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Biotic assessment of upper Searsville Lake and the lower floodplain of Corte Madera Creek

Submitted to:

Philippe Cohen
Jasper Ridge Biological Preserve

From:

Craig Fee
Alan Launer
Steve Rottenborn

Center for Conservation Biology
Department of Biological Sciences
Stanford University

Summary

Despite their limited extent and the degradation they have suffered, riparian habitats support higher biodiversity than any other habitat type in the western United States. In 1995 and 1996, the Center for Conservation Biology conducted an assessment of communities of woody plants, crayfish, fishes, amphibians, reptiles, birds, and small mammals in the riparian habitats in the floodplain above Searsville Lake and surrounding areas. This study was conducted in order to provide a set of baseline data on the distribution of woody plants and animals in the floodplain above Searsville Lake, to determine whether any species of conservation concern were present, and to allow for predictions of the impacts of continued sediment deposition or management efforts on these taxa.

The riparian zone upstream from Searsville Lake is a complex mosaic of lentic, lotic, and terrestrial habitats. This habitat mosaic is produced and maintained by the dynamic nature of stream channels, sediments, and water levels in the floodplain, which act in concert to determine the distribution of plant species with varying tolerances for flooding and shading. The floodplain is dominated by flood-tolerant and early-successional species such as willows and cottonwoods. The abundance of these species reflects both the relatively young age of the aggrading Corte Madera Creek delta and the frequency and duration of inundation during winter floods. As sedimentation of Searsville Lake continues, willows will encroach into the former lake-bed and later-successional species may become more abundant at higher elevations in the floodplain. Eventually most of the area currently occupied by Searsville Lake will be covered by riparian woodland. The composition and structure of this forest will depend on the duration and frequency of flooding and the amount of disturbance in the floodplain, but willows will likely dominate, at least initially.

This study found that the floodplain above Searsville Lake supports a comparatively high avian diversity and abundance, but relatively few native amphibian,

reptile, and mammal species. The high diversity and density of breeding birds attest to the ecological health of the riparian habitat above Searsville Lake and its importance to breeding bird communities; particularly telling was the abundance of several neotropical migrants (Wilson's warbler and Swainson's thrush) that are good indicators of high-quality riparian habitat. Willow thickets such as those at Searsville Lake are particularly important to breeding bird communities due to the loss of these habitats throughout California.

During the study period, only one bird species listed as threatened by the state of California, an individual bank swallow, was recorded in the study area; this individual was most undoubtedly a non-resident migrant. Seven species considered "species of special concern" by the California Department of Fish and Game were recorded in the study area. Sharp-shinned hawk, Cooper's hawk, and yellow warbler probably nested in the study area. Double-crested cormorant, Vaux's swift, purple martin and yellow-breasted chat were most likely migrants or were using the study area only for foraging.

In addition, the emergent herbaceous vegetation and moist herbaceous understory in the lower portion of the willow thicket supported fairly high numbers of salt marsh common yellowthroat (*Geothlypis trichas sinuosa*), a former category 2 candidate for federal listing. Given the large numbers of yellowthroats nesting around the study area and the paucity of breeding habitat elsewhere on the Peninsula, Searsville Lake must be considered an important breeding area for this rare subspecies. Further sedimentation of Searsville Lake will probably increase the extent of breeding habitat for sharp-shinned hawk, Cooper's hawk, and yellow warbler; breeding habitat for common yellowthroat will probably increase initially but then decline as the valley becomes dominated by woody riparian habitat.

Red-legged frogs, conferred protection under the federal Endangered Species Act in 1996, were observed downstream from the study areas -- along San Francisquito Creek near the boundary between Jasper Ridge Biological Preserve, SLAC, and the

Boething tree farm. Introduced centrarchid fishes, crayfish, and bullfrogs in Searsville Lake may have been responsible for the decline of red-legged frogs in the vicinity of Searsville Lake. These introduced species are detrimental to virtually all native aquatic organisms and any landuse decisions should be evaluated in terms of their impact on non-native species. Control of these non-native species is probably necessary to allow re-colonization of the study area by red-legged frogs.

These surveys found that at the present time, exotic terrestrial vegetation is probably not an important threat to riparian habitats in the study area. European starling and brown-headed cowbird, neither species native to California, were also found in low numbers in the floodplain forest.

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1. INTRODUCTION

Riparian systems in western North America have been severely degraded by clearing for agriculture and development, alteration of hydrologic regimes and fluvial dynamics, and invasion by exotic vegetation. In addition to providing energy and structural resources to both terrestrial and aquatic organisms, riparian vegetation is important in maintaining water quality through erosion control, absorption of sediments and nutrients from runoff, and shading.

The riparian zone in the floodplain above Searsville Lake is highly dynamic. Sediment accumulation in Searsville Lake, particularly at the mouth of Corte Madera Creek, has resulted in the encroachment of riparian vegetation into the upper end of Searsville Lake. The floodplain above Searsville Lake has also experienced much sediment deposition, raising the elevation of the floodplain considerably. This sedimentation is expected to continue at a high rate, resulting in dramatic and relatively rapid changes in the structure and distribution of terrestrial and aquatic habitats.

Discussion of management options to relieve flooding and reduce sediment deposition in the floodplain above Searsville Lake has prompted a consideration of the impacts of further sedimentation of Searsville Lake or of regulation of Corte Madera Creek on native plant and animal communities. Management efforts that alter the hydrologic regimes and fluvial processes of the tributaries of Searsville Lake will certainly result in changes in these biotic communities. Due to a lack of information on the biological communities present in and above Searsville Lake, these impacts are difficult to predict. In order to address this lack of information, the Center for Conservation Biology began a study of the floodplain above Searsville Lake (frequently referred to hereafter as the "study area") in fall, 1995, with the following objectives:

(1) Provide a general description of the riparian vegetation in the study area with attention to patterns of succession and disturbance that might

explain the current distribution of vegetation and aid in the prediction of future vegetation dynamics.

(2) Survey certain animal taxa (fishes, crayfish, reptiles, amphibians, mammals and birds) within the floodplain above Searsville Lake and in surrounding areas to determine the presence/abundance of

(a) species of conservation concern (those species listed by local, state, or federal agencies).

(b) species potentially detrimental to the native flora and fauna (non-native species and "invasive" native species).

(c) native species indicative of the "health" of aquatic or terrestrial ecosystems.

(3) Characterize tree, bird and mammal communities at discrete points in the floodplain above Searsville Lake and fish, reptile and amphibian communities in the vicinity of Searsville Lake.

(4) Predict how the distribution of rare or detrimental species and the structure of plant and animal communities are expected to change as Searsville Lake becomes increasingly filled with sediment or as a result of proposed management efforts.

2. GENERAL METHODS AND ACTIVITIES

In order to gather data sufficient to address the study objectives, two different field strategies were employed. The first strategy included broad-scale surveys for species of conservation concern. These surveys focused on the riparian zone upstream from Searsville Lake, but, by necessity, included some areas downstream and others outside of Jasper Ridge. Surveys from outside of the Searsville riparian zone aid in interpreting data, particularly data indicating that an organism is not present in the area. For example, surveys in the study area for red-legged frogs were typically paired with surveys at nearby Matadero Creek. Matadero Creek supports a good population of red-legged frogs, and surveys there were used to reduce the possibility that a lack of observations at Searsville Lake was the result of inappropriate sampling conditions.

The second strategy included designating 20 study sites scattered within the riparian zone upstream from Searsville Lake (Map 1). The locations of these sites were identified and marked in late winter 1996 (positions recorded with a GPS unit). One site had to be eliminated from the study, as it was still under water as of late June 1996. On each of these non-overlapping sites, bird and mammal communities and the composition of tree and shrub assemblages were characterized as described in the following sections. Preliminary surveys for reptiles, amphibians, and fishes in these plots indicated that sample sizes would have been too low for statistical analyses, so surveys for these taxa were conducted in a broader area.

All observers conducting field work contributing to this report (Alan Launer, crayfish, fishes, reptiles and amphibians; Mike Westphal and Rich Seymour, reptiles and amphibians; David Stiles, mammals; and Steve Rottenborn, birds and plants) are experienced with their corresponding taxa within central California and with the methods appropriate for sampling these taxa. Craig Fee, Jamie Reaser, and Ian Woods also participated in the field work.

