An Ecological Survey of the Jewel Lake Area, with Recommendations for Proposed Dredging

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Introduction

Jewel Lake is a small man-made lake located of the Nature Area in Tilden Park (Figure 1). Tilden Park is located in the Berkeley Hills and is under the jurisdiction of the East Bay Regional Parks District (EBRPD). Jewel Lake was created by construction of a dam across Wildcat Creek in the early 1920's (Gordon, 1988, pers. comm.). In several years this lake will be dredged to alleviate the problem of excessive siltation, which detracts from the intended uses of the lake. The purpose of this study is to provide data on the ecology of the lake area. These data will then be available to park officials when they make final decisions on the type, extent, time frame, and details of the dredging. The study will also provide recommendations on how to proceed with the dredging. The data provided will be in the form of three transects (Figure 2), with plant types given in terms of density.

Because of the many uncertainties involved with altering an ecosystem, the EBRPD attempts to maximize information before acting. This study is consistent with the EBRPD Master Plan Section IV.G.4, which states that "Research and experimentation for the management of the District's land resources...shall be undertaken as time and resources are available" (EBRPD, 1980). The study also addresses Section IV.K., the Natural Conditions Restoration Policy.

The Jewel Lake basin is what is defined by the East Bay Regional Parks District as a "drainage basin", a rough topographical term. Note that "basin" is not used in the hydrologic sense of all land surface from which water flows through a specific point (Winsley et al., 1982), but to describe the area through which all of the water flows and which will be affected by dredging. No previous studies of this area are on record.

The East Bay Regional Parks District Vegetation Management handbook notes that there are "...a variety of processes for establishing and maintaining a desired vegetation mosaic. Virtually all of these processes are of a destructive nature, or require destructive preliminary work" (Nicoles , 1976). It also notes that drainage bottoms (of which the study area is one) are "generally...the most favorable sites for vegetation."

