SACRAMENTO MUNICIPAL UTILITY DISTRICT
UPPER AMERICAN RIVER PROJECT
(FERC Project No. 2101)

and

PACIFIC GAS AND ELECTRIC COMPANY
CHILI BAR PROJECT
(FERC Project No. 2155)

RESERVOIR SHORELINE HABITAT TECHNICAL REPORT

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APRIL 2005
Version 2

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4.11 Reservoir Fish Habitat

This study is designed to assess the effects of reservoir water level fluctuations at the Sacramento Municipal Utility District's Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project on fishes. The overall approach is divided into four phases. The first phase includes identifying for each reservoir the normal season, weekly and daily water level fluctuations and the extent of the susceptibility of the fishes that occur in that reservoir to those fluctuations. The second and third phases include, for those fishes that are susceptible, characterizing and quantifying the amount of habitat affected by water level fluctuations. The last phase is an assessment of how the water level fluctuations affect each fish species. The work will occur in 2002, and information from the UARP Relicensing Fish Survey Study and Water Temperature Study as well as UARP's recent bathymetry study will be needed for the UARP reservoirs.

4.11.1 Pertinent Issue Questions

This Reservoir Fish Habitat Study Plan addresses the following Aquatic/Water Issue Questions:

18. Do annual/seasonal/daily water level fluctuations in reservoirs affect aquatic species? Which ones are affected? How are they affected? When are they affected?
30. What are the effects of the Project to warm water fisheries in the project reservoirs?
35. How are project releases into Chili Bar affecting aquatic resources?

Note that this study plan only addresses fish: amphibians and aquatic reptiles are addressed in the Amphibians and Aquatic Reptiles Study Plan. The fish species that occur in the Project reservoirs will be confirmed based on the Fish Surveys Study. For the purposes of this study plan's execution, it is understood that SMUD will address the UARP reservoirs and SMUD and PG&E will jointly address Chili Bar Reservoir.

4.11.2 Background

This study focuses on the potential effects of reservoir water level fluctuations on fishes. While studies have not yet been completed, SMUD's Initial Information Package (SMUD 2001) provides some insight into the fish species composition in the UARP reservoirs and normal UARP Project reservoir water level fluctuations. This information is summarized in Table 1 below.

TABLE 1. Fishes reported to occur in Sacramento Municipal Utility District's Upper American River Project reservoirs and normal water level fluctuations in those reservoirs.

Reservoir	*Fishes Reported to Occur*[1]	*Normal Water Level Fluctuations (feet)*
Rubicon	Rainbow Trout, Brown Trout, Brook Trout & Golden Trout	12
Rockbound	Rainbow Trout, Brown Trout & Brook Trout	---
Buck Island	Rainbow Trout, Brown Trout & Brook Trout	11
Loon Lake	Rainbow Trout, Brown Trout, Brook Trout, California Roach, Chubs, Sacramento Sucker & Green Sunfish	36
Gerle Creek	Rainbow Trout, Brown Trout & Brook Trout	5
Robbs Peak	Rainbow Trout & Brown Trout	6
Ice House	Rainbow Trout, Brown Trout, Brook Trout, Kokanee Salmon, & Golden Shiner	42
Union Valley	Rainbow Trout, Lake Trout, Cutthroat Trout, Kokanee Salmon, Sacramento Sucker, Smallmouth Bass, Golden Shiner, Green Sunfish & Mosquitofish	53
Junction	Rainbow Trout, Lake Trout, Stocked Cutthroat Trout, Kokanee Salmon, Sacramento Sucker, Smallmouth Bass, Golden Shiner, Green Sunfish & Mosquitofish	15
Camino	Rainbow Trout, Brown Trout, Brook Trout, Sacramento Sucker, Minnows, California Roach & Riffle Sculpin	20
Brush	Rainbow Trout	20
Slab Creek	Rainbow Trout, Brown Trout, Brook Trout, Kokanee Salmon, Sacramento Sucker, Minnows, California Roach, Hardhead, Speckled dace, Smallmouth Bass & Sculpin	30

[1] From Page E3-14 through 30 of SMUD's IIP.
[2] From Pages B21 through 42 of SMUD's IIP

4.11.3 Study Objectives

The objective of this study is to assess how reservoir water level fluctuations effect fish.

4.11.4 Study Area

The study area will include all UARP reservoirs with the exception of Robbs Peak reservoir since it fluctuates only 5 to 6 feet annually. Also, Rockbound Lake is not included in the study area since the Licensee does not control water level fluctuations in this lake. PG&E's Chili Bar Reservoir is included in the study area.

4.11.5 Information Needed From Other Studies

Information needed from other studies includes: 1) the fish species that occur in each reservoir from the Fish Surveys Study; 2) channel geomorphology data from the Channel Morphology Study Plan; 3) water quality data from the Water Quality Study Plan; and 4) water temperature conditions in the reservoirs from the Water Temperature Study. Additionally, SMUD and PG&E will need to characterize seasonal, weekly and daily water level fluctuations in each reservoir. Lastly, information from SMUD's recent reservoir bathymetry study will be valuable in the initial identification of potential habitat in UARP reservoirs

4.11.6 Study Methods And Schedule

The study assessing coldwater and warmwater fish habitat will be conducted in four phases, each of which is described below.

Phase 1 – Identify Fish Species in Each Reservoir and Their Likely Sensitivity to Water Level Fluctuation

- As a first step, SMUD and PG&E will confirm which fishes (and life stages) occur in each Project reservoir in the study area (from the Fish Survey Study) and, by reviewing existing scientific literature, determine the susceptibility of each of these fishes and their life stages to water level fluctuation. This could include dewatering of nests for fish that nest in shallow water, loss of cover for species that use shallow vegetated areas for cover, loss of spawning opportunities for species such as trout that may migrate from the reservoir into streams for spawning if channels in the reservoirs have impassable sections, and water temperature impacts if reservoir pools are drawn down to very low levels.

Phase 2 – Characterize Habitat

- For those fishes that could be affected by water level fluctuations, SMUD and PG&E will identify the variety of habitats in the reservoir areas that are normally subject to fluctuation. This will be done first using existing reservoir bathymetry maps, and then confirmed in the field when the reservoir is drawn down. For instance, bathymetry maps may allow the Licensee to categorically exclude portions of the reservoirs (such as steep walled granite areas, areas near the dam, etc.) while other areas (shallow flat areas) may suggest potential habitat. The steep walled areas will not be visited in the field. The shallow areas will be visited to describe the quality of the habitat (substrate, bank stability, vegetation, etc.). The habitat types will be grouped and displayed on a map of the reservoir. Also, any barriers in channels that might provide access to fish migrating from the reservoir to streams will be identified and shown on the map. During this phase, any areas that show obvious erosion will be documented.

Phase 3 – Quantify Habitat and Minimum Pool

- Using the maps developed in Phase 2, the SMUD and PG&E will quantify the amount of habitat affected for each reservoir and species as that reservoir undergoes normal water level fluctuations. This will include an estimate of minimum pool.

Phase 4 – Assess Impacts to Fishes

- Based on the amount and quality of habitat in the reservoir water level fluctuation zone and the timing of when that habitat is effected, the SMUD and PG&E will assess the potential effects of water level fluctuations on

fishes. This assessment will include an evaluation of how water level fluctuations might affect warm water fish species in the reservoir, and the quality of the current fishery if known.

It is anticipated that Phase 1 will occur in mid to late summer 2002 after the Fish Surveys Study is complete. Phase 2 (evaluating habitat) will occur in late summer and early fall 2002 when the reservoirs are normally at their lowest level, and will likely be combined with other fieldwork in the Project reservoirs. Phase 3 and 4 will occur in fall and early winter 2002. It is anticipated that a presentation will be made to the Aquatics TWG and Plenary Group in late winter 2002/2003, and will include recommendations for gathering any additional information, if needed. If additional field studies are needed, they will occur in 2003.

4.11.7 Analysis

As described above, data analysis will include identifying and mapping potential fish habitat in the normal water level fluctuation zone for each reservoir, and quantifying the amount of habitat affected during normal Project operations. Barriers to fish movement into streams will be identified. An assessment of potential affects will be made.

4.11.8 Study Output

A presentation of study progress will be made to the Aquatics TWG and the Plenary Group in late winter 2002/2003. A written report including the issues addressed, objectives, description of study area and sampling locations, methods, results, discussion and conclusions will be prepared after field visits and analyses are complete. The report will be prepared in a format that can easily be incorporated into SMUD's draft environmental assessment that will be submitted to FERC with SMUD's Licensee's application for a new license.

4.11.9 Preliminary Estimated Study Cost

A preliminary cost estimate for this study will be developed after approval by the Plenary Group.

4.11.10 Plenary Group Endorsement

The Aquatics TWG approved this plan on April 25, 2002. The participants a the meeting who said they could "live with" this study plan were PCWA, El Dorado County, BLM, CDFG, USFS, USFWS, SMUD, SWRCB and PG&E. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group approved the plan on June 5, 2002. The participants a the meeting who said they could "live with" this study plan were PCWA, El Dorado County, BLM, BOR, USFS, CSPA, SMUD, FOR, PG&E. None of the participants at the meeting said they could not "live with" this study plan.

4.11.11 Literature Cited

SMUD (Sacramento Municipal Utility District). 2001. Initial Information Package for Relicensing of the Upper American River Project (FERC Project No. 2101). Sacramento, CA.

RESERVOIR SHORELINE HABITAT TECHNICAL REPORT

SUMMARY

This reservoir habitat study addresses the effects of reservoir water-level fluctuations on fishes in UARP reservoirs and in Chili Bar Reservoir. More specifically, the study looks at how annual, seasonal, and daily water-level fluctuations in project reservoirs affect aquatic species, which fish species are affected, how are they affected, and when are they affected.

Five UARP reservoirs and the one Chili Bar Project reservoir were mapped for shoreline fish habitat (Loon Lake, Union Valley, Ice House, Junction, Slab Creek, and Chili Bar). The selection of reservoirs for the shoreline habitat study was based on historical fish species composition; reservoirs that were known to include warm-water or reservoir-spawning fish species were included in the study. Fish species observed in each UARP reservoir, as identified in the *Reservoir Fisheries Technical Report,* were evaluated for their use of habitat and spawning requirements. The reservoir shoreline was then characterized and the amount of available habitat for those species quantified.

The shoreline perimeter of each study reservoir was mapped when the reservoir was drawn down to a low level during the fall. The perimeter of the reservoir was divided into segments. These segments were characterized by angle of bank slope, dominant and subdominant substrate, presence of vegetation, and bank stability. Potential habitat used for spawning of these fish species was delineated along each reservoir perimeter within the eulittoral zone (reservoir water-level fluctuation area).

Potential fish migration barriers to reservoir tributaries were surveyed within the eulittoral zone. Any barriers were noted as being natural or potentially caused by reservoir level fluctuation. No major barriers to fish migration within the reservoir fluctuation zone were identified.

Substantial areas of suitable shoreline habitat for spawning warm-water fish (e.g., smallmouth bass and green sunfish), are present in the reservoir fluctuation zones of all of the surveyed reservoirs except Junction and Slab Creek reservoirs. Although Loon Lake and Ice House reservoirs have suitable shoreline habitat, warm-water species were not documented there during the 2002 surveys, and their high elevation places them near the limit of the range of many warm-water species.

Union Valley Reservoir has both habitat for and documented populations of warm-water and reservoir spawning species (e.g., lake trout, smallmouth bass, green sunfish). Shoreline areas most suitable for supporting warm-water fish species are typically subject to rising or stable water surface elevations during the spawning season. Chili Bar Reservoir also has documented populations of both warm-water species as well as hardhead, and has suitable habitat for these species.

1.0 INTRODUCTION

This technical report is one in a series of reports prepared by Devine Tarbell and Associates, Inc., (DTA) and Stillwater Sciences for the Sacramento Municipal Utility District (SMUD) and Pacific Gas and Electric Company (jointly referred to as the Licensees) to support the relicensing of SMUD's Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project. The Licensees intend to append this technical report to their respective applications to the Federal Energy Regulatory Commission (FERC) for new licenses. This

report addresses fish populations in reservoirs of the two projects. This report includes the following sections:

- **BACKGROUND** – Includes when the applicable study plan was approved by the UARP Relicensing Plenary Group; a brief description of the issue questions addressed, in part, by the study plan; the objectives of the study plan; and the study area. In addition, requests by resource agencies for additions to and modifications of this technical report are described in this section.
- **METHODS** – A description of the methods used in the study, including a listing of study sites.
- **RESULTS** – A description of the most important data results. Raw data, where copious and detailed model results are provided by request in a separate compact disc (CD) for additional data analysis and review by interested parties.
- **LITERATURE CITED** – A listing of all literature cited in the report.

This technical report does not include a detailed description of the UARP Alternative Licensing Process (ALP) or the UARP, which can be found in the following sections of the Licensee's application for a new license: The UARP Relicensing Process, Exhibit A (Project Description), Exhibit B (Project Operations), and Exhibit C (Construction). Nor does this technical report include a detailed discussion of Pacific Gas and Electric Company's relicensing process or Chili Bar Project.

Also, this technical report does not include a discussion regarding the effects of the Projects on reservoir shoreline habitat, nor does the report include a discussion of appropriate protection, mitigation, and enhancement (PME) measures. An impacts discussion regarding the UARP is included in SMUD's applicant-prepared preliminary draft environmental assessment (PDEA) document, which is part of the SMUD's application for a new license for the UARP. Similarly, an impacts discussion regarding the Chili Bar Project will be included in Pacific Gas and Electric Company's Chili Bar Project license application. Development of PME measures will occur in settlement discussions, in 2004, and will be reported on in the UARP application PDEA and the Chili Bar Project license application.

2.0 BACKGROUND

2.1 Reservoir Habitat Study Plan

On June 5, 2002, the UARP Relicensing Plenary Group approved the Reservoir Habitat Study Plan that was developed by and approved by the relicensing Aquatic TWG on April 25, 2002. The study plan was designed to address, in part, the following issues questions developed by the Plenary Group:

Issue Question 18.	Do annual/seasonal/daily water-level fluctuations in reservoirs affect aquatic species? Which ones are affected? How are they affected? When are they affected?

Issue Question 30.	What are the effects of the project to warm-water fisheries in the project reservoirs?
Issue Question 35.	How are project releases into Chili Bar affecting aquatic resources?

The principle objective of this study was to assess how reservoir water-level fluctuations affect fish. Amphibians and aquatic reptiles are addressed in the Amphibians and Aquatic Reptiles Study Plan.

The study area included all of the UARP reservoirs with the exception of Robbs Peak and Gerle Creek reservoirs, since they fluctuate only five to six feet annually. Also, Rockbound Lake was not included in the study area since the Licensee does not control water-level fluctuations in this lake. The study area also included Pacific Gas and Electric Company's Chili Bar Reservoir.

2.2 Water Year Types

As described in the *Water Temperature Technical Report*, the UARP Relicensing Water Balance Model Subcommittee established five water year types to be applied to all preliminary analysis with the understanding that the UARP Relicensing Plenary Group, with cause, may modify the current water year types in the future. For reference purposes, the water year types that would have applied to the period when the Reservoir Shoreline Habitat study was performed (2002) are included below (Table 2.2-1). See the *Water Temperature Technical Report* for a detailed discussion of water year type designations.

Table 2.2-1. Water year types applied to individual months of years 2001-2004.*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2001	AN	D	D	D	D	D	D	D	D	D	D	D
2002	D	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN
2003	BN	BN	BN	D	BN	BN	BN	BN	BN	BN	BN	BN
2004	BN	BN	BN	-	-	-	-	-	-	-	-	-

*CD=Critically Dry; D=Dry; BN=Below Normal; AN=Above Normal; W=Wet

2.3 Agency Requested Information

In a letter dated December 17, 2003 to SMUD, the agencies identified, by study, information they believed they needed to begin settlement discussions, with the understanding that additional information might be requested. The Reservoir Shoreline Habitat Study was not listed in the agencies' letter.

3.0 METHODS

3.1 Study Phases

The overall approach to this study was divided into four phases:

Phase 1 – Identification of fish species in study reservoirs and their likely sensitivity to seasonal weekly and daily water-level fluctuation.
Phase 2 – Characterization of reservoir water elevation fluctuation and shoreline habitat.
Phase 3 – Quantification of shoreline fish habitat and minimum pool.
Phase 4 – Assess effects of water-level fluctuation on fishes.

Each of these phases is described in more detail below.

3.1.1 Phase 1 - Identification of Fish Species in Study Reservoirs and Their Likely Sensitivity to Water-Level Fluctuation

Reservoirs in the study area were sampled for species composition in near shore areas. The results of this work are presented in the *Reservoir Fisheries Technical Report* and summarized in Table 4.1-1 of the Results section of this report. In addition, existing scientific literature was reviewed to determine the susceptibility of each of these fishes to effects from water-level fluctuation. Effects could include dewatering of nests for fish that nest in shallow water, loss of cover for species that use shallow vegetated areas for cover, loss of spawning opportunities for species such as trout that may migrate from the reservoir into streams for spawning if channels in the reservoirs have impassable sections, and water temperature impacts if reservoir pools are drawn down to very low levels.

3.1.2 Phase 2 - Characterization of Reservoir Water Elevation Fluctuation and Shoreline Habitat

This phase of the study identified the variety of habitats in the reservoir areas that are subject to fluctuation under normal project operations.

3.1.3 Phase 3 - Quantification of Shoreline Fish Habitat

By mapping selected reservoirs within the UARP area and Chili Bar Reservoir for shoreline habitat and combining that information with historical reservoir elevation levels, habitat that is critical to the different life stages of fishes, and that is subject to reservoir level fluctuation, was quantified. This study focuses on the habitat used by fishes for spawning and rearing.

3.1.4 Phase 4 - Effects of Water-Level Fluctuation on Fishes

Based on the amount and quality of habitat in the reservoir water-level fluctuation zone and the timing of when that habitat is affected, the potential effects of water-level fluctuations on fishes were assessed. This assessment includes an evaluation of how water-level fluctuations might affect warm-water fish species in the reservoir.

3.2 Sample Reservoirs

The study area contains one lake and 12 reservoirs, including Chili Bar Reservoir. In 2002, seven reservoirs, including Chili Bar Reservoir, were initially selected for the Reservoir Fisheries Study based on historical or suspected fish species composition that included non-trout species:

- Loon Lake Reservoir
- Ice House Reservoir
- Union Valley Reservoir
- Junction Reservoir
- Camino Reservoir
- Slab Creek Reservoir
- Chili Bar Reservoir

Camino Reservoir was subsequently removed from the study due to safety and access constraints. The six study reservoirs range from an elevation of 6,410 feet down to 997 feet, a 5,413-foot elevation difference. The five UARP study reservoirs have a combined capacity of 419,300 acre-feet, which makes up over 98 percent of the total UARP reservoir capacity. Chili Bar Reservoir contributes an additional 3,139 acre-feet holding capacity. The reservoirs occur in the Rubicon, Silver Creek, and South Fork American River drainages, which are a part of the American River drainage, and eventually the Sacramento River drainage.

3.2.1 Loon Lake Reservoir

Loon Lake Dam has a base elevation of 6,320 feet, and a spill crest elevation of 6,410 feet. Loon Lake is a headwater lake, with supplemental water from Buck Island Reservoir. Loon Lake Reservoir spills into Gerle Creek west of Wentworth Springs, and Loon Lake Powerhouse discharges to Gerle Creek Reservoir. Loon Lake Reservoir has a holding capacity of 76,200 acre-feet, which makes up 18 percent of the volume of the UARP reservoirs.

Loon Lake Reservoir was included as a study reservoir based on the historical fish composition data of fish species other than salmonids, including California roach, chubs, green sunfish, Sacramento sucker, and tule perch (*Reservoir Fisheries Technical Report*).

3.2.2 Ice House Reservoir

Ice House Dam has a base elevation of 5,300 feet, and a spill crest elevation of 5,450 feet. Ice House reservoir is located on South Fork Silver Creek, a tributary to Silver Creek. The primary tributary to the reservoir is the upper South Fork Silver Creek, headwaters to the Silver Creek drainage system. Ice House Dam releases flow down South Fork Silver Creek, which flows into Junction Reservoir. Ice House Reservoir also provides water to Jones Fork Powerhouse on Union Valley Reservoir. Ice House Reservoir has a holding capacity of 45,960 acre-feet, which makes up 11 percent of the volume of the UARP reservoirs.

Ice House Reservoir was included as a study reservoir based on the historical fish composition data of fish species other than salmonids, including green sunfish (*Reservoir Fisheries Technical Report*).

3.2.3 Union Valley Reservoir

Union Valley Dam has a base elevation of 4,450 feet, and a spill crest elevation of 4,870 feet. Union Valley Reservoir collects water from Gerle Creek Reservoir via canal and pipe system into Robbs Peak Powerhouse, and Ice House Reservoir via outflow pipe to Jones Fork Powerhouse, along with several tributaries, including Jones Fork Silver Creek. Releases flow directly into Junction Reservoir, which releases into Silver Creek. Union Valley Reservoir has a holding capacity of 277,290 acre-feet, which makes up 65 percent of the volume of the UARP reservoirs, and makes Union Valley Reservoir the largest storage reservoir in the UARP area.

Union Valley Reservoir was included as a study reservoir based on the historical fish composition data of fish species other than salmonids, including green sunfish, golden shiner, mosquitofish, smallmouth bass, and Sacramento sucker (*Reservoir Fisheries Technical Report*).

3.2.4 Junction Reservoir

Junction Dam has a base elevation of 4,290 feet, and a spill crest elevation of 4,450 feet. Junction Reservoir is an afterbay of Union Valley Reservoir and releases into Silver Creek. Junction Reservoir also receives water from South Fork Silver Creek inflows. Junction Reservoir has a holding capacity of 3,250 acre-feet, which makes up less than one percent of the volume of the UARP reservoirs.

Junction Reservoir was included as a study reservoir based on the historical fish composition data of fish species other than trout, including Sacramento sucker and kokanee (*Reservoir Fisheries Technical Report*).

3.2.5 Slab Creek Reservoir

Slab Creek Dam has a base elevation of 1,650 feet, and a spill crest elevation of 1,850 feet. Slab Creek Reservoir is located on the South Fork American River downstream of the confluence with Silver Creek and upstream of Chili Bar Reservoir. Slab Creek Reservoir receives water from Slab Creek, Brush Creek (which is regulated by Brush Creek Dam) and the South Fork American River, which at this point includes the Silver Creek Drainage (regulated by four different dams). Inflow from Brush Creek is also diverted through a tunnel to Camino Powerhouse at the head of Slab Creek Reservoir. Outflow from the reservoir is released into the South Fork American River as well as into a bypass to White Rock Powerhouse at Chili Bar Reservoir. Slab Creek Reservoir has a holding capacity of 16,600 acre-feet, which makes up four percent of the volume of the UARP reservoirs.

Slab Creek Reservoir was included as a study reservoir based on the historical fish composition data of fish species other than salmonids, including hardhead, smallmouth bass, speckled dace, California roach, and Sacramento sucker (*Reservoir Fisheries Technical Report*).

3.2.6 Chili Bar Reservoir

Chili Bar Dam has a spill crest elevation of 997 feet. Chili Bar Reservoir is operated by Pacific Gas and Electric Company and is the lowermost reservoir in the Reservoir Shoreline Habitat study. Chili Bar Reservoir is located on the South Fork American River downstream of Slab Creek Reservoir and receives water from the South Fork American River as well as from the White Rock Powerhouse, which releases water diverted from Slab Creek Reservoir. Chili Bar Reservoir has a holding capacity of 3,139 acre-feet.
Chili Bar Reservoir was included as a study reservoir because of potential for warm-water fish populations, although there was no historical fish survey information.

3.3 Shoreline Perimeter Mapping

The shoreline perimeter of the six study reservoirs was mapped when each reservoir was drawn down to a low level during the fall, with the exception of Chili Bar Reservoir which fluctuated more on a daily than seasonal basis (Table 3.3-1). The perimeter of the reservoir was divided into segments. These segments were characterized by angle of bank slope, dominant and subdominant substrate, presence of vegetation, and bank stability, as presented in Table 3.3-2.

Table 3.3-1. Sampling dates and reservoir elevations for the Reservoir Shoreline Habitat Study.

Reservoir	Sampling Dates	Maximum Elevation (ft)	Elevation (ft) on Sampling Dates	Vertical Feet of Exposed Shoreline
Loon Lake	Oct 31-Nov 1, 2002	6410	6397	13
Ice House	November 4-5, 2002	5454	5426	28
Union Valley	October 24-25, 2002	4870	4819	51
Junction	October 14-15, 2002	4468	4428	40
Slab Creek	October 28, 2002	1850	1839	11
Chili Bar	November 13, 2002	998	993	5

Table 3.3-2. Habitat attributes for Reservoir Shoreline Habitat Study.

- Bank slope
  1. Near vertical (>45%)
  2. Steep (30-45%)
  3. Moderate (10-30%)
  4. Gradual (5-10%)
  5. Relatively Flat (0-5%)

- Presence of emergent vegetation
  - y Present
  - n Not present

- Dominant and subdominant substrate
  1. Bedrock
  2. Boulder
  3. Cobble
  4. Gravel
  5. Sand-silt

- Bank stability
  1. Stable
  2. Mild erosion
  3. Significant erosion
  4. Slope failure

The perimeter of the reservoir was segmented. The start point and endpoint of each segment was recorded with GPS. The shoreline was then mapped in a counterclockwise direction as individual segments were identified. Segments were divided when one component of the

classification changed, with minimum segment lengths being 250 feet long. The mapping continued around the perimeter of the reservoir until the start point was again reached. Photos were taken of various habitat types for documentation.

3.4 Fish Barrier Identification

During the shoreline perimeter mapping, tributaries to the individual study reservoirs were identified. Potential fish migration barriers to reservoir tributaries were identified within the eulittoral (flow fluctuation) zone. The barriers were noted as being natural cascades or as potentially caused by reservoir level fluctuation. Barriers identified as potentially being caused by reservoir level fluctuations were within the eulittoral zone and had geomorphic features such as a large cascade or step in the streambed.