3. SPECIFIC METHODS, RESULTS, AND DISCUSSION

3.1.1. Trees and shrubs -- introduction

Riparian vegetation is the most important biotic component of riparian ecosystems, and conclusions regarding a biological inventory of the floodplain above Searsville Lake cannot be made without an understanding of vegetation patterns. This report provides an overview of the spatial and successional patterns of vegetation in the study area, and predicts the likely changes in vegetation as sedimentation continues.

A detailed understanding of the factors influencing the spatial patterns of vegetation in the study area requires analyses of relationships between environmental parameters and the distribution of tree and shrub species. In addition, the riparian vegetation above Searsville Lake is extremely important in determining the distribution of animal species in the study area. Analyses of associations between vegetation parameters and bird or mammal diversity or abundance will help to explain the distribution of these animals while allowing for the development of methods by which one group of variables might be used as indicators of the status of other variables. Finally, changes in plant and animal communities as Searsville Lake becomes increasingly filled with sediment will be more accurately predicted if relationships between the various parameters are quantified rather than based on qualitative assessments of successional patterns. Once the lake is filled, most fishes will be gone, and the biota will be determined primarily by the vegetation.

3.1.2. Trees and shrubs -- methods

A qualitative description of the general spatial patterns of vegetation within the study area was made based on numerous visits to the study area. The discussion of successional patterns is based on published studies of the life history characteristics of

these tree and shrub species and of the influence of fluvial dynamics on germination and survival of these species.

More detailed, quantitative surveys of riparian trees and shrubs were conducted at each of the 19 plots established in the floodplain above Searsville Lake (briefly described in Section 2). The distribution of trees and shrubs was characterized within a 25-m radius of the center of each plot. Within this circle, all stems of woody plants >1 cm in diameter were identified and measured. Because riparian trees and shrubs frequently branch close to the ground, measurements of stem diameters were taken approximately 10 cm above the ground's surface. Small-diameter stems, particularly those of dogwoods and young willows, were so abundant on many plots that actual measurement of these small stems was not feasible; all stems that appeared to be at least 1 cm in diameter but were obviously less than 5 cm in diameter were simply identified to species and classified as "< 5 cm." In order to minimize error in diameter estimates for stems in the "< 5 cm" category, a small transparent ruler was frequently used to determine whether a stem was at least 1 cm in diameter, and all stems that were not obviously smaller than 5 cm were measured. Dead trees (called snags) were measured and identified to species (when possible) but were tallied separately from live trees.

From these data, individual trees and shrubs were grouped into discrete diameter classes which can be used as crude estimates of tree age when compared among individuals of the same species. The relative abundance of various tree and shrub species are compared among plots in terms of stem density and "basal area density" (in cm^2 of basal area per m^2 of plot area). Analysis of the distributions of individuals among diameter classes provides information on stand age and seral stage.

These vegetation data do not, by themselves, provide a great deal of information about the factors influencing patterns of vegetation beyond the general description in section 3.1.4. Rather, future analyses of associations between these vegetation data

and physical parameters will attempt to explain the distribution of tree and shrub species. The elevation of each plot may be one important factor influencing the age and composition of vegetation on these plots; in the study area, small differences in elevation may reflect important differences in factors influencing vegetation, such as inundation duration and frequency. Plot elevation and distance to the edge of the creek delta is probably also related to the age of the stand when compared among plots on the prograding Corte Madera Creek delta.

Further analyses of associations between bird or mammal communities and vegetation composition are being conducted. Multivariate analyses using canonical correspondence analysis may identify habitat parameters (e.g., the presence or abundance of a certain tree species, a particular mix of tree and shrub species, or the size or density of certain species) associated with the diversity or abundance of these taxa.

3.1.3. Trees and shrubs -- results and discussion

These surveys yielded an abundance of information, only some of which have relevance to the goals of this study. This discussion, therefore, will focus only on factors deemed important for landuse decision-making.

Some 7,500 trees and shrubs were recorded within the 19 study plots (see Appendix E for tree survey summaries, Map 2 for species composition at each point, and Appendix F for graphical representation of the distribution of size classes of the trees and shrubs present in each plot). The composition of trees and shrubs varied considerably among plots, ranging from plots dominated by numerous young willows (e.g., plots G and H) to those dominated by mature cottonwoods and willows with a dense understory of dogwood and box-elder (e.g., plots E and F).

Two points are worth mentioning in the context of land-use planning and obtaining a broad understanding the dynamics of the system. First, few exotic tree and

shrub species were present in the floodplain above Searsville Lake. In some parts of the western United States, invasion of riparian systems by saltcedar (*Tamarix*), Russian olive (*Elaeagnus*), *Eucalyptus* spp., and giant reed (*Arundo donax*) has resulted in the loss of much native riparian vegetation. However, these exotics are generally most invasive in much warmer, drier conditions than exist at JRBP, and with the exception of scattered stands of *Arundo*, these exotics have not become a conservation problem in the San Francisco Bay area. A few small *Eucalyptus* were observed in the study area, but the other exotic species mentioned above were not noted. Therefore, although invasion by exotic plants has degraded riparian habitats in many locations elsewhere in California, the riparian habitat in the study area does not seem to be threatened by exotic vegetation.

Second, the floodplain forests of the study area were dominated by only a few native tree and shrub species. Dominant canopy tree species were limited to black cottonwood (*Populus trichocarpa*) and four willow species (*Salix lucida, S. lasiolepis, S. laevigata* and *S. exigua*), all considered early-successional species. *Cornus* and *Quercus* species, on the other hand, tend to be more flood-intolerant. White alder (*Alnus rhombifolia*) was found at scattered locations (more common near the upper portion of the study area) but represented a relatively small proportion of the canopy trees overall, and only a few individuals of redwood (*Sequoia sempervirens*), oaks (*Quercus* spp.), and California laurel (*Umbellularia californica*) were recorded. Both dogwood (*Cornus occidentalis*) and box-elder (*Acer negundo*) were abundant understory species, with some box-elder reaching canopy height. Poison oak (*Toxicodendron diversilobum*) was common only on two plots (Q and R) near the upper portion of the study area.

3.1.4. General description of spatial and successional vegetation patterns and terrestrial habitats in the floodplain above Searsville Lake

The riparian zone upstream from the study area is highly complex. Continued sedimentation of Searsville Lake will result in an increase in the extent of terrestrial riparian habitat in the Searsville Lake area at the expense of aquatic habitats. As the Corte Madera Creek delta expands outward into Searsville Lake, the area occupied by emergent herbaceous vegetation and dense young willows is expected to increase. These habitats are generally short-lived in aggrading areas, as emergent herbaceous vegetation is gradually replaced by woody riparian vegetation. If the rate of sedimentation is high, then the area occupied by quickly-growing emergent herbaceous vegetation is likely to be greater (relative to that occupied by the more slowly maturing woody vegetation) than if the rate of sedimentation is low, at least for a period of several years. As Searsville Lake fills with sediment, an increasing area of the former lake bed will be invaded by emergent herbaceous vegetation followed by willows (and perhaps cottonwoods), until eventually woody riparian vegetation fills most of the former lake bed. After sedimentation of Searsville Lake is complete, these willows will mature and thin out, and other tree and shrub species may become established. Such a pattern of succession can be seen across some of the study plots. Plot G is located close to the limit of riparian vegetation on the Corte Madera Creek delta, and is dominated by a dense stand of small willows (with some emergent vegetation still present). Plot H, some 150 meters upstream from plot G, has slightly more mature, less dense willows but still no other well-established species. Plot B has some dense young willows but also some more mature willows (still no other species, because inundation frequency and duration are still high). Plots E and F support a later seral stage characterized by larger willows, box-elder and dogwood.

The future state of riparian vegetation in the former Searsville Lake area will depend largely on the inundation duration and frequency of the floodplain and the degree to which the stream is able to meander across the floodplain. Where the "Searsville Valley" (Kittleson et al. 1996) is still flooded for long durations, flood-tolerant

species such as cottonwoods and willows, and possibly stands of emergent herbaceous vegetation, may persist. Conversely, if drainage of the valley improves after sedimentation, areas infrequently flooded (perhaps on the higher margins of the floodplain) will gradually be colonized by shade-tolerant late-successional species, such as oaks and California bay.

Disturbance, either catastrophic (e.g., from fire or very large flood events) or gradual (i.e., meandering of an incised stream channel) will probably be necessary to allow for the regeneration of cottonwoods and willows, as these species do not reproduce under the shade of a canopy. Alternately, it is possible that a hydrologic regime in which long periods of inundation, preventing the establishment of flood-intolerant, late-successional tree species, are interspersed with drier periods would allow for the establishment of young cottonwoods and willows (during the drier periods) in gaps created by the death of older individuals.

