of the aluminum plate coated with a mixture of carpenter's chalk and 70% isopropyl alcohol (two parts chalk to five parts alcohol). The remaining half of the plate was covered with contact paper and enclosed in a plywood box (25.4 × 25.4 × 81.3 cm). Traps were baited with wet cat food placed at the back of the box. Track plate stations were placed near six of the avian point count stations. Track plates were checked every three days for a twelve-day period. At each check, we replaced the contact paper, re-baited, and re-chalked if necessary.

DATA ANALYSIS

Butterflies

We calculated the average number of butterflies detected per species per visit (Appendices J-2 - L-2). We also calculated the average number of individuals detected in different vegetation classes (Appendix M-2). Finally, we calculated the average number of individuals detected of 22 single-brooded species that prefer wet meadows or stream sides that were detected within the Basin to serve as the preliminary target species for restoration. To determine differences in butterfly species composition between sites we used spearman rank correlations.

Herpetofauna

We calculated general descriptive statistics to determine the average number of individuals detected per species.

Avifauna

Relative abundance was calculated as the average number of birds detected within 50 m per point per visit. We present the data separately for birds detected along the major creek drainages from those detected in the upland habitat surrounding the marsh (Appendices N-2 - T-2). Avian community similarity was examined using spearman rank correlations. Avian abundance at the mouth of Taylor Creek, Tallac Creek, Meeks Creek, and General Creek was calculated as the average number of individuals detected per visit.

We evaluated nest success by calculating apparent nest success (success versus failure) and by calculating Mayfield estimates of daily mortality (Mayfield 1961). Mayfield estimates account for the stage at which a nest was found (e.g., exposure days) and generally provide better estimates of mortality. Nests were considered successful if one or more young fledged from the nest. Nests were considered unsuccessful if parental activity ceased prior to confirmed hatching or fledgling period. Nests were considered parasitized if the presence of a Brown-headed Cowbird egg or nestling was detected. When calculating Mayfield estimates, we considered parasitized nests that fledged cowbirds as nest failures and nests that were parasitized but fledged at least one host young as successful.

Mammals

Bats.—Bat sonograms were analyzed with program SonoBat version 2.2 (DNDesign 2004), which compares sonograms recorded to known species standards. We used the number of recordings of each species on a tape as an approximation of relative occurrence during a recoding session.

Small mammals.—We calculated the number of unique individuals captured, by subtracting the number of recaptures from total captures. We present data on the number of unique individuals captured. Because deer mice were not marked, we present the maximum number of individuals captured in one day during the entire trapping session. Relative abundance of Douglas squirrels was calculated as the average number of squirrels detected within 50 m per point per visit.

RESULTS

Butterflies

The average number of butterflies detected was similar between Tallac Marsh (2.93 ± 0.78) and Taylor Marsh (2.16 ± 0.57); however, Tallac and Taylor Marsh

supported >40% more butterflies than did Truckee Marsh (1.53 ± 0.35). Dry meadows consisting of annual and perennial grasses and forbs supported 42 times more butterflies than other vegetation types at Taylor Marsh. Dry meadows at Tallac Marsh supported 33 times more butterflies than other vegetation types and dry meadows at Truckee Marsh supported 13 times more butterflies than other vegetation types (Appendix M-2). Of the 22 single-brooded species that we identified as preliminary target species for restoration, Taylor Marsh (n = 10) supported the most species followed by Truckee Marsh (n = 9) and Tallac Marsh (n = 8) (Table 2.1). Tallac Marsh supported twice as many focal butterflies as Taylor Marsh and three times more focal butterflies than Truckee Marsh. The most abundant species observed at Tallac Marsh and Taylor Marsh was the common checkered skipper (*Pyrgus communis*) while the orange sulphur (*Colias eurytheme*) was the most abundant butterfly species detected at Truckee Marsh (Appendices J-2 – L-2). Community composition between sites was similar in all Pairwise comparisons (Truckee v. Tallac r = 0.55, P < 0.001; Truckee v. Taylor r = 0.61, P < 0.001; Tallac v. Taylor r = 0.674, P < 0.001).

Table 2.1. Preliminary list of focal butterfly species that prefer meadows or stream sides and average number (± SE) detected at Tallac Marsh, Taylor Marsh, and Truckee Marsh.

Species	Tallac Marsh	Taylor Marsh	Truckee Marsh
Clodius Parnassian (*Parnassius clodius*)	0	0	0
Western tiger swallowtail (*Papilo rutulus*)	2.25 ± 0.48	1.50 ± 0.96	0.25 ± 0.25
Edith's copper (*Lycaena editha*)	0.25 ± 0.25	0.50 ± 0.50	2.00 ± 1.22
Lilac-bordered copper (*Lycaena nivalis*)	1.00 ± 1.00	0.25 ± 0.25	0.25 ± 0.25
Mariposa copper (*Lycaena mariposa*)	0	0	0
Sylvan hairstreak (*Satyrium sylvinus*)	0	0	0
Arrowhead blue (*Glaucopsyche piasus*)	0	0	1.75 ± 1.75
Northern blue (*Lycaeides idas*)	0	0	0
Silvery blue (*Glaucopsyche lygdamus*)	0	0	0
Greenish blue (*Plebejus saepiolus*)	10.5 ± 5.01	2.50 ± 1.04	0.50 ± 0.29
Boisduval's blue (*Icaricia icarioides*)	0	0.75 ± 0.75	0.75 ± 0.75
Sierra Nevada blue (*Agriades cassiope*)	0	0	0
Great basin fritillary (*Speyeria egleis*)	0	0	0
Pacific fritillary (*Boloria epithore*)	0	0	0
Northern Checkerspot (*Chlosyne palla*)	0.50 ± 0.50	0.25 ± 0.25	0
Field crescent (*Phyciodes pratensis*)	0.25 ± 0.25	0.50 ± 0.50	0
California crescent (*Phyciodes orseis*)	13.25 ± 1.93	4.75 ± 1.93	0.50 ± 0.29
Mourning cloak (*Nymphalis antiopa*)	0	1.75 ± 1.18	1.00 ± 0.58
Mexican cloudywing (*Thorybes mexicanus*)	0	0	0
Persius duskywing (*Erynnis persius*)	0	0	0
Sandhill skipper (*Polites sabuleti*)	0	0	0
Sonora skipper (*Polites Sonora*)	9.75 ± 4.52	10.00 ± 3.87	6.75 ± 4.31

Herpetofauna

Species richness was highest at Tallac Marsh (*n* = 5), followed by Taylor Marsh (*n* = 4) and Truckee Marsh (*n* = 3) (Table 2.2). Bullfrogs (*Rana catesbeiana*), pacific treefrogs (*Hyla regilla*), and western terrestrial garter snakes (*Thamnophis elegans*) were detected at all three sites. Common garter snakes (*Thamnophis sirtalis*) were detected only at Taylor Marsh and Tallac Marsh, while western aquatic garter snake (*Thamnophis atratus*) was detected only at Tallac Marsh. Although four times more individuals were detected at Tallac Marsh, nearly half of the detections were of non-native bullfrogs (Table 2.2).

Table 2.2. Number of reptile and amphibian species detected at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Tallac Marsh	Taylor Marsh	Truckee Marsh
Pacific treefrog	*Hyla regilla*	72	32	1
Bullfrog	*Rana catesbeiana*	112	7	1
Common garter snake	*Thamnophis sirtalis*	2[a]	4	
Western terrestrial garter snake	*Thamnophis elegans*	1[a]	2	1
Western aquatic garter snake	*Thamnophis atratus*	1[a]		

[a]Not detected during scheduled surveys.

Avifauna

Owls.—No owls were detected at Tallac Marsh during the 2004 surveys. We detected a Long-eared Owl (*Asio otus*) on two occasions at Truckee Marsh and heard a Western Screech-Owl (*Otus kennicottii*) at Taylor Marsh, although the detection was not 100% verifiable.

Avian point counts.—Overall relative abundance of individuals detected along the main creek channel was 1.6 times greater at Taylor Marsh (0.69 ± 0.15) than Tallac Marsh (0.40 ± 0.11) or Truckee Marsh (0.42 ± 0.10). This difference was due, in part, to the large number of human commensalist and common species detected at Taylor Marsh (Fig. 2.1 and Appendix P-2). Among the focal nest-searching species, relative abundance was 60% higher at Tallac Marsh. Only two focal species (Yellow Warbler and Wilson's Warbler) were detected at Truckee Marsh (Fig. 2.2). Overall species richness was 21% higher at Truckee Marsh (n = 41) than at either Taylor Marsh (n = 34), or Tallac Marsh (n = 33). Although species richness was higher at Truckee Marsh, community composition was similar between all sites (Tallac Marsh and Taylor Marsh [r = 0.62, P < 0.001], Truckee Marsh and Taylor Marsh [r = 0.27, P = 0.05], Truckee Marsh and Tallac Marsh [r = 0.29, P = 0.03]). Nineteen species were common between all sites. Twenty percent of the avian community at Taylor Marsh was comprised of Red-winged Blackbirds followed by Common Mergansers (9 %), Mallards (8%), Brewer's Blackbirds (7%), Steller's Jays (7%), and Brown-headed Cowbirds (6%) (See Appendix P-2 for scientific names). The remaining species detected at Taylor Marsh made up less than 5% of the total observations. Tallac Marsh was primarily composed of Red-winged Blackbirds (24%), Brewer's Blackbirds (15%), American Robins (7%), Song Sparrows (7%), Brown-headed Cowbirds (5%), Warbling Vireos (5%), and Yellow Warblers (5%) (See Appendix N-2 for scientific names). Truckee Marsh was primarily composed of Red-winged Blackbirds (19%), Brewer's Blackbirds (10%), Yellow-headed Blackbirds (9%), Savannah Sparrows (8%), Song Sparrows (7%), and Cliff Swallows (7%) (See Appendix R-2 for scientific names).

Relative abundance of birds detected in the uplands surrounding Tallac and Taylor Marshes was similar (0.39 ± 0.08 and 0.36 ± 0.07, respectively). Community similarity also was positively correlated (r = 0.63, P < 0.001). The uplands surrounding

Tallac Marsh were primarily composed of Mountain Chickadees (16%), Brown-headed Cowbirds (11%), Dark-eyed Juncos (9%), Steller's Jays (9%), American Robins (7%), Brown Creepers (6%), Western Wood-Pewees (6%), and Brewer's Blackbirds (6%) (Appendix O-2). Mountain Chickadees (13%) dominated the uplands surrounding Taylor Marsh, followed by Steller's Jays (14%), Brown-headed Cowbirds (10%), Western Wood-Pewees (8%), Pygmy Nuthatches (5%), and American Robins (5%) (Appendix Q-2).