In addition to the survey of the eulittoral zone, tributary streams were surveyed upstream of the study reservoir to identify any potential barriers.

3.5 Analysis

Fish composition of the individual study reservoirs was compiled using historical survey information, and confirmed with the results from the fish sampling performed by the Licensees in the reservoirs in 2002, as described in the *Reservoir Fisheries Technical Report*. Shoreline mapping data was plotted onto a USGS base map. Analyses included calculating the segment lengths and shoreline habitat type frequency. Fish that would potentially use these habitat types for spawning or rearing habitat were then identified.

Of the 19 species of fish identified in the reservoirs, those that spawn or rear in reservoirs were identified using existing life history information. The habitat types associated with the spawning and rearing life stages of the reservoir dwelling fishes were identified. Reservoir shoreline habitat that could potentially be used by fish for spawning or rearing was initially identified by using existing reservoir bathymetry maps to locate reservoir margins with lower slopes, then confirmed by the shoreline habitat mapping data.

Spawning habitats were defined as either “preferred” or “potential.” Preferred spawning habitats contained the appropriate slope, substrate type, vegetation requirements, and cover type. Shoreline habitat that was identified as potential spawning habitat included the appropriate slope and substrate, but was missing one of the preferred elements of cover type or vegetation.

Rearing habitat requirements for each species were summarized from existing literature. Rearing habitat of juvenile fishes was then identified along the shoreline from the shoreline mapping data. Rearing habitat of some species includes substrates and water velocities, whereas the rearing habitat of other species may include vegetation or cover along with water depth criteria. Rearing habitat also contains specific characteristics that cannot be easily delineated from the mapping data. When available, rearing habitat was identified as abundant or limited.

Spawning and rearing habitat distribution and the timing of spawning and rearing for individual fish species was then compared with historical reservoir elevation levels. The elevation of the

preferred and potential habitat along the shoreline was compared to the historical reservoir elevation records to determine whether or not the reservoir margin areas, most likely used during critical life stages, are inundated during the time of year when fish may be using the area to spawn or as rearing habitat.

The reservoir water elevation, combined with the spawning habitat elevation, was then compared to the typical spawning depths of the selected fish species to ensure adequate inundation occurs to allow for spawning. Historical reservoir operations were then included to ensure that the areas inundated during the spawning seasons of selected fish species were not de-watered during the egg incubation period.

Spawning season and spawning habitat elevations (based on preferred depths) were plotted with historical reservoir water-elevation levels to create a "spawning box" that graphically depicts spawning habitat availability for warm-water fish species. The spawning box was created by plotting the time of spawning against elevation of spawning habitat (some habitat is only found at certain elevations within the reservoir). This was then plotted against the average monthly reservoir water elevation with maximum and minimum levels. In reservoirs that fluctuate daily as well as seasonally, the same boxes were plotted against the average daily fluctuations. The lowermost water depths at which preferred and potential habitat are depicted was based upon the lowest water level of the historical record. This assumes that the habitat types found at the shoreline within the fluctuation zone during the mapping survey are the same at greater depths.

4.0 RESULTS

4.1 Identification of Fish Species in Study Reservoirs and Their Likely Sensitivity to Water-level Fluctuation

A summary of fish species known to occur in each of the UARP and Chili Bar reservoirs is presented in Table 4.1-1. Fish that are likely to be affected by reservoir fluctuation were identified from 2002, 2003, and historical studies. Of the 19 species of fish identified in the UARP and Chili Bar Project reservoirs (Table 4.1-1), nine species of fish were identified as having the potential to spawn in reservoirs (lake trout, kokanee, smallmouth bass, green sunfish, tule perch, golden shiner, speckled dace, mosquitofish, and chub species), and seven were identified as having the potential to rear in reservoirs (kokanee, hardhead, Sacramento pikeminnow, Sacramento sucker, smallmouth bass, green sunfish, and tule perch). Spawning habitat requirements of reservoir spawning fish are summarized in Table 4.1-2.

Table 4.1-1. Known species composition for UARP and Chili Bar Project reservoirs.[1]

	Species[2]																				
Reservoir	**RBT**	**BRN**	**BRK**	**CR**	**CT**	**CH**	**GS**	**GSH**	**GT**	**HH**	**KS**	**LT**	**MF**	**MN**	**SB**	**SD**	**SS**	**RS**	**TP**	**SPM**	**References**
Rubicon	●	●	●						●												CDFG surveys, various dates
Buck Island	●	●	●																		CDFG surveys, various dates
Loon Lake	● o	● o	●	● o		●	●										● o		●		SMUD 2001; EDAW 1978
Gerle Creek	●	●o	●	o																	Turney 1986
Robbs Peak	●	●																			CDFG surveys, various dates; EA 1982; SMUD 2001
Union Valley	● o	●			●		●	●			● o	● o	●		● o		● o				SMUD 2001; CDFG surveys, various dates; EA 1980
Ice House	● o	● o	●	o			●				●										SMUD 2001; EA 1980; EDAW 1978; CDFG surveys, various dates
Junction	●	● o	●								●						● o				Thomas 1994a
Camino	●	●	●	●										●			●	●			SMUD 2001; ENF Stream Survey, not dated
Brush Creek	●	●																			ENF Stream Survey 1974
Slab Creek	● o	● o	●	●						● o	●				●	●	● o			o	SMUD 2001; Thomas 1994b; Jordan and Brown 1992; Jones and Stokes 1994; WESCO 1980
Chili Bar		o								o							o				SMUD and Pacific Gas and Electric Company fish tissue sampling for the Water Quality study in 2004

[1] ● Historical data
o 2002 and 2003 Surveys

[2] Species:

BRK=Brook trout	GS=Green sunfish	LT=Lake trout	SB=Smallmouth bass
BRN=Brown trout	GSH=Golden shiner	MF=Mosquito fish	SD= Speckled dace
CH=Chubs	GT=Golden trout	MN=Minnows	SPM=Sacramento pikeminnow
CR=California roach	HH=Hardhead	RBT=Rainbow trout	SS= Sacramento sucker
CT= Cutthroat	KS=Kokanee salmon	RS=Riffle sculpin	TP=Tule perch

Table 4.1-2. Habitat spawning requirements for reservoir spawning fish historically found in UARP and Chili Bar Project reservoirs.

Species	Spawning season	Incubation period	Bank slope	Substrate	Depth (feet)	Temp. (C)	Cover type	Notes
Lake trout	Sep - Nov	4-6 mo.	n/a	boulder / rubble	< 121	< 13	boulder	Sometimes spawns in macrophytes at depths of 40-60m (Moyle 2002).
Kokanee	Aug - Feb (Oct-Nov)	6 mo.	relatively flat to flat	gravel	<59, close to shore	6-13	n/a	Primarily spawns in streams (Moyle 2002).
Smallmouth bass	late March - June	7-14 days	relatively flat to flat	gravel / sand	3-16	> 16	near large cover object	Warm-water (Moyle 2002).
Green sunfish	May - Jun	5-7 days	relatively flat to flat	fine gravel	0.13-1.5	> 19	overhanging veg. or large cover object	Prefer beds of aquatic vegetation soon after hatching (Moyle and Nichols 1973, Moyle 2002).
Tule perch	May - Jun	live bearer	n/a	n/a	< 3	< 22	boulder / overhanging veg.	Near shore (Moyle 2002).
Golden shiner	June - Sept (Jul)	4-5 days	n/a	benthic veg or debris	< 3	20	emergent veg.	Near shore (Moyle 2002, Becker 1983).
Speckled dace	Jun - Jul	6 days	relatively flat to flat	coarse gravel	n/a	> 16	sometimes in reservoir bass nests	Spawn in intermittent streams during high flow events (John 1963, Moyle 2002).
Mosquitofish	year round	live bearer	n/a	n/a	< 3	> 16	emergent veg.	Warm-water (Moyle 2002).
Chub	Apr - Jul	3-6 days	relatively flat to flat	aquatic vegetation or algae covered rocks	< 5	13-17	dense aquatic veg .	CDFG identified chub in Loon Lake Reservoir (species cannot be determined)

The spawning success of smallmouth bass, green sunfish, golden shiner, and chub are potentially affected by reservoir water fluctuations. These species were the focus of the reservoir shoreline spawning habitat analysis. Kokanee and speckled dace are not likely to be affected by water fluctuations because they prefer to spawn in the tributary streams (John 1963, Moyle 2002, Moyle and Daniels 1982, Moyle and Baltz 1985, Baltz et al. 1982, and Moyle and Vondracek 1985). Mosquitofish and tule perch are live bearers that do not require specific substrates for spawning, only cover for the fry, and are unlikely to be greatly affected by changing reservoir elevations. Lake trout spawn in the deep portions of the reservoirs (Moyle 2002) and are not likely to be affected by the change in water elevations.

In addition to the effects of the reservoir water elevation fluctuations on spawning, the use of shoreline habitat for rearing was also reviewed. With the exception of lake trout, trout species are likely to initially rear in the stream margin. These fish can be expected to primarily rear in streams before a certain percentage later migrate downstream into the reservoirs (Moyle 2002). Lake trout present an exception in that they spawn and rear in deep areas of the reservoir and are therefore not affected by fluctuations in water surface elevation along the shoreline (Moyle 2002).

Twelve non-trout species have historically been identified in project reservoirs (Table 4.1-1).Five of these species (riffle sculpin, chub species, golden shiner, speckled dace, and California roach) are not discussed further in this report. Riffle sculpin select habitat with oxygen levels near the saturation point, restricting them to swift water streams. Their benthic larvae are not mobile after hatching and are unlikely to be flushed downstream into reservoirs (Moyle 2002). Riffle sculpin are therefore unlikely to occur in the reservoir environment. Chub, golden shiner, speckled dace, and California roach have rearing habitat requirements that are not dependant upon the reservoir environment. Mosquitofish are tolerant of a wide range of environmental factors usually lethal to most fish. They are omnivorous, opportunistic feeders with a high reproduction capacity (Moyle 2002). These highly adaptable fish are unlikely to be affected by changing water levels within reservoirs.

The juvenile rearing success of kokanee, hardhead, Sacramento pikeminnow, Sacramento sucker, smallmouth bass, green sunfish, and tule perch are potentially affected by reservoir water fluctuations. These species were the focus of the reservoir shoreline habitat analysis and are discussed further below.

4.2 Characterization of Reservoir Water Elevation Fluctuations and Shoreline Habitat

The daily, yearly, and seasonal fluctuations of reservoir water elevation along with shoreline substrate composition were assessed for each reservoir. The six reservoirs included in the reservoir habitat mapping study varied greatly between seasonal and daily water elevation fluctuations (Table 4.2-1) (CDEC 2002; pers. comm., Bruce McGurk, Pacific Gas and Electric Company hydrologist)

Table 4.2-1. Average UARP and Chili Bar Project reservoir water elevation changes.

	UARP Study Reservoir					
	Loon Lake	**Ice House**	**Union Valley**	**Junction**	**Slab Creek**	**Chili Bar**
Average elevation change / day (feet) [a]	0.4	0.3	0.6	20.7	3.3	4.2 [c]
Average elevation change / year (feet) [b]	43.6	36.9	66.1	32.2	29.6	14.5 [d]
Capacity (acre-feet)	76,200	45,960	277,290	3,250	16,600	3,139

[a] Compiled from 1995 through 2002 hourly data.
[b] Compiled from 1988 through 2000 daily averages.
[c] Compiled from 2002 hourly data; Fluctuates up to 7 feet / day..
[d] Compiled from 1999 through 2002 daily averages.

The three larger reservoirs (Union Valley, Loon Lake, and Ice House) have daily elevation fluctuations of less than one foot per day, but have seasonal fluctuations between 36 feet and 66 feet per year (Table 4.2-1). In contrast, the three smaller reservoirs (Junction, Slab Creek, and Chili Bar) have daily elevation fluctuations between 3 feet and 20 feet with seasonal fluctuations of 14 feet to 32 feet per year.

4.2.1 Loon Lake Reservoir

The average water elevation in Loon Lake Reservoir has significant seasonal variations with little to no daily variation (Table 4.2-1). Average monthly elevation varies seasonally, rising in early spring and gradually dropping during the summer and fall (Figure 4.2-1). Daily fluctuations do not vary seasonally (Figure 4.2-2).

Emergent vegetation was present on 65 percent of the shoreline (Figure 4.2-3). Over 80 percent of the shoreline is characterized by a flat (0-5%) to moderate (10-30%) slope (Figure 4.2-4). The shoreline of Loon Lake Reservoir was predominantly stable (Appendix B). Bedrock and boulder dominated 70 percent of the dominant substrate and boulder, cobble, and bedrock comprised a majority of the subdominant substrates (Figure 4.2-4). Habitat types for Loon Lake Reservoir are delineated in Appendix A, Figure A-1.

4.2.2 Ice House Reservoir

Similar to the other storage-type reservoirs, the average water elevation in Ice House Reservoir has significant seasonal variations with little to no daily variation (Table 4.2-1). Average monthly elevations vary seasonally, rising in early spring and gradually declining during the summer and fall (Figure 4.2-5). Daily fluctuations do not vary seasonally (Figure 4.2-6).

Emergent vegetation was present on five percent of the shoreline (Figure 4.2-7). Mild erosion was visible on 74 percent of the shoreline and the remainder was stable (Appendix B). Most of the shoreline is characterized by a moderate (10-30%) to steep (30-45%) slope (Figure 4.2-8). Sand-silt dominated over 75 percent of the dominant substrate and sand-silt, boulder, and cobble comprised the subdominant substrates. Habitat types for Ice House Reservoir are delineated in Appendix A, Figure A-2.

4.2.3 Union Valley Reservoir

The average water elevation in Union Valley Reservoir has significant seasonal variations with little to no daily variation (Table 4.2-1). Average monthly elevations vary seasonally, rising in early spring and gradually dropping during the summer and fall (Figure 4.2-9). Daily fluctuations do not vary seasonally (Figure 4.2-10).

Emergent vegetation was present on 27 percent of the shoreline (Figure 4.2-11). Significant erosion was visible on 14 percent of the shoreline and mild erosion was visible on 80 percent (Appendix B). Most of the shoreline is characterized by a gradual (5-10%) to steep (30-45%) slope (Figure 4.2-12). Sand-silt was dominant along 70 percent of the shoreline and cobble and sand-silt comprised the subdominant substrates. Habitat types for Union Valley Reservoir are delineated in Appendix A, Figure A-3.

4.2.4 Junction Reservoir

The average water elevation in Junction Reservoir has little seasonal variation and more significant daily variation (Table 4.2-1). The average monthly reservoir elevation does not fluctuate seasonally and was stable at around 4,440 feet throughout the year with maximum and minimum levels fluctuating up to 60 feet (Figure 4.2-13). Average daily water elevation varies approximately 20 feet between November through May, 10 feet between June and September, and 40 feet in October (Figure 4.2-14).

Emergent vegetation was present on six percent of the shoreline (Figure 4.2-15). Mild erosion was visible on one percent of the shoreline and the remainder was stable (Appendix B). Most of the shoreline was characterized by a steep (30-45%) to near vertical (>45%) slope (Figure 4.2-16). Bedrock and cobble dominated over 85 percent of the dominant substrate and sand-silt, bedrock, and boulder comprised the subdominant substrates. Habitat types for Junction Reservoir are delineated in Appendix A, Figure A-5.

4.2.5 Slab Creek Reservoir

The average water elevation in Slab Creek Reservoir has minimal seasonal and daily variations (Table 4.2-1), largely because the reservoir serves as a forebay for White Rock Powerhouse. The average monthly water elevation does not fluctuate seasonally and was stable throughout the year at around 1,840 feet. Minimum water elevations dropped over 40 feet in August, October, and December (Figure 4.2-17). Daily fluctuations did not vary significantly seasonally (Figure 4.2-18).

Emergent vegetation was present on 54 percent of the shoreline (Figure 4.2-19). Mild erosion was visible on 18 percent of the shoreline, significant erosion on one percent, and the remainder was stable (Appendix B). Over 70 percent of the shoreline was characterized by a nearly vertical (>45%) slope (Figure 4.2-20). Bedrock dominated over 70 percent of the dominant substrate. Bedrock and boulder comprised the subdominant substrates. Habitat types for Slab Creek Reservoir are delineated in Appendix A, Figure A-6.

4.2.6 Chili Bar Reservoir

The average water elevation in Chili Bar Reservoir has relatively low seasonal and daily variations when compared to other study reservoirs (Table 4.2-1). The average monthly water elevation did not fluctuate seasonally and was stable throughout the year at around 995 feet (close to full capacity), with maximum and minimum levels being within 17 feet (Figure 4.2-21). Daily fluctuations vary seasonally from four feet in December through May, to near six feet in June through November (Figure 4.2-22).

Emergent vegetation was present on 94 percent of the shoreline of the Chili Bar Reservoir (Figure 4.2-23). The shoreline of Chili Bar Reservoir was predominantly stable (Appendix Table B-1). Most of the shoreline was characterized by a steep (30-45%) to near vertical (>45%) slope (Figure 4.2-24) of dominantly sand-silt substrate supported by dense vegetation. Sand-silt and bedrock comprised the subdominant substrates. Habitat types for Chili Bar Reservoir are delineated in Appendix A, Figure A-7.

4.3 Quantification of Shoreline Fish Habitat

The six reservoirs contain four fish species that utilize shoreline habitat for spawning (Table 4.1-2):

- Smallmouth bass prefer to spawn in shallow, warm water with large cover and relatively flat to flat substrate of gravel and sand (Moyle 2002).
- Green sunfish prefer warm water with large overhanging vegetation or large cover and spawn on relatively flat substrate in fine gravel. Fry move into aquatic vegetation soon after hatching (Moyle 2002).
- Golden shiner prefer shallow, warm water with emergent vegetation and spawn under debris or aquatic vegetation near shore (Moyle 2002).
- Chub prefer cool shallow water and spawn in relatively flat substrate of dense aquatic vegetation or algae covered rocks (Moyle 2002).

The rearing habitat of some species remains, in part, unknown. The six reservoirs contain seven species of fish that could potentially utilize shoreline habitat for juvenile rearing:

- Kokanee fry emerge from redds upstream and usually proceed immediately downstream for the reservoir or other large body of water (Moyle 2002), although some “river-type” fish may rear in the stream for a year or more (Wood et al. 1987).
- Hardhead larval and post-larval fish likely remain along the edges of streams in dense cover and move into deeper habitat as they grow. Juveniles can be found in shallow water (1–3 feet) near a densely-vegetated shoreline (Moyle and Baltz 1985) and in pools and shallower areas of larger streams with rock-bottom substrates (Moyle et al. 1982). Young hardhead prefer a warm-water environment with a large cobble and boulder substrate (Moyle 2002). Hardhead are abundant in reservoirs where centrarchid bass reproduction is limited by water level fluctuation. Smallmouth bass will compete with adult hardhead for forage and prey on hardhead juveniles (Moyle 2002).

- Sacramento pikeminnow juveniles are also associated with shallow water and low velocities. Pikeminnow will select depth based on individual fish size due to predation threats from herons in shallow water and piscivorous fishes in deeper water (Moyle 2002). Juveniles are found in a wide variety of stream conditions, including riffles, runs, and pools (Moyle 2002).
- Sacramento sucker prefer shallow (0.6-2 feet) low velocity areas with beds of aquatic plants and dense cover for rearing habitat (Moyle 2002). Larval suckers are found on stream edges and in beds of aquatic plants in or near pools. Juvenile suckers may move downstream into larger bodies of water after a period of rearing in the spawning tributary, or they may remain in shallow habitats with dense cover in streams with resident populations (Moyle 2002).
- Smallmouth bass are protected by the male of the species in dense shoals in deeper water for up to 30 days, later dispersing to shallow warm (25-31 ^{o}C) water. Cover is significant for young smallmouth and high densities of fish are often associated with snags (Lobb and Orth 1991). The juvenile fish will select shallow water habitat that is warmer than what adults prefer, with temperatures ranging as high as 29-31 ^{o}C (Coble 1975, as cited in Moyle 2002).
- Green sunfish are almost exclusively associated with tules in lakes and reservoirs. Larval fish settle in vegetation soon after hatching (Moyle 2002).
- Tule perch give birth to live young that congregate in dense vegetation along with pregnant females (Moyle 2002). Adults and juveniles require clear, flowing water and abundant cover (Moyle 2002, Moyle 1976 as cited in in CDFG 1995).

Shoreline habitat characteristics of the six study reservoirs were reviewed for both spawning and juvenile rearing habitat occurrence for reservoir fish species. The sections below identify the quantity of reservoir shoreline habitat that could potentially be used by reservoir fish species in each of the study reservoirs.

4.3.1 Loon Lake Reservoir

Loon Lake Reservoir contains three species of fish known to spawn in reservoirs: green sunfish, tule perch, and chub. Tule perch are live bearing fish and do not require a substrate to spawn. Loon Lake Reservoir contains a large amount of preferred spawning habitat for green sunfish and chub within the eulittoral zone (Appendix A, Figure A-1).

The preferred spawning habitat of green sunfish and chub includes emergent vegetation (Table 4.1-2). This type of habitat primarily occurs in Pleasant Lake, the northeast portion of Loon Lake where intermittent tributaries flow into the reservoir A large spawning area is located at the upper end of Pleasant Lake and is flooded when the reservoir elevation exceeds 6,400 feet. In addition, over 20,000 linear feet (29.3 percent) of shoreline could potentially be used for spawning by green sunfish below the 6,400 feet reservoir elevation.

Tule perch bear live young in areas that are in close proximity to aquatic vegetation. Both adults and juvenile fish require clear flowing water with abundant cover (Moyle 2002, Moyle 1976 as cited in CDFG 1995). This type of habitat is found near intermittent tributaries to the reservoir.

Loon Lake contains two species which could potentially rear in the reservoir: Sacramento sucker and tule perch. Sacramento sucker adults spawn in tributary streams where the young are expected to rear in areas with low velocities. Juveniles may then migrate downstream into larger bodies of water as adults. In Loon Lake, where there are only intermittent tributaries, the young may find refuge in areas with dense cover for rearing habitat. Loon Lake contains some emergent vegetation within the upper elevations of the reservoir. These areas are typically inundated in the spring, but this habitat is lost by mid to late summer.

There are no perennial tributaries that flow into Loon Lake. No potential fish-migration barriers were found on the smaller intermittent tributaries to the reservoir near the shoreline.

4.3.2 Ice House Reservoir

Ice House Reservoir contains two species of fish identified as reservoir spawners: kokanee and green sunfish. Kokanee prefer to spawn in tributary streams to the reservoir and are not likely to be affected by reservoir fluctuations. Ice House Reservoir contains a small amount of potential spawning habitat within the eulittoral zone for spawning of green sunfish (Appendix A, Figure A-2). There is no preferred spawning habitat for green sunfish, but there are more than 7,000 linear feet (15.9 percent) of potential spawning habitat available along the perimeter of the reservoir. Green sunfish prefer fine gravels that are likely to be found in the sand-silt substrate. Only 3.5 percent of the reservoir shoreline contains the preferred slope with potential substrate and vegetation for the green sunfish. Portions of these shoreline segments also contain stump cover, which may be used by green sunfish.

Ice House Reservoir contains two fish species that can potentially rear in the reservoir: kokanee and green sunfish. Neither of these species were observed in the 2002 surveys. Ice House Reservoir is at the upper elevation limit for green sunfish. Kokanee have previously been stocked in Ice House Reservoir, but the stocking was suspended in 1974. Green sunfish are not expected to find much rearing habitat in Ice House Reservoir due to the absence of emergent vegetation. They may use the limited stump cover in the reservoir in its place.

South Fork Silver Creek is the primary tributary flowing into Ice House Reservoir. No fish migration barrier was found on this tributary near the shoreline. A smaller intermittent tributary contained one migration barrier within the eulittoral zone, which could hinder migration of smaller fish during the normal water-level fluctuations (Appendix A, Figure A-2). California roach, identified in Ice House Reservoir (Table 4.1-1), could potentially use this tributary for spawning.

4.3.3 Union Valley Reservoir

Union Valley Reservoir contains six species of fish that spawn in reservoirs: lake trout, kokanee, smallmouth bass, green sunfish, golden shiner, and mosquitofish. Mosquitofish are live bearing fish that do not require substrate to spawn. Kokanee prefer to spawn in the tribuary streams to the reservoir, and lake trout require deep and cold habitats. Union Valley Reservoir contains a large amount of spawning habitat within the eulittoral zone for smallmouth bass, green sunfish, and golden shiner (Appendix A, Figure A-3 and Figure A-4).

Smallmouth bass benefit the most from the types of habitat present in Union Valley Reservoir. There are nearly 40,000 linear feet (32 percent) of preferred habitat along the shoreline for spawning of smallmouth bass. This habitat contains the preferred slope, substrate, and large cover objects, including boulder and stump cover.

Contained within the habitat delineated for smallmouth bass is spawning habitat for green sunfish. There are 6,609 linear feet of shoreline (5 percent) of preferred spawning habitat and 33,340 feet of potential habitat for green sunfish present in Union Valley Reservoir.

Golden shiner spawn in areas with water depths of less than three feet with emergent vegetation. Emergent vegetation primarily occurs in the higher elevation levels of the reservoir shoreline. There are more than 33,000 linear feet (27 percent) of shoreline habitat containing some emergent vegetation; however, most of this vegetation would be insufficient cover for golden shiner. Golden shiner also spawn under debris. Debris occurrence was not documented as a habitat characteristic of the reservoir shoreline due to its instability.

Union Valley Reservoir contains six species which could potentially rear in the reservoir: kokanee, lake trout, mosquitofish, green sunfish, Sacramento sucker and smallmouth bass. Lake trout juveniles rear in deep water and are not affected by the reservoir fluctuation levels. Mosquitofish are generalists and are expected to find habitat along the shoreline. Of the remaining four species, kokanee are expected to rear throughout the reservoir. Sacramento sucker adults spawn in tributary streams where the young are expected to rear in areas with low velocities. Juveniles may then migrate downstream into the reservoir as adults. Within the reservoir, there is little rearing habitat for suckers due to the lack of dense vegetation. Smallmouth bass are expected to find habitat throughout the reservoir near stump cover that is found along the shoreline of the reservoir. There is limited preferred rearing habitat for green sunfish due to the lack of emergent vegetation along the reservoir shoreline. Green sunfish may use the woody debris and stump cover for rearing habitat.