3.2. General description of aquatic habitats in the floodplain above Searsville Lake

The lentic habitats in upper Searsville Lake and in the Middle and Upper Marsh areas consist of still or very slow-moving water, varying in depth but generally quite shallow. Algae and submerged woody debris provide some structure to lentic environments within Searsville Lake itself, while at the margins of Searsville Lake dense stands of emergent vegetation (cattails and rushes) are present. The extent to which this perennial herbaceous vegetation is inundated depends on water levels in Searsville Lake. During years of normal or above-average rainfall, standing water may be present continuously from Searsville Dam well into the willow forest above the Middle Marsh area. In addition, isolated pools of standing water (remnants of high winter flows) may be present throughout the floodplain in spring, particularly in former stream channels.

Standing water may also be present in the vicinity of Skipper's Pond and nearby on both the north and south sides of Family Farm Road.

Lotic habitats in the floodplain above Searsville Lake are quite dynamic. The channels of Searsville Lake's tributaries, particularly lower Corte Madera Creek, wander throughout the floodplain, changing their locations from one flood event to the next depending on the positions of piles of debris and sediment. These channels may become braided on the flat floodplain, spreading into a number of narrow, shallow, sinuous channels. As a result, there are few places within the floodplain immediately above Searsville Lake where the channel is incised more than 1-2 feet, and pools of deeper water are relatively scarce. Such pools may form on the downstream sides of trees in the channel or behind or below debris dams. The Corte Madera Creek channel above the causeway breach, on the east side of the floodplain, is moderately incised and has several relatively deep pools, whereas the braided channels of Corte Madera Creek on the western side of the floodplain are shallow with few pools.

3.3.1. Fishes -- introduction

As is typical of many drainages in western North America, the San Francisquito Creek drainage supported comparatively few species of native fishes prior to colonization of the area by Europeans. In the face of major habitat loss, habitat alteration, and introduction of non-native species, few native species of the already depauperate native fish fauna remain in the drainage. In the area that is now the highly modified reservoir and floodplain of the Searsville Lake/Family Farm Road study area, original native species likely included steelhead/rainbow trout (*Oncorhynchus mykiss*), sculpin (one or more species of the genus *Cottus*), roach (*Hesperoleucas symmetricus*), hitch (*Lavinia exilcauda*), speckled dace (*Rhinichthys osculus*), Sacramento sucker (*Catostomus occidentalis*), lampreys (one or more species of the genus *Lampetra*), and perhaps three-spined stickleback (*Gasterosteus aculeatus*), Sacramento squawfish

(*Ptychocheilus grandis*), Sacramento blackfish (*Orthodon microlepidontus*), and coho salmon (*Oncorhynchus kisutch*). In recent years, however, the only native species that have been observed with any regularity in the study area are Sacramento sucker and rainbow trout.

In spite of the general lack of native fishes, the nearly complete physical alteration of the drainage in the study area, and the large numbers of non-native species inhabiting Searsville Lake, the area cannot be ignored in terms of conservation planning. Of particular interest for conservation planning are rainbow trout (*Oncorhynchus mykiss*). This species is protected by numerous conservation and game laws and the steelhead form is being considered for federal protection at the present time (we expect some type of increased protection for steelhead in the next 18 months -- either full listing as threatened by the USFWS or simply an increase in attention from public and private agencies in an effort to eliminate the need for listing.) The presence of rainbow trout/steelhead in the study area or downstream from the study area definitely impacts landuse decisions. The presence of non-native species of centrarchid fishes (sunfish, blackbass, and crappie) is also an important consideration for conservation planning. These fishes are detrimental to virtually all native aquatic organisms and any landuse decisions should be evaluated in terms of their impact on non-native fishes.

3.3.2. Fishes -- methods

Fish surveys were conducted with seines, dip nets, and hook-and-line. Surveys for fishes were initiated when water levels were low, and were conducted over a 12 month period (May 1995 - June 1996). A portion of some 30 person-days was spent surveying for fishes during the study period. Searsville Lake (divided into three portions, including: lower -- main body of reservoir, from dam to berm and large footbridge; middle lake or marsh, extending from footbridge to Portola Road; upper lake or marsh,

unfenced area, southwest of Portola Road), the large pool below Searsville Dam, Corte Madera Creek (main channel and various side channels, from Searsville Lake to just upstream from the Jasper Ridge boundary), and Skipper's Pond (a pond complex adjacent to Family Farm Road) were specifically surveyed for this project. Other portions of the drainage were also sampled during the study period in conjunction with other projects.

3.3.3. Fishes -- results and discussion

No real surprises were found by these surveys. Searsville Lake, including lower, middle, and upper portions, was found to support abundant bluegill[1] (*Lepomis macrochirus*), redear sunfish[1] (*Lepomis microlophus*), pumpkinseed[1] (*Lepomis gibbosus*), green sunfish[1] (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), and black crappie (*Pomoxis nigromaculatus*). All of these centrarchids are non-native and have been widely introduced throughout the western United States. Several other non-native species were observed in Searville Lake, including mosquito fish (*Gambusia affinis*) and brown bullhead (*Ictalurus nebulosus*, but see following discussion for questions as to exact identification). Several of these species, most notably largemouth bass and brown bullhead, are significant predators on other fishes (and anything else they can swallow) and are impacting the biotic communities present in the area -- undoubtedly to the extent that bass are a major factor in structuring the aquatic community present in Searsville Lake. Bass are also likely having a significant impact on many terrestrial and semi-terrestrial organisms -- bass will eat a wide range

[1] Young bluegill, pumpkinseed, redear sunfish, and, to some extent, green sunfish are very similar in appearance. Members of the genus *Lepomis* also frequently hybridize, with the resulting hybrid offspring typically being viable, fertile, and of roughly intermediate phenotype. This makes field identification of many specimens difficult (if not impossible). As determined by the examination of adult male specimens, there are definitely bluegill, green sunfish and pumpkinseed in Searsville Lake, and it is likely that "pure" redear are also present. There are, however, a fairly large number of individuals present in the system that are probably of mixed stock.

of small vertebrates, including ducklings, snakes, turtles, frogs, and rodents. The other non-native species present (sunfish, crappie, and mosquito fish) may also prey on native organisms, especially the eggs and fry of native fishes and amphibians, and may compete with native organisms for food and hiding places.

Green sunfish have been recorded from the San Francisquito drainage regularly since 1989, but this species had not been positively documented from above Searsville Dam. In the 1995/1996 surveys, green sunfish were found in all three portions of Searsville Lake. While this species has surely been present in Searsville Lake for some time, it appears that it is increasing in density. Green sunfish are potentially more problematic than the other species of sunfish since they have comparatively larger mouths, frequent vegetated inshore areas favored by the young of other fishes, and survive and reproduce well under a wide range of aquatic conditions. In many areas, including lower Alameda Creek, green sunfish are so successful that populations of stunted individuals occur. In these populations, individuals tend to be very numerous, and have comparatively small-bodies and large heads. Prey is the limiting factor in these populations, and the availability of potential prey ultimately becomes very low. Needless to say, bodies of water supporting populations of stunted green sunfish do not typically support a good community of native animal species.

Catfish of the family Ictaluridae have long been reported from Searsville Lake, and one individual was captured in early summer 1996. This specimen was a young-of-the-year (spawned in 1996) individual, and was tentatively identified as a brown bullhead (*Ictalurus nebulosus*). (In late summer, a large individual was observed in the pool at the "Railroad car" bridge, just downstream from the Searsville dam, but was not captured.) Ictalurid catfish, including three species of bullhead catfish, white catfish, and channel catfish, have been widely introduced in the region as game, and several species are expected to occur in Searsville Lake. However, since these fishes are typically quite easy to detect, our data suggest that they are not present in large

numbers in the drainage. These species would likely reproduce poorly in the shallow, rapidly flowing creeks typical of most of the drainage. Thus, they would quite possibly decline throughout the drainage if Searsville Lake was not acting as a source population.