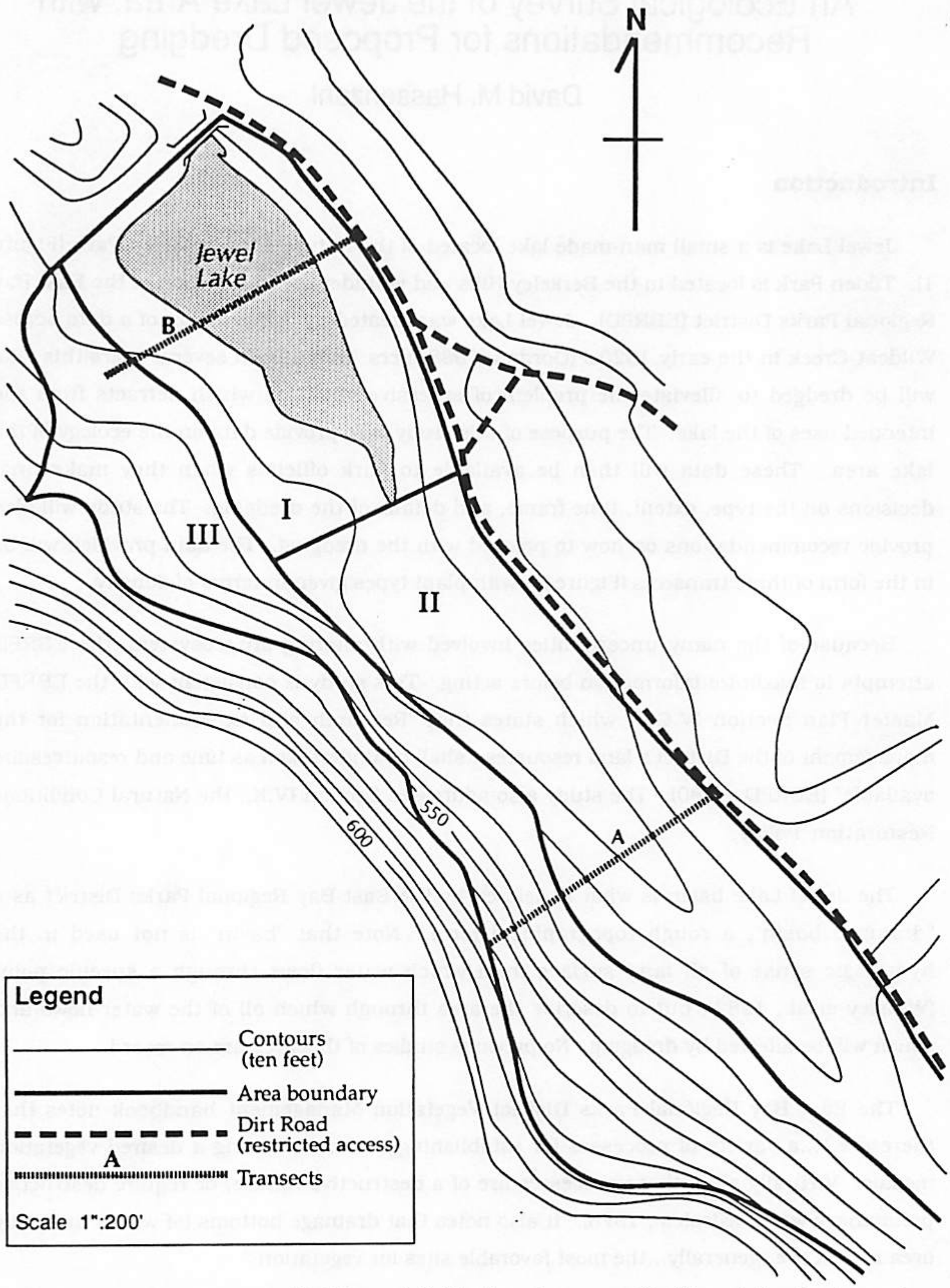

Figure 1. Jewel Lake Topographic Map, subdivided into three areas, I to III, and showing transects.
Source: After EBRPD, Design Department, 1964.

Relevant Issues: Several questions are important in determining the most desirable type, extent, time-frame, and details of the dredging. The various types of vegetation present in the drainage basin may have both long- and short-term responses to dredging. It is necessary to evaluate the impacts on vegetation, and from this base of knowledge and other external factors, such as time constraints and financial aspects, determine the conditions and type of dredging that are consistent with the desired goals.

History of Jewel Lake

In the early 1920's, earth was transported from the slope above Jewel Lake to build a dam across Wildcat Creek (Gordon, 1988). The dam is approximately 70 meters long, and produces a lake covering about 7500 m^2, depending on the season (low point is in October, high point in March or April). Redwoods were planted along this dam to provide stability. The present purpose of the lake is to provide a representative pond/lake environment for the visitor to the Nature Study Area.

Jewel Lake was last dredged in the early 1970's. This was done by draining the lake, then spending several seasons with earth-moving equipment, such as bulldozers and dump trucks, removing excess sediment from the lake bottom. As a result, the habitats in and around the lake were disrupted during this time. After dredging was completed, the remaining sediment that had accumulated upstream of the lake, still within the greater lake area, was reworked by the higher energy of the creek, and refilled part of the dredged section quickly. Presently, the lake contains enough sediment that, once again, dredging is warranted.

Dredging

Dredging is a process whereby sediments are removed from the floor of a body of water, in this case, Jewel Lake. There are several methods by which dredging may be accomplished.

The first is dry dredging. This method, the one used in the last dredging, consists of several steps. First, the water is drained and the stream rerouted. Equipment is then brought in to excavate the sediment, which is removed to a landfill. This type of dredging is the most ecologically traumatic, as it changes a previously flooded area to an area of no water inflow. It is also results in the most complete possible dredging, and completion may easily be confirmed. One way to reduce the potential damage of this type of dredging is to dam the creek at a higher point, thus allowing a proximal refuge for dependent fauna (Gordon, 1988, pers. comm.).