The perennial tributaries flowing into Union Valley Reservoir are Jones Fork Silver Creek, Bassi Fork Silver Creek, and Tells Creek. A potential small fish migration barrier was observed at the inlet of Tells Creek (Appendix A, Figure A-3). The barrier was a natural cascade found at the high water line of the reservoir. Fish that would possibly use this creek for spawning include: rainbow trout, brown trout, cutthroat trout, kokanee, and Sacramento sucker. Salmonids and Sacramento sucker are expected to be able to pass this barrier.

4.3.4 Junction Reservoir

Junction Reservoir contains one species of fish, kokanee, which could potentially spawn in the reservoir. Kokanee have historically been observed in Junction Reservoir. Kokanee are identified as a species that may spawn in the reservoir, but prefer to spawn in tributary streams. All of the other species known to use Junction Reservoir are stream spawning fish. Junction Reservoir is located immediately downstream of Union Valley Reservoir. Spawning habitat for the species of Union Valley Reservoir was also considered. No preferred or potential

spawning habitat was observed for green sunfish or smallmouth bass. Golden shiner spawning habitat was minimal to non-existent as there was only six percent of the shoreline containing some emergent vegetation and no dense vegetation.

Junction Reservoir contains two species of fish which could potentially rear in the reservoir: kokanee and Sacramento sucker. Kokanee juveniles would be expected to find rearing habitat in Junction Reservoir. Sacramento sucker adults are expected to spawn in tributary streams where the young are expected to rear in areas with low velocities. There is good rearing habitat in South Fork Silver Creek and suckers may potentially rear in Little Silver Creek as well. Juveniles may also migrate downstream into the reservoir as they grow. Within the reservoir, there is little rearing habitat for suckers due to the lack of dense vegetation.

The primary tributaries to Junction Reservoir are Little Silver Creek and South Fork Silver Creek. A natural cascade was found just above the high water line on Little Silver Creek, which is a potential small fish migration barrier (Appendix A, Figure A-5). Salmonids and Sacramento sucker are expected to pass this barrier. No fish migration barriers were observed on additional tributaries, including South Fork Silver Creek, or on the smaller intermittent tributaries.

4.3.5 Slab Creek Reservoir

Slab Creek Reservoir contains three species of fish that spawn in reservoirs: kokanee, smallmouth bass, and speckled dace. Kokanee and speckled dace prefer to spawn in tributary streams and would not be affected by reservoir water elevation changes. Slab Creek Reservoir contains a small amount of spawning habitat within the eulittoral zone for smallmouth bass (Appendix A, Figure A-6). Smallmouth bass could potentially spawn on two sand bars on the uppermost end of the reservoir which comprise 629 feet (1 percent) of the shoreline. This habitat is not suitable for spawning, however, due to the high velocity of the water flowing through this section of the reservoir.

Slab Creek Reservoir contains six species which could potentially rear in the reservoir: lake trout, Sacramento sucker, smallmouth bass, hardhead, Sacramento pikeminnow and kokanee. Lake trout spawn and rear in deep water and are not expected to be affected by flow fluctuations. Suckers are expected to spawn and rear in the SFAR upstream of the reservoir. Juvenile suckers would find little rearing habitat within the reservoir due to the lack of emergent vegetation.

Smallmouth bass may find some habitat in Slab Creek Reservoir for rearing, since the upper sections of the reservoir contain some moderately shallow edges along with some woody debris. The habitat for smallmouth bass may be restricted, however, due to temperature constraints. Slab Creek Reservoir is a well-mixed reservoir (*Water Temperature Technical Report)* with cold inflows from Camino Powerhouse and the SFAR. Since the shallower areas of the reservoir preferred by smallmouth bass are near the SFAR inflow where water velocities are elevated and water temperatures are cooler than the 28-31^{o}C preferred temperatures for rearing smallmouth bass (Coble 1975, as cited in Moyle 2002), it is unlikely that there is much rearing habitat associated with Slab Creek Reservoir.

Hardhead are expected to rear primarily in the SFAR upstream of Slab Creek Reservoir. Juveniles may move downstream into the reservoir, but will not find abundant preferred rearing habitat that includes shallow water (1–3 feet) near a densely-vegetated shoreline (Moyle and Baltz 1985). Slab Creek Reservoir does contain abundant habitat that includes their preferred warm-water environment with a large cobble and boulder substrate, but the reservoir is missing the preferred habitat characteristics of shallow water and densely vegetated shorelines (Moyle 2002, Moyle et al. 1982).

Sacramento pikeminnow have similar rearing preferences as hardhead and are primarily expected to rear in the tributary streams. Kokanee are expected to find rearing habitat in Slab Creek Reservoir. From the *Stream Fisheries Technical Report,* juvenile pikeminnow and sucker are known to rear in the SFAR upstream of Slab Creek Reservoir.

The primary tributaries that flow into the Slab Creek Reservoir are Slab Creek, Brush Creek, and South Fork American River. No fish migration barriers within the flow fluctuation zone were found on these perennial tributaries or on any smaller intermittent tributaries.

4.3.6 Chili Bar Reservoir

Chili Bar Reservoir contains one reservoir-spawning species: smallmouth bass. Chili Bar Reservoir contains a moderate amount of spawning habitat within the eulittoral zone for smallmouth bass (Appendix A, Figure A-7).

There is approximately 1,242 linear feet (5 percent) of shoreline mapped as containing preferred spawning habitat characteristics for smallmouth bass. The preferred habitat of smallmouth bass occurs primarily in the upper half of the reservoir where there are sand deposits, and shallower water. Potential spawning habitat for smallmouth bass occurs throughout the reservoir in habitat below the water level fluctuation zone. The bathymetry of the reservoir indicates potential habitat below the fluctuation zone, and through field observations and slope analysis, it is presumed that the sand and fine gravels deposits in these shallow portions of the reservoir could provide additional spawning habitat.

Chili Bar Reservoir contains four species of fish that could potentially rear in the reservoir: Sacramento sucker, smallmouth bass, hardhead, and Sacramento pikeminnow.

Sacramento sucker are expected to spawn and rear in the SFAR upstream of the reservoir. Juvenile suckers may also find rearing habitat within the reservoir with the presence of emergent vegetation. Smallmouth bass may find habitat in Chili Bar Reservoir for rearing, but similar to Slab Creek Reservoir, the habitat may be restricted due to the temperature constraints. Chili Bar Reservoir is a well-mixed reservoir (*Water Temperature Technical Report)* and inflows from White Rock Powerhouse are cooler than the preferred 28-31^{o}C temperatures for rearing smallmouth bass (Coble 1975, as cited in Moyle 2002). Juvenile smallmouth bass may be limited to the section of the reservoir just upstream of the powerhouse, or to warmer areas in the SFAR upstream of the reservoir.

Hardhead are expected to rear primarily in the SFAR upstream of the reservoir as well. Juveniles may move downstream into the reservoir and may find abundant preferred rearing habitat that includes shallow water (1–3 feet) near a densely vegetated shoreline (Moyle and Baltz 1985). Chili Bar Reservoir does not contain abundant rearing habitat for hardhead that includes their preferred warm-water environment with a large cobble and boulder substrate (Moyle 2002, Moyle et al. 1982). Sacramento pikeminnow have similar rearing preferences as hardhead and are primarily expected to rear in the tributary streams.

From the S*tream Fisheries Technical Report,* juvenile Sacramento sucker, hardhead, and Sacramento pikeminnow have been observed in the Slab Creek Dam Reach upstream of Chili Bar Reservoir.

The South Fork American River is the primary tributary that flows into Chili Bar Reservoir. No fish migration barrier was found on this tributary; however, two naturally occurring fish migration barriers were identified above the high water line on smaller, intermittent tributaries (Appendix A, Figure A-7). No fish species identified in the 2002 UARP and Chili Bar Project reservoir fish surveys would use these intermittent tributaries for spawning.

4.4 Water-Level Fluctuation Effects

4.4.1 Loon Lake Reservoir

Green sunfish and chub are likely to use the reservoir shoreline habitat to spawn. Their combined spawning season is April through July. The fish spawn in water less than five feet deep and the incubation period of their eggs is less than seven days (Table 4.1-2). The reservoir elevation level increases during the spawning months with little to no daily level fluctuations. Therefore, the spawning beds would not typically be de-watered under normal reservoir operations. The preferred habitat of green sunfish and chub occurs above 6,400 feet elevation, which is typically inundated in June through August. Both species are likely to use this habitat for spawning. The spawning season of both fish species is displayed with the elevation of the preferred spawning habitat along with the average reservoir levels in Figure 4.4-1.

In years where the reservoir does not fill above the 6,400 feet level, there is still additional, potential habitat for green sunfish below 6,400 feet (Figure 4.4-1 and Appendix A, Figure A-1). There is little additional habitat for chub below 6,400 feet.

4.4.2 Ice House Reservoir

Green sunfish use the reservoir shoreline habitat for spawning. They spawn in water less than 1.5 feet deep between May and June. The incubation period of the eggs is less than seven days (Table 4.1-2). The reservoir elevation level increases during the spawning months with little to no daily level fluctuations. The nests would typically be submerged and would not be de-watered under normal reservoir operations. The preferred habitat of green sunfish occurs above the 5,430 feet elevation, which is typically inundated in May through August. The spawning

season of green sunfish is displayed with the elevation of the preferred spawning habitat along with the average reservoir levels in Figure 4.4-2.

In years where the reservoir does not fill above the 5,430 feet level, there is still additional potential habitat for green sunfish below 5,430 feet (Figure 4.4-2 and Appendix Figure A-2).

4.4.3 Union Valley Reservoir

Smallmouth bass, green sunfish, and golden shiner use the reservoir shoreline habitat for spawning. Smallmouth bass spawn in depths up to 16 feet and have an egg incubation period of 7 to 14 days, while green sunfish and golden shiner spawn in water less than three feet deep and have an egg incubation period of four to seven days. The combined spawning season of the three species is March through July (Table 4.1-2). The reservoir elevation levels are either increasing during these months or remaining constant with little to no daily level fluctuations. The nests of these three species would not be de-watered under normal reservoir operations.

The preferred habitat of smallmouth bass occurs in most elevations of the reservoir. Spawning habitat of smallmouth bass is therefore typically inundated under normal water years and the bass are likely to find preferred habitat within their spawning season of March through June.

The preferred habitat for green sunfish and golden shiner occurs above reservoir elevations of 4,855 feet, which is not typically inundated in May through June. The green sunfish are not likely to find preferred habitat in May or June, but could in high water years. Golden shiner are also not likely to find preferred habitat in their principal or extended spawning time from June through September. The spawning season of the three fish species is displayed in Figure 4.4-3 with the elevation of the preferred spawning habitat and average reservoir levels.

In years where the reservoir does not fill above the 4,855 feet level, there is still additional potential habitat for smallmouth bass, green sunfish, and golden shiner (Figure 4.4-3 and Appendix Figures A-3 and A-4). The limiting habitat characteristic for green sunfish and golden shiner is emergent vegetation, which primarily occurs in the upper elevation levels within the eulittoral zone of the shoreline. The average reservoir water elevation did not reach these levels between 1988 and 2002.

4.4.4 Junction Reservoir

There are no fish species identified in Junction Reservoir that would use the reservoir shoreline habitat for spawning.

4.4.5 Slab Creek Reservoir

Smallmouth bass have occurred historically in Slab Creek Reservoir. They spawn in water less than 16 feet deep between late March and July. The incubation period of their eggs is less than 14 days (Table 4.1-2). The reservoir elevation levels typically remain constant through the spawning months; however, there is a small average daily fluctuation of 3.3 feet (Table 4.2-1). Given that this daily reservoir level fluctuation is a regular occurrence, smallmouth bass are

likely to avoid this zone for spawning. The nests of smallmouth bass should not typically be de-watered under normal reservoir operations. The preferred habitat of smallmouth bass occurs at the uppermost end of the reservoir, near an elevation of 1,830 feet. This elevation is just below the range of the daily reservoir fluctuation during late March through May and its location just below the inlet of the South Fork American River. The flow through this area still has relatively high velocities at times. Smallmouth bass are, therefore, not likely to use this habitat for spawning. The spawning season of smallmouth bass is displayed with the elevation of the preferred spawning habitat along with both the seasonal and daily average reservoir levels in Figures 4.4-4 and 4.4-5.

The potential habitat (versus "preferred" habitat) also occurs at the upper end of the reservoir and is subject to high water velocities.

4.4.6 Chili Bar Reservoir

Smallmouth bass were observed in Chili Bar Reservoir during a 2003 CDFG water quality survey. Smallmouth bass spawn in water less than 16 feet deep between late March and July. The incubation period of their eggs is less than 14 days (Table 4.1-2). The reservoir elevation levels typically remain constant through the spawning months; however, there is an average daily fluctuation of 4.2 feet (Table 4.2-1). Given that this daily reservoir level fluctuation is a regular occurrence, smallmouth bass are likely to avoid this zone for spawning. The nests of smallmouth bass should not typically be de-watered under normal reservoir operations. The spawning season of smallmouth bass is displayed with the elevation of the preferred spawning habitat along with both the seasonal and daily average reservoir levels in Figure 4.4-6.

5.0 ANALYSIS

The *Reservoir Fisheries Technical Report* documented the presence of many fish species that were recorded historically in the project reservoirs. Current data indicates that Union Valley, Slab Creek, and Chili Bar reservoirs support warm-water species or hardhead (a special-status species).

Though Loon Lake and Ice House reservoirs have historically (late 1970s) contained warm-water, reservoir dependent species (tule perch in Loon Lake Reservoir and green sunfish in Loon Lake and Ice House reservoirs), none were documented in 2002. This may be a result of the species' inability to sustain a population in the high elevation reservoirs, which occur at the margin of their elevation range. It is also possible that the scope of the 2002 sampling was insufficient to detect species with very small populations.

Warm-water fish species have not been historically documented in Junction Reservoir, and none were captured in the 2002 surveys.

Smallmouth bass (n=1) were observed in the upper portion of Chili Bar Reservoir during a CDFG water quality survey in 2003 as well in the Slab Creek Dam Reach just upstream of the inlet into Chili Bar Reservoir (pers. comm. USDA Forest Service, Jann Williams). This species was not observed during the Reservoir Fisheries Study, which may indicate a limited presence of

smallmouth bass in the reservoir. One possible explanation for the limited number of smallmouth bass, given the presence of spawning and rearing habitat in Chili Bar Reservoir, is that they primarily occur at the upper end of the reservoir due to temperature constraints. White Rock Powerhouse, located just below the head of the reservoir, adds cooler water to the reservoir the SFAR. Warmer temperatures in the lower portions of Slab Creek Dam Reach, and in Chili Bar Reservoir just upstream of White Rock Powerhouse, may provide the most suitable habitat for smallmouth bass.

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FIGURES

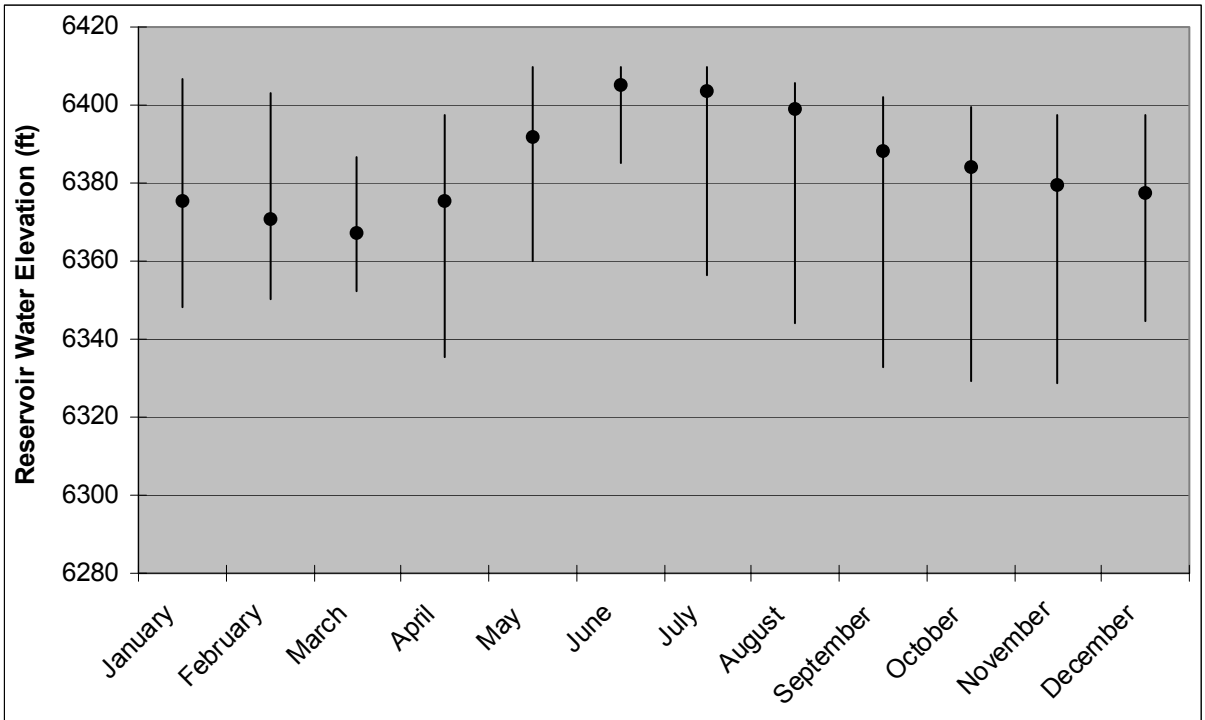

Figure 4.2-1. Average monthly elevation of Loon Lake Reservoir with maximum and minimum water levels, from 1988 through 2002.

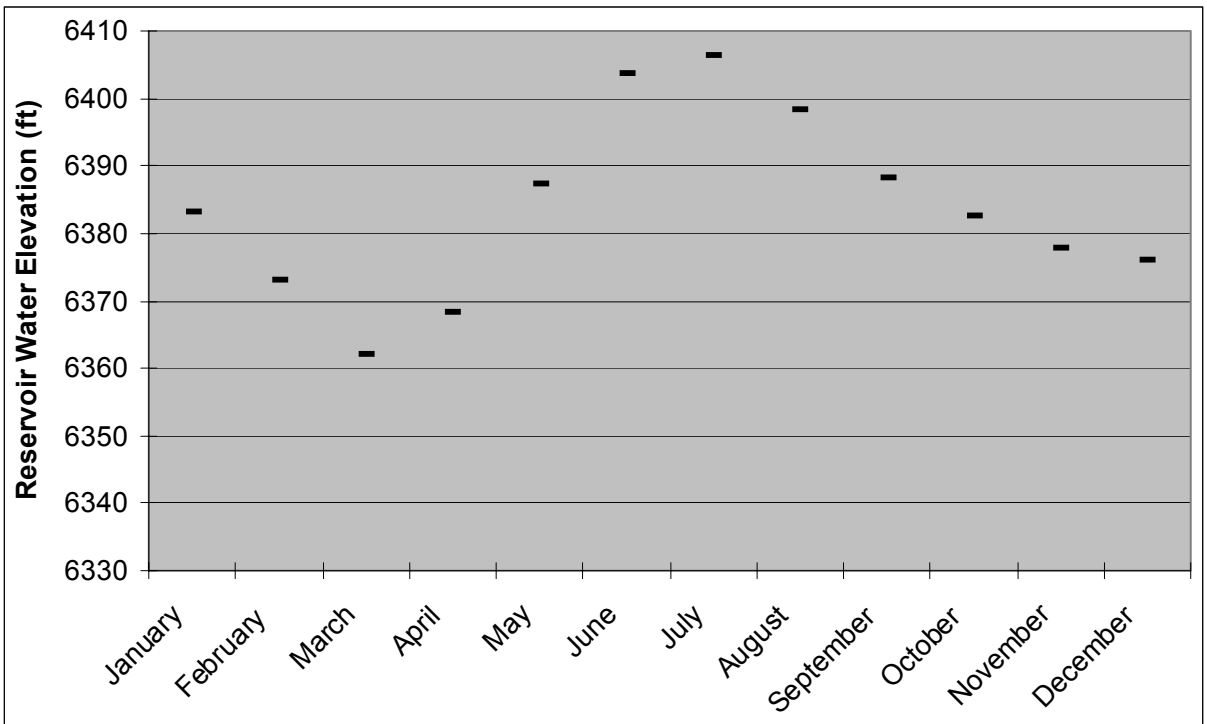

Figure 4.2-2. Daily water-elevation change in Loon Lake Reservoir, from 1995 through 2002.

- Reflects reservoir elevation change of less than 2 feet per day.

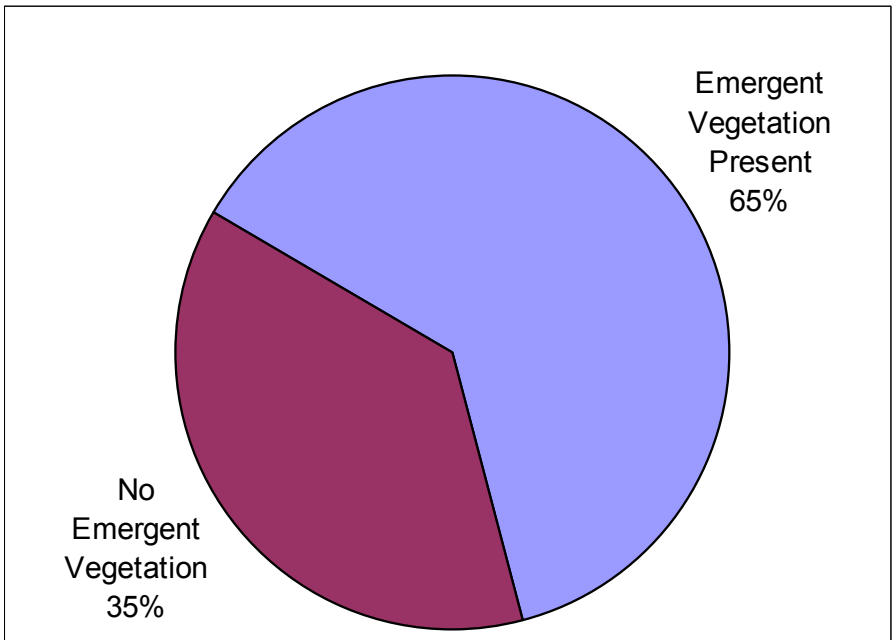

Figure 4.2-3. Loon Lake Reservoir shoreline vegetation, October 2002.

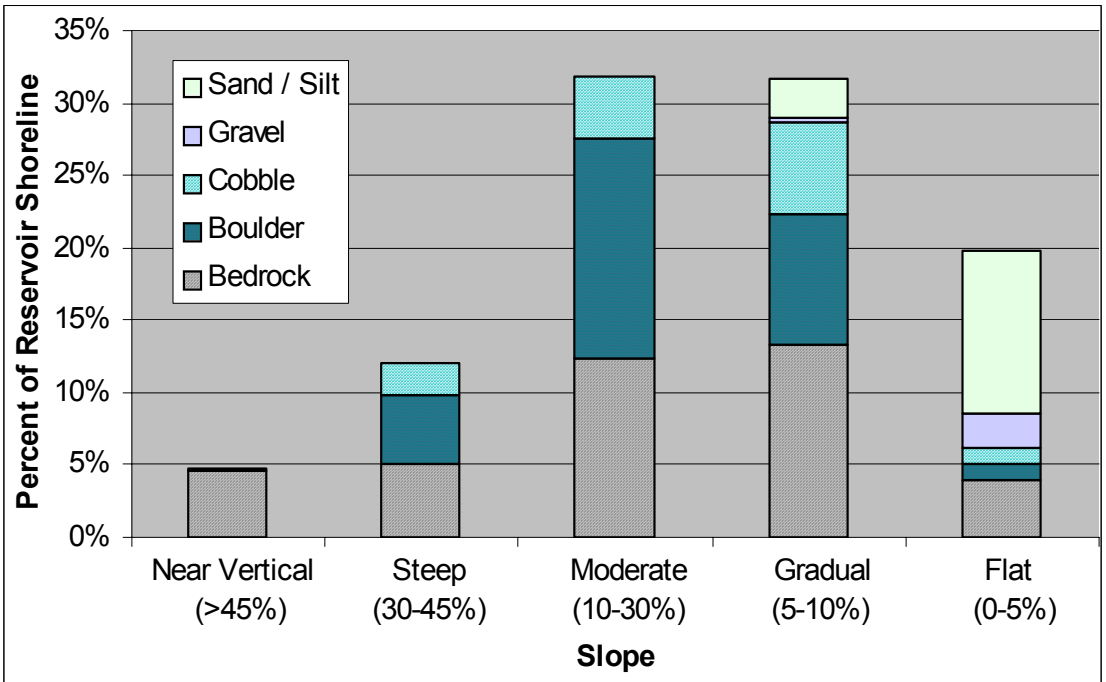

Figure 4.2-4. Slope and dominant substrate composition of Loon Lake Reservoir shoreline, October 2002.