In the upper watershed of Taylor Creek and Tallac-Spring Creek, relative abundance of birds also was similar (0.20 ± 0.05 and 0.24 ± 0.06, respectively). The avian community at Taylor Creek was primarily comprised of Mountain Chickadees (22%), Steller's Jays (13%), Brown-Creepers (8%), Dark-eyed Juncos (6%), and Red-breasted nuthatches (5%) (Appendix T-2). Twenty percent of the avian community at Tallac-Spring Creek was comprised of Dark-eyed Juncos, followed by Mountain Chickadees (16%), Evening Grosbeaks (10%), Steller's Jays (7%), Brown Creepers (6%), Warbling Vireos (5%), and American Robins (5%) (Appendix S-2).

Species richness of birds detected using the mouth of Taylor (n = 13) and Tallac Creeks (n = 12) was similar (Table 2.3). Relative to other near shore areas (Meeks Creek [n = 14] and General Creek [n = 13]) throughout the Basin, there was no difference in species richness between sites (Table 2.3). Taylor Creek supported the most marsh and water-bird associated species (n = 10) and Meeks Creek (n = 5) supported the fewest (Table 2.3). Canada Geese (*Branta canadensis*) were the most abundant species detected at all four sites. Other species detected include Bald Eagle (*Haliaeetus leucocephalus*), Long-billed Curlew (*Numenius americanus*), Common Merganser (*Mergus merganser*), Forster's Tern (*Sterna forsteri*), Belted Kingfisher (*Ceryle alcyon*), and Mallard (*Anas platyrhynchos*) at Taylor Marsh. At Tallac Marsh, we detected Osprey (*Pandion haliaetus*), Common Merganser, Mallard, and Forster's Tern (Table 2.3).

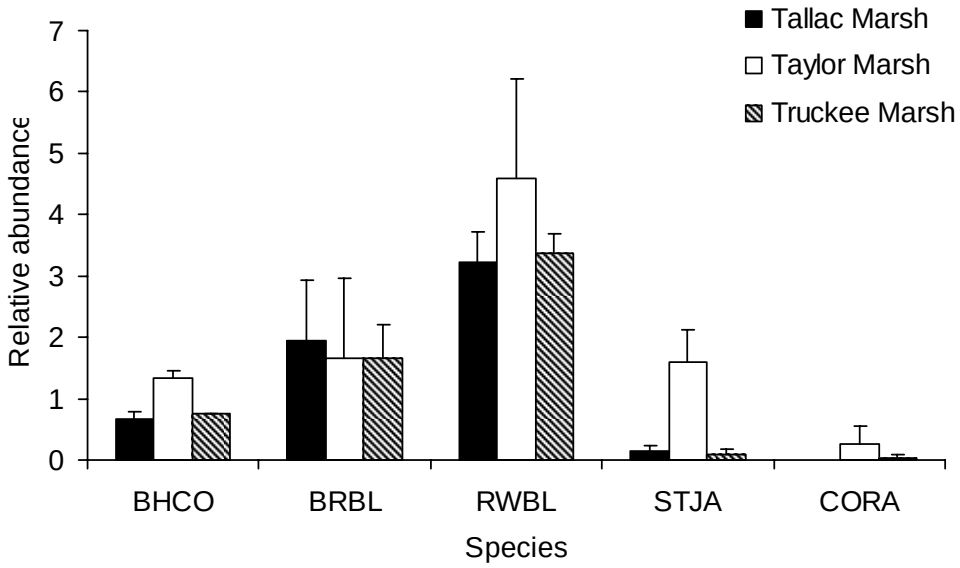

Fig. 2.1. Relative abundance (± SE) of species often associated with human habitations detected within 50 m of point count stations located along the major creek drainages at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004. BHCO = Brown-headed Cowbird, BRBL = Brewer's Blackbird, RWBL = Red-winged Blackbird, STJA = Steller's Jay, CORA = Common Raven.

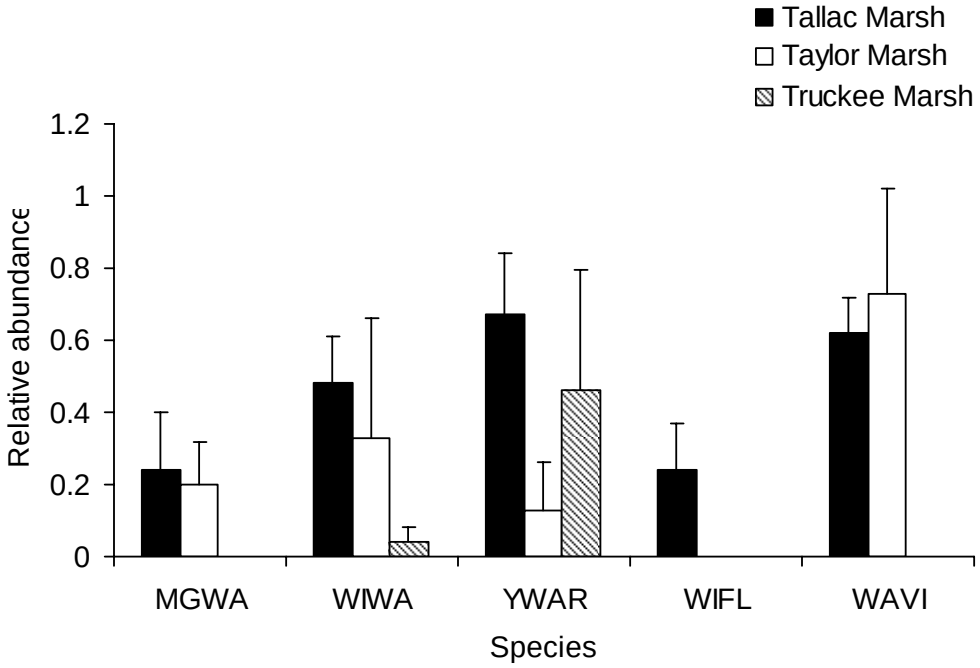

Fig. 2.2. Relative abundance (± SE) of focal-nesting species detected along the main creek channel at Tallac Marsh, Taylor Marsh, Truckee Marsh, Lake Tahoe Basin, California, 2004. MGWA = MacGillivray's Warbler, WIWA= Wilson's Warbler, YWAR = Yellow Warbler, WIFL = Willow Flycatcher, WAVI = Warbling Vireo.

Table 2.3. Average number (± SE) of individuals detected using the mouth of each creek, Lake Tahoe Basin, California, 2004. *Species not directly associated with the mouth of the creek.

Species	General Creek	Meeks Creek	Tallac Creek	Taylor Creek
Unknown Grebe	0	0.25 ± 0.25	0	0
Canada Goose	4.75 ± 4.42	17.50 ± 6.64	30.25 ± 15.09	77.5 ± 4.56
Mallard	0	1.25 ± 0.48	1.50 ± 0.50	1.00 ± 0.58
Gadwall	0.25 ± 0.25	0	0	0
Common Merganser	1.50 ± 0.65	3.50 ± 0.87	0.25 ± 0.25	10.25 ± 6.20
Osprey	0.25 ± 0.25	0	0.25 ± 0.25	0
Bald Eagle	0	0	0	0.75 ± 0.48
Killdeer	0.75 ± 0.75	0	1.00 ± 0.58	1.50 ± 0.87
Spotted Sandpiper	1.25 ± 0.95	0.50 ± 0.29	1.25 ± 0.75	2.00 ± 0.71
Long-billed Curlew	0	0	0	0.25 ± 0.25
Unknown Gull	0	0	0.50 ± 0.29	0.50± 0.50
Ring-billed Gull	0	0	0	2.25 ± 2.25
Forester's Tern	0	0	1.25 ± 0.75	8.50 ± 2.78
Mourning Dove	0	0.75 ± 0.75	0.25 ± 0.25	0
Belted Kingfisher	0	0	0	0.25 ± 0.25
Northern Flicker	0	0.25 ± 0.25*	0	0
Hairy Woodpecker	0	1.00 ± 0.58	0	0
White-headed Woodpecker	0	0.25 ± 0.25	0	0
Western Wood-Pewee	0	0.50 ± 0.29*	0	0
Steller's Jay	0.50 ±	2.00 ± 1.08	0	0

Common Raven	**0.50 0**	**0.25 ± 0.25***	**0**	**0**
Tree Swallow	**1.25 ± 0.63**	**2.00 ± 0.71**	**0**	**3.75 ± .85**
Violet-green Swallow	**0**	**0.50 ± 0.50***	**0**	**0**
Cliff Swallow	**0**	**0.50 ± 0.50**	**0.50 ± 0.50**	**0**
Barn Swallow	**2.00 ± 0.82**	**1.50 ± 0.50**	**0.50 ± 0.50**	**0**
Mountain Chickadee	**0**	**0.75 ± 0.75***	**0**	**0**
Pygmy Nuthatch	**0**	**0.75 ± 0.75***	**0**	**0**
American Robin	**0**	**0.75 ± 0.48***	**0**	**0**
European Starling	**0**	**0**	**0.50 ± 0.29***	**0**
Yellow Warbler	**0**	**0.25 ± 0.25***	**0**	**0**
Yellow-rumped Warbler	**0**	**0.50 ± 0.50***	**0**	**0**
MacGillivray's Warbler	**0.50 ± 0.50***	**0**	**0**	**0**
Western Tanager	**0.25 ± 0.25**	**0**	**0**	**0**
Green-tailed Towhee	**0.25 ± 0.25**	**0**	**0**	**0**
Dark-eyed Junco	**0**	**1.25 ± 0.75***	**0**	**0**
Brown-headed Cowbird	**0.75 ± 0.75**	**1.00 ± 0.58**	**0.50 ± 0.50**	**0**
Brewer's Blackbird	**0.25 ± 0.25**	**6.25 ± 1.55**	**4.25 ± 1.44***	**2.00 ± 0.91**
House Sparrow	**0**	**0.25 ± 0.25***	**0**	**0**

Nest searching and monitoring.—We monitored nests at Tallac Marsh (*n* = 23), Taylor Marsh, (*n* = 15), and Truckee Marsh (*n* = 4). Of these nests, approximately 18% more nests failed at Taylor and Tallac Marsh than at Truckee Marsh (Fig. 2.3). Among the focal species, nest failures were >60% for Warbling Vireos at both Tallac and Taylor Marsh (*n* = 11 and *n* = 6, respectively) (Table 2.4). Fifty percent of the Wilson's Warblers (*n* = 2) failed at Taylor Marsh and 50% of the Willow Flycatchers (*n* = 2) failed at Tallac Marsh (Table 2.4). Similarly, 50% of the Yellow Warbler (*n* = 2) nests failed at Truckee Marsh and Taylor Marsh, while only 33% failed at Tallac Marsh (*n* = 3) (Table 2.4). Parasitism by Brown-headed Cowbirds was 10% higher at Tallac Marsh (35%) than at Truckee Marsh (25%) and was 2% lower at Taylor Marsh (33%) than at Tallac Marsh (Fig. 2.3). Species-specific parasitism was ≥50% for MacGillivray's Warblers (*n* = 1) and Wilson's Warblers (*n* = 3) at Tallac Marsh, for Yellow Warblers (*n* = 4) at Taylor Marsh and for Yellow Warblers (*n* = 2) at Truckee Marsh. Mayfield estimates of daily mortality were not significantly different between Tallac, Taylor, and Truckee Marshes (Fig. 2.4).