Young-of-the-year Sacramento suckers were also observed in Searsville Lake, indicating a reproducing population of native suckers still exists above the dam. Suckers typically require water of good quality and access to short stretches of stream for limited spawning migrations. The presence of suckers in the lake should be taken as a sign that the lake has the potential to support a good community of native fishes. No rainbow trout or native minnows were observed in Searsville Lake during these surveys. As mentioned, rainbow trout were recorded from Searville Lake in the years just prior to the study, and it is probable that some trout are present in the lake. Whether these trout are part of a self-maintaining population, indicating at least occasional spawning runs up Corte Madera Creek, or are the result of undocumented and fairly recent introductions is unknown.

Very few fishes of any kind were observed in lower Corte Madera Creek. Mosquito fish were noted on several occasions at a few locations, mainly within 200 meters of Searsville Lake, but scattered throughout the floodplain. One rainbow trout was encountered within the primary study area. This specimen was isolated in one of the pools of standing water present in spring 1996, along one of the old Corte Madera Creek channels (approximately 100 meters upstream from the small footbridge crossing the old creek channel). Several trout were also seen in Corte Madera Creek upstream from Jasper Ridge. As with the trout observed in Searsville Lake, these either represent resident stock or are the result of unauthorized introductions.

Somewhat surprisingly, comparatively few fishes were observed in Skipper's Pond -- only mosquito fish were captured during these surveys. Given the apparently more stable nature of this pond, proximity to source populations, and easy access from

Family Farm Road, it is expected that other fish species inhabit the more difficult to reach portions (with a muddy bottom and many snags, the pond is difficult to net). Although some native species may persist in this pond, it is not expected to serve as a refuge for native species of fishes or amphibians. Future electroshocking activities in the area could survey this pond.

In respect to fishes, there are two important considerations for landuse and resource management discussions at Jasper Ridge. The first is that Searsville Lake is undoubtedly acting as a source of non-native species for much of the drainage. The number of largemouth bass, in particular, would likely be reduced throughout the entire drainage if the bass population residing in Searsville Lake could be controlled or eliminated. Since largemouth bass are associated with slow-moving or standing water and do not generally reproduce well in small, rapidly flowing creeks, filling of Searsville Lake would likely decrease significantly the number of bass in the system. The number of other centrarchid fishes in the system would also likely decline as Searsville Lake fills (with the exception being the green sunfish, which does quite well under creek conditions). Filling of Searsville Lake, therefore, would likely help control at least some non-native species and benefit the entire San Francisquito Creek drainage.

Any actions that might enhance the ability of non-native species to invade downstream from Searsville Lake need to be avoided. Fortunately, except for possible increased summer releases of water, there are few ways to worsen the situation. Lowering the water level, channelizing Corte Madera Creek, or pumping water out of flooded areas into Searsville Lake could have some short-term impacts (transporting a few non-natives around the area), but would likely have few, if any, lasting impacts (especially if screens or nets were used to "filter" any re-oriented water). Lowering the water level of the lake and channelizing Corte Madera could also hasten the filling of Searsville Lake -- which, as discussed, should not be viewed as a negative change.

The second consideration is that the exceptionally high density of non-native fishes in Searsville Lake is having a strong negative impact on the native organisms that utilize the lake. Even if the role of Searsville Lake as a source for non-native species for the rest of the watershed is ignored, the fauna of the lake is sufficiently problematic as to warrant attention -- the non-native species are so dominant that the lake is probably acting as a biological sink for some native organisms. The centrarchid fishes, especially when coupled with bullfrogs and crayfish, are potentially predating on and competing with native fishes, amphibians, reptiles, birds, and invertebrates -- basically, since the lake supports such a "who's who" of invasive and noxious species, individuals of native species that happen into Searsville Lake face a decidedly tough time surviving. It is not surprising that many of our more threatened native elements are no longer present in Searsville Lake.

As discussed while considering its role in the entire watershed, the filling of Searsville Lake would help reduce the number of non-native fishes. However, this filling would also essentially eliminate several types of aquatic habitats (open standing water, deep water, etc.). Since the lake is an artificial body of water, many of these standing water habitats did not naturally exist in the system, and in some respects, loss of these aquatic habitats would not be a problem.

On the other hand, a Searsville Lake devoid of non-native fishes could be a very valuable resource. Properly stocked with native fishes, the lake could prove to be excellent habitat for pond turtles, red-legged frogs, and a host of other uncommon native species. (Even if the native amphibians and reptiles did not increase in abundance, a community of native fishes would have greater conservation and academic value than what presently exists in Searsville Lake.)

3.4.1. Crayfish -- introduction

Non-native crayfish have been implicated in the decline of many native organisms, including red-legged frogs, yellow-legged frogs, native fishes, and native invertebrates. Prior to European colonization there may have been one species of crayfish in the San Francisquito drainage, *Pacifastacus nigrescens*. This species is now presumed to be extinct. At least three species probably currently inhabit the San Francisquito drainage; *Pacifastacus leniusculus* (native to the Shasta River system of California and Oregon), *Orconectes virilis* (native to the eastern United States), and *Procambarus clarkii* (native to the eastern United States). (See Appendix D.)

While there are many interspecific differences in the behavioral ecology of crayfish, most are omnivorous -- eating a wide range of vegetable and animal matter. Dead animal matter is frequently scavenged, but living organisms, particularly eggs and larvae, are also consumed. Some crayfish are also quite adept at modifying their habitat by constructing extensive tunnel systems.

In general, large numbers of non-native crayfish should be viewed as a conservation problem -- the more abundant non-native crayfish are, the less likely the site is to be occupied by native species of conservation concern.

3.4.2. Crayfish -- methods

Surveys for crayfish were conducted concurrent with the fish surveys. Crayfish surveys were conducted with seines and dip nets. Surveys for crayfish were initiated when water levels were low, and were conducted over a 12 month period (May 1995 - June 1996). A portion of some 30 person-days was spent surveying for crayfish during the study period. Crayfish were typically not identified to species -- precise identifications usually require adult males, and since all crayfish in the system are assumed to be non-native, species-level identifications were not considered absolutely necessary. Crayfish were identified using the key by Theo Light, which is included in this report as Appendix D.

3.4.3. Crayfish -- results and discussion

Crayfish are abundant in all portions of Searsville Lake. There were likely two species represented in the samples, Louisiana red swamp crayfish or eastern green crayfish (*Procambarus clarkii* and *Orconectes virilis*, respectively). These two species have been widely introduced throughout California. No crayfish were seen in lower Corte Madera Creek. The absence of crayfish from lower Corte Madera Creek is likely the result of recent heavy flooding and sediment deposition -- most resident crayfish were possibly buried or "flushed" from the area.

Below Searsville Dam, crayfish were observed scattered throughout the San Francisquito Creek system -- often quite common in deeper, calmer pools. In many stretches of creek, well down from the study area, the most commonly encountered species was the signal crayfish (*Pacifastacus leniusculus*). This species is con-generic with the presumed native, but extinct, crayfish (*P. nigrescens*). While there are no known studies comparing the ecology of the two Pacifastacus species, it is likely that they were similar. Accordingly, the presence of a healthy population of signal crayfish may not be an environmental disaster. At least one species of the eastern-originating crayfish is also found in the creek proper.

As with fishes, Searsville Lake is likely a source for several of the non-native crayfish. Some years ago, it was noted that following heavy winter rains, few crayfish could be found in the creeks, while they remained common in Searsville Lake. After that scour, it appeared that the creeks were slowly recolonized -- perhaps by individuals originating from Searsville Lake.

When Searsville Lake fills, the system will become less hospitable for non-native crayfish, particularly *Procambarus* and *Orconectes*. Once Searsville Lake is filled, crayfish will remain in the system, but, hopefully, at lower population levels.

3.5.1. Amphibians -- introduction

Of the 8-12 amphibian species thought to be potentially present within the study area, two are species of conservation concern (red-legged frogs and yellow-legged frogs). The California red-legged frog (*Rana aurora draytonii*) was recently listed as "threatened" by the U.S. Fish and Wildlife Service. As such, the presence of this species in the study area or downstream would impact significantly any proposed alterations of the study area. This species is present in San Francisquito Creek, and should have been present historically throughout the study area. The foothill yellow-legged frog (*Rana boylei*), a former category 2 candidate for federal listing, was also thought to be present historically in the San Francisquito Creek drainage. These two species have declined due to habitat loss resulting from stream regulation and channelization, and the introduction of non-native predators, including centrarchid fishes, crayfish, and bullfrogs (*Rana catesbeiana*).