The other method for dredging is wet dredging—dredging with removal of only some or none of the water. This too may be accomplished by scraping and digging; it may also be done with a vacuum system, which draws the fluid sludge out through a tube. In the case of Jewel Lake, a boat-mounted apparatus, such as is used in San Francisco Bay would be impractical. However, a shore-based vacuum system or crane could accomplish the task.

Methods and Materials

The study area, which is shown on the Jewel Lake map (Figure 1), is divided into three subareas, Areas I-III, which correspond to the immediate lake area (I), the slow inflow area (II), and the slope/high energy area (III).

Area I: This area covers 20,000 m^2. It is primarily a lacustrine area and includes the lake and the dam. The lake is approximately 60 m by 150 m and covers 7500 m^2. The northwest boundary of the area is a man-made earthen dam with a concrete spillway. This is the area to be dredged, although not all of it will be affected.

Area II: This area covers approximately 16,000 m^2. It is the area through which all of the lake inflow passes as runoff. It includes several culverts under the northwest trail, random runoff from Area III (see below), and a culvert at the southwest end. This is also the basin in which sediment accumulates, sediment which may be reworked when the energy of the flow-through increases after dredging.

During the summer season (late May to November), this area is devoid of surface water. During the rainy season, water is present in two primary forms; water flowing through one main channel with several sources, and pools (3-10 m diameter), many of which rapidly stagnate due to the large amounts of organic matter, especially fescue, grasses, and leaf litter.

Area III: This area covers approximately 15,000 m^2. This is the steep sloping area immediately above the lower runoff basin of Area II. It is the suspected source of much of the excess sediment buildup of Area II. Area III includes much of the lower trail, as well as numerous unofficial trails. It is mostly dense vegetation, except where broken by trails or too steep to support vegetation due to erosion.

The area has no permanent stocks of water; the only temporary stocks are puddles on the man-made trails. The water flow is mostly surface runoff.

The area is densely overgrown, with large trees (especially willow, madrone, California laurel, and oak) and abundant ferns. The vegetation and direction of the slope (north-facing) allow the area to remain damp even in the summer, and summer temperature is several degrees lower than in the surrounding area.

Habitat mapping: The habitats were mapped during field observations, revised into a presentable form, and then taken back to the field for confirmation and possible further revision. The map was created on MacIntosh computers with Aldus Freehand, based on a scan of the 1964 topographic map prepared by the EBRPD Design Department. The topography of the area has not changed significantly since the map was made. The three main areas, I-III, were paced off (measurement and field experience show a 5' stride), and major landmarks (permanent recognizable objects) were plotted as references.

Transect methodology: Line transect analysis was chosen because it has the advantages of eliminating the exaggerations of a point analysis, allowing greater efficiency of operation for a large area (Greig-Smith, 1983), and providing information across several vegetation types. Transect method was based on guidelines of Greig-Smith (1983). The transects in this study were based on a straight line from boundary to boundary, lined up by compass heading.

All vegetation originating within 0.5 m of each side of the transect line was recorded in terms of density. The total number of trees in each segment was recorded. Other plants were measured as percent of ground shaded. Data were taken for each 10 m segment along a transect. Consequently, the area of each segment was 10 m x 1 m, or 10 m^2. Because one plant may overshadow another, total ground cover for an area may exceed 100 percent (Greig-Smith, 1983). No attempt was made to estimate biomass of individuals, except in the case of trees, for which diameter at breast height (dbh) was measured. Litter, water, and bare ground along each transect were also recorded. Numbers above 10 percent are accurate to within ±2 percent; those below 10 percent are accurate to within ±0.5 percent. Trees, recorded by number of individuals, are here represented by number per unit area.

The exact location of each transect is not necessary for an accurate study. The transects were chosen to be representative, and therefore are random in nature. A transect beginning within a 20 m radius in any direction of the actual points of origin of transects in this study and following the same compass heading should give comparable results. A repeat of this study, therefore, could be performed by approximation of the three points of origin shown on Figure 1.