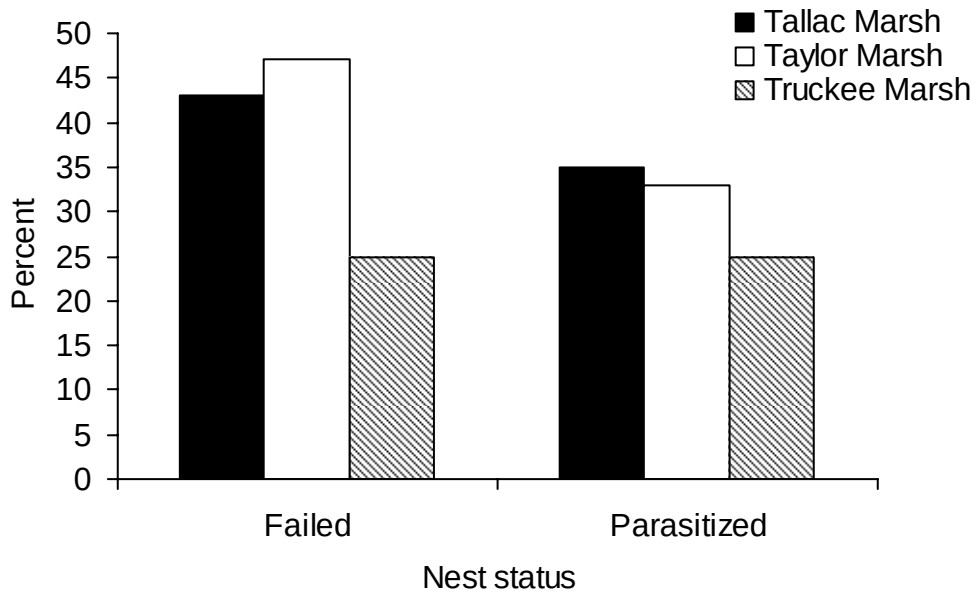

Fig. 2.3. Percentage of nest failed and percentage of nests parasitized by Brown-headed Cowbirds at Tallac Marsh (*n* = 23), Taylor Marsh (*n* = 15), and Truckee Marsh (*n* = 4), Lake Tahoe Basin, California, 2004.

Table 2.4. Percentage of failed and parasitized nests of focal-nesting species at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004. Number in parenthesis indicates sample size.

Nest status	Species	Tallac Marsh	Taylor Marsh	Truckee Marsh
Failed	**Willow Flycatcher**	**50 (2)**		
	Warbling Vireo	**64 (11)**	**67 (6)**	
	Yellow Warbler	**33 (3)**	**50 (4)**	**50 (2)**
	Wilson's Warbler		**50 (2)**	
Parasitized	**Warbling Vireo**	**27 (11)**	**17 (6)**	
	Yellow Warbler	**33 (3)**	**50 (4)**	**50 (2)**
	MacGillivray's Warbler	**100 (1)**		
	Wilson's Warbler	**67 (3)**	**50 (2)**	

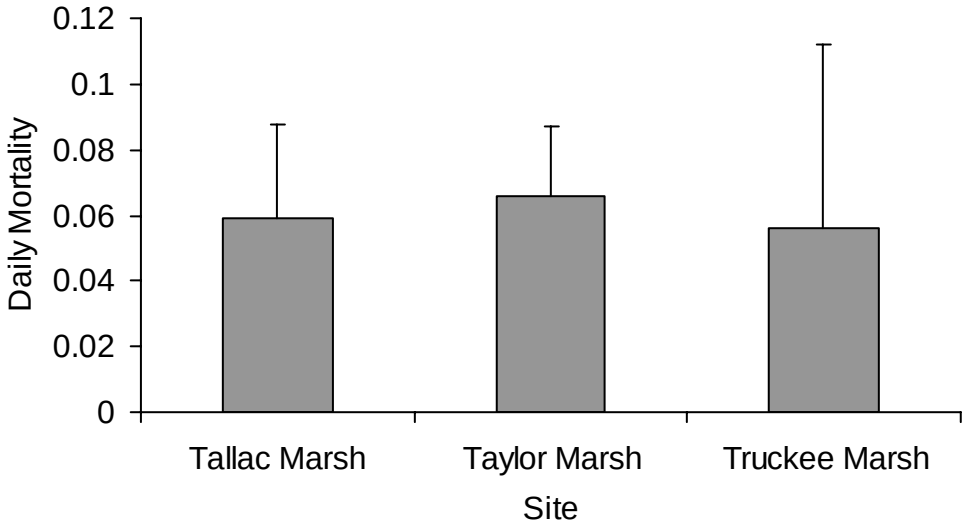

Fig. 2.4. Daily mortality (± SE) of nests at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004.

Mammals

Bats.—We detected nine species of bats across Taylor-Tallac-Truckee sampling locations (Table 2.5). We detected six species at Tallac Marsh and seven species at Taylor Marsh, while only four species were detected at Truckee Marsh. The predominate species detected across all sites were the hoary bat (*Lasiurus cinereus*) followed by the little brown bat (*Myotis lucifugus*) (Table 2.5). Big brown bats (*Eptesicus fuscus*) also were detected regularly at Taylor and Tallac Marshes. The most notable species detected

was the western red bat (*Lasiurus blossevillii*) at Tallac Marsh, a focal species of concern throughout the western United States.

Table 2.5. Frequency of occurrence of bat species recorded at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004.

Site	Tallac Marsh	Taylor Marsh	Truckee Marsh
Big brown bat (*Eptesicus fuscus*)	**11.4**	**12.5**	
Western red bat (*Lasiurus blossevillii*)	**12.3**		
Hoary bat (*Lasiurus cinereus*)	**37.7**	**70**	**80.8**
Silver-haired bat (*Lasionycteris noctivagans*)		**1.7**	
Long-eared myotis (*Myotis evotis*)	**0.9**		**4.2**
Little brown bat (*Myotis lucifigus*)	**19.1**	**7.5**	**12.5**
Fringed myotis (*Myotis thysanodes*)	**0.5**	**1.7**	
Yuma myotis (*Myotis yumanensis*)		**4.2**	
Mexican free-tailed bat (*Tadarida brasiliensis*)		**2.5**	**2.5**

Small mammals.—Species richness was similar among all sites, although 60% more individuals were detected at Tallac Marsh and 86% more individuals were detected at Taylor Marsh than at Truckee Marsh (Table 2.6). Similar species were captured at all sites with the exception of shadow chipmunks (*Tamias senex*), which were captured only at Tallac and Taylor Marshes, California ground squirrels (*Spermophilus beecheyi*), which were captured only at Truckee and Taylor Marsh, and short-tailed weasels (*Mustela erminea*), which were captured only at Tallac Marsh. The most abundant species captured at both Taylor and Tallac was the yellow-pine chipmunk (*Tamias amoenus*) (52% and 40% of total captures, respectively), while the montane vole (*Microtus montanus*) was most abundant at Truckee Marsh (51% of total captures) (Table 2.6). Relative abundance of Douglas squirrels was nearly nine times higher in the uplands at Taylor Marsh (1.13 ± 0.35) compared to the main marsh area at Taylor (0.13 ± 0.07). Relative abundance of Douglas squirrels also was higher (three times) in the uplands at Tallac Marsh (0.73 ± 0.29) than in the main marsh area at Tallac (0.24 ± 0.10). Douglas squirrels were 46% more abundant along Tallac-Spring Creek (0.73 ± 0.07) than along Taylor Creek (0.50 ± 0.14).

Table 2.6. Number of unique small mammal individuals captured at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California 2004.

Common name	Scientific name	Tallac Marsh	Taylor Marsh	Truckee Marsh

Vagrant shrew	*Sorex vagrans*	10	4	1
Deer mouse	*Peromyscus maniculatus*	37[a]	26[a]	1
Montane vole	*Microtus montanus*	20	6	25
Yellow-pine chipmunk	*Tamias amoenus*	58	47	21
Shadow chipmunk	*Tamias senex*	19	5	
California ground squirrel	*Spermophilus beecheyi*		3	1
Short-tailed weasel	*Mustela erminea*	2		

[a]Maximum number captured within one day over the three day period.

Medium to large mammals.—Mammals detected at track plate stations were similar to those detected during small mammal trapping sessions. One additional species (California ground squirrel) was detected at Tallac Marsh and two additional species (Canine species [*Canis* spp.] and golden-mantled ground squirrel [*Spermophilus lateralis*]) were detected at Truckee Marsh (Table 2.7). Other species incidentally detected include coyote (*Canis latrans*) at Truckee Marsh and Taylor Marsh, black bear (*Ursus americanus*) at Tallac Marsh and Taylor Marsh, muskrat (*Ondatra zibethicus*) at Tallac Marsh, and a porcupine (*Erithrozon dorsatum*) at Tallac Marsh.

Table 2.7. Mammal species detected at track plate stations at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004. X indicates species presence.

Common name	Scientific name	Tallac Marsh	Taylor Marsh	Truckee Marsh
Mouse spp.	*Peromyscus* spp.	X	X	X
Chipmunk spp.	*Tamias* spp.	X	X	X
California ground squirrel	*Spermophilus beecheyi*	X		X
Golden-mantled ground squirrel	*Spermophilus lateralis*			X
Douglas squirrel	*Tamiasciurus douglasii*	X	X	X
Canine spp.	*Canis* spp.			X
Weasel spp.	*Mustela* spp.	X		

DISCUSSION

Our data represent the first year of a multi-year study designed to monitor wildlife species before and after restoration activities. We will (1) discuss our major findings and relate them to other studies conducted in the Lake Tahoe Basin, (2) discuss major differences in species composition in relation to species representative of the desired ecological conditions developed for the Taylor/Tallac watershed, and (3) discuss management issues that may potentially influence wildlife species in the Taylor, Tallac, and Truckee watersheds. Management issues and potential restoration activities are summarized in Table 1.1.