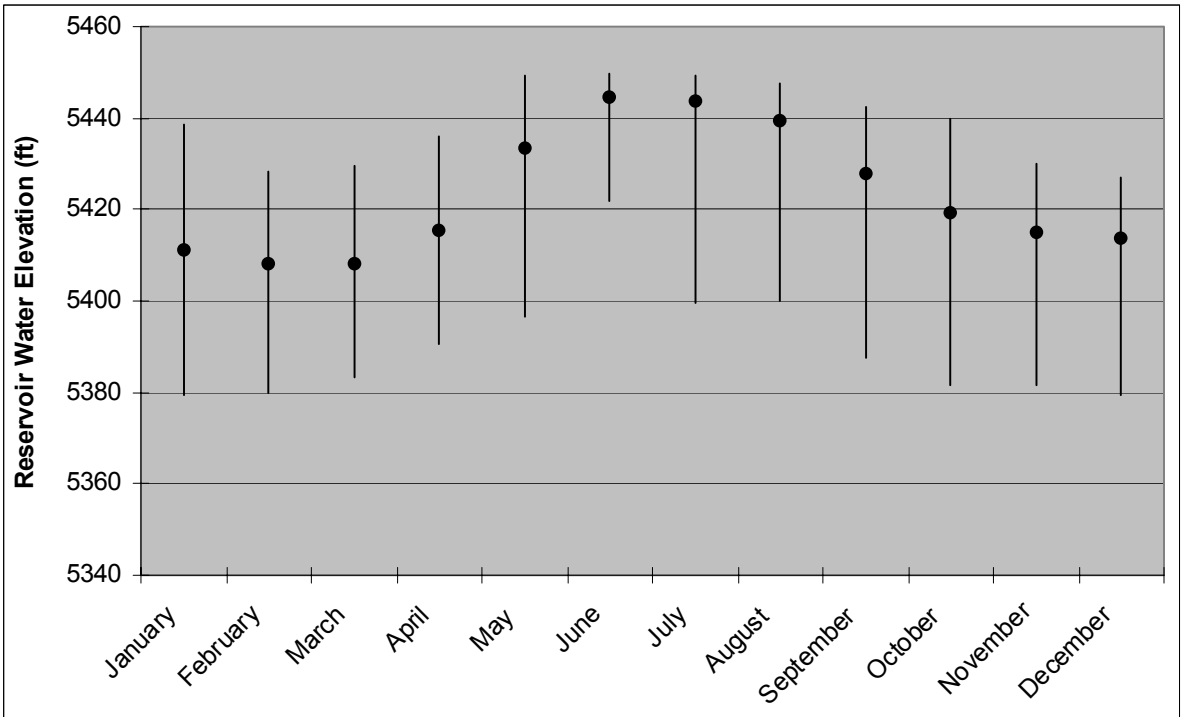

Figure 4.2-5. Average monthly elevation of Ice House Reservoir with maximum and minimum water levels, from 1988 through 2002.

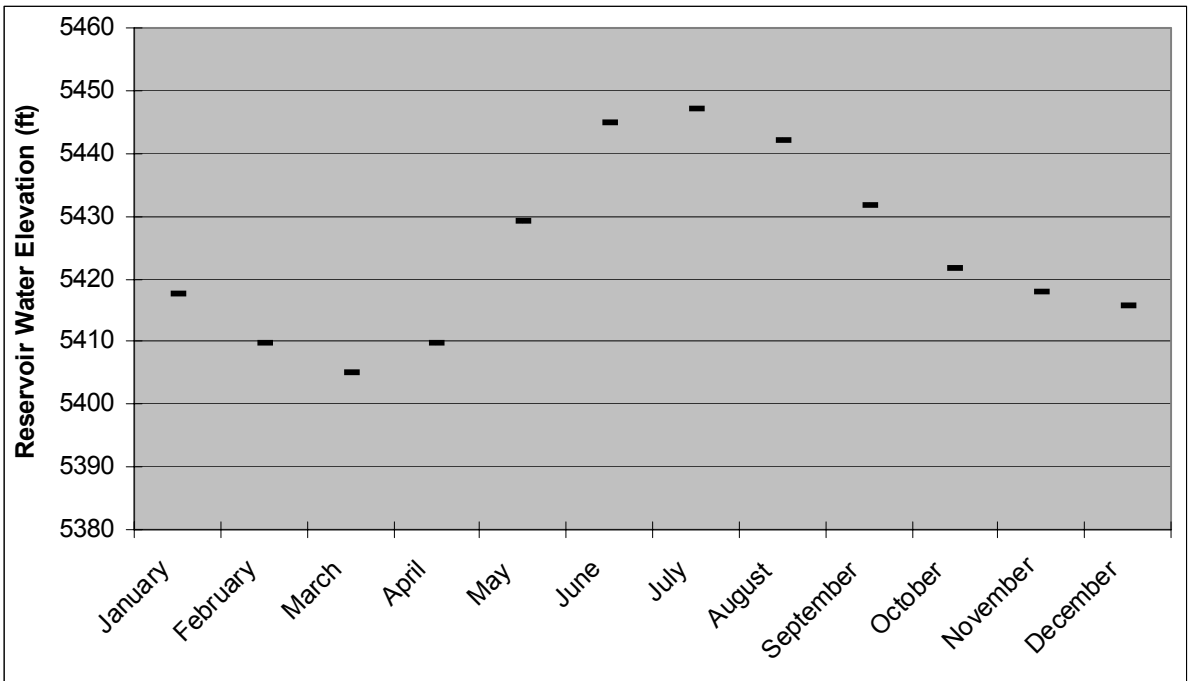

Figure 4.2-6. Average daily elevation change in Ice House Reservoir, 1995 through 2002.
- Reflects reservoir elevation change of less than 2 feet per day.

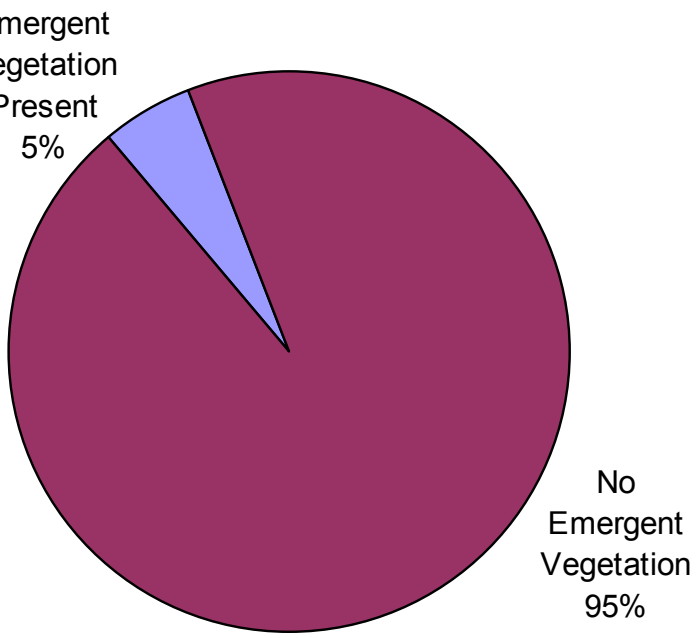

Figure 4.2-7. Ice House Reservoir shoreline vegetation, November 2002.

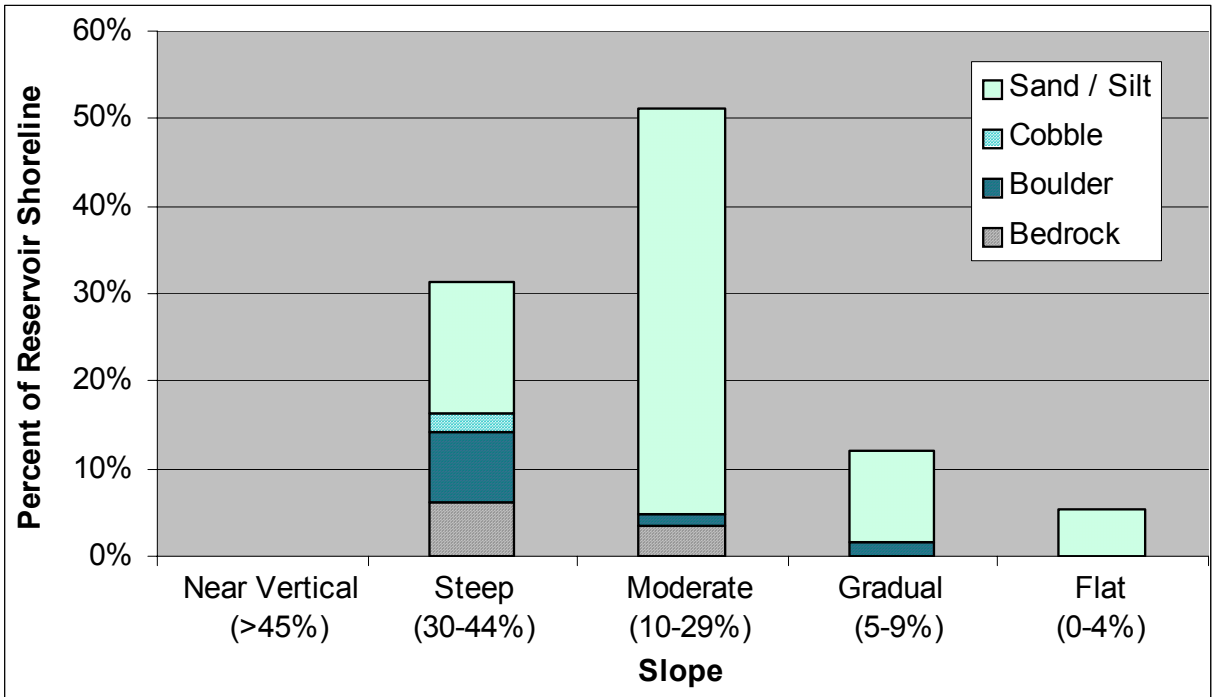

Figure 4.2-8. Slope and dominant substrate composition of Ice House Reservoir shoreline, October 2002.

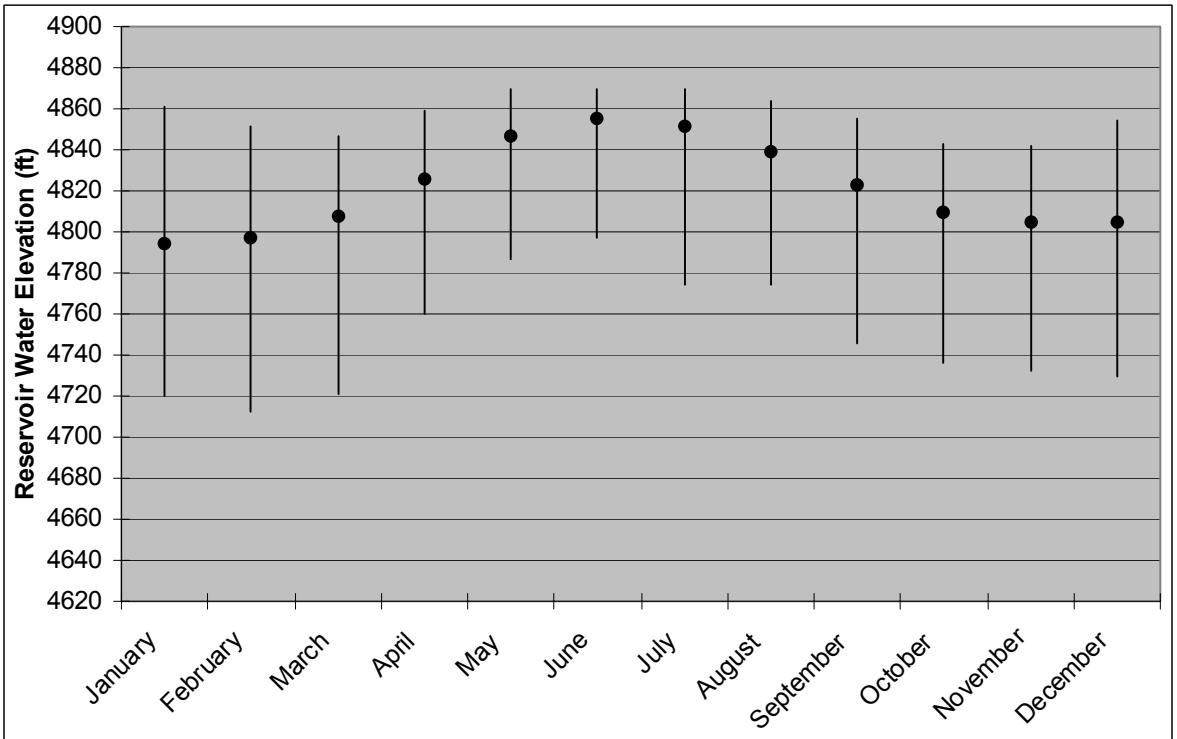

Figure 4.2-9. Average monthly elevation of Union Valley Reservoir with maximum and minimum levels, from 1988 through 2002.

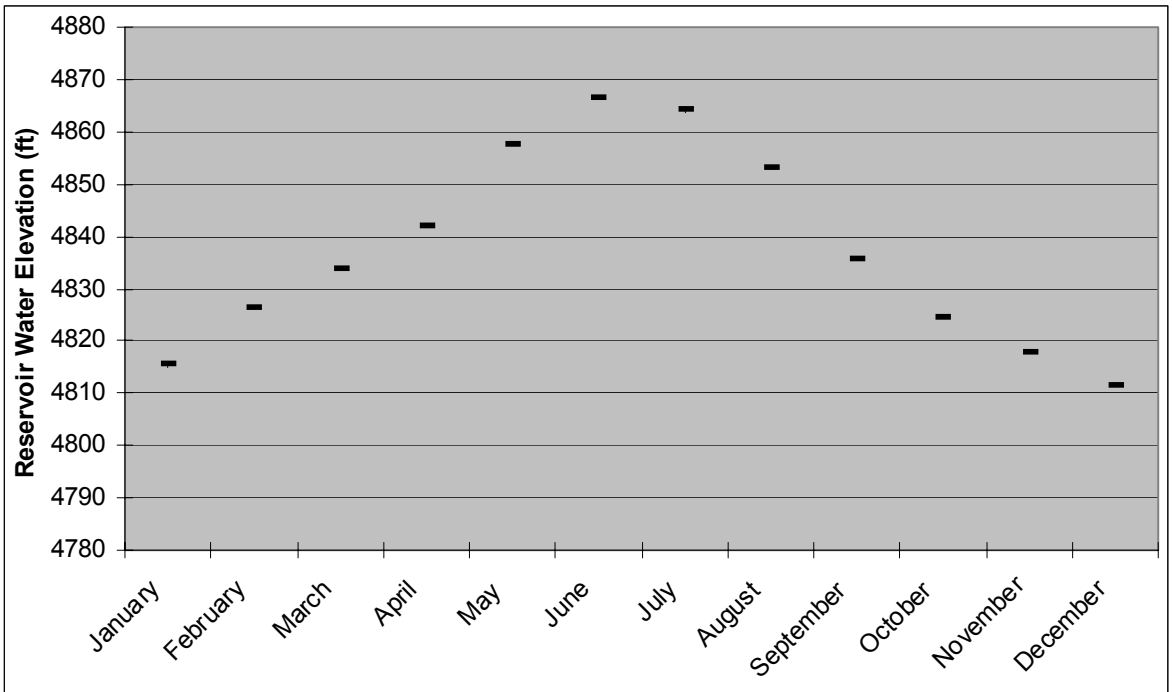

Figure 4.2-10. Daily water-elevation change in Union Valley Reservoir, from 1995 through 2002.

- Reflects reservoir elevation change of less than 2 feet per day.

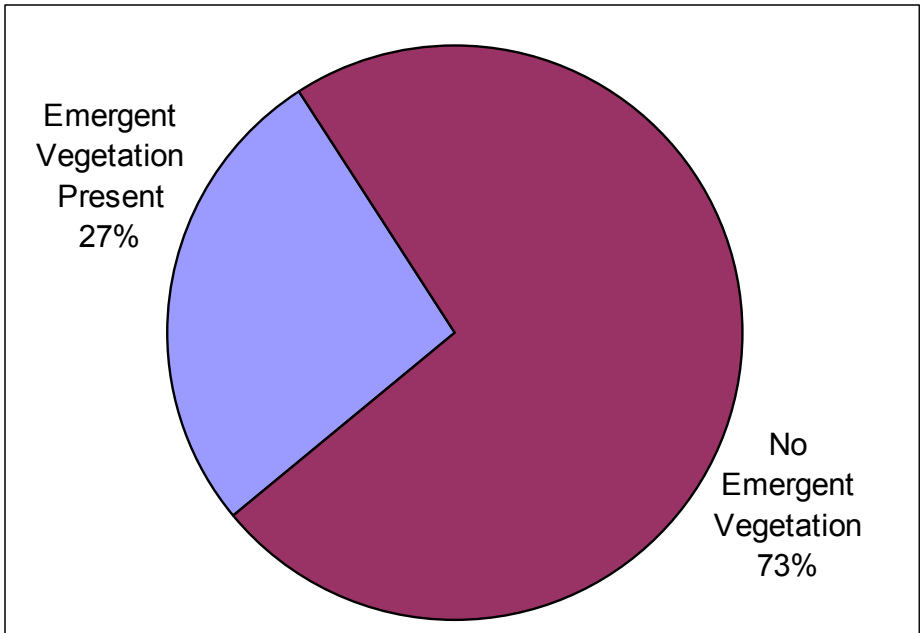

Figure 4.2-11. Union Valley Reservoir shoreline vegetation, October 2002.

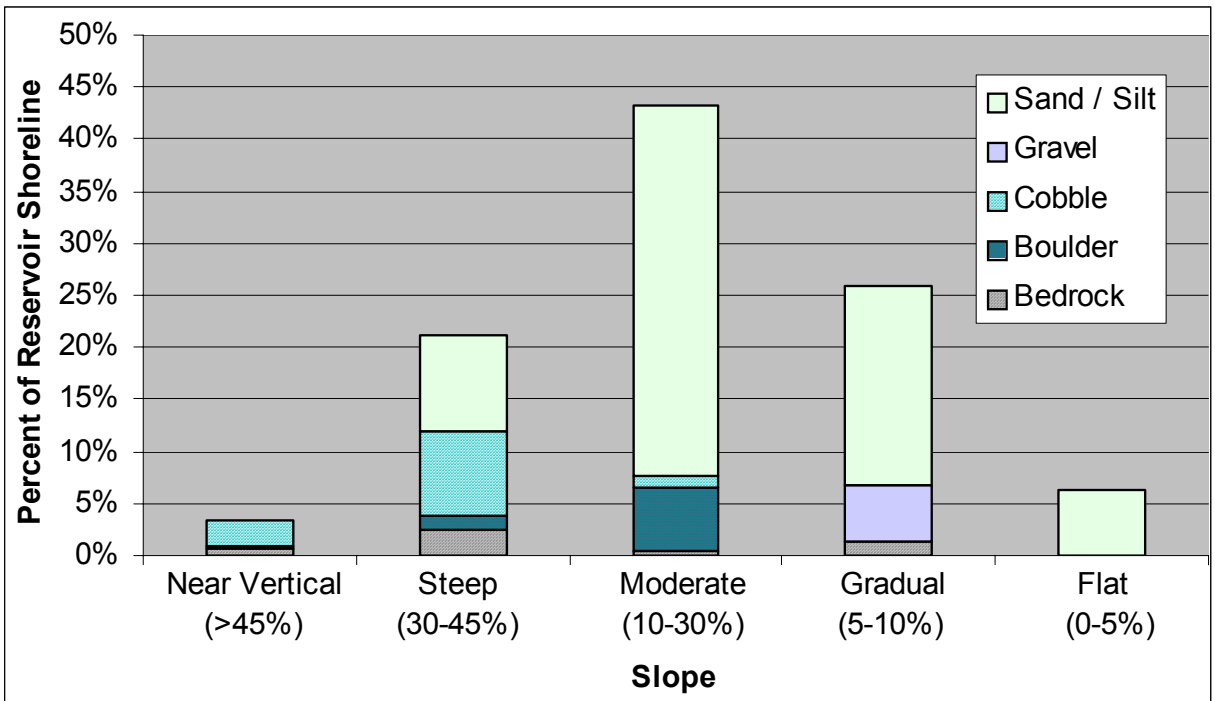

Figure 4.2-12. Slope and dominant substrate composition of Union Valley Reservoir shoreline, October 2002.

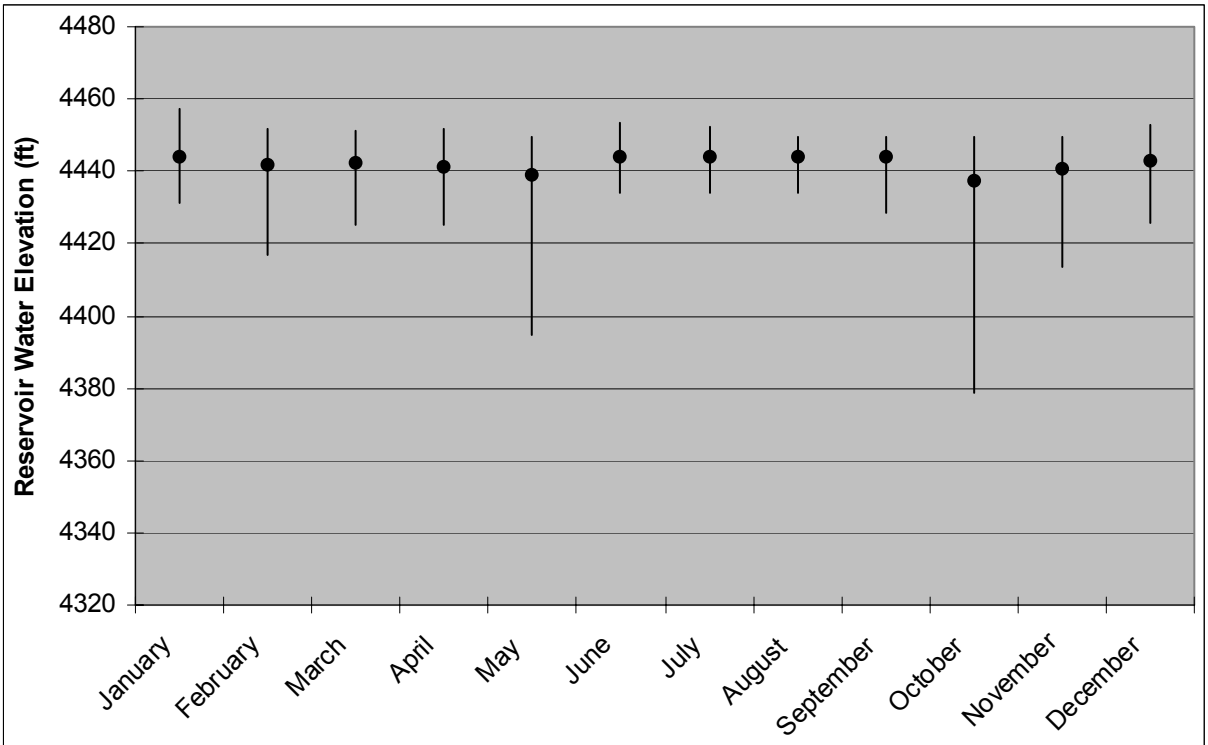

Figure 4.2-13. Average monthly elevation of Junction Reservoir with maximum and minimum levels, 1988 through 2002.

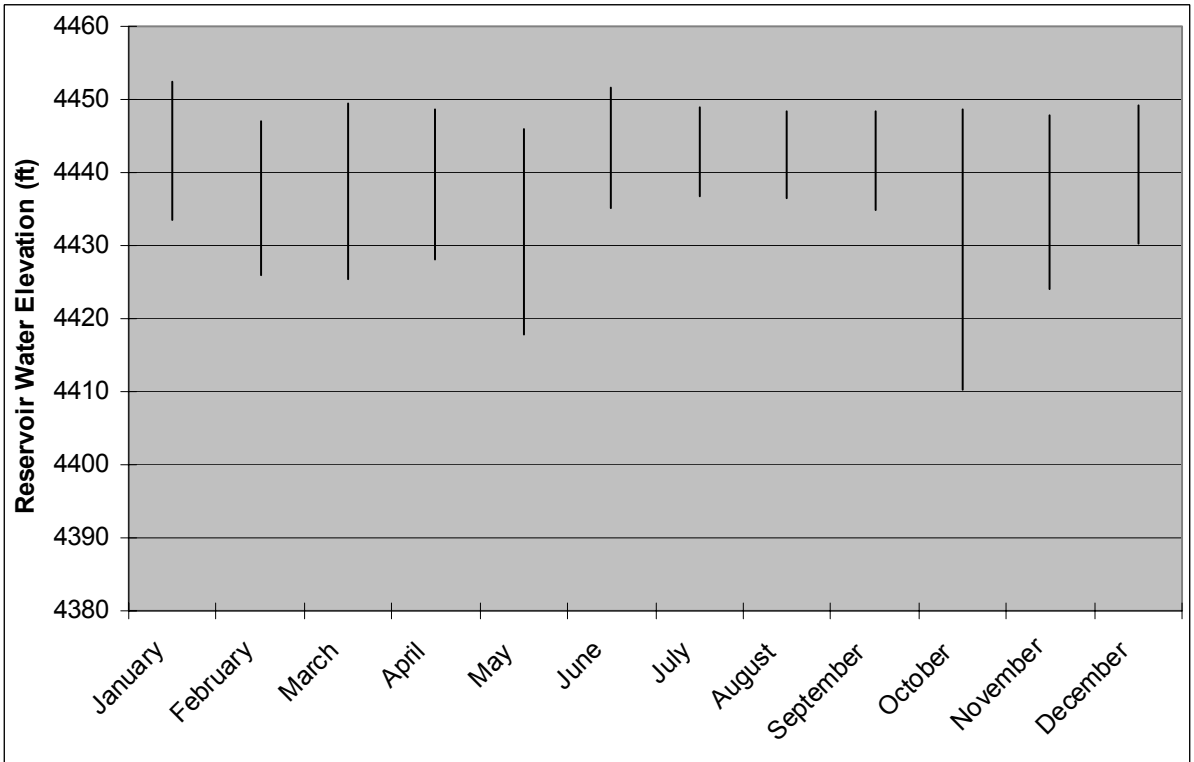

Figure 4.2-14. Daily water-elevation change in Junction Reservoir, from 1995 through 2002.