Value of data: These data have been recorded in semi-quantitative terms; the attempt was made to avoid qualitative assessment. However, species vary in conspicuousness as a function of mode of life, seasonal changes, and distribution (Greig-Smith, 1983). Ideally, the transect method, recording all plants originating within the sections, has alleviated this problem, resulting in a set of data that is independent of sampling method.

Transects: All transects originate at the road (Figure 1).

Transect A begins 115 m northeast of the road junction. It follows a straight line 230° from north, and is 80 m long.

Transect B begins 60 m southeast of the southeast end of the bridge across the dam. It crosses the lake proper, is 100 m long, and runs 230° from north.

Floral identifications were based on personal knowledge with assistance by D. Michael Foulkes, amateur botanist, and several source books (Gordon, 1986; Grillos, 1966; Little, 1980; Niehouse and Ripper, 1976; Reid, 1967; Watts and Watts, 1986a, 1986b). Bird identifications were done by Cynthia Coates, fellow Environmental Science Major and amateur ornithologist.

Data

Information gathered is presented in Tables I and II, with a list of birds observed in Appendix I and supplementary raw data in Appendix II. Table I, a species list, is presented in terms of types of vegetation along the transects. These species represent two major floral realms. First, the cattails, horsetails, and others are species frequently found in lacustrine or riparian areas. Others, especially ferns, are characteristic of moist, shaded, temperate areas.

An analysis of the species from Table I as observed in Table IIa (and compared to actual data in Appendix I) show how these two characteristic floras exist in the lake area.

Area I, the actual lake area, is represented by Transect B. A large number of cattails and grasses border the lake. Shrubs are found clustered a short distance to either side of the lake. Trees near the lake are lacustrine/riparian varieties; the one Ponderosa Pine is about

60m from the actual lake. The large percentage of bare ground is of two types: man-made (trails) and presumably allelopathic (beneath trees).

Ferns and fern allies
- *Polystichum* sp. (ferns)
- *Equisetum* sp. (Horsetails)

Cattails
- *Typha latifolia* (Broad-leaved cattail)

Grasses
- fescue
- others

Herbs
- *Symplocarpus foetidus* (skunk cabbage)
- *Fragaria californica* (wood strawberry)

Shrubs
- *Myrica californica* (Pacific bayberry)
- *Rubus vitifolius* (California blackberry)
- (Pussywillow)
- *Rhus diversiloba* (Poison oak)

Trees
- *Umbellularia californica* (California laurel)
- *Arbutus menziesii* (Madrone)
- *Salix* sp. (Willow)
- *Cornus nuttalii* (Pacific Dogwood)
- *Quercus agrifolia* (Coast Live Oak)
- *Pinus ponderosa* (Ponderosa Pine)

Table I. Species found along Transects A and B at Jewel Lake

Area II is represented by the first half of Transect A (0-40m). This area is quite similar to Transect B, except that there is less bare ground (no trails), fewer large trees, and very few cattails. Cattails and horsetails are associated with the flowing water channels.

	Percent Cover	
	Transect A	Transect B
Bare ground	5	20
Ferns and fern allies	10	0
Cattails	4	10
Grasses	1	10
Herbs	5	0
Shrubs	50	40
Trees	1 per 20 m^2	1 per 10 m^2

Table IIa. Percent cover of dominant vegetation along each transect.

Area III is represented by the second half of Transect A (40-80m). Dominant vegetation here is wild blackberry, interspersed with ferns and herbs. This is expected given the topography of the area, a steep north-facing slope. Most observed erosion in the area is associated with trails; where there are no trails, erosion is effectively controlled by shrubs.

The bird list of Appendix I shows birds that inhabit the area. Some occupy a range greater that just the study area. Nesting sites were not observed; however, it is assumed that many of the smaller birds nest within the area, especially in Area II.

Litter
- Transect A: Predominantly willow and oak leaves
- Transect B: Eucalyptus, oak, and bay leaves. Ponderosa needles and cones, redwood segments and cones.