Butterflies

We detected 19 butterfly species in 13 genera at Tallac Marsh, 19 species in 14 genera at Taylor Marsh, and 21 species in 16 genera at Truckee Marsh. Similarly, Manley and Schlesinger (2001) identified 15 genera of butterflies throughout the Basin. The common checkered skipper was the most abundant butterfly species detected at both Tallac and Taylor Marshes. Common checkered skippers generally inhabit open areas with at least some bare soil and feed on weedy host plants (Opler and Wright 1999). The orange sulphur was the most abundant butterfly detected at Truckee Marsh and prefers a wide variety of open sites including meadows, fields, road edges, and vacant lots (Opler and Wright 1999). Interestingly, one of the most common butterfly species detected by Manley and Schlesinger (2001) was the meadow fritillary (*Boloria bellona*), which is out of range for the Sierra Nevada and commonly inhabits Canada, the Rocky Mountains, and the upper Midwest (Opler and Wright 1999). Orange-tips (*Anthocharis* spp.) also were commonly detected by Manley and Schlesinger (2001); however, orange tips were rarely detected at our other study sites. We detected three species that either were stray or out of range for our area (Opler and Wright 1999). Monarchs, which are strays in the Sierra Nevada's (Opler and Wright 1999), were present at Taylor Marsh and Truckee Marsh. The gray hairstreak, a stray in the region, was detected at Taylor Marsh. We also detected a great copper (*Lycaena xanthoides*) at Truckee Marsh, which is slightly out of range for this species. The great copper commonly inhabits the foothills and lower elevations in California (Opler and Wright 1999).

Butterflies can be influenced by a variety of factors including habitat alteration, succession, fire (or lack of fire), and land use changes. For example, successional vegetation changes that result in reduced host plant abundance can negatively affect northern blue butterflies (Opler and Wright 1999). Plant diversity also may influence butterfly species, although the relationship is unclear. Some argued that plant species richness is correlated with butterfly abundance and diversity (Ehrlich and Raven 1964, Kremen 1992), whereas others argued that plant diversity is not a good predictor of butterfly diversity (Hawkins and Porter 2003). Lack of fire also can influence butterfly communities. In recently burned riparian areas in Yosemite National Park, butterfly diversity increased twofold relative to unburned control plots (Huntzinger 2003). Several studies have shown that land use changes such as urbanization can decrease butterfly abundance and diversity, shifting the species composition from single-brooded specialized species to vagile multi-brooded species that are capable of feeding on weedy plants (Ruszczyk and DeAraujo 1992, Blair and Launer 1997).

Few butterfly studies have been conducted in the Lake Tahoe Basin and those that have resulted in incongruent detections, likely the result of misidentification, sampling intensity, and/or temporal variation in sampling. Therefore, we know little about historic butterfly abundance and diversity. Data collected from this and subsequent years will assist in determining desired conditions for restoration projects within the Basin. Preliminary desired conditions will focus on single-brooded species that prefer meadows and stream sides (Table 2.1). Because butterfly species have temporal flights, we suggest expanding the sampling period and reducing the sampling intensity to twice a month.

Herpetofauna

We detected five species (including incidental observations) within the Taylor, Tallac, and Truckee watersheds; however, the majority of detections were of the pacific

treefrog (*Hyla regilla*) and the non-native bullfrog (*Rana catesbeiana*). 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 at our study sites: Ensatina (*Ensatina eschscholtzii platensis*), California newt (*Taricha torosa*), southern alligator lizard (*Elgaria multicarinata*), California mountain kingsnake (*Lampropeltis zonata*), and gopher snake (*Pituophis catenifer*).

Few other species were detected due, in part, to species-specific detectability. For example, snakes are often cryptic and other reptiles and amphibians are nocturnal or crepuscular. We suggest that survey methods and restoration objections be re-evaluated based on time and detectability. A complete survey of the herpetofauna requires pit fall traps, cover board layouts, night acoustic surveys, and visual encounter surveys. However, the time required to complete such a survey is currently unfeasible.

A variety of factors including the presence of bullfrogs, non-native fishes, and aquatic habitat modification and loss can impact the aquatic habitat in the Tallac, Taylor, and Truckee watersheds. Bullfrogs are non-native west of the Rockies (Stebbins 1985) and their presence in western landscapes has been implicated in the decline of ranid frogs (Moyle 1973, Bury and Luckenbach 1976, Kiesecker et al. 2001). For example, bullfrog larvae reduced pacific treefrog metamorph size by 16%, although no significant effect on survivorship was detected (Kupferberg 1997). Although bullfrogs may contribute to the decline of native frog species, other concurrent factors such as habitat modification and exotic fishes also may affect native frog species (Hayes and Jennings 1986, Adams 1999). Non-native fishes (e.g., rainbow trout), for example, are negatively affecting populations of mountain yellow-legged frogs (*Rana muscosa*) in the Sierra Nevada's (Knapp and Matthews 2000).

Based on historic data and current survey results (Schlesinger and Romsos 2000), the desired herpetofauna includes increasing the abundance of western toads (*Bufo boreas*), western aquatic garter snakes, western terrestrial garter snakes, common garter snakes, and gilbert skinks (*Eumeces gilberti*), monitoring populations of pacific treefrogs, and decreasing the abundance of bullfrogs. Retention of ephemeral wetland habitat may prove beneficial to native amphibians because bullfrogs and non-native fishes are more often associated with permanent open-water bodies (Adams 1999). Eradication of bullfrogs may also prove beneficial. All of the species listed above (except gilbert skink) 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.

Avifauna

Owls.—Surveys in 2004 resulted in minimal owl detections, in part, due to survey restrictions requested by the US Forest Service. Surveys were conducted during the post-

breeding season when owls are unlikely to respond to conspecific calls. We suggest that surveys be conducted during the breeding season to increase detectability. To comply with research conducted by the USFS we will eliminate the California Spotted Owl call from the call-playback series when conducting surveys in subsequent years.

According to historic data (Orr and Moffitt 1971, Keane and Morrison 1994), Great-horned Owls, Northern Pygmy Owls, Western Screech Owls, and Spotted Owls should be present in the Basin; however, we are unable to assess presence of owl species because we feel that surveys inadequately sampled owl species.

Avian point counts.—We detected a total of 49 species at Tallac Marsh, 50 species at Taylor Marsh, and 62 species at Truckee Marsh (includes incidental observations and half-hour observations). Surveys conducted from 1999 to 2003 by the Tahoe Regional Planning Agency (TRPA) and the US Forest Service within the same area, recorded more species at both Tallac Marsh and Taylor Marsh (n = 60) and fewer species at Truckee marsh (n = 55) (TRPA, unpublished data). However, the species detected in 2004 differed from those detected in earlier surveys. Seventeen species were detected at Tallac Marsh and Taylor Marsh between 1999 and 2003 that were not detected in 2004 and 21 species were detected at Truckee Marsh between 1999 and 2003 that were not detected in 2004. Several of these species were rarely occurring marsh and water dependent birds such as the American Avocet (*Recurvirostra americana*), American Coot (*Fulica americana*), Snowy Egret (*Egretta thula*), Cinnamon Teal (*Anas cyanoptera*), and Pied-billed Grebe (*Podilymbus podiceps*). We detected four species in 2004 that were not detected in previous surveys including House Wren (*Troglodytes aedon*) and Northern Pintail (*Anas acuta*) at Tallac Marsh and MacGillivray's Warbler and Wilson's Warbler at Taylor Marsh.

Relative abundance of birds differed between sites; 1.6 times more individuals were detected at Taylor Marsh relative to Tallac Marsh and Truckee Marsh. This is due, in part, to the large numbers of common species (e.g., Steller's Jay, Common Raven, and Brown-headed Cowbird) that were detected at Taylor Marsh (Fig. 2.1). Many of these species have a positive association with fragmentation and human disturbances (Whitcomb et al. 1981, Yahner and Scott 1988, Andren 1992, Marzluff et al. 2004). Relative abundance of Brown-headed Cowbirds, Common Ravens, and Steller's Jays also increased at Taylor Marsh compared to TRPA surveys conducted from 1999 to 2003. Compared to other locations in the Basin, relative abundance of Steller's Jays, Common Ravens, and Brown-headed Cowbirds was highest at Taylor Marsh, which may account for relatively high nest failures and parasitism at Taylor Marsh.

Compared to TRPA surveys, relative abundance of Wilson's Warblers, MacGillivray's Warblers, and Willow Flycatchers increased at Tallac Marsh, while Warbling Vireos decreased. Relative abundance of Wilson's Warblers and MacGillivray's Warblers also increased at Taylor Marsh compared to previous surveys (TRPA, unpublished data). Although it appears that species increased in abundance, the data may not be directly comparable due to differences in the sampling area and intensity of surveys. Other studies throughout California indicate declining trends for MacGillivray's Warbler, Wilson's Warbler, Warbling Vireo, and Yellow Warbler over the past 20 years (Sauer et al. 2004). In addition, recent evidence suggests that Warbling Vireo populations are experiencing a significant decline, although the mechanisms are not currently understood (Gardali et al. 2000, Gardali and Jaramillo 2001, Ballard et al.

2003). Because this is the first year of data collection, it is difficult to determine population trends.

Overall community composition in the Tallac Watershed (including Tallac-Spring Creek and the uplands surrounding Tallac Marsh), Taylor Watershed (including Taylor Creek and the uplands surrounding Taylor Marsh), and Truckee Marsh were composed of relatively common species within the Basin including American Robins, Dark-eyed Juncos, Mountain Chickadees, Brown-headed Cowbirds, and blackbirds. Few individuals associated with wet meadows (e.g., Willow Flycatcher) or riparian vegetation (e.g., Wilson's Warbler) were detected at any of the sites. Based on historic data (Orr and Moffitt 1971, TRPA, unpublished data), restoration efforts should seek to improve habitat conditions for marsh and water associated birds as well as birds associated with riparian vegetation (Appendix U-2).

The near shore area provides important habitat for waterfowl, wading birds, and raptors; however, much of the near shore area is heavily impacted by human recreation. Although Taylor Creek supported the most water bird species relative to other sites, only 10 species were observed and seven of these species made up less than 5% of the total abundance. We recommend continued monitoring of the creek mouths especially since this area is a focal restoration area.

Several factors can influence avian populations including forest fragmentation, land use changes, and loss of habitat (Andren 1994, Faaborg et al. 1995, Friesen et al. 1995, McGarigal and McComb 1995, Flather and Sauer 1996, Trzcinski et al. 1999). Recent impacts within the Taylor-Tallac Watershed include increased residential development, increased human disturbance, and loss of marsh habitat (e.g., Rowlands Marsh) (Lindstrom et al. 2000). Habitat loss and conversion is especially problematic for species with large home ranges or those that rely on specific habitat types. For instance, the loss of willows can decrease the abundance of Yellow Warblers and Willow Flycatchers (Taylor and Littlefield 1986, Sedgwick 2000). Changes in land use such as urban or residential development can also affect avian populations. Abundance and diversity of Neotropical migrants in Ontario, Canada decreased as the number of residential developments increased irrespective of patch size (Friesen et al. 1995). Increased human activity also can cause nest abandonment or failure in birds. In Colorado, Wilson's Warblers deserted nests more often in heavily used recreation areas relative to unused areas (Ammon 1995).