Bullfrogs, introduced to California and present in Searsville Lake and San Francisquito Creek, prey upon native amphibians and have been implicated in the decline of the California red-legged frog and yellow-legged frog. Because bullfrog larvae require two years to mature, they are most abundant in lentic habitats. In fast-flowing or seasonal streams, larvae frequently perish in winter floods or during summer drying. This species is an important conservation concern; the number of bullfrogs in Searsville Lake and its tributaries might be an important problem for native amphibian communities.

3.5.2. Amphibians -- methods

Initial surveys in the floodplain above Searsville Lake found few species of native amphibians and activities were altered accordingly. Most of the amphibian surveys were conducted specifically to search for California red-legged frogs, yellow-legged

frogs, and bullfrogs. Portions of 28 person days were spent searching, including seining and dip netting, the waterways from just below the dam to the area above the floodplain. Day and night visual surveys were also used.

3.5.3. Amphibians -- results and discussion

No yellow-legged frogs were observed during this study. This result is not surprising, as this species has apparently not been observed in the Searsville Lake area for some time. As this is a poorly understood species, it is unclear what factors have contributed to its decline.

Surveys of lower Corte Madera Creek and Searsville Lake failed to locate California red-legged frogs. Observers did note, however, that the portions of Corte Madera Creek upstream from the causeway breach and of San Francisquito Creek below the dam did look similar to habitats where red-legged frogs occur elsewhere in the Santa Cruz Mountain foothills.

One red-legged frog was seen downstream from the primary study area, near the point of the creek's closest proximity to the Stanford Linear Accelerator Center. This site is approximately 1.4 kilometers northwest of Searsville Dam and approximately 0.5 kilometer upstream from the site adjacent to the Boething tree farm where the species had been previously recorded. The red-legged frog was seen on the south bank of the stream, approximately one meter from the water's edge, adjacent to a long, deep, slow-moving pool. The observer noted that many other locations along this reach seemed suitable habitat for red-legged frogs, although no others were seen. The same day, a visit to Matadero Creek in order to determine the activity of the species found four red-legged frogs within a 10-minute period.

The absence of red-legged frogs in lower Corte Madera Creek and Searsville Lake may be the result of predation by introduced fish, crayfish, and bullfrogs. It may also be partially the result of the extremely dynamic nature of the Corte Madera

floodplain -- individuals may have a difficult time surviving during periods of heavy flooding and high sediment deposition.

In general, red-legged frogs should tend to be more tolerant of relatively narrow, swift-moving streams than bullfrogs. This is because red-legged frogs complete the egg to metamorphosis portion of their life cycle during one year, while bullfrogs take 1.5 years or more. Therefore, unless the creek is too prone to flooding, red-legged frogs should do better in many of our local, often seasonal creeks than bullfrogs. The impounded waters of Searsville Lake and Skipper's Pond, however, provide near ideal habitats for bullfrogs. Indeed, our surveys found bullfrogs scattered throughout the floodplain upstream from Searsville Lake, but common only at Searsville Lake and Skipper's Pond. While flooding may clear much of the floodplain of bullfrogs, this species is able to re-invade from both upstream and downstream areas. One bullfrog was found below the Searsville Dam (in the pool immediately upstream from the road crossing).

When Searsville Lake fills with sediment, the stream channel remaining will hopefully be only marginally suitable for bullfrogs, but more appropriate for red-legged frogs. However, as long as pooled water remains in Searsville Valley, bullfrogs and centrarchid fishes will probably persist. Because such pools are predicted to be present after sedimentation of Searsville Lake is complete (Kittleson et al. 1996), more active predator control methods might be necessary to allow California red-legged frogs to once again re-populate areas above Searsville Lake. Because there are no known populations of yellow-legged frog in the vicinity of JRBP, this species will probably not re-populate the Searsville Lake area unless intentionally reintroduced.

These surveys also noted California newts (*Taricha torosa*), both adults and larvae, Pacific tree frogs (*Hyla regilla*), and ensatinas (*Ensatina eschscholtzi*) scattered throughout the lower Corte Madera Creek floodplain. Most of these were observed on

the margins of the study area, with very few being observed in the interior areas that have been recently subjected to high rates of flooding and silt deposition.

3.6.1. Reptiles -- introduction

Of the 12-15 species of reptiles thought to potentially exist in the study area, two are species of conservation concern: western pond turtle (*Clemmys marmorata*) and San Francisco garter snake (*Thamnophis sirtalis tetrataenia*). The western pond turtle, once found on a regular basis in Searsville Lake, was formerly classified as a category 2 candidate for federal protection. The San Francisco garter snake is listed as "endangered" by the U.S. Fish and Wildlife Service. The garter snakes in the vicinity of Stanford University have long been considered intergrade between the protected "San Francisco" form found to the north and west (*T. s. tetrataenia*) and the more common and unlisted form to the south. As intergrade zones can be dynamic, it is important to determine the distribution, abundance, and phylogenetic status of the garter snakes inhabiting the study area.

Although no exotic reptiles are known to occur within the study area (although specimens of non-native kingsnake species have been repeatedly observed in the more xeric portions of the JRBP), introduced turtles can be locally common at some locations in the San Francisco Bay area (e.g., streams in the Santa Clara Valley); individuals could potentially be released in the study area.

3.6.2. Reptiles -- methods

Field surveys attempted to determine the distribution and abundance of reptiles in the study area. These surveys, however, were conducted along with fish and amphibian surveys, and were definitely a third priority. Searsville Lake was scanned for turtles (with 10X binoculars) on at least five occasions during the study period.

3.6.3. Reptiles -- results and discussion

No turtles were seen during the study, and the only reptiles recorded from the floodplain above Searsville Lake were western fence lizards (*Sceloporus occidentalis*). Individuals of this species were abundant at the edges of the floodplain but were absent toward the center of the floodplain. No snakes were observed in the study area.

Most of the floodplain above Searsville Lake was inundated on several occasions during the winters of 1994-95 and 1995-96. Few reptiles could have survived these periods of inundation within the study area. The degree to which the floodplain would be re-populated by individuals from the surrounding uplands or from unflooded areas farther upstream is unknown but is of potential importance in understanding the impacts of flooding and changes in flow patterns (e.g., due to potential management efforts) on riparian animal communities.

Sedimentation of Searsville Lake will increase habitat for most reptile species, as the majority of reptiles in the study area are terrestrial. The only aquatic reptile occasionally recorded in the area, western pond turtles, might decline as Searsville Lake is filled. But since this species is essentially absent from the system already, it probably does not make much difference to conservation planning -- unless one wants to make this the focus of a large restoration/re-population effort (which would be a great project, but one which would take many years and significant funding). If this species is still present in the vicinity of JRBP, however, it might persist in smaller pools or in the narrow stream channel.

3.7.1. Birds -- introduction

At least 20 bird species of potential conservation concern have previously been recorded at JRBP. Of these species, eight would not be expected to breed at the Preserve. California clapper rail (*Rallus longirostris obsoletus*), listed as "endangered"

on both state and federal lists, was reported at Searsville Lake on 4 January 1959 (Wood, 1959). This species nests only in salt marshes, so certainly has never bred at Searsville Lake. Although clapper rails occasionally wander away from saltmarsh habitats, they do so very rarely, and this record is somewhat dubious. Another eight species which are California Department of Fish and Game "species of special concern" have been recorded at JRBP only as non-breeders, and none have nested in the vicinity of the Preserve. The breeding populations of common loon (*Gavia immer*), double-crested cormorant (*Phalacrocorax auritus*), osprey (*Pandion haliaetus*), northern goshawk (*Accipiter gentilis*), northern harrier (*Circus cyaneus*), and short-eared owl (*Asio flammeus*) are considered “species of special concern” in California, whereas peregrine falcon (*Falco peregrinus*) and merlin (*Falco columbarius*) are considered “species of special concern” throughout their range, year-round.

Another four species of special concern have not bred at the Preserve but might be expected to breed in the future. All four are currently considered rare visitors to JRBP, but breed or have bred nearby in habitats similar to those found at the Preserve. All California populations of loggerhead shrike (*Lanius ludovicianus*), horned lark (*Eremophila alpestris actia*) and Bell's sage sparrow (*Amphispiza belli belli*) are of special concern (year-round), and these species were formerly category 2 candidates for federal protection. Only active nest sites of burrowing owl (*Athene cunicularia*), recorded only once at the Preserve, are "of concern." Loggerhead shrike, horned lark, and burrowing owl are all grassland species, while Bell's sage sparrow nests primarily in chamise chaparral.