Water
- Transect A: 2 channels, 1 m wide and 1.5 m wide.
- Transect B: Lake, 40 m cross section.

Table IIb. Non-living ground cover along Transects A and B at Jewel Lake.

Discussion

These data provide a description of the current status of the vegetation. Interpretations cannot be made without some prior knowledge of the species involved, especially with respect to ability to withstand abnormal long-term reductions in seasonal water availability, and the length of time needed to rebound from such a fluctuation.

Area I will undoubtedly be the area most affected by the dredging. The trees in the area, which are relatively widely spaced and at least several years old (well established), probably get most of their water from subsurface sources. They will show little or no effects even from several years of lake reduction. The ground cover more than 5 m from the lake banks should also show no significant changes during the dredging, as it is more dependent on flows than permanent water.

What will be affected in this area is the lake side flora. These plants are dependent on large and permanent water supplies. It is probable, however, that even with several years without a water supply, these plants would recolonize on their own or be replanted by park staff within one or two seasons.

Area II is the area at risk if the lake is not dredged. As the lake bottom fills with sediment, the maximum surface level will creep progressively further into the area. As this happens, deposits could increasingly fill the upper section, resulting in a sediment deposition-stream energy decrease feedback loop. The result of this would be to transform Area II into a marsh-like environment.

The area would not be subjected to the immediate effects of dredging; however, it is likely that dredging would cause an increase in stream energy in the area. This would alter the channels somewhat and would further undermine the banks. As most of the area is dependent on seasonal water fluctuation (which would remain largely unaltered), overall effects of dredging would be minimal.

Area III is above the point at which dredging would cause a change in stream energy; no net changes in vegetation would be expected.

Conclusions/ recommendations

The goals for Jewel Lake include maintaining it as a lake for the benefit of visitors. It is the most accessible "natural" lake environment in Tilden Park. Partly because it is artificial, Jewel Lake is not in a state of long-term equilibrium; the dam causes a decrease in energy, allowing suspended sediments to settle out. To maintain Jewel Lake in the desired form (as is consistent with the Master Plan), dredging, although disruptive, is absolutely necessary.

Because it is unlikely that even long-term rerouting of water flow will have a lasting effect on the area, economics may be the key to the method of dredging. Several points should be kept in mind to minimize the effects, and insure a rapid return to the ideal.

Heavy equipment may change the densities of the ground by compaction; it could also cause unusual erosion and increased sedimentation. Therefore, roads should be followed as much as possible, and departures should be consistent in location. The southeast edge of the lake is probably the ideal approach, as it is closest to the area entrance, and has a gradual slope to the lake that is relatively free of vegetation.

The optimum time for the dredging to be started would be late summer/early fall (ie. at minimum water level, prior to the rainy season). This would allow migrational water dependent fauna (newts, migrating birds, etc.) to choose alternate sites. In addition, the water content of the sediments would be at a minimum, especially in areas where the sediment is exposed by the low water level. 1989 could be an ideal year, as consecutive drought years have resulted in an unusually low water level.

Some work in Area II could also be beneficial. Removing some of the backlog of sediment would increase the time before the next dredging. Some restructuring of the channel, especially supporting the banks, would reduce undesired erosion upon stream energy increase.

In Area III, reducing the number of trails (especially unofficial trails), and reinforcing those remaining, would decrease the rapid erosion from the steep slope. Additional culverts under the trails would have the effect of decreasing erosion and reducing overall trail maintenance.

As an alternative to following the present plans for the conditions of Jewel Lake, it might be useful to reconsider the desired state of the lake. If dredging is not done, the system will most likely remain much as it is now; the lake will creep farther into Area II over time as the bottom fills in, the wash through the area will decrease in energy, and the overall nature will continue the trend towards "swampiness." Allowing the lake to follow a normal, unaltered evolution would provide an interesting study of change over time of a lake to a marsh; this could be regularly photographed, mapped, and otherwise recorded, and presented as a sequence at the nature area. This alternative would require reevaluating policy of the management of Jewel Lake, but could be a valuable exercise.