Nest searching and monitoring.—Nest failures were 18% greater at Taylor and Tallac Marshes than the reference site, Truckee Marsh and nest failures at Taylor and Tallac Marshes exceeded 40%. High levels of nest predation at Taylor Marsh and Tallac Marsh may be due, in part, to elevated numbers of avian and mammalian predators at these sites (Fig. 2.1 and Table 2.6). Relative to nest failures throughout the Basin, nest failure at the majority (75%) of the sites monitored throughout the Basin was ≥35%, which may be too high to maintain populations of some species. For example, nest failure of a population of Warbling Vireos in coastal California was 79%, which may be too high to prevent population declines (Gardali et al. 2000). Additional monitoring is required to determine if predation levels are resulting in unstable populations in the Basin.

Overall parasitism by Brown-headed Cowbirds was ≥25% for all sites. Only two other sites in the Basin (General Creek and Big Meadow) had parasitism levels ≥ those

observed at Taylor, Tallac, and Truckee Marshes. High levels of parasitism could be the result of increased human habitation, habitat alteration, or the nearby pack station. In fact, several studies have shown that Brown-headed Cowbird populations increase with increasing proximity to human habitation and pack animals (Rothstein et al. 1980, Robinson et al. 1995, Tewksbury et al. 1998, Chace et al. 2003, Morrison and Hahn 2002).

Brown-headed Cowbirds lay their eggs in the nests of other species, resulting in brood parasitism. Brood parasitism reduces host breeding productivity because (1) Brown-headed cowbirds often remove host eggs and (2) cowbird young typically hatch before and develop faster than host young, which often leads to increased provisioning by adult hosts at the expense of the host young (Robinson et al. 1995). 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). For example, Wilson's Warblers in parts of coastal California are suffering from high levels (33%) of parasitism and predation (73%) which, without immigration could result in local extirpation (Michaud et al. 2004). Thus, parasitism levels observed for MacGillivray's Warblers, Wilson's Warblers, and Yellow Warblers maybe cause for concern. However, because our sample sizes are small, it is unclear how severe Brown-headed Cowbird parasitism is at these sites and whether cowbirds are negatively affecting populations. Cowbird control can successfully reduce parasitism (reviewed in Robinson et al. 1995) and may be a viable restoration option, however additional years of pre-restoration data are need to determine if parasitism continues to be problematic.

Mammals

Bats.—The number of species detected meets or exceeds the number of bat species previously located in the Basin. This is likely the result of our intensive use of acoustic sampling, which detects more species than mist-netting. Our results were similar to those obtained by the ongoing multi-species inventory and monitoring project (P. Manley, unpublished data) in that most sites were predominated by 2-3 species with varying numbers of relatively rare species also occurring. In particular, our detection of the western red bat at Tallac Marsh is significant because of the widespread concern over the status of this species. Red bats roost in the foliage of deciduous trees such as cottonwoods. The high species richness and frequency of occurrence on the recording tapes of bats indicates that there must be numerous roosting and maternity sites throughout our project area. Three other species that are considered federal species of concern (Manley et al. 2000) also were detected, long-eared myotis (*Myotis evotis*) at Tallac and Truckee Marshes, fringed myotis (*Myotis thysanodes*) at Tallac Marsh and Taylor Marsh, and the Yuma myotis (*Myotis yumanensis*) at Taylor Marsh. Different bat species use different substrates for roosting and breeding, including tree cavities, caves and mines, rock crevices, and tree bark and foliage. We recommend that more intensive studies be initiated to locate and quantify roosting and maternity sites, including the use of telemetry.

Small mammals.—The most abundant species captured in our study area included the deer mouse (22% of the total captures), yellow-pine chipmunk (44% of the total captures), and montane vole (18% of total captures). Similarly, deer mice and yellow-

pine chipmunks made up 56% of the total abundance of small mammals captured by Manley and Schlesinger (2001). Based on historic data (Orr 1949, Keane and Morrison 1994, Manley and Schlesinger 2001), five small mammal species that should be present at these sites were not detected during surveys. These include long-tailed weasel (*Mustela frenata*), bushy-tailed woodrat (*Neotoma cinerea*), belding's ground squirrel (*Spermophilus beldingi*), western jumping mouse (*Zapus princes*), and broad-footed mole (*Scapanus latimanus*). Restoration efforts should seek to increase habitat conditions for the aforementioned species. Based on habitat preferences, restoration should improve moist soils and meadow condition for broad-footed moles, western jumping mice, and Belding's ground squirrels, improve riparian vegetation for long-tailed weasels, and improve old-growth conditions for bushy-tailed woodrats. Continued monitoring of other small mammal species is necessary to determine population status more accurately and to re-assess desired conditions for restoration.

Factors such as *in situ* disturbances and environmental conditions may influence small mammal populations. For example, environmental variables such as vegetation type (e.g., meadow), precipitation, and downed woody debris may influence small mammal populations (Manley and Schlesinger 2001). In Lake Tahoe, mammalian species richness was positively associated with aspen-cottonwood, lodgepole pine, and elevation (Manley and Schlesinger 2001). Site disturbances also may affect populations. For example, in the northern Sierra Nevada's (Nevada County, California), yellow-pine chipmunks and lodgepole chipmunks were detected more often in open and disturbed stands relative to closed stands (Sharples 1983). Higher numbers of yellow-pine chipmunks were captured at Tallac and Taylor Marshes relative to shadow chipmunks, which may indicate site disturbance. Few chipmunks were captured at Truckee Marsh, in part, because willows, grasses, and sedges predominate in Truckee Marsh, while Taylor and Tallac contained more structurally diverse vegetation. Additional data on forest structure and abundance of small mammals is needed to determine how forest structure or disturbances influence small mammal populations.

Medium to large mammals.—Numbers of individuals and species typically cannot be distinguished based on tracks alone. Although track plate stations provided minimal data, track plate stations allowed us to record or more complete species list. We suggest continued use of track plate stations in subsequent years.

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Appendix A-2. Location of butterfly survey areas at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004.

Site	Location[a]
Tallac Marsh	C01 – C02
	C03 – C04
	C06 – C07
	L01 – L02
	U01 – U02
	U03 – U04
Taylor Marsh	C01 – C02
	C03 – C04
	L01 – L02
	L03 – L04
	U01 – U02
Truckee Marsh	C02 – C03
	C03 – C04
	C05 – C06
	C07 – C08

[a]Butterfly surveys conducted between avian point count stations. See appendix B-2 for Universal Transverse Mercator coordinates.

Appendix B-2. Universal Transverse Mercator (UTM) coordinates (NAD 27, Zone 10S) of avian point count stations at Tallac Marsh, Tallac-Spring Creek, Taylor Marsh, Taylor Creek, and Truckee Marsh, Lake Tahoe Basin, California.

Site	Point	Northing	Easting
Tallac Marsh	C01	4313411	753400
	C02	4313465	753594
	C03	4313636	753700
	C04	4313796	753820
	C06	4314183	753870
	C07	4314364	753968
	L01	4314127	754062
	L02	4314084	754257
	U01	4313609	754404
	U02	4313660	754209
	U03	4313704	754014
	U04	4313506	753985
Tallac-Spring Creek	C01	4312931	753178
	C02	4312704	753307
	C03	4312447	753378
	C04	4312204	753419
	C05	4311974	753342
	C06	4311726	753361
	C07	4311522	753416
	C08	4312055	753139
	C09	4311792	753118
	C10	4311550	753031
Taylor Marsh	C01	4313384	755316
	C02	4313578	755330
	C03	4313782	755320
	C04	4313967	755225
	L01	4313794	755041
	L02	4313805	754830
	L03	4313834	754629
	L04	4313876	754440
	U01	4313577	754600
	U02	4313555	754797
	U03	4313512	754988
Taylor Creek	C01	4313121	755245
	C02	4312974	755381
	C03	4312757	755397
	C04	4312562	755337
	C05	4312370	755214
	C06	4312137	755161

Appendix B-2 cont.

	C07	4312038	754962
	C08	4311925	754774
Truckee Marsh	C01	4313342	761348
	C02	4313463	761211
	C03	4313463	761012
	C04	4313460	760766
	C05	4313624	760646
	C06	4313809	760525
	C07	4313916	760326
	C08	4314086	760182

Appendix C-2. Incidental observations of bird species at Tallac Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name
Great Blue Heron	*Ardea herodias*
Dusky Flycatcher	*Empidonax oberholseri*
Cassin's Vireo	*Vireo cassinii*
Townsend's Solitaire	*Myadestes townsendi*
Cedar Waxwing	*Bombycilla cedrorum*
Evening Grosbeak	*Coccothraustes vespertinus*

Appendix D2. Incidental observations of bird species at Taylor Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name
Black-crowned Night-Heron	*Nycticorax nycticorax*
Osprey	*Pandion haliaetus*
Virginia Rail	*Rallus limicola*
White-headed Woodpecker	*Picoides albolarvatus*
Cedar Waxwing	*Bombycilla cedrorum*
Hooded Warbler	*Wilsonia citrina*
Lazuli Bunting	*Passerina amoena*
Savannah Sparrow	*Passerculus sandwichensis*
Evening Grosbeak	*Coccothraustes vespertinus*

Appendix E-2. Incidental observations of bird species at Truckee Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name
American Bittern	*Botaurus lentiginosus*
Canada Goose	*Branta canadensis*
Northern Harrier	*Circus cyaneus*
White-tailed Kite	*Elanus leucurus*
Osprey	*Pandion haliaetus*
Forster's Tern	*Sterna forsteri*
Rock Pigeon	*Columba livia*
Common Nighthawk	*Chordeiles minor*
Western Kingbird	*Tyrannus verticalis*
Brown Creeper	*Certhia americana*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Evening Grosbeak	*Coccothraustes vespertinus*
House Finch	*Carpodacus mexicanus*

Appendix F-2. Incidental observations of bird species at Tallac-Spring Creek, Lake Tahoe Basin, California, 2004.

Common name	Scientific name
Canada Goose	*Branta canadensis*
Red-tailed Hawk	*Buteo jamaicensis*
Mountain Quail	*Oreotyx pictus*
Red-breasted Sapsucker	*Sphyrapicus ruber*
Northern Flicker	*Colaptes auratus*
Western Wood-Pewee	*Contopus sordidulus*
Common Raven	*Corvus corax*
Hermit Thrush	*Catharus guttatus*
Pine Siskin	*Carduelis pinus*

Appendix G-2. Incidental observations of bird species at Taylor Creek, Lake Tahoe Basin, California, 2004.

Common name	Scientific name
Northern Flicker	*Colaptes auratus*
Clark's Nutcracker	*Nucifraga columbiana*
White-breasted Nuthatch	*Sitta carolinensis*
Golden-crowned Kinglet	*Regulus satrapa*
Fox Sparrow	*Passerella iliaca*
Black-headed Grosbeak	*Pheucticus melanocephalus*

Appendix H-2. Location of Pettersson ultrasonic bat detectors at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004.