Six “species of special concern” have previously bred at the Preserve. Yellow warbler was historically a common nesting species around Searsville Lake (although reduced in numbers in recent years), while sharp-shinned hawk and Cooper's hawk have been recorded breeding only a few times at JRBP. Purple martin (*Progne subis*) was more common historically than it is currently; adults feeding fledged young at

Searsville Lake in the 1950s indicate that nesting occurred locally, if not at JRBP. Only California nesting populations of these four species are of concern. Golden eagle (*Aquila chrysaetos*) and tricolored blackbird (*Agelaius tricolor*), a former category 2 candidate for federal protection, have been recorded breeding only once at the Preserve. Golden eagles nested in a redwood downstream from Searsville Dam in 1995, while tricolored blackbirds (a large colony) nested in cattails around Searsville Lake in 1960. Both of these species are considered "species of special concern" throughout the year and throughout their ranges in California.

Finally, the salt marsh common yellowthroat (*Geothlypis trichas sinuosa*), a common breeder around Searsville Lake, is a former category 2 candidate[2] for protection under the federal Endangered Species Act. Of these 17 species of potential conservation concern that have previously been recorded at JRBP, five (yellow warbler, sharp-shinned hawk, Cooper's hawk, tricolored blackbird and common yellowthroat) might be expected to breed in the floodplain above Searsville Lake.

Riparian habitats support higher breeding bird density and diversity than any other habitat type in the western United States; on a local scale, riparian vegetation is critical in maintaining bird diversity at JRBP, even though it comprises only a small fraction of the habitat at the Preserve. At least 12 species potentially breeding within the study area are considered neotropical migrants, a group of species that are generally declining in western North America due to habitat loss and increased rates of brood parasitism and nest predation. Most of these neotropical migrants are dependent on healthy riparian habitats for breeding, showing local declines following degradation or alteration of these habitats. For this reason, the diversity and abundance of neotropical

[2] In 1995, all category 2 candidates were reclassified. At that time, the salt marsh common yellowthroat was neither granted protection nor elevated to the new status of candidate. However, it was not completely denied protection, and presently occupies a rather unclear "grey" zone -- it does not have the protection afforded to a candidate or listed species, but it does require consideration in landuse planning.

migrants, particularly riparian-obligate nesters, might be an indicator of the health of riparian habitats in the study area.

3.7.2. Birds -- methods

At each of the 19 plots established in the floodplain above Searsville Lake, birds were censused three times between 1 May and 15 June 1996 (hereafter referred to as "the study period" in this section), the period of maximum breeding activity of birds in the study area. On each census, the observer walked to the plot center, waited for one minute for bird activity to return to normal (in the event that birds were disturbed by movements of the observer), then counted all individuals of all species identified by sight or sound within 40 meters of the plot center during a five-minute period. Birds flying over the plots were not included in survey totals. In addition, birds using the floodplain habitat within the study area were noted during informal surveys and during efforts to measure habitat parameters on the study plots. Evidence of breeding noted during the point counts or during incidental observations at other times was also recorded.

Due to the former status of the "salt marsh common yellowthroat" as a candidate for federal protection, surveys for this species were conducted at various points around the perimeter of Searsville Lake (including the Middle and Upper Lakes) in order to determine the extent of the common yellowthroat population at Searsville Lake. The locations of territorial singing males at various points around Searsville Lake were noted, the sum of these survey totals giving an estimate of the number of breeding pairs in the vicinity of Searsville Lake.

The abundance of the European starling, an exotic that usurps the holes of native cavity-nesting birds, and the brown-headed cowbird, a brood parasite implicated in the local declines of some riparian-nesting species, were assessed during casual surveys in the JRBP in addition to the point counts.

3.7.3. Birds -- results and discussion

A total of 45 bird species were recorded during the formal point counts; these species are listed in Appendix A. Of these species, only one (western tanager) was thought to be a migrant rather than a locally breeding species, based on the observer's knowledge of the habitat requirements and distribution of these species. The other 44 species probably breed regularly in the study area.

A majority of the species recorded were permanent residents, occurring at Jasper Ridge year-round. Only 12 of the 45 species (26.7%) recorded on point counts are present only in summer; all are considered neotropical migrants, with a majority of these species' populations overwintering in tropical areas. These summer visitors comprised 28.2% of total bird abundance during point counts.

The high abundance of certain riparian-obligate species on point counts suggests that the riparian habitat in the study area is of high quality and is potentially very important to bird populations. Warbling vireo, Wilson's warbler, and Swainson's thrush, all riparian-obligate neotropical migrants at JRBP, were abundant in the study area. The latter two species in particular are excellent indicators of riparian habitat quality; these species were formerly abundant in most riparian habitats in the South San Francisco Bay area but have disappeared from riparian habitats showing only minor degradation elsewhere in the region. Solitary vireo, another neotropical migrant which nests primarily in riparian habitats, was recorded on six plots. An occupied solitary vireo nest along Corte Madera Creek on one plot near the upper edge of the study area represents the first confirmed breeding record of this species for JRBP.

In addition to the 45 species recorded on point counts, 28 other species were observed in the study area between 1 May and 15 June 1996 but not recorded on point counts. These species are listed in Appendix B. Nine of these additional species were thought to be potential breeders in the floodplain above Searsville Lake. These included

four species (sharp-shinned hawk, green heron, white-breasted nuthatch, and European starling) observed in the woody riparian habitat in which most plots were located; these species were not recorded on the formal point counts most likely due to their low abundance within the study area. Another five species (pied-billed grebe, mallard, gadwall, ruddy duck, and American coot) were observed only on upper Searsville Lake and probably nested in emergent herbaceous vegetation at the edge of Searsville Lake. These species were absent from point counts because the vegetation type in which they nested was poorly sampled by point counts, and the quiet nature of these species during nesting precluded auditory detection on the few plots that did include emergent herbaceous vegetation.

Seven species of swallows and one swift, aerial foragers omitted from point counts due to problems in detection of these species above the dense canopies, were recorded foraging over the riparian forest in the study area or over Searsville Lake. Although none of the species bred within the study area itself, cliff, barn, tree and violet-green swallows breed elsewhere at JRBP, and northern rough-winged swallow and Vaux's swift probably breed nearby. Two other swallow species, bank swallow and purple martin, were represented by single individuals on 15 and 9 May, respectively, foraging over Searsville Lake; both were most likely migrants.

Forster's tern, Caspian tern, great blue heron, great egret, black-crowned night-heron, double-crested cormorant, and belted kingfisher were observed hunting fish in Searsville Lake during the study period. Of these species, belted kingfisher is the only species currently breeding at JRBP (though not in the study area). Great blue heron formerly bred in cottonwoods at the upper end of Searsville Lake, but it and the remaining piscivores in this group used Searsville Lake only as a foraging site in 1996. White-tailed kite, red-tailed hawk, common raven, and turkey vulture were observed flying over the study area; a kite nest just outside the Corte Madera Creek floodplain

fledged young in May 1996, but none of these four species actually nested within the study area.

Thirty-two of the 45 species recorded on point counts were confirmed as breeding within the riparian habitat of the study area. These species are marked with an asterisk in Appendix A. Of the species not recorded on point counts, those for which breeding was confirmed were pied-billed grebe, mallard, gadwall, American coot, and white-breasted nuthatch. Because breeding is difficult to confirm for most species, requiring substantially more time than was available for these surveys, it would be inappropriate to assume that species not confirmed as breeding did not breed in the study area.

Although formal surveys were not conducted at other locations at JRBP, observations from numerous casual surveys throughout the Preserve and vicinity indicate that the riparian habitats at JRBP support considerably higher bird diversity and density than are found in any other habitat type in the Preserve (Rottenborn, pers. obs.). Of the 45 species recorded on point counts (Appendix C), it is estimated that at least 18 species are so dependent on riparian habitats that their populations would decline significantly or disappear altogether from JRBP if the Preserve's riparian habitats were severely degraded. The juxtaposition of a variety of wetland types is certainly responsible for much of the avian diversity in the study area, but the presence of such an extensive and dense stand of willows as is found at the upper end of Searsville Lake is probably the primary factor responsible for the extremely high densities of some riparian-dependent species.

