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)

FISH PASSAGE BARRIERS
TECHNICAL REPORT

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AUGUST 2004
Version 1

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4.8 Fish Passage Study Plan

This study is designed to assess the effects of Project operations on fish migration. The study will focus on upstream migration out of reservoirs, migration within stream reaches, migration barriers at major dams, and migration barriers at tributary confluences for those fishes known to occur in the study area. The study will also consider more general, non-migratory movements of the fish.

4.8.1 Pertinent Issue Questions

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

32. How are fish migrations and movements affected by the project?

For the purposes of this study plan's execution, it is understood that SMUD will address the UARP reservoirs and stream reaches, and SMUD and PG&E will jointly address Chili Bar Reservoir and the reach below Chili Bar.

4.8.2 Background

Based on information from Moyle et al. (1996) and other sources, there are 21 species or subspecies of native fish that may have historically occurred or may currently occur in the Project area (SMUD 2001). Fish populations and species composition in the Sierra Nevada have changed substantially in the last century due to development, non-native species introductions, fish stocking, and other factors. Various species of trout are now the dominant fish species throughout most of the Project area. There are no anadromous fish in the Project area, although there is a land-locked population of kokanee in Union Valley Reservoir. Quantitative and qualitative fish surveys have been conducted in several stream reaches and reservoirs in the UARP Project Area, as summarized in SMUD (2001) and Tables 1 and 2. Additional fish population information was collected in 2002. These studies provide information on species composition, distribution or abundance.

4.8.3 Study Objectives

The objective of this study is to assess how project operations affect fish migration.

4.8.4 Study Area

The study area will include all of the Project dams, stream segments within reservoir fluctuation zones, regulated stream reaches below reservoirs, and major tributary confluences in regulated stream reaches. The area also includes the PG&E reservoir at Chili Bar and the reach downstream of Chili Bar Dam.

4.8.5 Information Needed From Other Studies

Information needed from other studies includes: 1) updated information on fish species that occur in each reservoir and stream reach from the Fish Surveys Study; 2) any potential barriers identified at inflows from the Reservoir Fish Study, and 3) any potential barriers identified in stream reaches from the Habitat Mapping Study. Additionally, information from SMUD and PG&E helicopter video and aerial photos will be valuable in the identification and assessment of potential migration barriers.

4.8.6 Study Methods And Schedule

Fish migration and movement within the study area will be broken down into four primary components.

- Upstream migration from reservoirs
- Migration within stream reaches
- Migration barriers at dams
- Migration barriers at tributary confluences

Upstream Migration From Reservoirs
The fish species present in each reservoir will be identified to determine which species are migratory and likely to require access to riverine spawning areas. The general seasonal movements of all fish species present will be assessed in regards to their ability to utilize adjoining habitats in the reservoir inflow areas.

Information from the Reservoir Fish Study along with any available reservoir mapping data will be used to determine if migration barriers are present in the fluctuation zone of inflow areas. Field visits would be required for inflow areas where no mapping data exists.

Migration Within Stream Reaches
The fish species present in each stream reach will be identified to determine which species are migratory and likely to require access to spawning areas not available within adjoining habitats. The general seasonal movements of all fish species present will be assessed in regards to their ability to utilize adjoining habitats within the stream reach.

Information from the Habitat Mapping Study will be used along with available helicopter video of stream channels and aerial photos to determine if potential migration barriers are present in the stream reaches. Barriers will most likely exist at higher gradient cascades and waterfalls. An evaluation of available potential spawning habitat will then be made to determine if barriers are preventing access to spawning areas during periods of low flow. Field visits would be required for areas where mapping data or video does not fully characterize the potential barrier.

Migration Barriers at Dams
The fish species present in each stream reach above and below dams will be identified to determine which species are migratory and likely to require access to spawning areas not available within adjoining habitats. The general movements of all fish species present will be assessed in regards to their ability to utilize adjoining habitats within the stream reaches above and below the dams.

A literature review will be conducted to document the migration and movement tendencies of the resident fish species.

Migration Barriers at Tributary Confluences
The fish species present in each stream reach will be identified to determine which species are migratory and likely to require access to spawning areas in major tributaries within the reach. The general movements of all fish species present will be assessed in regards to their ability to utilize tributary habitats.

Information from the Habitat Mapping Study will be used along with any available helicopter video of stream channels to determine if major tributaries occur within any given stream reach that would be considered potentially suitable and accessible for spawning or seasonal refugia. Tributaries with extreme gradients found in canyon reaches would not be considered suitable. A preliminary investigation to identify suitable tributaries would be made. Field visits would be required for tributaries where mapping data or video does not fully characterize the potential barrier.