Site	Visit number	Northing	Easting	Zone[a]
Tallac Marsh	1	4313876	754245	10 S
	1	4313955	753939	10 S
	2	4313480	753615	10 S
	2	4313629	753680	10 S
	3	4314452	753981	10 S
	3	4314211	753906	10 S
Taylor Marsh	1	4313801	755301	10 S
	1	4313563	755308	10 S
	2	4313626	755132	10 S
	2	4313778	755095	10 S
	3	4313356	755356	10 S
	3	4313836	754621	10 S
Truckee Marsh	1	4313423	241118	11 S
	1	4313412	240664	11 S
	2	4314075	240128	11 S
	2	4313908	240257	11 S
	3	4313382	240878	11 S
	3	4313406	241018	11 S

[a]North American Datum 27.

Appendix I-2. Location of small mammal trap lines and number of traps at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004.

Site	Number of traps set[a]	Location[b]
Tallac Marsh	10 L, 5 XL	C01 – C02
	10 L, 5 XL	C03 – C04
	10 L, 5 XL	C06 – C07
	10 L, 5 XL	L01 – L02
	10 L, 5 XL	U01 – U02
	10 L, 5 XL	U03 – U04
Taylor Marsh	10 L, 5 XL	C01 – C02
	10 L, 5 XL	C03 – C04
	10 L, 5 XL	L01 – L02
	10 L, 5 XL	L03 – L04
	10 L, 5 XL	U01 – U02
Truckee Marsh	8 L, 4 XL	C02 – C03
	8 L, 4 XL	C03 – C04
	8 L, 4 XL	C05 – C06
	8 L, 4 XL	C07 – C08

[a]Number of Large (L) and Extra Large (XL) Live Sherman Traps set
[b]Traps placed between avian point count stations. See Appendix B-2 for UTM coordinates.

Appendix J-2. Average number (± SE) of butterfly species detected at Tallac Marsh, Lake Tahoe, Basin, California, 2004. Nomenclature based on Opler and Wright (1999).

Common name	Scientific name	Average number ± SE
Western Tiger Swallowtail	*Papilio rutulus*	2.25 ± 0.48
Pale Swallowtail	*Papilio eurymedon*	1.25 ± 0.75
Unknown White	Subfamily Pierinae	0.50 ± 0.29
Unknown Sulphur	Subfamily Coliadinae	1.25 ± 0.75
Orange Sulphur	*Colias eurytheme*	11.50 ± 4.01
Unknown Copper	*Lycaena* spp.	0.25 ± 0.25
Edith's Copper	*Lycaena editha*	0.25 ± 0.25
Purplish Copper	*Lycaena helloides*	0.50 ± 0.29
Lilac Bordered Copper	*Lycaena nivalis*	1.00 ± 1.00
Gray Hairstreak	*Strymon melinus*	0.25 ± 0.25
Unknown Blue	Subfamily Polyommatinae	4.25 ± 1.60
Spring Azure	*Celastrina ladon*	0.25 ± 0.25
Greenish Blue	*Plebeius saepiolus*	10.50 ± 5.01
Lupine Blue	*Plebeius lupine*	0.25 ± 0.25
Unknown Fritillary	Subfamily Heliconiinae	0.25 ± 0.25
Northern Checkerspot	*Chlosyne palla*	0.50 ± 0.50
Unknown Crescent	*Phyciodes* spp.	0.75 ± 0.48
Field Crescent	*Phyciodes pratensis*	0.25 ± 0.25
California Crescent	*Phyciodes orseis*	5.00 ± 1.96
Mylitta Crescent	*Phyciodes mylitta*	0.50 ± 0.50
American Lady	*Vanessa virginiensis*	0.25 ± 0.25
Monarch	*Sanaus plexippus*	0.25 ± 0.25
Unknown Skipper	Subfamily Hesperiinae	7.00 ± 3.67
Common Checkered Skipper	*Pyrgus communis*	13.25 ± 1.93
Western Branded Skipper	*Hesperia Colorado*	6.00 ± 5.02
Sonora Skipper	*Polites sonora*	9.75 ± 4.52

Appendix K-2. Average number (± SE) of butterfly species detected at Taylor Marsh, Lake Tahoe Basin, California, 2004. Nomenclature based on Opler and Wright (1999).

Common name	Scientific name	Average number ± SE
Unknown Swallowtail	*Papilio* spp.	0.25 ± 0.25
Western Tiger Swallowtail	*Papilio rutulus*	1.50 ± 0.96
Pale Swallowtail	*Papilio eurymedon*	1.00 ± 1.00
Unknown White	Subfamily Pierinae	0.50 ± 0.50
Cabbage White	*Pieris rapae*	0.50 ± 0.29
Unknown Sulphur	Subfamily Coliadinae	0.50 ± 0.29
Orange Sulphur	*Colias eurytheme*	4.75 ± 1.44
Edith's Copper	*Lycaena editha*	0.50 ± 0.50
Lilac Bordered Copper	*Lycaena nivalis*	0.25 ± 0.25
Behr's Hairstreak	*Satyrium behrii*	3.25 ± 1.11
Unknown Blue	Subfamily Polyommatinae	4.25 ± 2.17
Greenish Blue	*Plebeius saepiolus*	2.50 ± 1.04
Boisduval's Blue	*Plebeius icarioides*	0.75 ± 0.75
Unknown Fritillary	Subfamily Heliconiinae	0.25 ± 0.25
Gray Comma	*Polygonia progne*	0.25 ± 0.25
Northern Checkerspot	*Chlosyne palla*	0.25 ± 0.25
Unknown Crescent	*Phyciodes* spp.	0.50 ± 0.50
Field Crescent	*Phyciodes pratensis*	0.50 ± 0.29
California Crescent	*Phyciodes orseis*	4.75 ± 1.93
Mylitta Crescent	*Phyciodes mylitta*	0.75 ± 0.48
Mourning Cloak	*Nymphalis antiopa*	1.75 ± 1.18
Lady spp.	*Vanessa* spp.	0.25 ± 0.25
Unknown Admiral	Subfamily Limenitidinae	0.25 ± 0.25
Lorquin's Admiral	*Limenitis lorquini*	0.75 ± 0.48
Unknown Skipper	Subfamily Hesperiinae	4.75 ± 1.89
Common Checkered Skipper	*Pyrgus communis*	13.50 ± 4.99
Western Branded Skipper	*Hesperia colorado*	2.00 ± 1.08
Sonora Skipper	*Polites sonora*	10.00 ± 3.87

Appendix L-2. Average number (± SE) of butterfly species detected at Truckee Marsh, Lake Tahoe, Basin, California, 2004. Nomenclature based on Opler and Wright (1999).

Common name	Scientific name	Average number ± SE
Western Tiger Swallowtail	*Papilio rutulus*	0.25 ± 0.25
Unknown White	Subfamily Pierinae	2.00 ± 0.71
Western White	*Pontia occidentalis*	2.25 ± 1.65
Cabbage White	*Pieris rapae*	1.25 ± 0.95
Unknown Sulphur	Subfamily Coliadinae	2.25 ± 0.25
Orange Sulphur	*Colias eurytheme*	8.75 ± 1.93
Unknown Copper	*Lycaena* spp.	0.50 ± 0.50
Great Copper	*Lycaena xanthoides*	0.50 ± 0.50
Edith's Copper	*Lycaena editha*	2.00 ± 1.22
Purplish Copper	*Lycaena helloides*	2.00 ± 1.22
Lilac Bordered Copper	*Lycaena nivalis*	0.25 ± 0.25
Unknown Blue	Subfamily Polyommatinae	2.00 ± 1.08
Arrowhead Blue	*Glaucopsyche piasus*	1.75 ± 1.75
Greenish Blue	*Plebeius saepiolus*	0.50 ± 0.29
Boisduval's Blue	*Plebeius icarioides*	0.75 ± 0.75
Unknown Fritillary	Subfamily Heliconiinae	3.75 ± 1.31
Hydapse Fritillary	*Speyeria hydaspe*	0.75 ± 0.75
Unknown Crescent	*Phyciodes* spp.	0.25 ± 0.25
California Crescent	*Phyciodes orseis*	0.50 ± 0.29
Mylitta Crescent	*Phyciodes mylitta*	0.25 ± 0.25
Mourning Cloak	*Nymphalis antiopa*	1.00 ± 0.58
Lady spp.	*Vanessa* spp.	0.25 ± 0.25
Lorquin's Admiral	*Limenitis lorquini*	1.00 ± 0.41
California Sister	*Adelpha bredowii*	0.25 ± 0.25
Monarch	*Sanaus plexippus*	0.25 ± 0.25
Unknown Skipper	Subfamily Hesperiinae	2.00 ± 1.35
Common Checkered Skipper	*Pyrgus communis*	0.75 ± 0.48
Western Branded Skipper	*Hesperia colorado*	0.50 ± 0.29
Sonora Skipper	*Polites sonora*	6.75 ± 4.31

Appendix M-2. Average number (± SE) of butterflies detected within specified vegetation categories at Tallac Marsh, Taylor Marsh, and Truckee Marsh, Lake Tahoe Basin, California, 2004.