Extensive willow thickets, once found in numerous locations throughout the San Francisco Bay area have been severely degraded and fragmented. Species that depended on dense willow stands have either been extirpated from the region (e.g., yellow-billed cuckoo [*Coccyzus americanus*], willow flycatcher [*Empidonax traillii*], and Bell's vireo [*Vireo bellii*]), or have had local populations reduced considerably (e.g.,

yellow-breasted chat [*Icteria virens*], Swainson's thrush, Wilson's warbler, and yellow warbler). It is therefore not unexpected that the few remaining willow thickets in the region, such as the one above Searsville Lake, support high densities of riparian bird species.

There are few usable data on the breeding avifauna of the Searsville Lake area with which the results of this study can be compared, as the results of long transect surveys that have been conducted at JRBP cannot accurately pinpoint the abundance of a species in a particular habitat type or within a small area. Nevertheless, comparison of these results with descriptions of the abundance of species at JRBP in 1960 (Row 1960) suggests that populations of most species have remained fairly stable or have increased. Of species that have bred regularly at JRBP, only great blue heron and yellow warbler have shown obvious declines as nesting species within the study area. The loss of great blue heron as a breeding species in the study area is not particularly alarming, as the colony that once nested in cottonwoods above Searsville Lake simply moved to a grove of redwoods in Portola Valley, where the colony is now larger than it was historically.

In contrast, there is no obvious explanation for the dramatic decline of the riparian-obligate yellow warbler at Searsville Lake. Whereas there were at least 12 nesting pairs present in 1960 (Row 1960), no more than one pair nested in the study area in 1996. Yellow warblers have declined state-wide due to loss of riparian habitat, and brood parasitism has been implicated as an important factor contributing to this decline. However, the willow-dominated habitat preferred by this species has actually increased above Searsville Lake since 1960 due to the establishment of willows on the progading Corte Madera Creek delta, and brown-headed cowbirds were found to be quite rare in the study area.

Nine bird species of conservation concern were observed in the study area during the study period. Seven species are considered California Department of Fish

and Game "species of special concern": double-crested cormorant, sharp-shinned hawk, Cooper's hawk, Vaux's swift, purple martin, yellow warbler, and yellow-breasted chat. Up to two double-crested cormorants were observed on Searsville Lake during the surveys, although this species is not expected to breed at JRBP. This species is regularly seen at Searsville Lake during migration or winter, although individuals from the nearest breeding colonies (on electrical transmission towers along the San Francisco Bay in Mountain View) probably use Searsville Lake as a foraging site during the breeding season. During the study, a Cooper's hawk nest found along Corte Madera Creek near the upper end of the study area fledged young. An adult male sharp-shinned hawk was observed once during the study period in the middle of the willow thicket above Searsville Lake, and an adult female was seen near the top of Jasper Ridge outside the study area. Both of these *Accipiter* species breed in a variety of wooded habitats. The dense woodland in the floodplain above Searsville Lake, combined with the high densities of these species' prey (small birds), provides ideal nesting habitat. Loss of or alterations to these riparian woodlands might reduce the suitability of the study area for nesting by these species.

Up to two Vaux's swifts were seen foraging on insects low over the study area. This species breeds in the Santa Cruz Mountains but uses chimneys or large hollow trees, so it is unlikely that Vaux's swifts nest in the study area. A single female purple martin foraging over Searsville Lake on 9 May 1996 may have been either a migrant or a visitor from one of the few breeding sites in the Santa Cruz Mountains; no other individuals of this fairly conspicuous species were observed. As stated previously, only one pair of yellow warblers over-summered in the study area, probably breeding in the willows in the Middle Marsh area. A singing male yellow-breasted chat heard in the willow thicket above the causeway on 9 May 1996 represented the first record of this species for JRBP. Although chats have not previously been recorded nesting in San Mateo County, they have bred as close as Santa Clara and nest at scattered locations

in Santa Clara County. This individual was not observed subsequently and was therefore probably a migrant, but the dense willow-dominated habitat above Searsville Lake may provide suitable nesting habitat for the species.

One species listed as "threatened" in California was observed in the study area. A single bank swallow (*Riparia riparia*) observed foraging over Searsville Lake on 15 May 1996 represented the first record for the Preserve. This species requires high, vertical banks of bare earth for nesting; because no suitable habitat exists at JRBP, this bird was undoubtedly a migrant.

Salt marsh common yellowthroats were found to be common in emergent herbaceous vegetation (mostly cattails and tules) around Searsville Lake (see Map 3). Efforts to estimate the breeding population at Searsville Lake in May and June 1996 revealed at least 22 singing males around Searsville Lake, and at least five broods of recently fledged young were noted. The presence of 22 pairs of salt marsh yellowthroats would represent a substantial increase over the 11 pairs estimated in 1975-76 and the 9 pairs estimated by Foster in 1977 (unpublished, Jasper Ridge report).

The two species potentially detrimental to native bird populations were seen in the study area in very low numbers. European starlings were observed only once in the study area (not on a formal census) but were more common in nearby non-riparian habitats. Brown-headed cowbird was recorded on only one census, and few were seen in the vicinity of JRBP. In contrast to suburban habitats in the Palo Alto area, where young cowbirds were frequently seen being fed by their host parents during the study period, no evidence of breeding by cowbirds was observed at JRBP. Therefore, it appears that during the breeding season of 1996, neither European starlings nor brown-headed cowbirds posed significant threats to bird populations in the study area. This further underscores the importance of the riparian woodland at Searsville Lake to bird communities on a regional scale. Sites with such low rates of brood parasitism (as

estimated by the lack of observed parasitism despite the numerous broods of fledged young observed) may be important sources for populations nesting in riparian habitats where brood parasitism is more common. Nevertheless, populations of starlings and cowbirds at JRBP should be monitored.

Because the impacts of further sedimentation on local vegetation can be predicted with reasonable confidence, and the habitat affinities of most of the bird species recorded in the study area are well known, it is possible to speculate on the future of these bird species in the study area. Sedimentation of Searsville Lake will result in an increase in the extent of riparian habitat in the Searsville Lake area. Populations of species requiring or using wooded riparian habitats for nesting, such as warbling vireo, solitary vireo, Swainson's thrush, Wilson's warbler, hairy woodpecker, and most of the species recorded during the 1996 bird surveys, will probably increase as a result of the succession occurring in the filled lake.

Species requiring open water, including all waterfowl, herons, terns, double-crested cormorants and ospreys, will decline, being restricted to the remaining ponded areas at the edge of the "Searsville Valley." Mallards and wood ducks may persist in stream channels after Searsville Lake is filled. Species such as salt marsh common yellowthroat and red-winged blackbird, and song sparrow to a lesser extent, may initially increase in number as sedimentation of Searsville Lake progresses and the area occupied by emergent herbaceous vegetation and dense young willows increases. These habitats are generally short-lived in aggrading areas, as emergent herbaceous vegetation is gradually replaced by woody riparian vegetation. If the rate of sedimentation is high, then the area occupied by quickly-growing emergent herbaceous vegetation is likely to be greater (relative to that occupied by the more slowly maturing woody vegetation) than if the rate of sedimentation is low. Therefore, numbers of salt marsh common yellowthroats, red-winged blackbirds and song sparrows are likely to increase until the extent of marshy herbaceous vegetation reaches its maximum extent.

At this point, the extent of the marshy vegetation may provide suitable habitat for rarer nesting species, such as sora, Virginia rail and tricolored blackbird. After this time, woody riparian vegetation will gradually encroach on the marshy vegetation. Eventually, as succession replaces preferred habitats with more mature woody riparian vegetation, common yellowthroats and red-winged blackbirds will be restricted to the marshy borders of ponds that might still exist at the edges of "Searsville Valley."

Of the species of conservation concern breeding in the study area, sharp-shinned hawk, Cooper's hawk, and yellow warbler will probably increase as the extent of riparian woodland increases with further sedimentation of Searsville Lake. Common yellowthroat will initially increase, but eventually replacement of emergent herbaceous vegetation with woody plants will cause yellowthroat populations to decline.

3.8.1. Mammals -- introduction

The mammals using the riparian habitats at JRBP have received little research attention relative to other taxa. At least one mammal species previously recorded at the Preserve is of conservation concern: Townsend's big-eared bat (*Plecotus townsendi*) is both considered a state species of special concern, and is a former category 2 candidate for federal protection. The pallid bat (*Anthrozous pallidus*), also a state species of special concern, may also be in the area. Both species are aerial feeders and might forage on the insects and riparian habitat above Searsville Lake.