4.8.7 Analysis

As described above, data analysis will include identifying and mapping potential fish migration barriers for each reservoir inundation zone, stream reach, dam, and major tributary confluence and quantifying either the amount of habitat potentially affected during normal Project operations and/or describing possible effects on the fish population. Barriers to fish migration and movement will be identified and an assessment of potential effects (e.g., reservoir elevation and/or instream flow levels at which barriers are surmountable by target species and life stages) will be made.

Table 1. Known species composition for study reaches†

	Species*														
Stream Reach	***RBT***	***BRN***	***BRK***	***HCH***	***MSK***	***PS***	***GSH***	***CR***	***SPM***	***HH***	***RS***	***SD***	***SS***	***SMB***	***References***
Rubicon River Dam Reach	●○	○	●	○	○							○			USDA 1979a
Rubicon Tunnel Outlet Reach															No species composition data
Rockbound Dam Reach															No species composition data
Buck Island Dam Reach	○						○								No species composition data
Loon Lake Dam Reach	●○	●○	●					●							CDFG Gerle Creek surveys, various dates
Gerle Creek Dam Reach	●○	●○	●					●							Turney 1986 [Stillwater UARP Library #100]; CDFG Gerle Creek surveys, various dates
Robbs Peak Dam Reach	○	○													No species composition data
Ice House Dam Reach	●○	●○			○								●		USDA South Fork Silver Creek survey 1979b
Junction Dam Reach	●○	●○									●		●○		CDFG Silver Creek surveys, various dates [Stillwater UARP Library #394].
Camino Dam Reach	●○	●○									●		●○		Thomas 1994b [Stillwater UARP Library #231]
South Fork American Reach	●							●	●	●	●	●	●		TRPA (1998). Survey at El Dorado Powerhouse, downstream of the falls 1 mile below Silver Creek. Sculpin cited were presumed to be riffle sculpin.
Brush Creek Dam Reach	●	●													CDFG Brush Creek surveys, various dates [Stillwater UARP Library # 302-303].
Slab Creek Dam Reach	●○	●○				○		○	●○	●○	●○	●○	●○	●	WESCO 1980 [Stillwater UARP Library #249]
Reach Downstream of Chili Bar Dam															No information gathered yet.

† ● Historical data
o 2002 Surveys

*Species: BRN=Brown trout; SMB = Smallmouth bass; MSK= Mountain sucker; BRK=Brook trout; HCH=Hitch; SPM= Sacramento pikeminnow; CR=California roach; RS=Riffle sculpin; HH=Hardhead; RBT=Rainbow trout; SD=Speckled dace; GSH=Golden shiner; PS = Prickly sculpin; SS=Sacramento sucker

Table 2. Known species composition for Project reservoirs.†

	Species*																			
Reservoir	***RBT***	***BRN***	***BRK***	***CR***	***CT***	***CH***	***GS***	***GSH***	***GT***	***HH***	***KS***	***LT***	***MF***	***MN***	***SB***	***SD***	***SS***	***RS***	***TP***	***SMB***	***References***
Rubicon	●	●	●						●												CDFG surveys, various dates
Buck Island	●	●	●																		CDFG surveys, various dates
Loon Lake	● o	● o	●	● o		●	●										● o		●		SMUD 2001; EDAW 1978 [Stillwater UARP Library #118]
Gerle Creek	●	●	●																		Turney 1986 [Stillwater UARP Library #100]
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 [Stillwater UARP Library #117]
Ice House	● o	● o	●	o			●				●										SMUD 2001, EA 1980 [Stillwater UARP Library #117], EDAW 1978 [Stillwater UARP Library #118]; CDFG surveys, various dates
Junction	●	● o	●								●						● o				Thomas 1994b [Stillwater UARP Library #231]
Camino	●	●	●	●										●			●	●			SMUD 2001, ENF Stream Survey, not dated
Brush Creek	●	●																			ENF Stream Survey 1974 [Stillwater UARP Library #250]
Slab Creek	●	● o	●	●						● o	●				●	●	● o				SMUD 2001, Thomas 1994c [Stillwater UARP Library #233]; Jordan and Brown 1992; Jones and Stokes 1994; WESCO 1980
Chili Bar		o								o							o				No information gathered yet

† ● Historical data
o 2002 Surveys

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

4.8.8 Study Output

A presentation of study progress will be made to the Aquatics TWG and the Plenary Group in fall 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 the Licensee's draft environmental assessment that will be submitted to FERC with the Licensee's application for a new license.