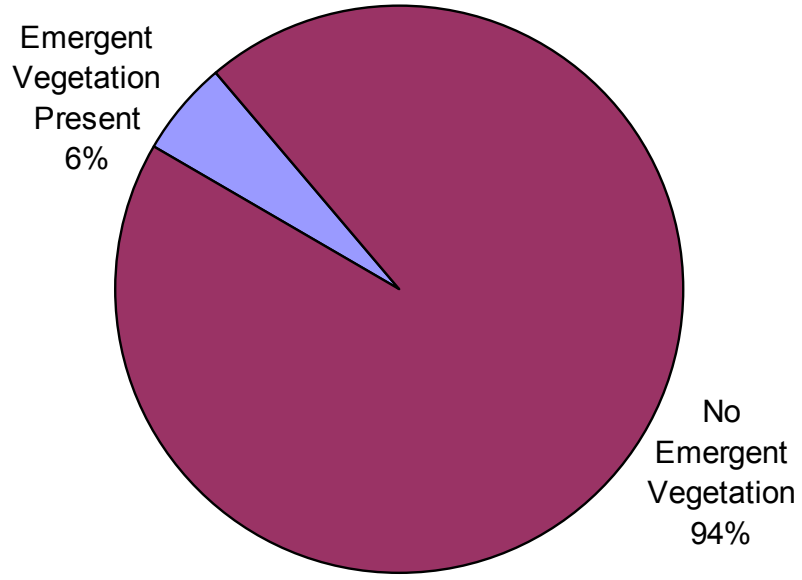

Figure 4.2-15. Junction Reservoir shoreline vegetation, November 2002.

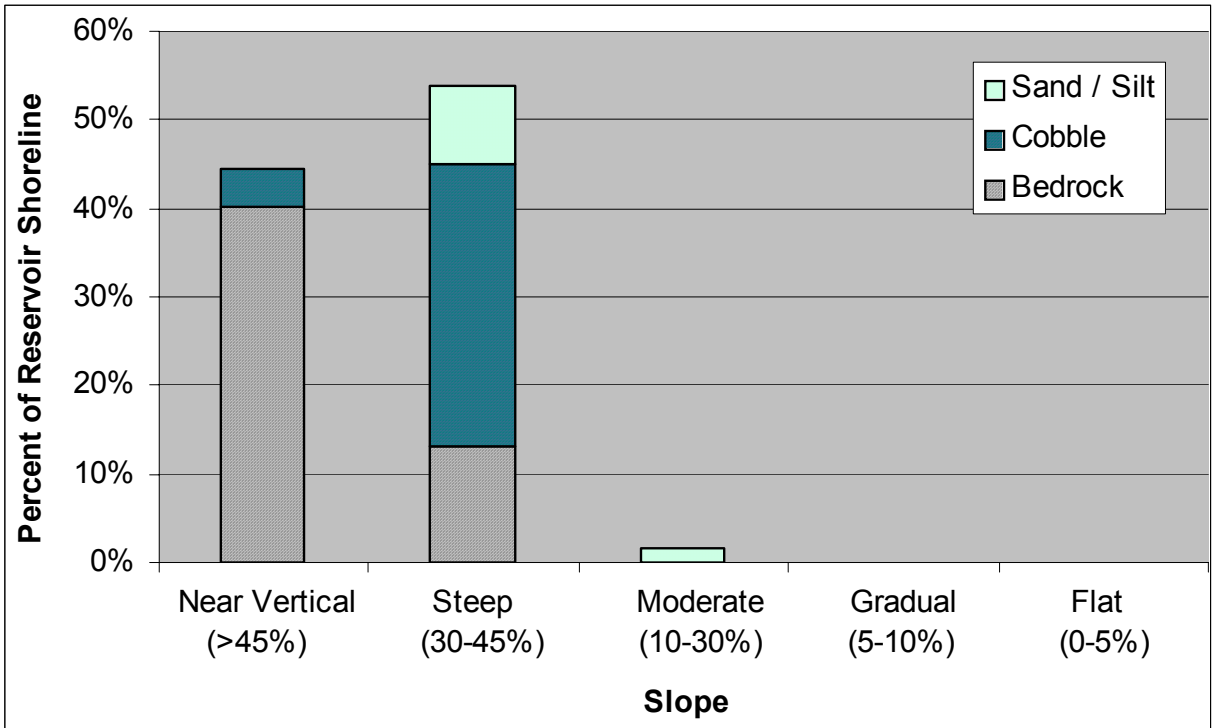

Figure 4.2-16. Slope and dominant substrate composition of Junction Reservoir shoreline, October 2002.

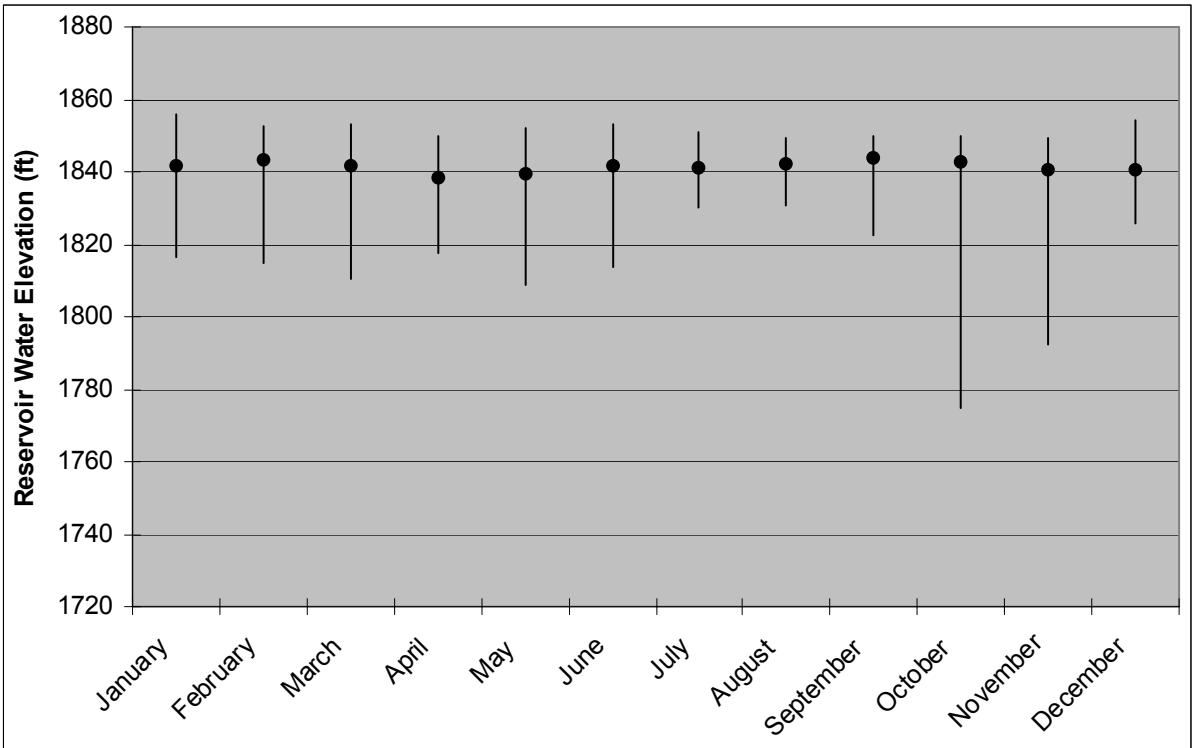

Figure 4.2-17. Average monthly elevation of Slab Creek Reservoir with maximum and minimum levels, 1988 through 2002.

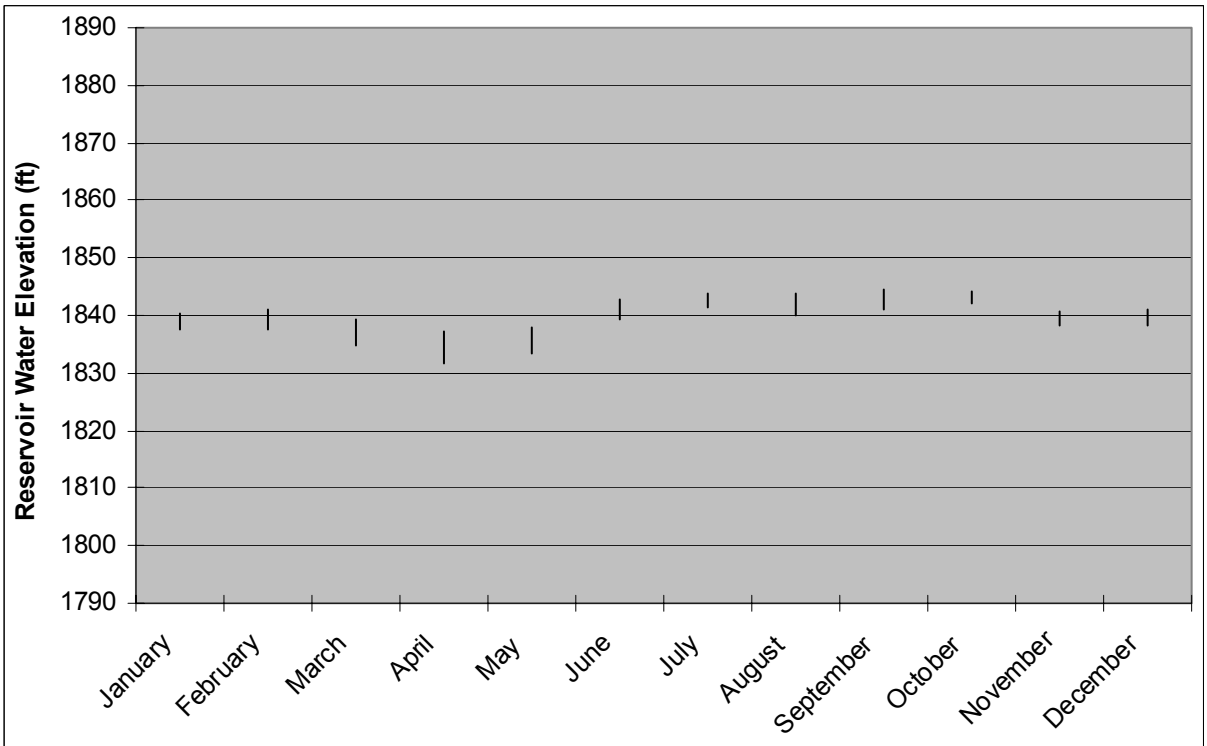

Figure 4.2-18. Daily water-elevation change in Slab Creek Reservoir, from 1995 through 2002.

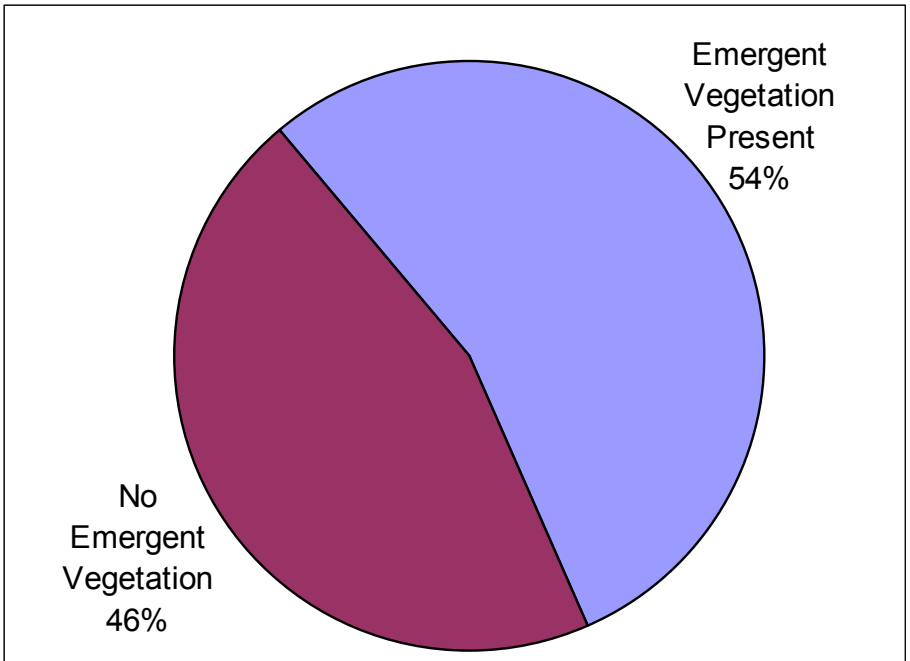

Figure 4.2-19. Slab Creek Reservoir shoreline vegetation, October 2002.

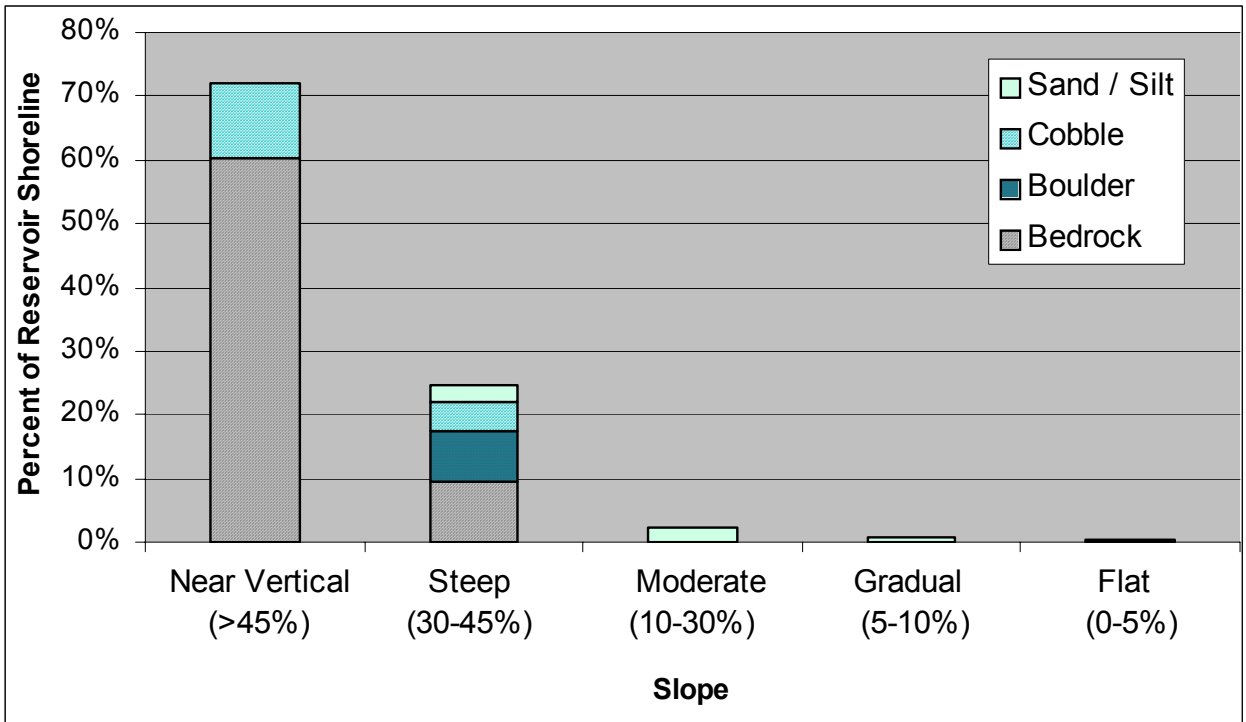

Figure 4.2-20. Slope and dominant substrate composition of Slab Creek Reservoir shoreline, October 2002.

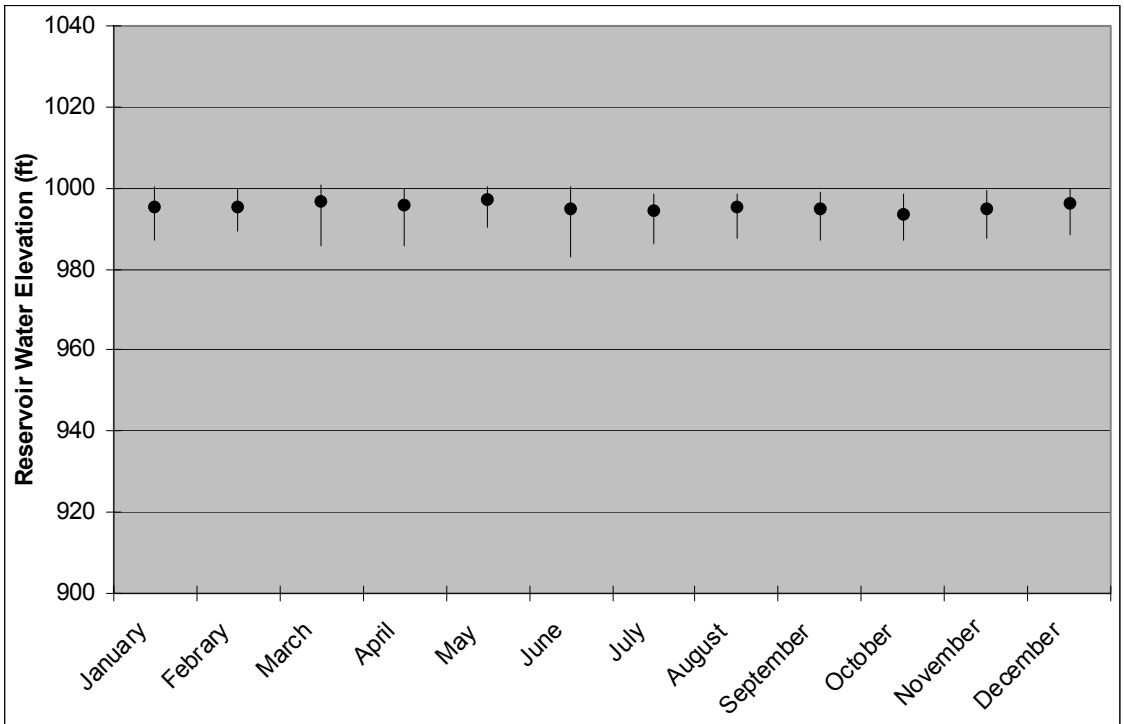

Figure 4.2-21. Average monthly elevation of Chili Bar Reservoir with maximum and minimum levels, 2000 through 2002.

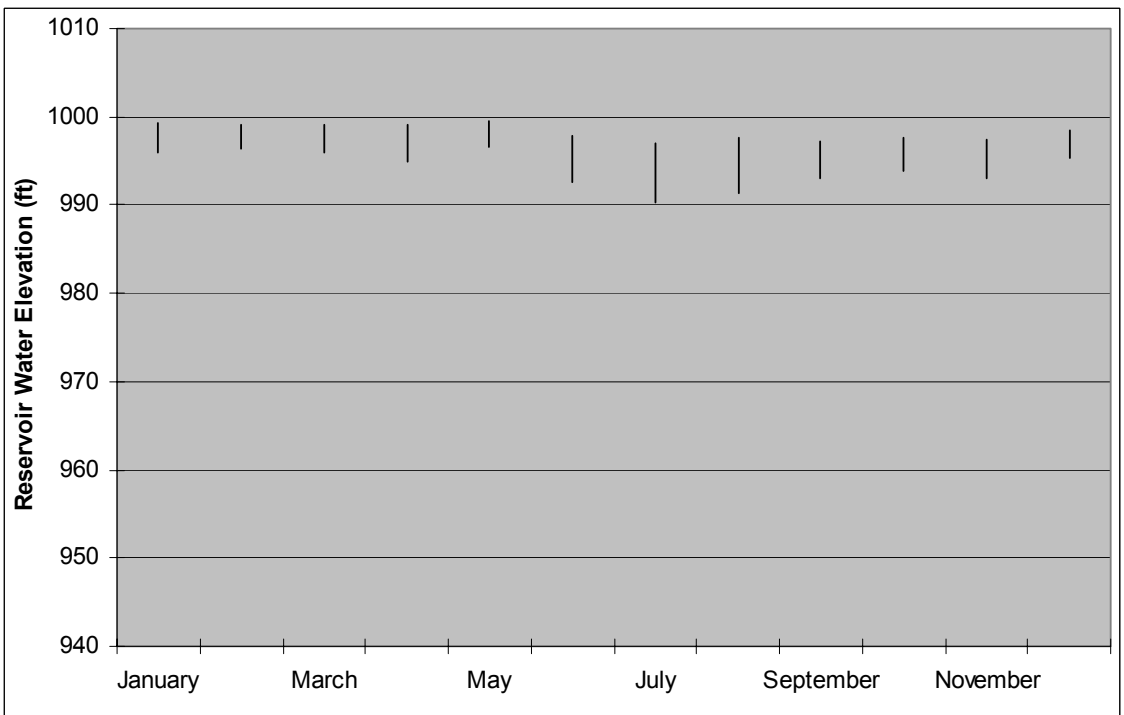

Figure 4.2-22. Daily water-elevation change of Chili Bar Reservoir in 2002.

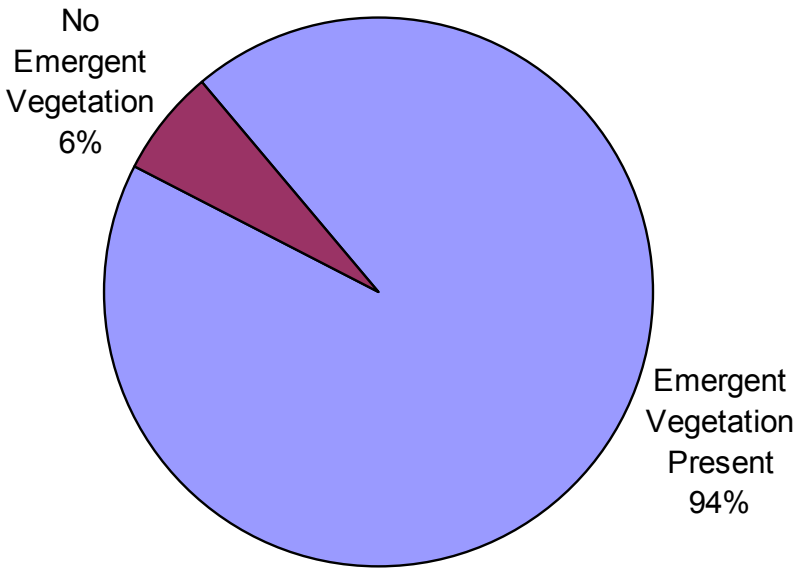

Figure 4.2-23. Chili Bar Reservoir shoreline vegetation, November 2002.

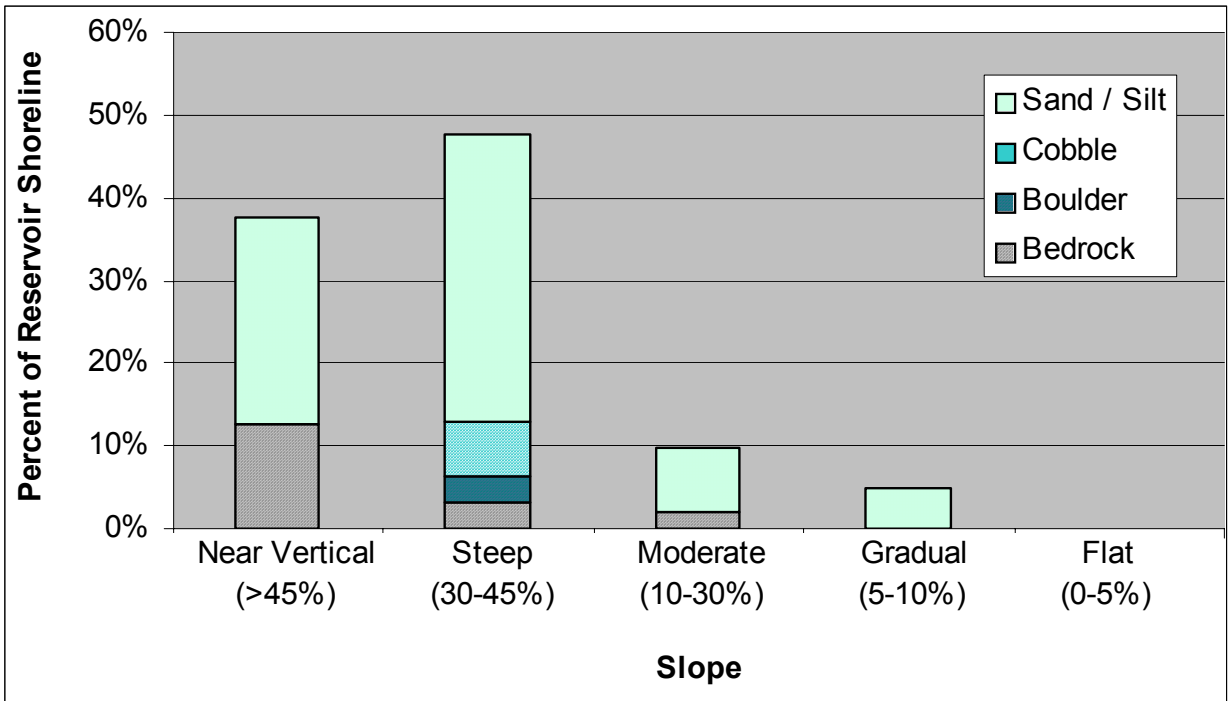

Figure 4.2-24. Slope and dominant substrate composition of Chili Bar Reservoir shoreline, October 2002.

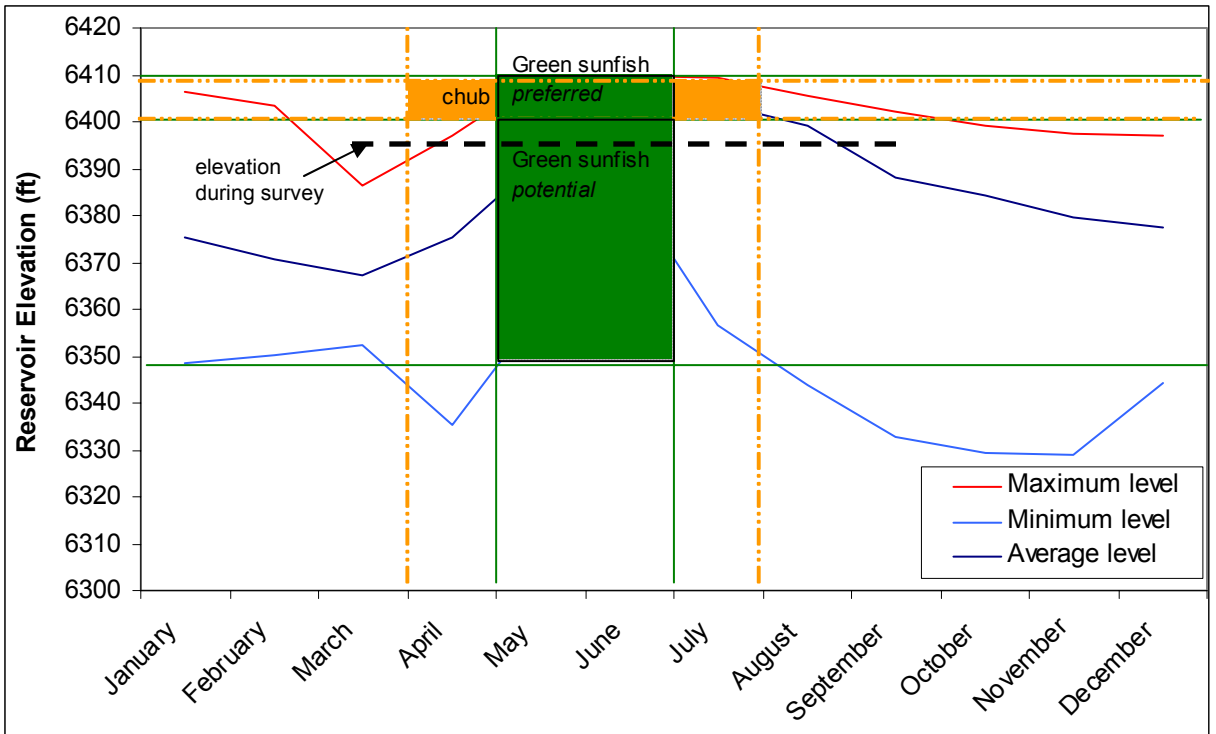

Figure 4.4-1. Preferred and potential spawning habitat (elevation and season) of Loon Lake Reservoir spawning fish with historical water elevations from 1988 through 2002.