Vegetation category	Tallac Marsh	Taylor Marsh	Truckee Marsh
Alder		**0.25 ± 0.25**	
Alder & dry meadow	**2.25 ± 2.25**		
Alder & wet meadow	**1.25 ± 1.25**		
Alder & willow	**2.50 ± 1.44**	**0.50 ± 0.50**	
Conifer	**0.50 ± 0.50**	**1.50 ± 0.96**	
Conifer & dry meadow		**2.25 ± 2.25**	
Conifer & willow		**0.25 ± 0.25**	
Dry meadow	**42.75 ± 9.93**	**50.50 ± 9.82**	**42.75 ± 9.94**
Grass	**0.50 ± 0.50**		
Quaking aspen	**1.75 ± 0.85**	**0.25 ± 0.25**	
Quaking aspen & alder & dry meadow		**0.25 ± 0.25**	
Quaking aspen & alder & wet meadow	**0.25 ± 0.25**		
Quaking aspen & dry meadow	**0.25 ± 0.25**		
Quaking aspen & wet meadow	**0.50 ± 0.50**		
Wet meadow	**2.50 ± 1.66**	**6.00 ± 6.00**	
Willow		**0.25 ± 0.25**	
Willow & dry meadow	**3.25 ± 1.89**	**0.50 ± 0.50**	**3.25 ± 1.89**
Willow & wet meadow	**2.50 ±**		

1.50

Appendix N-2. Relative abundance (± SE) and percent composition of bird species detected within 50 m of point count stations at Tallac Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Relative abundance ± SE	% composition
Canada Goose	*Branta canadensis*	0.24 ± 0.24	2
Mallard	*Anas platyrhynchos*	0.29 ± 0.16	2
Northern Pintail	*Anas acuta*	0.05 ± 0.05	<1
Common Merganser	*Mergus merganser*	0.05 ± 0.05	<1
Copper's Hawk	*Accipiter cooperi*	0.05 ± 0.05	<1
Turkey Vulture	*Cathartes aura*	0.05 ± 0.05	<1
Killdeer	*Charadrius vociferous*	0.05 ± 0.05	<1
Spotted Sandpiper	*Actitis macularia*	0.10 ± 0.05	1
Wilson's Snipe	*Gallinago delicata*	0.24 ± 0.10	2
Belted Kingfisher	*Ceryle alcyon*	0.05 ± 0.05	<1
Northern Flicker	*Colaptes auratus*	0.05 ± 0.05	<1
Western Wood-Pewee	*Contopus sordidulus*	0.19 ± 0.05	1
Willow Flycatcher	*Empidonax traillii*	0.24 ± 0.13	2
Warbling Vireo	*Vireo gilvus*	0.62 ± 0.10	5
Steller's Jay	*Cyanocitta stelleri*	0.14 ± 0.08	1
Tree Swallow	*Tachycineta bicolor*	0.33 ± 0.27	3
Mountain Chickadee	*Poecile gambeli*	0.38 ± 0.10	3
Brown Creeper	*Certhia americana*	0.14 ± 0.14	1
House Wren	*Troglodytes aedon*	0.24 ± 0.05	2
American Robin	*Turdus migratorius*	0.86 ± 0.22	7
Orange-crowned Warbler	*Vermivora celata*	0.10 ± 0.10	1
Yellow-rumped Warbler	*Dendroica coronata*	0.10 ± 0.10	1
Yellow Warbler	*Dendroica petechia*	0.67 ± 0.17	5
MacGillivray's Warbler	*Oporornis tolmiei*	0.24 ± 0.13	2
Wilson's Warbler	*Wilsonia pusilla*	0.48 ± 0.13	4
Black-headed Grosbeak	*Pheucticus melanocephalus*	0.10 ± 0.05	1
Savannah Sparrow	*Passerculus sandwichensis*	0.14 ± 0.08	1
Song Sparrow	*Melospiza melodia*	0.90 ± 0.31	7
Dark-eyed Junco	*Junco hyemalis*	0.19 ± 0.10	1
Brown-headed Cowbird	*Molothrus ater*	0.67 ± 0.10	5
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	0.05 ± 0.05	<1
Red-winged Blackbird	*Agelaius phoeniceus*	3.24 ± 0.50	25
Brewer's Blackbird	*Euphagus cyanocephalus*	1.95 ± 0.98	15

Appendix O-2. Relative abundance (± SE) and percent composition of birds detected within 50 m of point count stations within upland habitats surrounding Tallac Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Relative abundance ± SE	% composition
Mourning Dove	*Zenaida macroura*	0.20 ± 0.12	2
Red-breasted Sapsucker	*Sphyrapicus ruber*	0.13 ± 0.07	1
Hairy Woodpecker	*Picoides villosus*	0.40 ± 0.20	4
White-headed Woodpecker	*Picoides albolarvatus*	0.07 ± 0.07	1
Northern Flicker	*Colaptes auratus*	0.13 ± 0.07	1
Olive-sided Flycatcher	*Contopus cooperi*	0.20 ± 0.12	2
Western Wood-Pewee	*Contopus sordidulus*	0.67 ± 0.27	6
Warbling Vireo	*Vireo gilvus*	0.33 ± 0.07	3
Steller's Jay	*Cyanocitta stelleri*	0.93 ± 0.24	9
Tree Swallow	*Tachycineta bicolor*	0.07 ± 0.07	1
Mountain Chickadee	*Poecile gambeli*	1.67 ± 0.24	16
Red-breasted Nuthatch	*Sitta Canadensis*	0.27 ± 0.06	3
Pygmy Nuthatch	*Sitta pygmaea*	0.20 ± 0.20	2
Brown Creeper	*Certhia americana*	0.67 ± 0.24	6
House Wren	*Troglodytes aedon*	0.33 ± 0.07	3
Golden-crowned Kinglet	*Regulus satrapa*	0.13 ± 0.13	1
American Robin	*Turdus migratorius*	0.73 ± 0.13	7
Yellow-rumped Warbler	*Dendroica coronata*	0.07 ± 0.07	1
MacGillivray's Warbler	*Oporornis tolmiei*	0.13 ± 0.13	1
Western Tanager	*Piranga ludoviciana*	0.13 ± 0.13	1
Chipping Sparrow	*Spizella passerina*	0.13 ± 0.13	1
Savannah Sparrow	*Passerculus sandwichensis*	0.07 ± 0.07	1
Fox Sparrow	*Passerella iliaca*	0.07 ± 0.07	1
Dark-eyed Junco	*Junco hyemalis*	1.00 ± 0.20	9
Brown-headed Cowbird	*Molothrus ater*	1.13 ± 0.47	11
Red-winged Blackbird	*Agelaius phoeniceus*	0.13 ± 0.13	1
Brewer's Blackbird	*Euphagus cyanocephalus*	0.60 ± 0.35	6

Appendix P-2. Relative abundance (± SE) and percent composition of bird species detected within 50 m of point count stations at Taylor Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Relative abundance ± SE	% composition
Great Blue Heron	*Ardea herodias*	0.07 ± 0.07	<1
Canada Goose	*Branta canadensis*	0.93 ± 0.93	4
Mallard	*Anas platyrhynchos*	1.80 ± 1.51	8
Common Merganser	*Mergus merganser*	2.20 ± 1.14	9
Bald Eagle	*Haliaeetus leucocephalus*	0.60 ± 0.50	3
Killdeer	*Charadrius vociferous*	0.20 ± 0.12	1
Spotted Sandpiper	*Actitis macularia*	0.40 ± 0.23	2
Wilson's Snipe	*Gallinago delicata*	0.13 ± 0.13	1
Forster's Tern	*Sterna forsteri*	0.33 ± 0.18	1
Mourning Dove	*Zenaida macroura*	0.27 ± 0.07	1
Northern Flicker	*Colaptes auratus*	0.07 ± 0.07	<1
Olive-sided Flycatcher	*Contopus cooperi*	0.07 ± 0.07	<1
Western Wood-Pewee	*Contopus sordidulus*	0.67 ± 0.29	3
Warbling Vireo	*Vireo gilvus*	0.73 ± 0.29	3
Steller's Jay	*Cyanocitta stelleri*	1.60 ± 0.53	7
Common Raven	*Corvus corax*	0.27 ± 0.27	1
Tree Swallow	*Tachycineta bicolor*	1.13 ± 0.64	5
Cliff Swallow	*Petrochelidon pyrrhonota*	0.13 ± 0.13	1
Mountain Chickadee	*Poecile gambeli*	0.93 ± 0.47	4
Pygmy Nuthatch	*Sitta pygmaea*	0.27 ± 0.27	1
Brown Creeper	*Certhia americana*	0.07 ± 0.07	<1
House Wren	*Troglodytes aedon*	0.20 ± 0.00	1
American Robin	*Turdus migratorius*	0.80 ± 0.23	3
Yellow Warbler	*Dendroica petechia*	0.13 ± 0.13	1
Yellow-rumped Warbler	*Dendroica coronata*	0.07 ± 0.07	<1
MacGillivray's Warbler	*Oporornis tolmiei*	0.20 ± 0.12	1
Wilson's Warbler	*Wilsonia pusilla*	0.33 ± 0.33	1
Black-headed Grosbeak	*Pheucticus melanocephalus*	0.04 ± 0.23	2
Fox Sparrow	*Passerella iliaca*	0.07 ± 0.07	<1
Song Sparrow	*Melospiza melodia*	0.67 ± 0.33	3
Dark-eyed Junco	*Junco hyemalis*	0.07 ± 0.07	<1
Brown-headed Cowbird	*Molothrus ater*	1.33 ± 0.13	6
Red-winged Blackbird	*Agelaius phoeniceus*	4.60 ± 1.62	20
Brewer's Blackbird	*Euphagus cyanocephalus*	1.67 ± 1.29	7

Appendix Q-2. Relative abundance (± SE) and percent composition of bird species detected within 50 m of point count stations in the upland habitat surrounding Taylor Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Relative abundance ± SE	% composition
Canada Goose	*Branta canadensis*	0.13 ± 0.13	1
Mourning Dove	*Zenaida macroura*	0.13 ± 0.13	1
Red-breasted Sapsucker	*Sphyrapicus ruber*	0.20 ± 0.12	2
Hairy Woodpecker	*Picoides villosus*	0.13 ± 0.13	1
Northern Flicker	*Colaptes auratus*	0.27 ± 0.07	2
Olive-sided Flycatcher	*Contopus cooperi*	0.33 ± 0.24	3
Western Wood-Pewee	*Contopus sordidulus*	0.87 ± 0.52	8
Dusky Flycatcher	*Empidonax oberholseri*	0.13 ± 0.13	1
Warbling Vireo	*Vireo gilvus*	0.33 ± 0.18	3
Steller's Jay	*Cyanocitta stelleri*	1.53 ± 0.64	14
Common Raven	*Corvus corax*	0.20 ± 0.20	2
Tree Swallow	*Tachycineta bicolor*	0.27 ± 0.13	2
Mountain Chickadee	*Poecile gambeli*	1.47 ± 0.35	13
Red-breasted Nuthatch	*Sitta Canadensis*	0.07 ± 0.07	1
Pygmy Nuthatch	*Sitta pygmaea*	0.60 ± 0.60	5
Brown Creeper	*Certhia americana*	0.47 ± 0.07	4
House Wren	*Troglodytes aedon*	0.13 ± 0.07	1
Golden-crowned Kinglet	*Regulus satrapa*	0.07 ± 0.07	1
Townsend's Solitaire	*Myadestes townsendi*	0.13 ± 0.13	1
American Robin	*Turdus migratorius*	0.60 ± 0.12	5
Orange-crowned Warbler	*Vermivora celata*	0.07 ± 0.07	1
Yellow-rumped Warbler	*Dendroica coronata*	0.27 ± 0.27	2
MacGillivray's Warbler	*Oporornis tolmiei*	0.20 ± 0.12	2
Wilson's Warbler	*Wilsonia pusilla*	0.07 ± 0.07	1
Western Tanager	*Piranga ludoviciana*	0.13 ± 0.07	1
Chipping Sparrow	*Spizella passerine*	0.13 ± 0.13	1
Song Sparrow	*Melospiza melodia*	0.33 ± 0.07	3
Dark-eyed Junco	*Junco hyemalis*	0.33 ± 0.18	3
Brown-headed Cowbird	*Molothrus ater*	1.13 ± 0.48	10
Red-winged Blackbird	*Agelaius phoeniceus*	0.13 ± 0.13	1
Brewer's Blackbird	*Euphagus cyanocephalus*	0.33 ± 0.24	3