Due to a lack of data regarding associations between local mammal species and riparian habitat parameters, the extent to which the distribution and abundance of mammal species in the study area can be used as an indicator of ecosystem health is unknown. However, mammals were surveyed as part of this study for three main reasons. First, riparian systems are known to support relatively high diversity of birds, and, to a lesser degree, of amphibians, reptiles and invertebrates, but the importance of these systems to mammals is relatively unknown. These surveys help to fill that gap in

knowledge of both riparian animal communities in general and, more specifically, of mammal distribution at JRBP. Second, most of the floodplain above Searsville Lake was inundated on several occasions during the winters of 1994-95 and 1995-96. Few or no small mammals, with the possible exception of squirrel or woodrat species that might have been able to climb and survive in trees, could have survived these periods of inundation within the study area. The degree to which the floodplain would be re-populated by individuals from the surrounding uplands or from unflooded areas farther upstream is unknown but is of potential importance in understanding the impacts of flooding and changes in flow patterns (e.g., due to potential management efforts) on riparian animal communities. Finally, future analyses of community parameters will test for associations between vegetation/physical parameters and the diversity and abundance of mammals. If these analyses find relationships between environmental parameters and the distribution of mammals in the study area, it might be possible to use measures of the mammal community as an indicator of the ecological status of the study area.

3.8.2. Mammals -- methods

At each of the 19 plots established in the floodplain above Searsville Lake (described in Section 2), small mammals were trapped on 14 nights between 22 May and 5 June 1996. One squirrel trap and two Sherman traps were used at each plot. Therefore, over 14 nights and 19 plots, small mammals were sampled with a total effort of 798 "trap-nights." Traps were pre-baited for one week prior to the onset of sampling. Sherman traps were baited with sunflower seeds, oats, and apples, while squirrel traps were baited with a seed mixture, apples, and meat jerky. All traps were baited in the early afternoon and animals were released the following morning.

3.8.3. Mammals -- results and discussion

A total of 89 individuals of 12 species were trapped in the study area. These species are listed in Appendix G with the number of individuals of each species and the number of plots on which each species was captured. Small mammals were trapped on 16 of the 19 plots. Larger mammals observed in the study area (but whose abundance was not quantified) included mule deer (*Odocoileus hemionus*), observed throughout the floodplain, and black-tailed jackrabbit (*Lepus californicus*) and California ground squirrel (*Otospermophilus beecheyi*), seen only near the edges of the floodplain. No mammal species of conservation concern were recorded, as bats were not formally surveyed during this study.

Four of the 12 species trapped are not native to California. Single individuals of house mouse and black rat, species normally associated with areas of human habitation, were captured; both were on plots near the fringes of the floodplain fairly close to residential homes. The other two exotics were tree squirrels: one eastern gray squirrel and four fox squirrels were captured. The presence of these two exotic tree squirrels in the study area is rather unusual, as both species are typically associated with urban and suburban areas where they have been introduced in California (Ingles, 1965). Only one individual of the native tree squirrel (*Sciurus griseus*) was captured; incidental observations in the study area confirm that the native western gray squirrel is fairly rare there.

All of the smaller rodents captured are known to be common in the Santa Cruz Mountains, and all but the California vole and Botta's pocket gopher seem to be most common in wooded habitats (Ingles 1965). That the California vole, most abundant in grasslands, should be captured more often than any other species in the riparian woodland above Searsville Lake seems unusual, but probably reflects the abundance of the species in grasslands at JRBP and in surrounding areas and the ability of voles to expand into the riparian area.

Because there were no data on the abundance of these species in the study area prior to spring of 1996, the extent to which their distribution or abundance may have been affected by flooding in winter 1995-96 is unknown. Nevertheless, it is clear that these species are able to re-invade inundated areas within a few months of flooding; the plots on which California voles were most abundant contained more standing water than most of the plots from which they were not trapped. Because no similar studies have been conducted at other locations at JRBP, it is not known how the diversity of small mammals in the floodplain at Searsville Lake compares with other locations and habitat types at the Preserve. Similarly, it is difficult to predict how further sedimentation of Searsville Lake and the resulting changes in vegetation will impact mammal communities. Because none of these mammals is dependent upon wetland habitats, however, it is likely that an increase in the extent of terrestrial habitats would provide more habitat for these species.

4.1. GENERAL DISCUSSION

The deposition of substantial amounts of sediment at the upper end of Searsville Lake has resulted in the encroachment of early-successional trees, primarily willows, into the former lake bed. As a result, the lower Corte Madera Creek floodplain is dominated by these tree species. With further sedimentation of Searsville Lake, an increasing area will be colonized and occupied by woody riparian vegetation, although continued flooding will probably limit succession, because later-successional species are not very tolerant of inundation. The composition and structure of this riparian woodland will depend on the duration and frequency of flooding and the amount of disturbance in the floodplain, but willows will likely dominate initially.

This study found that the floodplain above Searsville Lake supported very high avian diversity and abundance. Diversity of native fish, amphibian, reptile, and mammal species in the creek and floodplain is relatively low, possibly due to the effects of winter flooding on populations of these taxa in the floodplain and a lag in re-population of low-lying areas. This presents an interesting dilemma -- what is perhaps best for the fish, amphibians, and reptiles (and maybe mammals) is to get rid of the dam, or have Searsville Lake fill as fast as possible. This would help decrease the number of non-native species inhabiting the area. Birds, on the other hand, will likely benefit from a combination of continued open water and mix of young and older vegetation. Due to reductions in the extent of riparian habitats throughout the western U.S., particularly the loss of dense willow thickets, the floodplain habitat above Searsville Lake may be of regional importance to bird communities.

In terms of "protected species," few species pose problems for land use decision-making in the study area. Despite the high avian diversity in the floodplain, only one species (bank swallow) was recorded in the study area that is listed as threatened or endangered on state or federal species lists; the single bank swallow observed was

undoubtedly a migrant and, thus, not a major concern. Red-legged frogs, a recently listed species that was probably historically present in the study area, was not observed in Searsville Lake or in the lower Corte Madera Creek floodplain. Introduced centrarchid fishes, crayfish, and bullfrogs in Searsville Lake have probably been primarily responsible for the decline of this species in the vicinity of JRBP. Although the dynamic nature of the floodplain undoubtedly influences red-legged frog distribution, control of populations of the non-native species may be necessary to allow re-colonization of the study area by red-legged frogs.

Seven species of birds considered California Department of Fish and Game "species of special concern" were recorded in the study area. While sharp-shinned hawk, Cooper's hawk and yellow warbler probably nested in the study area, double-crested cormorant, Vaux's swift, purple martin and yellow-breasted chat were most likely migrants or were using the study area only for foraging. In addition, the emergent herbaceous vegetation and moist herbaceous understory in the lower portion of the willow thicket supported fairly high numbers of salt marsh common yellowthroat, a former category 2 candidate for federal listing. Given the large numbers of yellowthroats nesting around Searsville Lake and the paucity of breeding habitat elsewhere on the Peninsula, Searsville Lake must be considered a very important breeding area for this rare subspecies. Further sedimentation of Searsville Lake will probably increase the extent of breeding habitat for sharp-shinned hawk, Cooper's hawk and yellow warbler; breeding habitat for common yellowthroat will probably increase initially but then decline as the valley becomes dominated by woody riparian habitat.

Exotic vegetation was not found to be an important immediate threat to riparian habitats. While disturbance of existing native vegetation and alteration of hydrologic regimes (such as might occur as a result of channelization) might provide conditions conducive to invasion by exotics, the most common invaders of riparian systems in the U.S. will probably not present a problem in the study area. Nevertheless, any alteration

of riparian habitats at JRBP should be followed by monitoring for exotic species. Likewise, at the present time non-native bird species appear to pose little problem for the riparian areas of JRBP; European starling and brown-headed cowbird were observed only in low numbers, (starlings were abundant in the vicinity, but only in upland areas).

Sedimentation of Searsville Lake is likely to improve the area for red-legged frogs and native fishes by making the lake less suitable for the exotic predators (bullfrogs, crayfishes, and centrarchid fishes). These exotic predators are well adapted to lentic habitats such as Searsville Lake, so replacement of these habitats with a narrower, more incised channel will improve aquatic habitat conditions for native species. Reductions in populations of these exotics in their Searsville Lake nursery grounds will also reduce their numbers throughout the San Francisquito Creek system. However, it is likely that exotic fishes, crayfish, and bullfrogs will always be present in the system.