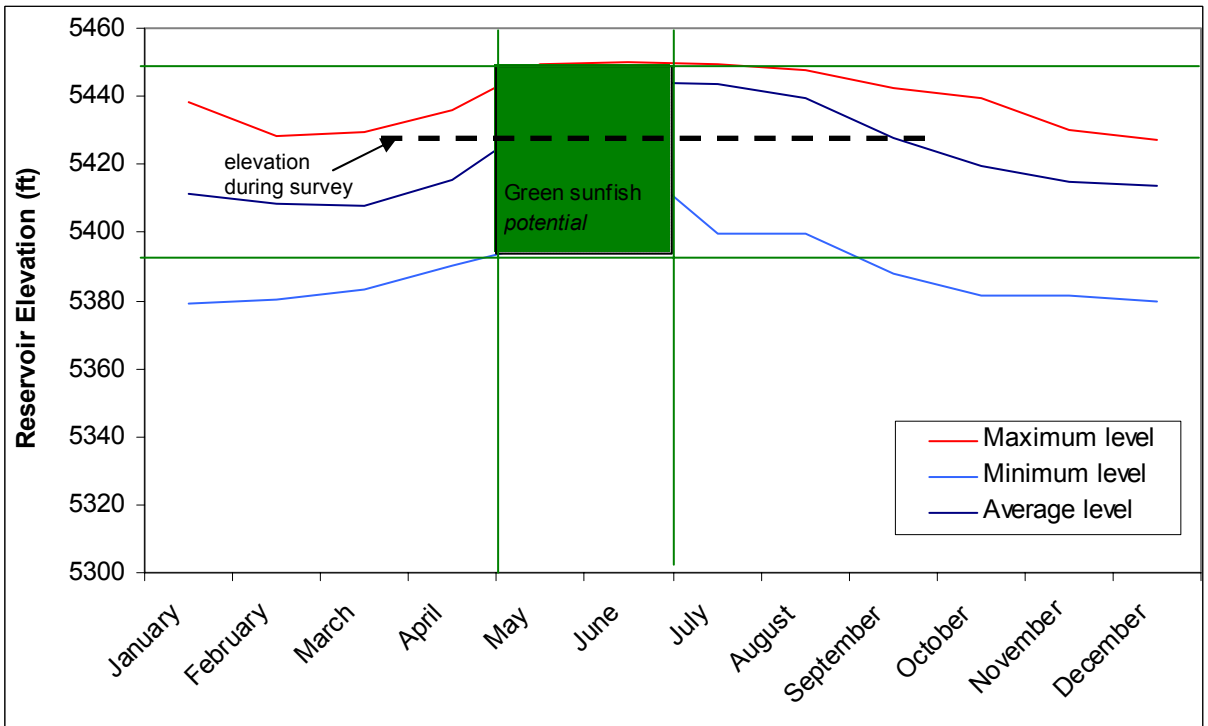

Figure 4.4-2. Preferred and potential spawning habitat (elevation and season) of Ice House Reservoir spawning fish with historical water-elevations from 1988 through 2002.

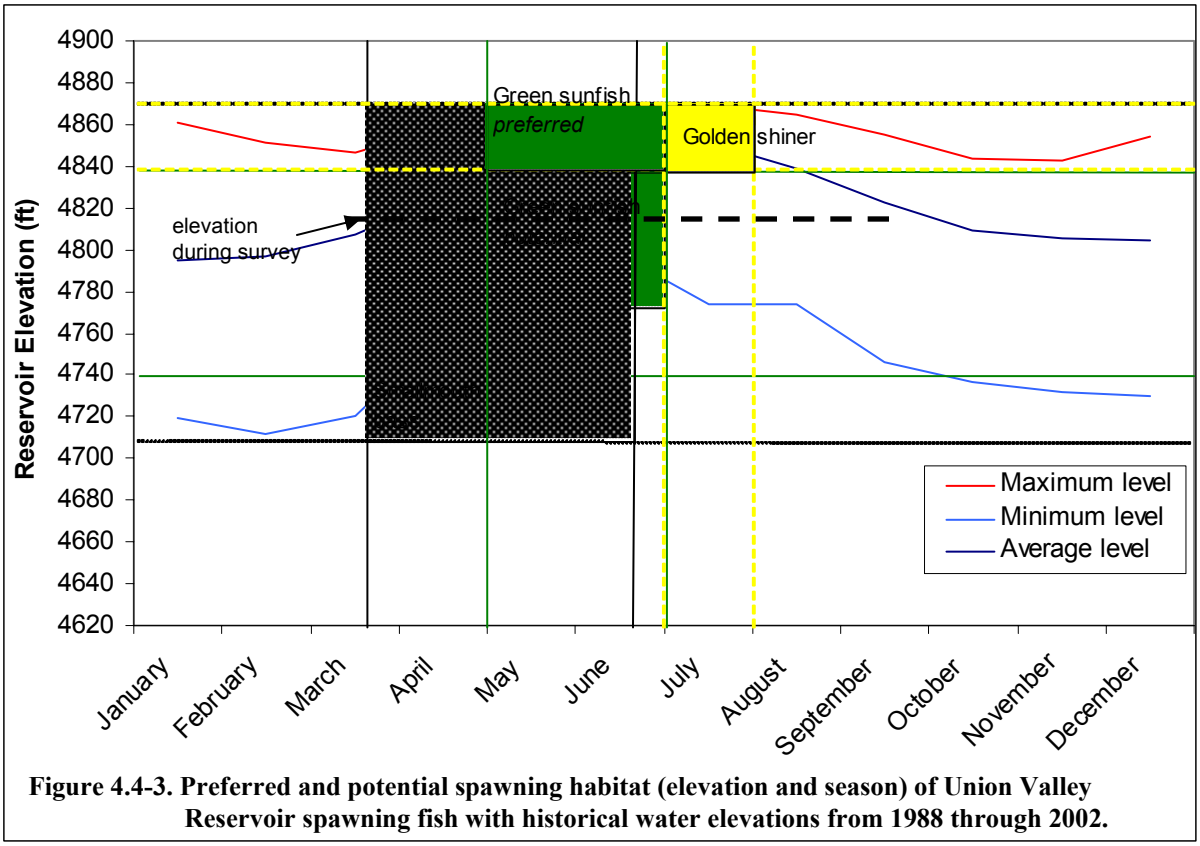

Figure 4.4-3. Preferred and potential spawning habitat (elevation and season) of Union Valley Reservoir spawning fish with historical water elevations from 1988 through 2002.

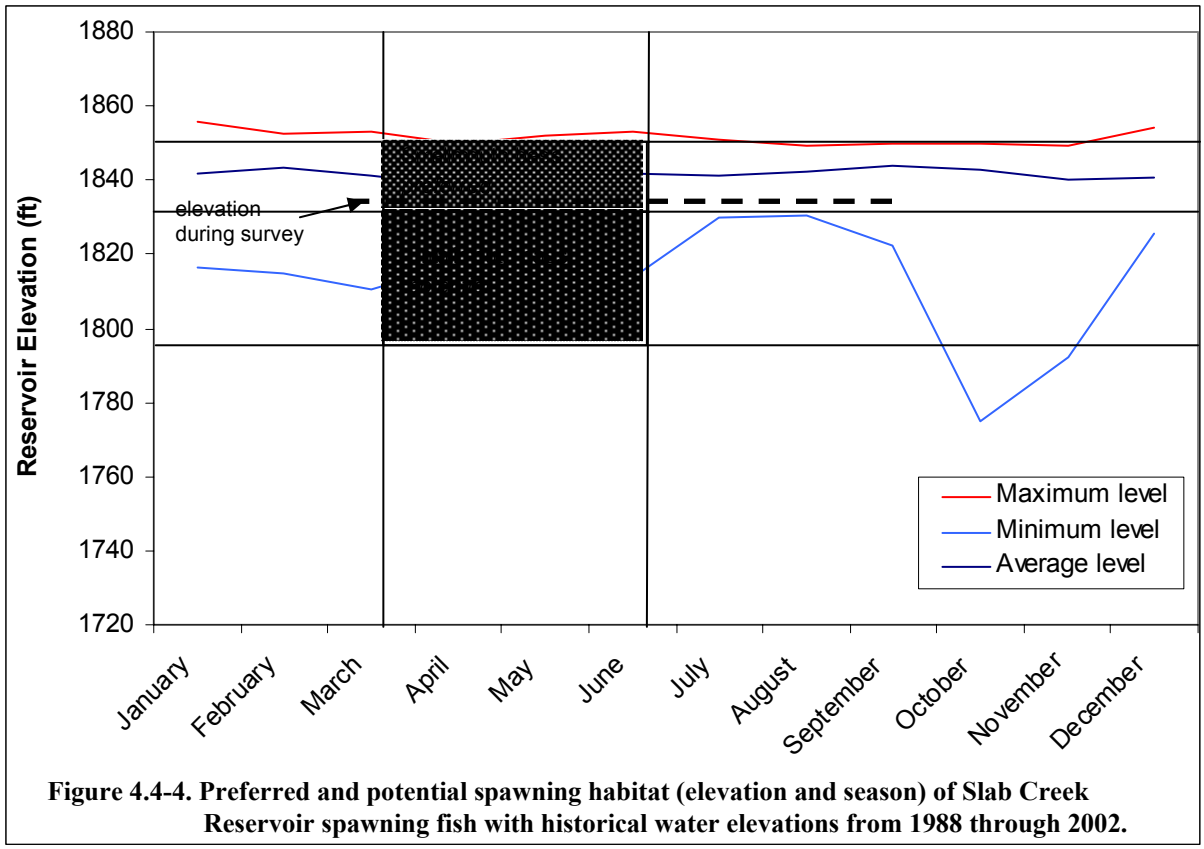

Figure 4.4-4. Preferred and potential spawning habitat (elevation and season) of Slab Creek Reservoir spawning fish with historical water elevations from 1988 through 2002.

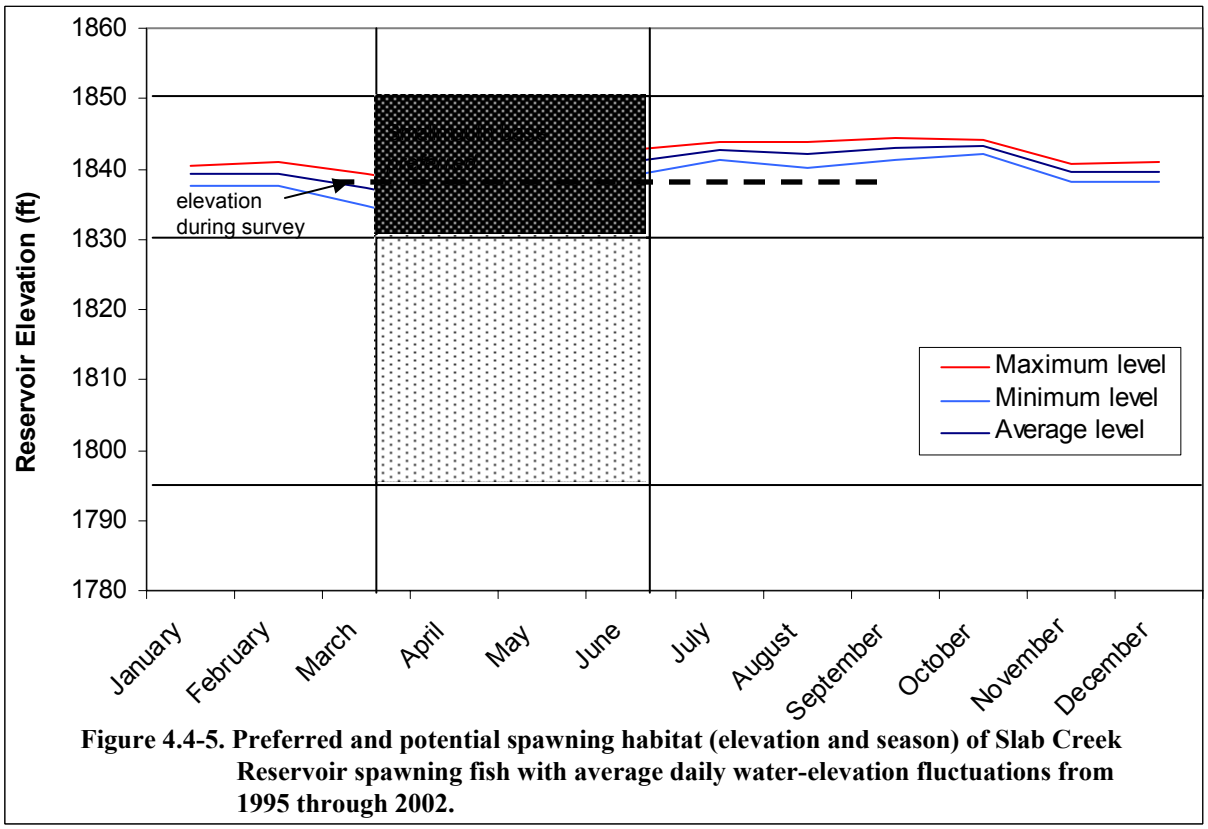

Figure 4.4-5. Preferred and potential spawning habitat (elevation and season) of Slab Creek Reservoir spawning fish with average daily water-elevation fluctuations from 1995 through 2002.

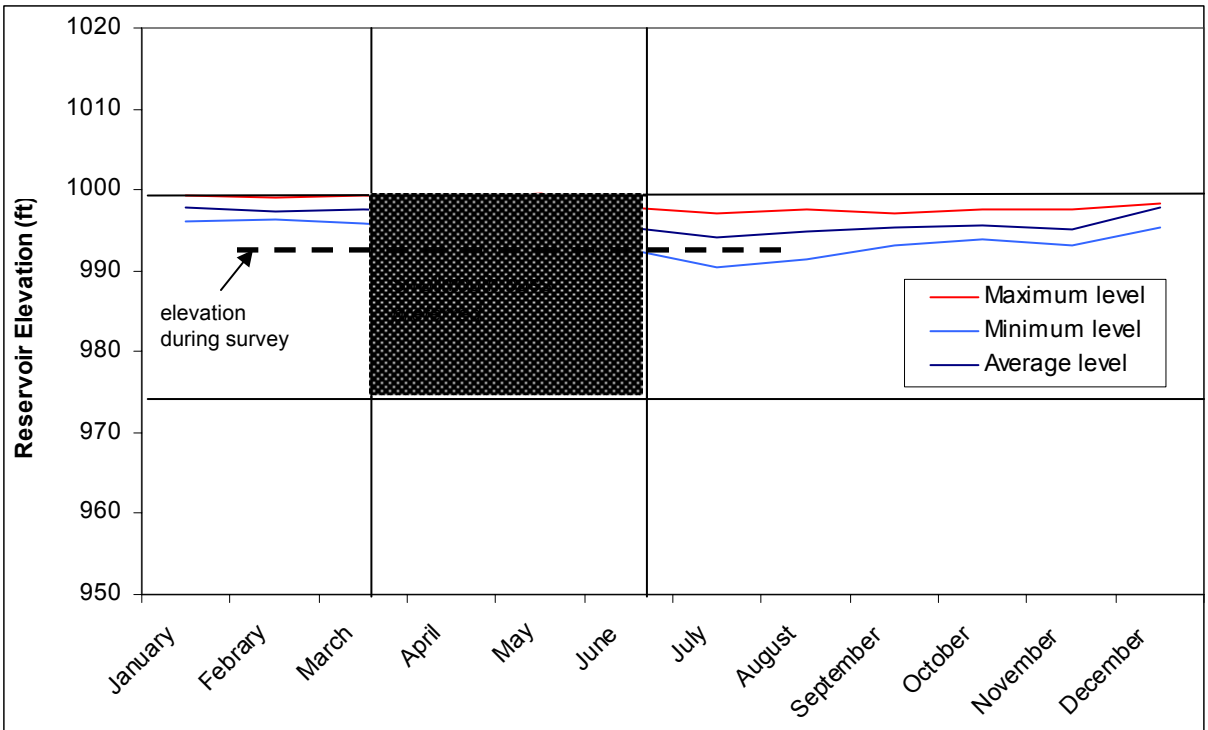

Figure 4.4-6. Chili Bar Reservoir spawning fish season and habitat elevation with average daily water elevation level changes for 2002.

APPENDIX A

UARP AND CHILI BAR PROJECT RESERVOIR SHORELINE HABITAT MAPS

- Figure A-1. Loon Lake Reservoir potential spawning habitat for green sunfish.
- Figure A-2. Ice House Reservoir potential spawning habitat for green sunfish.
- Figure A-3. Gerle Creek Reservoir potential spawning habitat for smallmouth bass.
- Figure A-4. Union Valley Reservoir potential spawning habitat for green sunfish.
- Figure A-5. Junction Reservoir shoreline habitat.
- Figure A-6. Slab Creek Reservoir potential spawning habitat for smallmouth bass.
- Figure A-7. Chili Bar Reservoir fish study sites potential spawning habitat for smallmouth bass.

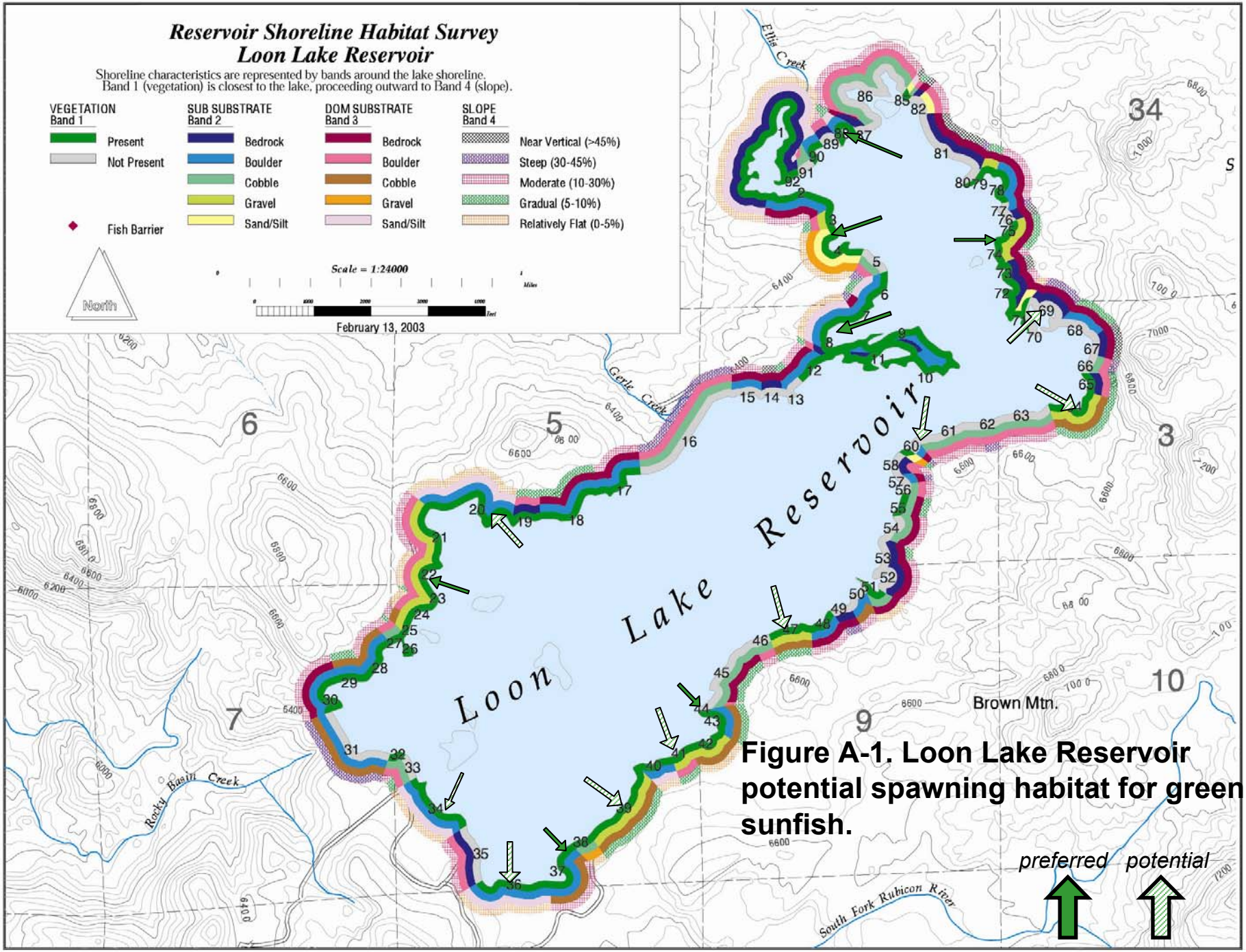

Figure A-1. Loon Lake Reservoir potential spawning habitat for green sunfish.

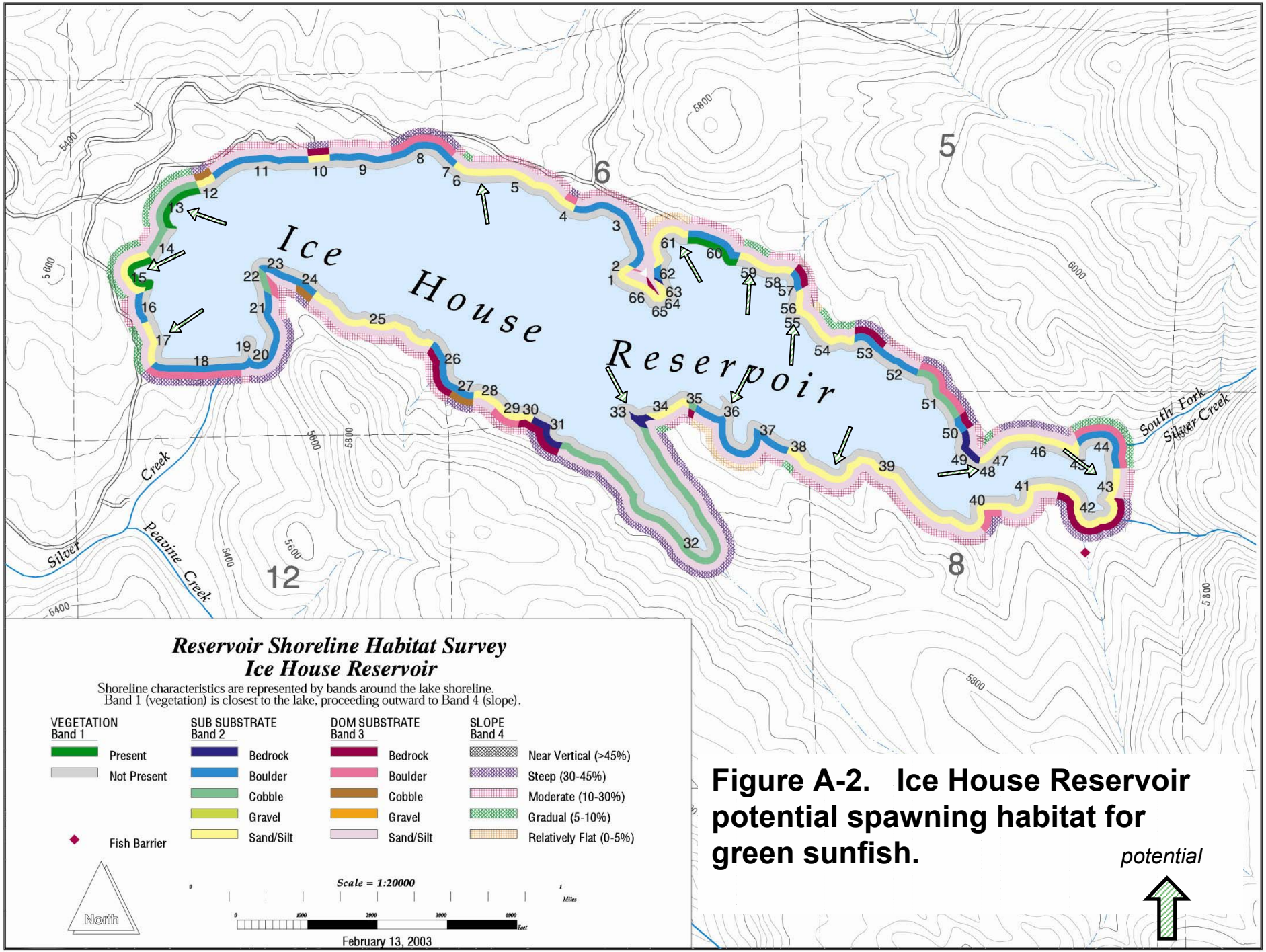

Figure A-2. Ice House Reservoir potential spawning habitat for green sunfish.