Appendix R-2. Relative abundance (± SE) and percent composition of bird species detected within 50 m of point count stations at Truckee Marsh, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Relative abundance ± SE	% composition
Black-crowned Night-Heron	*Nycticorax nycticoraz*	0.04 ± 0.04	<1
Mallard	*Anas platyrhynchos*	0.46 ± 0.29	3
Green-winged Teal	*Anas crecca*	0.04 ± 0.04	<1
Ring-necked Duck	*Aythya collaris*	0.04 ± 0.04	<1
Red-tailed Hawk	*Buteo jamaicensis*	0.04 ± 0.04	<1
American Kestrel	*Falco sparverius*	0.08 ± 0.04	<1
Virginia Rail	*Rallus limicola*	0.04 ± 0.04	<1
Sora	*Porzana Carolina*	0.08 ± 0.08	<1
Killdeer	*Charadrius vociferous*	0.29 ± 0.08	2
Spotted Sandpiper	*Actitis macularia*	0.08 ± 0.08	1
Wilson's Snipe	*Gallinago delicata*	0.29 ± 0.17	2
Wilson's Phalarope	*Phalaropus tricolor*	0.17 ± 0.11	1
Mourning Dove	*Zenaida macroura*	0.42 ± 0.29	2
Red-breasted Sapsucker	*Sphyrapicus ruber*	0.04 ± 0.04	<1
Hairy Woodpecker	*Picoides villosus*	0.04 ± 0.04	<1
Northern Flicker	*Colaptes auratus*	0.04 ± 0.04	<1
Western Wood-Pewee	*Contopus sordidulus*	0.13 ± 0.07	1
Steller's Jay	*Cyanocitta stelleri*	0.25 ± 0.25	1
Black-billed Magpie	*Pica hudsonia*	0.25 ± 0.13	1
Common Raven	*Corvus corax*	0.04 ± 0.04	<1
Violet-green Swallow	*Tachycineta thalassina*	0.08 ± 0.08	<1
Tree Swallow	*Tachycineta bicolor*	0.13 ± 0.07	1
Cliff Swallow	*Petrochelidon pyrrhonota*	1.29 ± 0.22	7
Mountain Chickadee	*Poecile gambeli*	0.42 ± 0.18	2
Red-breasted Nuthatch	*Sitta Canadensis*	0.04 ± 0.04	<1
Pygmy Nuthatch	*Sitta pygmaea*	0.25 ± 0.14	1
House Wren	*Troglodytes aedon*	0.25 ± 0.07	1
American Robin	*Turdus migratorius*	0.54 ± 0.29	3
European Starling	*Sturnus vulgaris*	0.46 ± 0.34	3
Orange-crowned Warbler	*Vermivora celata*	0.04 ± 0.04	<1
Yellow Warbler	*Dendroica petechia*	0.46 ± 0.33	3
Yellow-rumped Warbler	*Dendroica coronata*	0.04 ± 0.04	<1
Wilson's Warbler	*Wilsonia pusilla*	0.04 ± 0.04	<1
Western Tanager	*Piranga ludoviciana*	0.13 ± 0.07	1
Black-headed Grosbeak	*Pheucticus melanocephalus*	0.33 ± 0.04	2
Savannah Sparrow	*Passerculus sandwichensis*	1.46 ± 0.21	8
Song Sparrow	*Melospiza melodia*	1.29 ± 0.30	7
Brown-headed Cowbird	*Molothrus ater*	0.75 ± 0.00	4
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	1.50 ± 0.26	9
Red-winged Blackbird	*Agelaius phoeniceus*	3.38 ± 0.31	19
Brewer's Blackbird	*Euphagus cyanocephalus*	1.67 ± 0.55	10

Appendix S-2. Relative abundance (± SE) and percent composition of bird species detected within 50 m of point count stations at Tallac-Spring Creek, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Relative abundance ± SE	% composition
Band-tailed Pigeon	*Columba fasciata*	0.03 ± 0.03	<1
Hairy Woodpecker	*Picoides villosus*	0.07 ± 0.03	1
White-headed Woodpecker	*Picoides albolarvatus*	0.03 ± 0.03	<1
Dusky Flycatcher	*Empidonax oberholseri*	0.07 ± 0.03	1
Warbling Vireo	*Vireo gilvus*	0.33 ± 0.19	5
Steller's Jay	*Cyanocitta stelleri*	0.40 ± 0.10	7
Mountain Chickadee	*Poecile gambeli*	0.97 ± 0.37	16
White-breasted Nuthatch	*Sitta carolinensis*	0.03 ± 0.03	<1
Red-breasted Nuthatch	*Sitta Canadensis*	0.07 ± 0.03	1
Pygmy Nuthatch	*Sitta pygmaea*	0.03 ± 0.03	<1
Brown Creeper	*Certhia americana*	0.37 ± 0.19	6
Golden-crowned Kinglet	*Regulus satrapa*	0.13 ± 0.09	2
American Robin	*Turdus migratorius*	0.30 ± 0.15	5
Orange-crowned Warbler	*Vermivora celata*	0.07 ± 0.07	1
Nashville Warbler	*Vermivora ruficapilla*	0.10 ± 0.10	2
Yellow Warbler	*Dendroica petechia*	0.13 ± 0.09	2
Yellow-rumped Warbler	*Dendroica coronata*	0.23 ± 0.15	4
MacGillivray's Warbler	*Oporornis tolmiei*	0.17 ± 0.09	3
Wilson's Warbler	*Wilsonia pusilla*	0.10 ± 0.06	2
Western Tanager	*Piranga ludoviciana*	0.13 ± 0.09	2
Fox Sparrow	*Passerella iliaca*	0.23 ± 0.09	4
Song Sparrow	*Melospiza melodia*	0.03 ± 0.03	<1
Dark-eyed Junco	*Junco hyemalis*	1.23 ± 0.43	20
Brown-headed Cowbird	*Molothrus ater*	0.17 ± 0.12	3
Evening Grosbeak	*Coccothraustes vespertinus*	0.63 ± 0.26	10

Appendix T-2. Relative abundance (± SE) and percent composition of bird species detected within 50 m of point count stations at Taylor Creek, Lake Tahoe Basin, California, 2004.

Common name	Scientific name	Relative abundance ± SE	% composition
Mallard	*Anas plyatyrhynchos*	0.04 ± 0.04	1
Common Merganser	*Mergus merganser*	0.04 ± 0.04	1
Mourning Dove	*Zenaida macroura*	0.08 ± 0.08	2
Belted Kingfisher	*Ceryle alcyon*	0.13 ± 0.07	2
Red-breasted Sapsucker	*Sphyrapicus ruber*	0.04 ± 0.04	1
Hairy Woodpecker	*Picoides villosus*	0.21 ± 0.11	4
Pileated Woodpecker	*Dryocopus pileatus*	0.08 ± 0.04	2
Western Wood-Pewee	*Contopus sordidulus*	0.04 ± 0.04	1
Warbling Vireo	*Vireo gilvus*	0.17 ± 0.17	3
Steller's Jay	*Cyanocitta stelleri*	0.71 ± 0.25	13
Common Raven	*Corvus corax*	0.04 ± 0.04	1
Mountain Chickadee	*Poecile gambeli*	1.17 ± 0.11	22
Red-breasted Nuthatch	*Sitta Canadensis*	0.29 ± 0.15	5
Pygmy Nuthatch	*Sitta pygmaea*	0.21 ± 0.11	4
Brown Creeper	*Certhia americana*	0.42 ± 0.04	8
American Robin	*Turdus migratorius*	0.33 ± 0.15	6
Nashville Warbler	*Vermivora ruficapilla*	0.04 ± 0.04	1
Yellow-rumped Warbler	*Dendroica coronata*	0.21 ± 0.11	4
MacGillivray's Warbler	*Oporornis tolmiei*	0.04 ± 0.04	1
Wilson's Warbler	*Wilsonia pusilla*	0.08 ± 0.08	2
Western Tanager	*Piranga ludoviciana*	0.17 ± 0.11	3
Song Sparrow	*Melospiza melodia*	0.08 ± 0.08	2
Dark-eyed Junco	*Junco hyemalis*	0.33 ± 0.18	6
Brown-headed Cowbird	*Molothrus ater*	0.17 ± 0.08	3
Evening Grosbeak	*Coccothraustes vespertinus*	0.13 ± 0.07	2
Cassin's Finch	*Carpodacus cassinii*	0.04 ± 0.04	1
Pine Siskin	*Carduelis pinus*	0.08 ± 0.08	2

Appendix U-2. List of species representative of the desired ecological conditions by habitat type for Tallac Marsh and Taylor Marsh. List developed based on recent (1999-2003 TRPA) surveys and historic data (Orr and Moffitt 1971).

Common name	Scientific name
Marsh	
Eared Grebe	*Podiceps nigricollis*
Pied-billed Grebe	*Podilymbus podiceps*
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Black-crowned Night Heron	*Nycticorax nycticorax*
Northern Pintail	*Anas acuta*
Gadwall	*Anas strepera*
Green-winged Teal	*Anas crecca*
Redhead	*Aythya americana*
Common Merganser	*Mergus merganser*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Sora	*Porzana carolina*
Spotted Sandpiper	*Tringa solitaria*
Wilson's Snipe	*Gallinago delicata*
Wilson's Phalarope	*Phalaropus tricolor*
Black Tern	*Chlidonias niger*
Belted Kingfisher	*Ceryle alcyon*
Calliope Hummingbird	*Stellula calliope*
Willow Flycatcher	*Empidonax traillii*
Marsh Wren	*Cistothorus palustris*
Yellow Warbler	*Dendroica petechia*
Lincoln's Sparrow	*Melospiza lincolnii*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Aspen/riparian corridor	
Common Merganser	*Mergus merganser*
Spotted Sandpiper	*Tringa solitaria*
Belted Kingfisher	*Ceryle alcyon*
Williamson's Sapsucker	*Sphyrapicus thyroideus*
Red-breasted Sapsucker	*Sphyrapicus ruber*
American Dipper	*Cinclus mexicanus*
Swainson's Thrush	*Catharus ustulatus*
Forest	
Blue Grouse	*Dendragapus obscurus*
White-headed Woodpecker	*Picoides albolarvatus*
Williamson's Sapsucker	*Sphyrapicus thyroideus*
Red-breasted Sapsucker	*Sphyrapicus ruber*
Pygmy Nuthatch	*Sitta pygmaea*
House Wren	*Troglodytes aedon*
Ruby-crowned Kinglet	*Regulus calendula*
Swainson's Thrush	*Catharus ustulatus*
Hermit Warbler	*Dendroica occidentalis*