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Appendix I: Birds Observed in Jewel Lake Area

Common name	**Binomial**
Mallard	*Anas platyrhynchos*
Turkey Vulture	*Cathartes aura*
Red-tailed Hawk	*Buteo jamaicensis*
American Coot	*Fulica americanica*
Mourning Dove	*Zenaida macroura*
Anna's Hummingbird	*Calypte anna*
Allen's Hummingbird	*Selasphorus sasin*
Northern Flicker	*Colaptes auratus*
Black Phoebe	*Sayornis saya*
Steller's Jay	*Cyanocitta stelleri*
Scrub Jay	*Aphelocoma coerulescens*
Chestnut-backed Chickadee	*Parus rufescens*
Plain Titmouse	*Parus inornatus*
Bushtit	*Psaltriparus minimus*
Brown Creeper	*Certhia americana*
Bewick's Wren	*Thryomanes bewickii*
Ruby-crowned Kinglet	*Regulus calendula*
Hermit Thrush	*Catharus guttatus*
American Robin	*Tardus migratorius*
Wrentit	*Chamaea fasciata*
European Starling	*Sturnus vulgaris*
Hutton's Vireo	*Vireo Huttoni*
Warbling Vireo	*Vireo gilvus*
Orange-Crowned Warbler	*Vermivora celata*
Yellow-Rumped Warbler	*Dendroica coronata*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Brown Towhee	*Pipilo fuscus*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
White Crowned Sparrow	*Zonotrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*
Red-winged Blackbird	*Agelaius phoeniceus*
Brewster's Blackbird	*Euphagus cyanocephalus*
House Sparrow	*Passer domesticus*

Appendix II: Raw data recorded by Transect

Transect A:

Distance from origin	Cover
0-10m	10% fescue 60% wild blackberry 30% cattails 10% Pacific Bayberry Litter: willow and oak leaves
10-20m	40% wild blackberry 20% Pacific Bayberry 10% Pussywillow 1 California Laurel (at 20m, 1m wide flowing channel, dry in winter)
20-30m	5% poison oak 10% wild blackberry 1 California Laurel, 20cm diameter (at 25m, 1.5m channel, rapid flow)
30-40m	(slope begins) 5% maidenhair fern 85% wild blackberry 5% skunk cabbage 5% Pacific Bayberry
40-50m	(Steep slope begins) 15% maidenhair fern 90% wild blackberry 10% skunk cabbage 1 holly plant
50-60m	100% wild blackberry
60-70m	70% wild blackberry 25% wild strawberry 1 California Laurel, 14cm diameter
70-80m	(trail at 70m: bare) 40% maidenhair fern 1 Madrone, 30cm diameter

Transect B:

0-10m	25% grass 25% wild blackberries 1 Willow, 4 cm diameter Litter: eucalyptus and other leaves 10% bare ground
10-20m	(trail crosses at 10m, 1m wide) 75% wild blackberry (25% trampled) Lake edge at 15m, 16m at summer low
20-50m	Lake surface
50-60m	51m low lake level 54m high lake level 80% cattails 20% bare ground 1 Pacific Dogwood, 10cm diameter
60-70	50% wild blackberry 20% fescue 10% grasses 73-75m, trail (bare surface) 2 Coast Live Oaks, each 10cm diameter
70-80m	30% wild blackberry Litter: redwood segments and cones, oak and laurel leaves 1 California Laurel, 40cm diameter
80-90m	70% wild blackberry Litter: redwood segments and cones, oak and laurel leaves 1 Coast Live Oak, 45cm diameter
90-100m	20% wild blackberry 30% grasses Litter: Ponderosa Pine needles and cones, oak leaves
100-110m	10% poison oak 5% grasses 70% bare surface litter: Ponderosa needles and cones 1 Ponderosa Pine, 75 cm diameter