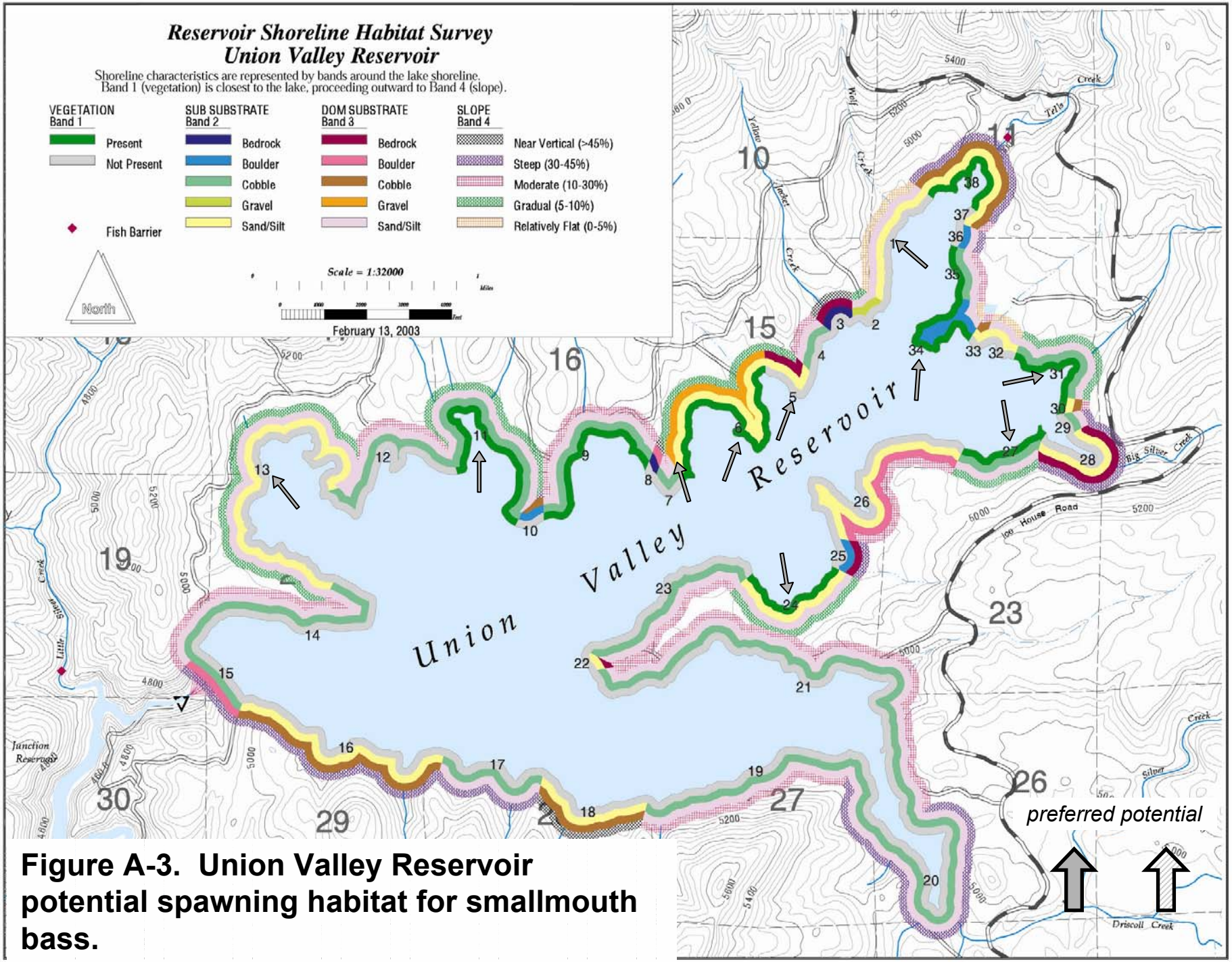

Figure A-3. Union Valley Reservoir potential spawning habitat for smallmouth bass.

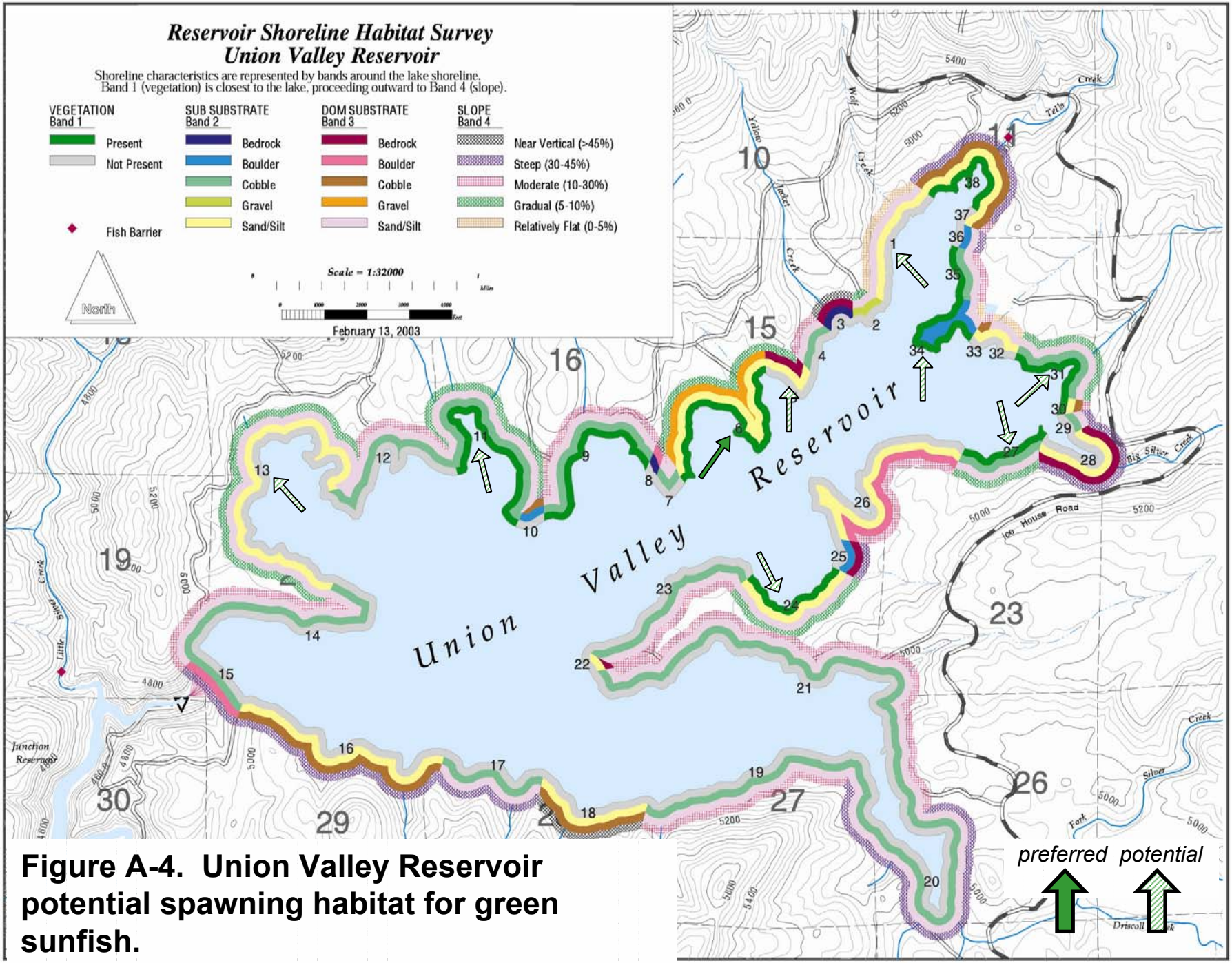

Figure A-4. Union Valley Reservoir potential spawning habitat for green sunfish.

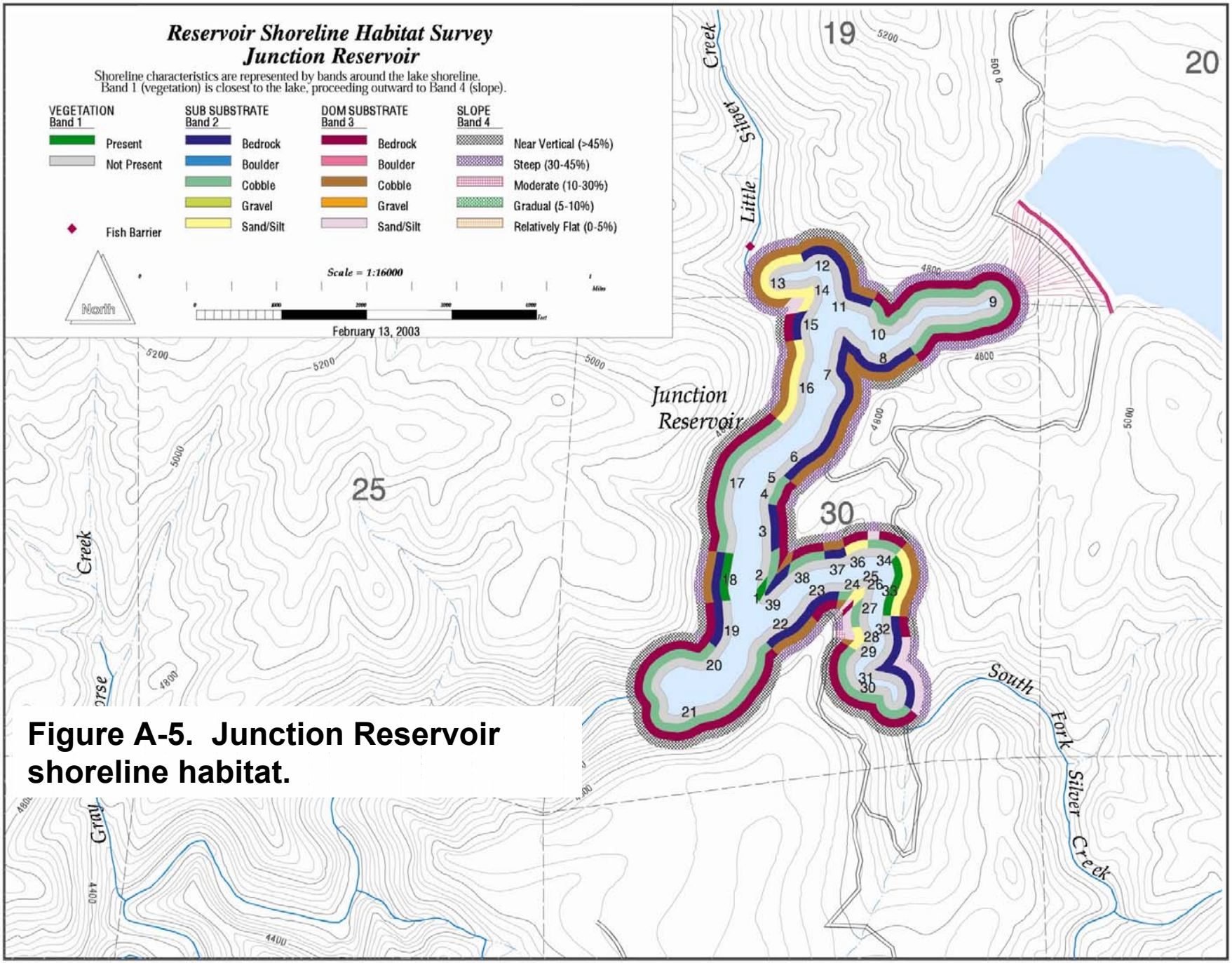

Figure A-5. Junction Reservoir shoreline habitat.

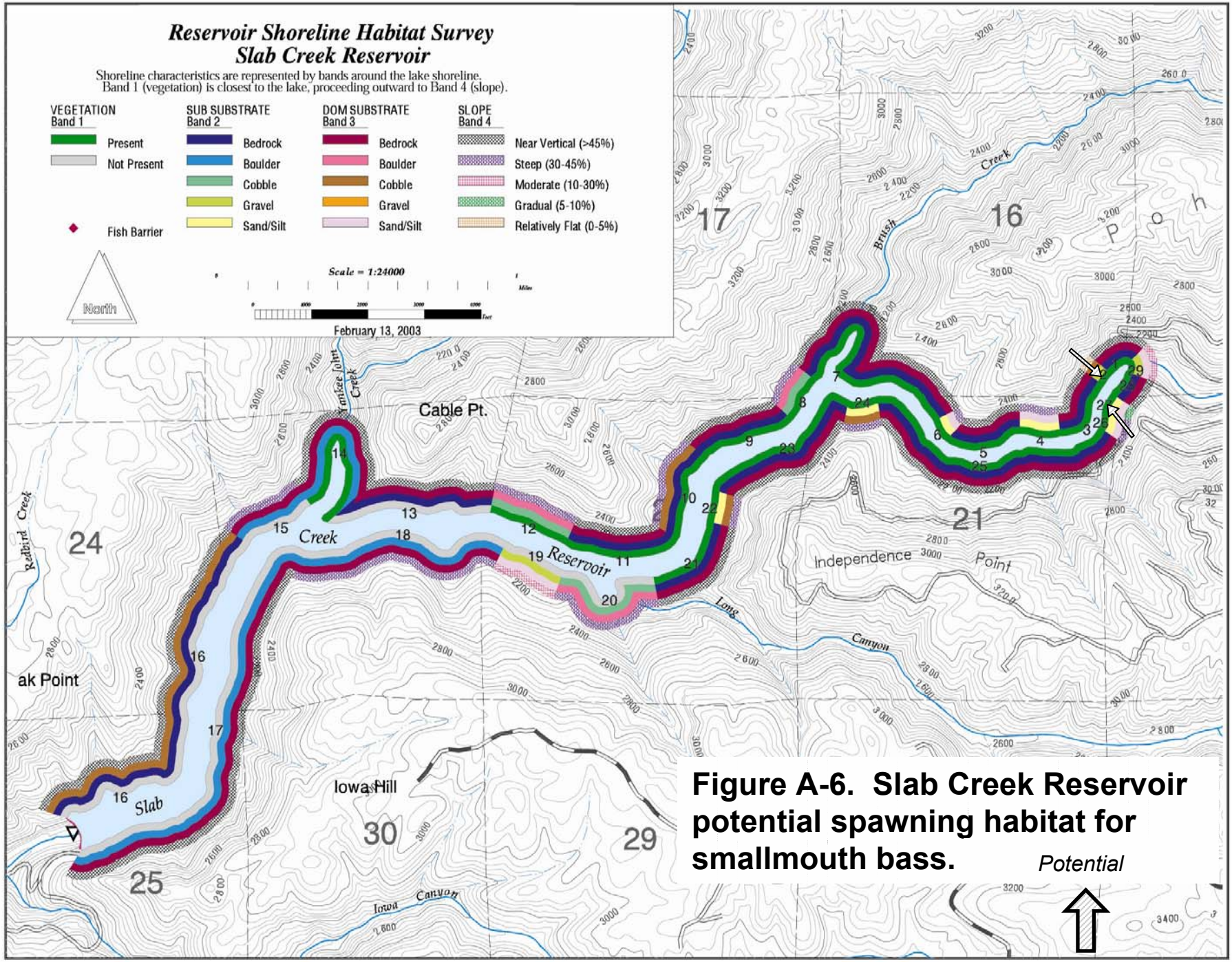

Figure A-6. Slab Creek Reservoir potential spawning habitat for smallmouth bass.

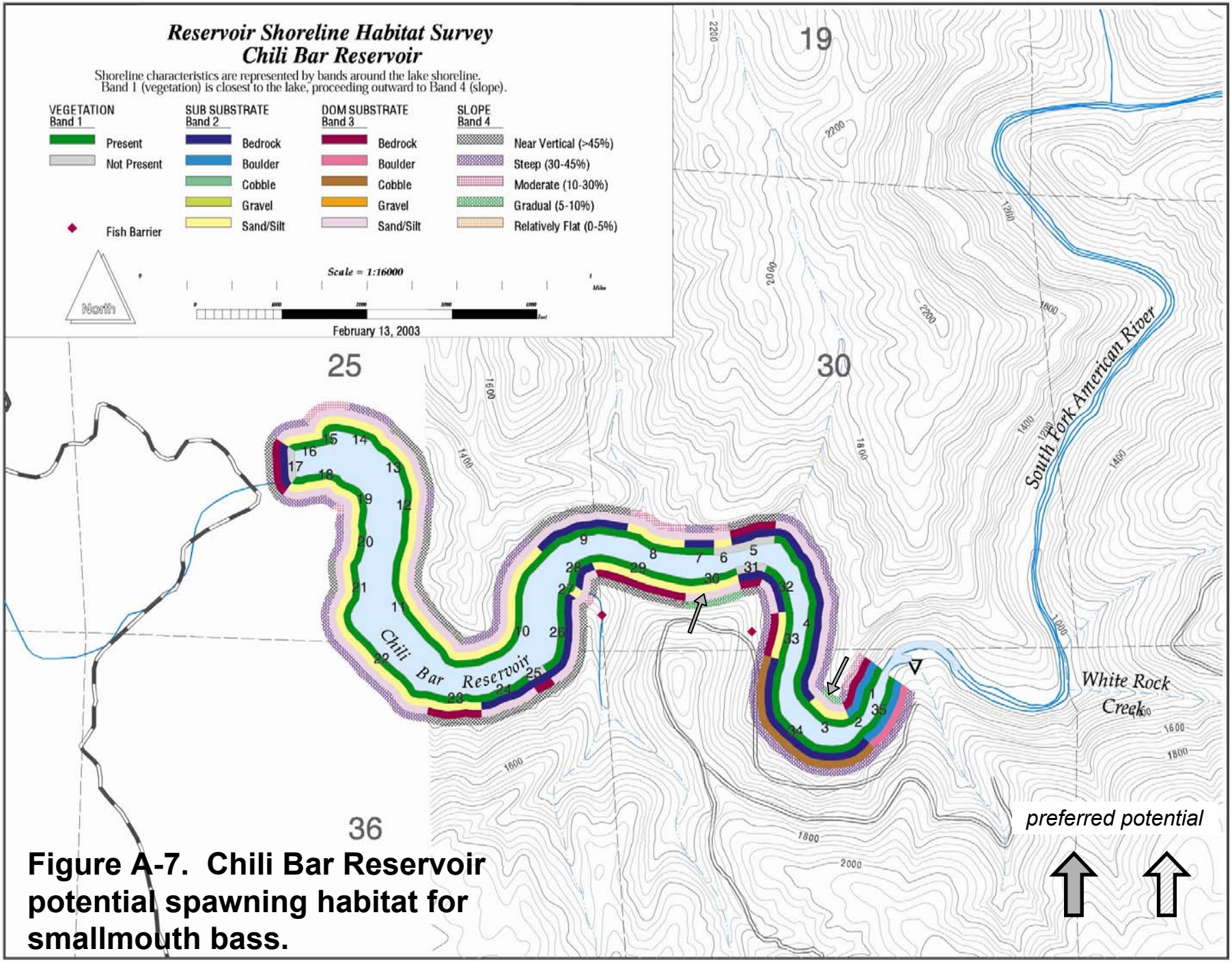

Figure A-7. Chili Bar Reservoir potential spawning habitat for smallmouth bass.

APPENDIX B

UARP AND CHILI BAR PROJECT RESERVOIR SHORELINE HABITAT DATA

- Appendix B1. Reservoir Shoreline Habitat Survey Data
  - Loon Lake Reservoir
  - Ice House Reservoir
  - Union Valley Reservoir
  - Junction Reservoir
  - Slab Creek Reservoir
  - Chili Bar Reservoir
- Appendix B2. Reservoir Tributary Barrier Survey Data
  - Loon Lake Reservoir
  - Ice House Reservoir
  - Union Valley Reservoir
  - Junction Reservoir
  - Slab Creek Reservoir
  - Chili Bar Reservoir

Stillwater Sciences

Appendix B1. Reservoir Shoreline Habitat Survey Data

Date: 31-Oct-02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Survey Direction: ***counterclockwise***
Reservoir: Loon Lake
Reservoir Elevation: 6397
Exposed Shoreline (ft): 13
Start Point Description: Upper Pleasant lake at island (on map)
Max Res. Elevation: 6410

Shoreline	Slope	Substrate Dom	Substrate Sub	Stability	Emergent Veg	Segment Length	UTM startpoint		UTM endpoint		Notes / Photos
1	5	5	1	1	y	709	733499	4321579	733371	4321576	103-398-400, large meadowlike
2	3	1	2	1	y	1,296	733371	4321576	733763	4321520	
3	4	2	4	1	y	427	733763	4321520	733798	4321422	
4	5	4	5	1	y	1,303	733798	4321422	733910	4321324	gillnet-6
5	2	2	3	1	n	575	733910	4321324	734040	4321178	
6	4	5	2	2	y	760	734040	4321178	733995	4320946	
7	2	1	2	1	y	384	733995	4320946	733896	4320852	
8	5	5	2	1	y	1,492	733896	4320852	-	-	large area 103-401 (200 ft long, pie shape)
9	4	1	2	1	y	2,817	-	-	734455	4320645	103-402
10	5	1	2	1	y	1,464	734455	4320645	734049	4320580	rock jetty at Pleasant / Loon break (gillnet-3), at rock outcrops
11	4	2	1	1	y	3,060	734049	4320580	733756	4320633	variable slope = 3-5
12	3	1	2	1	y	646	733756	4320633	733671	4320462	variable slope = 3-4
13	4	1	2	1	n	759	733671	4320462	733447	4320424	variable slope = 3-5 (exposed island)
14	1	1	1	1	n	382	733447	4320424	733350	4320422	103-403
15	3	1	2	1	n	571	733350	4320422	733182	4320441	
16	2	2	3	1	n	2,226	733182	4320441	732720	4320032	Dam @ Gerle w/ exposed rock off dam
17	3	1	2	1	y	1,012	732720	4320032	732507	4319849	gillnet-1
18	4	1	2	1	y	1,299	732507	4319849	732181	4319715	103-404, many shallow / exposed rocks off shore
19	4	2	1	1	y	593	732181	4319715	732012	4319721	
20	5	5	2	1	y	2,118	732012	4319721	731677	4319783	103-405
21	3	2	4	1	y	1,235	731677	4319783	731777	4319511	103-406, exposed islands off shore
22	5	2	4	1	y	473	731777	4319511	731725	431457	
23	4	2	4	1	y	573	731725	431457	731650	4319276	
24	5	2	4	1	y	386	731650	4319276	731561	4319251	
25	3	3	4	2	y	355	731561	4319251	731533	4319159	
26	4	2	3	1	y	481	731533	4319159	731529	4319040	
27	3	2	3	1	y	584	731529	4319040	731438	4319096	
28	3	3	2	1	y	953	731438	4319096	731248	4318875	~30% slope at times
29	4	3	2	1	y	388	731248	4318875	731152	4318890	
30	3	1	2	1	y	962	731152	4318890	731188	4318784	
31	2	3	2	1	n	1,501	731188	4318784	731423	4318652	Dam @ helaport / chalet
32	3	2	3	1	y	296	731423	4318652	731519	4318607	
33	4	2	3	1	n	446	731519	4318607	731608	4318470	
34	5	5	2	1	y	1,440	731608	4318470	731881	4318213	gillnet-4
35	3	2	1	1	n	1,040	731881	4318213	731948	4317926	
36	5	5	2	1	y	1,312	731948	4317926	732221	4317968	103-407, contains boat launch
37	3	3	2	1	y	1,059	732221	4317968	732319	4318116	103-407
38	5	4	3	1	y	395	732319	4318116	732400	4318191	
39	4	3	4	1	y	1,585	732400	4318191	732659	4318558	103-408, some slope=3
40	5	5	2	1	y	683	732659	4318558	732848	4318636	
41	4	2	4	1	y	380	732848	4318636	732947	4318682	
42	5	3	4	1	y	691	732947	4318682	733067	4318707	
43	4	3	2	1	y	653	733067	4318707	732983	4318819	
44	3	2	3	1	n	198	732983	4318819	733016	4318870	
45	4	1	3	1	n	1,566	733016	4318870	733287	4319233	contains small slope=4, gillnet5
46	3	2	3	1	n	302	733287	4319233	733369	4319255	
47	4	3	4	1	y	818	733369	4319255	733612	4319349	
48	3	1	2	1	y	465	733612	4319349	733691	4319398	
49	2	1	1	1	n	363	733691	4319398	733747	4319432	
50	3	3	2	1	n	591	733747	4319432	733803	4319522	
51	5	1	3	1	y	543	733803	4319522	733955	4319495	
52	3	1	1	1	n	757	733955	4319495	733899	4319552	
53	4	1	1	1	n	748	733899	4319552	733939	4319791	cabin
54	3	1	3	1	n	551	733939	4319791	733986	4319885	
55	4	1	3	1	y	463	733986	4319885	733989	4319986	
56	3	2	3	1	n	200	733989	4319986	734063	4320024	103-410
57	2	1	2	1	n	181	734063	4320024	734038	4320075	
58	3	2	1	1	n	470	734038	4320075	734056	4320231	
59	4	4	5	1	y	170	734056	4320231	734107	4320266	

Project Name: SMUD - UARP 166.00 / 6500
Survey Direction: ***counterclockwise***
Reservoir: Loon Lake
Reservoir Elevation: 6397
Exposed Shoreline (ft): 13
Start Point Description: Upper Pleasant lake at island (on map)
Max Res. Elevation: 6410

Shoreline	Slope	Substrate Dom	Substrate Sub	Stability	Emergent Veg	Segment Length	UTM startpoint		UTM endpoint		Notes / Photos
60	2	1	2	1	n	298	734107	4320266	734163	4320310	
61	3	2	3	1	n	1,202	734163	4320310	734502	4320430	
62	2	2	3	1	n	190	734502	4320430	734551	4320441	
63	3	2	3	1	n	1,034	734551	4320441	734862	4320513	
64	4	3	4	1	y	1,002	734862	4320513	735010	4320552	
65	4	2	1	1	y	353	735010	4320552	735002	4320645	
66	2	2	3	1	n	384	735002	4320645	735063	4320738	
67	1	1	1	1	n	269	735063	4320738	735060	4320794	103-414
68	4	1	2	1	n	721	735060	4320794	734947	4320804	
69	2	1	1	1	n	2,000	734947	4320804	734848	4320740	contains cove = 5,5,1,y,(100'x300')
70	3	1	1	1	n	178	734848	4320740	734751	4320789	
71	5	1	5	1	y	756	734751	4320789	734571	4320961	
72	3	1	1	1	y	905	734571	4320961	734590	4321105	slope =2-5
73	1	1	1	1	y	379	734590	4321105	734562	4321173	103-415
74	3	1	4	1	y	712	734562	4321173	734611	4321370	frog habitat
75	4	1	4	1	y	377	734611	4321370	734605	4321402	
76	1	1	1	1	n	242	734605	4321402	734576	4321453	
77	2	1	2	1	n	213	734576	4321453	734537	4321524	
78	3	1	2	1	y	703	734537	4321524	734510	4321578	
79	4	1	4	1	y	695	734510	4321578	734368	4321632	
80	2	1	1	1	n	169	734368	4321632	734414	4321688	
81	1	1	1	1	n	1,623	734414	4321688	734122	4321991	
82	3	2	5	2	n	265	734122	4321991	734097	4322030	
83	1	1	1	1	n	109	734097	4322030	734076	4322060	
84	4	2	3	1	y	59	734076	4322060	734067	4322069	backside of unit 1 (around knoll)
85	1	5	5	1	y	105	734067	4322069	-	-	~100ft long
86	3	2	3	1	n	3,149	-	-	733982	4321796	
87	1	1	1	1	n	236	733982	4321796	733894	4321770	
88	4	5	2	1	y	661	733894	4321770	733765	4321764	
89	3	2	1	1	n	395	733765	4321764	733714	4321766	
90	4	5	2	1	y	466	733714	4321766	733682	4321697	
91	3	2	3	1	n	342	733682	4321697	733575	4321610	
92	5	5	1	1	y	251	733575	4321610	733516	4321573	End = start

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Appendix B1. Reservoir Shoreline Habitat Survey Data

Date: Nov-02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Survey Direction: ***counterclockwise***
Reservoir: Ice House
Reservoir Elevation: 5426
Exposed Shoreline (ft): 27.9
Start Point Description: Knoll at Quad 6
Max Res. Elevation: 5454

Shoreline	Slope	Substrate Dom	Substrate Sub	Stability	Emergent Veg	Segment Length	UTM startpoint (NAD27)		UTM endpoint (NAD27)		Notes / Photos
1	3	5	5	2	N	331	730936	4300637	730932	4300757	stump cover, 20-30% slope
2	2	2	5	2	N	130	730932	4300757	730957	4300799	contains G1
3	3	5	2	2	N	1,379	730957	4300799	730740	4300933	104-429, 20-30% slope
4	2	2	5	2	N	255	730740	4300933	730656	4300968	
5	3	5	5	2	N	1,421	730656	4300968	730286	4301054	swim area
6	4	5	5	2	N	288	730286	4301054	730180	4301124	
7	3	5	2	2	N	103	730180	4301124	730156	4301148	
8	2	2	2	1	N	809	730156	4301148	730000	4301129	dam
9	3	5	2	2	N	930	730000	4301129	729712	4301102	104-430
10	2	1	5	1	N	310	729712	4301102	729615	4301094	
11	3	5	2	2	N	1,374	729615	4301094	729280	4301010	
12	2	3	5	2	N	284	729280	4301010	729157	4300954	
13	4	5	3	1	Y	828	729157	4300954	729104	4300888	little cover
14	3	5	3	2	N	606	729104	4300888	728976	4300695	
15	4	5	5	1	Y	816	728976	4300695	728970	4300622	500' around dry cove
16	3	5	2	1	N	471	728970	4300622	728975	4300516	
17	4	5	5	1	N	601	728975	4300516	729027	4300367	3/5 slope = average of 4
18	2	2	2	1	N	1,156	729027	4300367	729277	4300390	Dam
19	3	5	2	1	N	373	729277	4300390	729363	4300440	with spillway head
20	2	5	2	2	N	850	729363	4300440	729377	4300462	spillway
21	3	5	2	2	N	616	729377	4300462	729328	4300639	some stump cover
22	3	2	3	1	N	337	729328	4300639	729327	4300778	
23	3	5	2	1	N	691	729327	4300778	729569	4300745	104-431 some stump cover
24	2	3	2	2	N	408	729569	4300745	729698	4300687	104-432 some stump cover, some lg bedrock outcropping, 20-30% slope (contains gill net 6)
25	3	5	5	2	N	2,022	729698	4300687	730185	4300452	104-432 some stump cover, some lg bedrock outcropping, 20-30% slope (contains gill net 6)
26	3	1	2	1	N	757	730185	4300452	730273	4300248	
27	2	3	2	1	N	243	730273	4300248	730327	4300243	
28	3	5	5	2	N	490	730327	4300243	730499	4300197	
29	3	2	5	1	N	335	730499	4300197	730556	4300167	slope= 5-2, 3 average
30	3	1	5	1	N	210	730556	4300167	730635	4300139	
31	2	1	1	1	N	683	730635	4300139	730741	4300001	
32	2	5	3	2	N	5,021	730741	4300001	730940	4300009	some stump cover, (104-434), contains gill net 5, (104-436 into finger)
33	4	5	1	2	N	474	730940	4300009	731028	4300187	w/jetty
34	3	5	5	2	N	949	731028	4300187	731293	4300205	
35	3	1	3	1	N	153	731293	4300205	731343	4300201	
36	5	5	2	1	N	1,712	731343	4300201	731511	4300033	jetty and sandy beach with stump cover
37	3	5	2	2	N	836	731511	4300033	731730	43000008	
38	4	5	5	1	N	226	731730	43000008	731807	4299975	
39	3	5	5	2	N	3,055	731807	4299975	732486	4299691	small section of slope = 4 included
40	2	2	5	2	N	679	732486	4299691	732640	4299773	contains gill net 2
41	3	5	5	2	N	1,154	732640	4299773	732909	4299850	
42	2	1	5	2	N	1,198	732909	4299850	733035	4299755	
43	3	5	5	2	N	451	733035	4299755	733059	4299870	stump cover
44	4	2	2	2	N	800	733059	4299870	733048	4299873	
45	3	5	5	2	N	210	733048	4299873	732939	4229881	
46	2	5	5	2	N	999	732939	4229881	732707	4229885	
47	3	5	5	2	N	186	732707	4229885	732665	4229847	vehicle accessible (4x4)
48	4	5	5	2	N	307	732665	4229847	732529	4299791	
49	3	5	1	2	N	648	732529	4299791	732406	4299991	
50	2	1	2	1	N	238	732406	4299991	732375	4300051	
51	2	2	3	2	N	839	732375	4300051	732237	4300210	
52	3	5	2	2	N	750	732237	4300210	732045	4300307	

Project Name: SMUD - UARP 166.00 / 6500
Survey Direction: ***counterclockwise***
Reservoir: Ice House
Reservoir Elevation: 5426
Exposed Shoreline (ft): 27.9
Start Point Description: Knoll at Quad 6
Max Res. Elevation: 5454

Shoreline	Slope	Substrate		Stability	Emergent Veg	Segment Length	UTM startpoint (NAD27)		UTM endpoint (NAD27)		Notes / Photos
		Dom	Sub								
53	2	1	2	1	N	407	732045	4300307	731996	4300315	
54	4	5	5	2	N	935	731996	4300315	731720	4300447	
55	5	5	5	2	N	287	731720	4300447	731657	4300561	contains gill net 4
56	3	5	5	2	N	302	731657	4300561	731662	4300629	
57	3	1	2	1	N	248	731662	4300629	731672	4300684	
58	3	5	5	2	N	365	731672	4300684	731547	4300637	stump cover
59	4	5	5	2	N	403	731547	4300637	731466	4300698	stump cover
60	3	5	2	2	Y	820	731466	4300698	731271	4300812	Little cover
61	5	5	5	2	N	578	731271	4300812	731224	4300796	
62	3	5	2	2	N	411	731224	4300796	731253	4300694	
63	2	5	1	2	N	172	731253	4300694	731265	4300633	
64	3	5	5	1	N	242	731265	4300633	731212	4300524	
65	3	1	5	1	N	206	731212	4300524	731109	4300525	
66	3	5	5	2	N	607	731109	4300525	730907	4300665	END

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Appendix B1. Reservoir Shoreline Habitat Survey Data

Date: 24-Oct-02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Survey Direction: ***counterclockwise***
Reservoir: Union Valley
Reservoir Elevation: 4819 Exposed Shoreline (ft): 51.2 Start Point Description: Powerhouse
Max Res. Elevation: 4870

Shoreline Segment	Slope	Substrate		Stability	Emergent Veg	Segment Length	UTM startpoint (NAD27)		UTM endpoint (NAD27)		Notes / Photos
		Dom	Sub								
1	5	5	5	2	N	3,012	727378	4308154	727065	4307420	little cover with some flat spots
2	4	5	4	2	N	1,286	727065	4307420	726685	4307324	some stump cover
3	1	1	1	2	N	746	726685	4307324	726650	4307234	short outcropping (250')
4	3	5	3	2	N	1,198	726650	4307234	726512	4306932	some stump cover (103/0350)
5	4	1	5	2	N	1,696	726512	4306932	726161	4306831	some boulder cover
6	4	4	5	2	Y	6,609	726161	4306831	725614	4306167	contains gill net 2, little cover, some grass
7	3	5	3	3	N	1,051	725614	4306167	725189	4306177	
8	1	2	1	2	N	337	725189	4306177	725136	4306247	boulder outcrop
9	3	5	3	2	Y	4,648	725136	4306247	724550	4305839	contains gill net 6, no good cover, only a little cover
10	2	3	2	2	N	725	724550	4305839	724196	4305798	(103-0352) little cover
11	4	5	3	2	Y	5,653	724196	4305798	723962	4306175	large upper flat plain - photo 0353, little cover
12	3	5	3	2	N	5,646	723962	4306175	722751	4306127	
13	4	5	5	2	N	9,172	722751	4306127	723064	4305690	some stump cover/some flat, contains gill net 5
14	3	5	3	3	N	6,424	723064	4305690	722091	4305029	no cover
15	2	2	3	1	N	1,517	722091	4305029	722301	4304760	dam at boat launch
16	2	3	5	2	N	6,092	722301	4304760	723832	4304405	some stump cover (103/0354)
17	2	5	3	2	N	2,900	723832	4304405	724525	4304231	
18	1	3	5	2	N	3,008	724525	4304231	725280	4304102	contains gill net 4
19	3	5	3	2	N	5,633	725280	4304102	726794	4304332	stump cover/photo 103-356
20	2	5	3	3	N	7,377	726794	4304332	727040	4303731	contains gill net 3, some stump cover
21	3	5	3	2	N	12,966	727040	4303731	724706	4304862	very little cover, some stump cover, contains 1 flat terrace
22	3	1	5	3	N	640	724706	4304862	724727	4305096	some boulder cover
23	3	5	3	2	N	5,314	724727	4305096	726068	4305658	some bits of sig erosion, little stump cover
24	4	5	5	2	Y	2,772	726068	4305658	726433	4305775	little cover, near camp ground/Photo 357
25	2	1	2	1	N	809	726433	4305775	726440	4305851	
26	3	2	5	2	N	7,578	726440	4305851	727535	4306580	contains 200' of steep slope
27	4	5	3	2	Y	2,442	727535	4306580	728086	4306657	little cover
28	2	1	5	3	N	2,387	728086	4306657	728190	4306577	
29	2	5	3	2	N	587	728190	4306577	728033	4306785	
30	3	3	5	2	Y	437	728033	4306785	728100	4306897	little cover
31	4	5	3	2	Y	2,461	728100	4306897	727749	4306925	little cover
32	5	5	5	1	N	1,054	727749	4306925	727589	4307098	
33	3	3	5	2	N	382	727589	4307098	727433	4307130	
34	5	5	2	1	Y	3,647	727433	4307130	727240	4307569	little cover, contains gill net 1
35	3	5	3	2	Y	1,298	727240	4307569	727296	4307939	very little cover
36	2	5	2	2	N	592	727296	4307939	727379	4308138	
37	3	3	5	2	N	486	727379	4308138	727477	4308251	at powerhouse
38	2	3	5	2	Y	3,394	727477	4308251	up trib		very little cover

Stillwater Sciences

Appendix B1. Reservoir Shoreline Habitat Survey Data

Date: 11/15/02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Reservoir: Junction
Reservoir Elevation: 4428 Exposed Shoreline (ft): 40
Max Res. Elevation: 4468

Survey Direction: ***counterclockwise***

Start Point Description: Quad 30 Penninsula

Shoreline	Slope	Substrate Dom	Substrate Sub	Stability	Emergent Veg	Segment Length	UTM startpoint		UTM endpoint		Notes / Photos
1	2	1	3	1	y	162	721035	4303559	721029	4303641	
2	1	1	3	1	n	388	721029	4303641	721047	4303761	104-470
3	1	1	1	1	n	629	721047	4303761	721049	4303953	
4	2	1	3	1	n	275	721049	4303953	721085	4304044	
5	1	1	3	1	n	149	721085	4304044	721122	4304082	104-471
6	2	3	1	1	n	565	721122	4304082	721230	4304190	104-473 (Gill net 4 - 104-472)
7	2	3	1	1	n	1,763	721230	4304190	721460	4304539	
8	1	3	1	1	n	643	721460	4304539	721520	4304620	
9	2	1	3	1	n	2,536	721520	4304620	721230	4304620	104-475, into buoyed area
10	1	1	3	1	n	518	721230	4304620	721405	4304570	
11	2	3	1	1	n	675	721405	4304570	721274	4304730	(contains gill net-1) into silver creek
12	1	3	1	1	n	410	721274	4304730	721240	4304776	
13	2	3	5	1	n	790	721240	4304776	721242	4304770	contains silver creek
14	2	5	5	1	n	490	721242	4304770	721262	4304647	
15	1	1	1	1	n	376	721262	4304647	721232	4304528	
16	2	3	5	1	n	1,140	721232	4304528	721194	4304208	
17	1	1	3	1	n	1,736	721194	4304208	721013	4303765	Some slope=2 incl. 104-476, (gill net - 477-478)
18	2	3	1	1	y	552	721013	4303765	721007	4303606	little veg, some slope=1
19	1	1	1	1	n	637	721007	4303606	720961	4303410	
20	2	1	3	1	n	287	720961	4303410	720895	4303330	104-479 = gill net-3
21	1	1	3	1	n	2,569	720895	4303330	721059	4303518	104-480-482
22	2	3	1	1	n	588	721059	4303518	721186	4303612	
23	1	1	1	1	n	596	721186	4303612	721384	4303710	
24	2	3	3	1	n	266	721384	4303710	721457	4303737	
25	3	5	5	2	n	212	721457	4303737	721537	4303696	boat launch
26	1	1	5	1	n	109	721537	4303696	721503	4303657	gillnet 2
27	2	5	3	1	n	466	721503	4303657	721480	4303520	
28	3	5	5	1	n	215	721480	4303520	721502	4303457	
29	2	3	5	1	n	178	721502	4303457	721471	4303412	at SF Silver
30	1	1	3	1	n	961	721471	4303412	SF silver	SF Silver	into SF Silver
31	2	5	1	1	n	1,089	SF silver	SF Silver	721503	4303475	From SF Silver
32	1	1	1	1	n	259	721503	4303475	721487	4303563	
33	2	3	5	1	y	663	721487	4303563	721535	4303732	little veg.
34	1	1	3	1	n	166	721535	4303732	721502	4303769	
35	2	5	3	1	n	115	721502	4303769	721470	4303758	
36	1	1	5	1	n	244	721470	4303758	721401	4303729	
37	2	3	1	1	n	276	721401	4303729	721320	4303714	
38	1	1	3	1	n	578	721320	4303714	721183	4303623	
39	2	3	1	1	n	355	721183	4303623	721075	4303565	END

Stillwater Sciences

Appendix B1. Reservoir Shoreline Habitat Survey Data

Date: 28-Oct-02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Survey Direction: ***counterclockwise***
Reservoir: Slab Creek
Reservoir Elevation: 1838.9
Exposed Shoreline (ft): 11.1
Start Point Description: at upper end of res.
Max Res. Elevation: 1850

Shoreline	Slope	Substrate Dom	Substrate Sub	Stability	Emergent Veg	Segment Length	UTM startpoint (NAD27)		UTM endpoint (NAD27)		Notes / Photos
1	1	1	1	1	Y	318	705639	4296593	705574	4296403	
2	5	3	4	2	Y	236	705574	4296403	705531	4296352	sand bar
3	1	1	1	1	Y	1,311	705531	4296352	705287	4296063	
4	2	5	5	2	Y	729	705287	4296063	705065	4296091	
5	1	1	1	1	Y	1,438	705065	4296091	704662	4296060	
6	2	5	5	2	Y	414	704662	4296060	704589	4296155	
7	1	1	1	1	Y	4,161	704589	4296155	703980	4296355	
8	2	2	3	2	Y	813	703980	4296355	703853	4296153	
9	1	1	1	1	Y	1,695	703853	4296153	703405	4295937	
10	2	3	1	2	Y	1,593	703405	4295937	703263	4295497	photo 373
11	1	1	1	1	Y	2,142	703263	4295497	702579	4295435	
12	2	2	3	2	Y	1,447	702579	4295435	702205	4295603	
13	1	1	1	1	N	2,978	702205	4295603	701320	4295566	
14	1	1	2	1	Y	2,971	701320	4295566	701282	4295640	
15	2	1	2	1	N	1,323	701282	4295640	700980	4295427	photo 375
16	1	3	1	1	N	6,842	700980	4295427	700429	4294112	to dam
17	1	1	2	1	N	7,333	700429	4294112	701149	4295543	to dam
18	2	1	2	1	N	4,105	701149	4295543	702337	4295539	
19	3	5	4	2	N	1,126	702337	4295539	702625	4295389	part of sgment is bedrock, stump cover
20	2	2	3	2	N	2,181	702625	4295389	703092	4295390	stump cover
21	1	1	1	1	Y	1,496	703092	4295390	703326	4295626	
22	2	3	5	2	Y	550	703326	4295626	703351	4295783	
23	1	1	1	1	Y	3,229	703351	4295783	704147	4296293	
24	2	3	5	2	Y	513	704147	4296293	704284	4296305	gill net 5, stump cover
25	1	1	1	1	Y	4,677	704284	4296305	705473	4296147	photo 370
26	2	5	5	2	Y	247	705473	4296147	705474	4296219	photo 371
27	4	5	5	3	Y	392	705474	4296219	405523	4296347	sand bar
28	1	1	1	1	Y	478	405523	4296347	705613	4296452	
29	3	5	4	2	Y	127	705613	4296452	705639	4296593	

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Appendix B1. Reservoir Shoreline Habitat Survey Data.

Date: 14-Nov
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6630
Survey Direction: ***counterclockwise***
Reservoir: Chili Bar
Reservoir Elevation: 992.5
Exposed Shoreline (ft): 5
Start Point Description: Just below Powerhouse
Max Res. Elevation: 997.5

Shoreline	Slope	Substrate Dom	Substrate Sub	Stability	Emergent Veg	Segment Length	UTM startpoint (NAD27)		UTM endpoint (NAD27)		Notes/Photos
1	3	1	2	1	Y	544	692239	4292813	692176	4292664	104-457
2	2	1	2	1	Y	210	692176	4292664	692117	4292613	contains gill net 2
3	4	5	5	1	Y	649	692117	4292613	691939	4292694	104-458 sand bar contains gill net 4
4	2	5	1	1	Y	2,121	691939	4292694	691820	4293260	
5	1	1	1	1	N	494	691820	4293260	691685	4293190	
6	3	5	5	1	N	227	691685	4293190	691612	4293170	
7	2	5	1	1	Y	358	691612	4293170	691486	4293176	
8	3	5	5	1	Y	726	691486	4293176	691287	4293262	104-460
9	1	5	1	1	Y	1,003	691287	4293262	691059	4293172	104-461
10	2	5	5	1	Y	1,848	691059	4293172	690710	4292810	11/13-11/14/02 picnic table photo 104-463
11	1	5	5	1	Y	2,172	690710	4292810	690474	4293364	
12	2	5	5	1	Y	261	690474	4293364	690493	4293442	
13	1	5	5	1	Y	675	690493	4293442	690368	4293590	contains gill net 3
14	2	5	5	1	Y	368	690368	4293590	690274	4293624	
15	3	5	5	1	Y	450	690274	4293624	690243	4293583	contains boat launch area
16	2	5	5	1	Y	351	690243	4293583	to dam		
17	1	1	1	1	N	298	to dam	0	all of dam		
18	2	5	5	1	Y	714	all of dam	0	690305	4293451	start at dam
19	3	5	5	1	Y	407	690305	4293451	690373	4293360	
20	2	5	5	1	Y	604	690373	4293360	690353	4293179	
21	1	5	5	1	Y	498	690353	4293179	690346	4293034	
22	2	5	5	1	Y	1,491	690346	4293034	690594	4292707	Contains gill net 1, 104-464
23	1	1	5	1	Y	599	690594	4292707	690779	4292723	104-465-466 (deep hole)
24	1	5	1	1	Y	582	690779	4292723	690938	4292804	
25	1	1	1	1	N	225	690938	4292804	690995	4292838	contains gill net 6, rock wall
26	1	5	1	1	Y	979	690995	4292838	691045	4293111	
27	3	5	5	2	Y	126	691045	4293111	691036	4293142	at trib
28	1	5	1	1	Y	428	691036	4293142	691143	4293260	
29	1	1	5	1	Y	1,196	691143	4293260	691520	4293177	
30	4	5	5	1	Y	593	691520	4293177	691685	4293194	contains gill net 5
31	1	1	1	1	N	379	691685	4293194	691815	4293238	
32	2	5	1	1	Y	646	691815	4293238	691921	4293035	
33	2	1	5	1	Y	590	691921	4293035	691901	4292847	104-459
34	2	3	1	1	Y	1,719	691901	4292847	692088	4292683	
35	2	2	2	1	Y	775	692088	4292683	692239	4292813	

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Appendix B2. Reservoir Tributary Barrier Survey Data.

Date: 11/14/02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6630
Reservoir: Chili Bar

Shoreline Segment	Tributary Name	Photo No.	Barrier (y/n)	Estimated Discharge	UTM (NAD27)		Notes *(CAS LWD...)*
8			n	0	691319	4293270	
27		104-462	y	0.1	691036	4293142	Natural CAS barrier at and above water line
33			y	0.1	691890	4292650	Natural very steep

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Appendix B2. Reservoir Tributary Barrier Survey Data

Date: 10/31/02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Reservoir: Loon Lake

Shoreline Segment	Tributary Name	Photo No.	Barrier (y/n)	Estimated Discharge	UTM (NAD27)		Notes *(CAS, LWD, etc...)*
8		-	n	0	733896	4320852	
41			n	0	733075	4318682	
51		103-409	n	0	733960	4319496	
64		411-412	n	0	735009	4320486	Nat Cas u/s of high water line

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Appendix B2. Reservoir Tributary Barrier Survey Data

Date: 11/04/02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Reservoir: Ice House

Shoreline Segment	Tributary Name	Photo No.	Barrier (y/n)	Estimated Discharge	UTM (NAD27)		Notes *(CAS, LWD, etc…)*
26		104-433	n	0	730281	4300260	very intermittent looking
31			n	0	730735	4300001	
32		104-435	n	0.01	731367	4299506	
36			n	0	731550	4300000	
39			n	0.001	732489	4299664	
42			y	0.1	733040	4299676	barrier for ery small fish within res level
42			n	0.1	733040	4299676	
44	South		n	0.25	733048	4299918	
57			n	0	731672	4300684	

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Appendix B2. Reservoir Tributary Barrier Survey Data

Date: 24-Oct-02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Reservoir: Union Valley

Shoreline Segment	Tributary Name	Photo No.	Barrier (y/n)	Estimated Discharge	UTM (NAD27)		Notes *(CAS, LWD, etc…)*
1		103-349	n	0	727366	4308110	small/dry, North of powerhouse
6			n	0	726100	4306860	
9		103-351	n	0	724797	4306458	boulder, HGR at waterline
11		103-353	n	0.125	723971	4306604	3 come together well before res. Level
13			n	0	722580	4305997	
16			n	0.001	722969	4304385	
16			n	0.025	723499	4304311	
17			n	0.05	724291	4304158	LWD at top
18			n	0.2	724787	4304952	at gill net 4, LWD at top
18			n	0	724787	4304952	at gill net 4, LWD at top
19			n	0.08	725359	4304042	LWD at top
20			n	0	727040	4303731	
20			n	1.5	727305	4303505	second trib flowed into trib below power l
20			n	0	727272	4303665	possible fish barrier within waterline
21			n	0.08	726707	4304758	
26			n	0	726654	4306141	
27			n	0	727703	4306560	
27			n	0	727703	4306560	
28			n	1	728258	4306510	
30			n	0	728100	4306897	
32			n	0	727589	4307098	
38			y	0	727538	4308310	natural cascade at high water line

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Appendix B2. Reservoir Tributary Barrier Survey Data

Date: 11/15/02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Reservoir: Junction

Shoreline Segment	Tributary Name	Photo No.	Barrier (y/n)	Estimated Discharge	UTM (NAD27)		Notes *(CAS, LWD, etc…)*
13	Silver	-	y	2	721216	4304784	Natural Cas at and above high water line (small fish barrier)
30	SF Silver	104-484	n	5	721439	4303406	

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Appendix B2. Reservoir Tributary Barrier Survey Data

Date: 28-Oct-02
Crew: REL, ABH

Project Name: SMUD - UARP 166.00 / 6500
Reservoir: Slab Creek

Shoreline Segment	Tributary Name	Photo No.	Barrier (y/n)	Estimated Discharge	UTM (NAD27)		Notes *(CAS, LWD, etc…)*
1	SF American River		n	70	70550	4296650	
7			n	0	704490	4296282	
8	Brush Creek		n	1.5	704100	4296800	
10			n	0	703322	4295833	
14			n	1	701370	4295869	
23		374	n	0.5	702824	4295268	LWD at base, photo 374
29			n	0	705108	4296057	