4.8.9 Preliminary Estimated Study Cost

4.8.10 Plenary Group Endorsement

This study plan was approved on August 26, 2003 by the following participants of the Aquatic TWG: USFS, USBLM, Camp Lotus, PG&E, SWRCB, SMUD and CDFG. No participant said they could not "live with" the study plan. The Plenary Group approved the plan on September 9, 2003. The participants a the meeting who said they could "live with" this study plan were USFS, SWRCB, NPS, CDFG, El Dorado County, Taxpayers Association of El Dorado County, Teichert Materials, ARRA/Camp Lotus, El Dorado Irrigation District, SMUD, PCWA, City of Sacramento, FOR, and PG&E. None of the participants at the meeting said they could not "live with" this study plan.

4.8.11 Literature Cited

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Turney, M. 1986. Gerle Creek Reservoir Project. El Dorado Fish and Game Commission.

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WESCO (Western Ecological Services Company). 1980. Fishery investigations, South Fork American River between Slab Creek Dam and Chili Bar Reservoir. Prepared for SMUD, Sacramento, CA.

AQUATICS TWG NOTE:

1. *It is understood that PG&E and SMUD will consult with the Aquatics TWG to extend this study plan to Chili Bar Reservoir, as appropriate. It is the intent of the Aquatics TWG (including PG&E and SMUD) that this study plan be performed concurrently above and below Chili Bar.*

FISH PASSAGE BARRIERS TECHNICAL REPORT

SUMMARY

This report provides information regarding fish passage barriers in stream reaches affected by the Sacramento Municipal Utility District's (SMUD) Upper American River Project (UARP) and Pacific Gas and Electric Company's (PG&E) Chili Bar Project, between project reaches and tributaries, between project reservoirs and up stream habitat, and at project dams.

A total of 34 miles of riverine habitat were surveyed during the 2002 and 2003 studies using on-the-ground mapping techniques. In stream reaches that were not safely accessible by foot or where on the ground surveys were not feasible, including the Reach Downstream of Chili Bar, staff members mapped an additional 51 miles with aerial videography. Fish passage between project reservoirs and tributaries was assessed in Loon Lake, Union Valley, Ice House, Junction, Slab Creek, and Chili Bar reservoirs using on the ground surveys and in Camino Reservoir using aerial videography.

In addition to 11 project dams, all of which are barriers to upstream fish passage, 51 geologic barriers were identified within project reaches. An additional, 28 sites appeared to present seasonal barriers that were only passable at relatively higher flow levels expected during periods of spring run-off and/or winter storms. Fish passage barriers, which were vertical falls or high-gradient, high-velocity cascades, occurred in nine of 13 study reaches. The combination of geologic barriers and project dams results in relatively frequent passage barriers within the UARP area. Besides Chili Bar Dam, no barriers were observed in the Reach Downstream of Chili Bar. No barriers to fish passage between project reaches and tributaries were observed in reaches mapped on the ground. No barriers to fish passage between project reservoirs and tributaries were observed in project reservoirs surveyed either on the ground or with aerial videography, although a passage barrier out of Gerle Creek Reservoir has been reported when reservoir levels are lower than current operating conditions.

Analysis of barrier locations and habitat data indicated that passage barriers do not preclude access to critical habitats needed to complete salmonid life cycles, such as suitable gravel for spawning and deep pools for overwintering, in project reaches that were mapped on the ground.

A review of the available literature on salmonid movement patterns suggests the movement is relatively common in stream dwelling salmonid populations, but the extent and timing of fish movements are highly variable and specific to the individual, the species, and the watershed. The literature review focused on salmonids because they are the most widely distributed and most abundant species within the UARP and the Reach Downstream of Chili Bar and the species most likely to exhibit migratory life histories.

1.0 INTRODUCTION

This technical report is one in a series of reports prepared by Devine Tarbell and Associates, Inc., and Stillwater Sciences for the Sacramento Municipal Utility District (SMUD) and Pacific Gas and Electric Company (PG&E) (jointly referred to as the Licensees) to support the relicensing of SMUD's Upper American River Project (UARP) and PG&E'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 passage barriers in UARP reaches and the Reach Downstream of Chili Bar. This report includes the following sections:

- **BACKGROUND** – Summarizes the applicable study plan 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; the study area, and agency information requests. In addition, requests by resource agencies for additions to 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.
- **ANALYSIS** – A brief analysis of the results, where appropriate.
- **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 project, 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).

Also, this technical report does not include a discussion regarding the effects of the project on fish movement, nor does the report include a discussion of appropriate protection, mitigation, and enhancement (PM&E) measures. An impacts discussion regarding the UARP is included in SMUD's applicant-prepared preliminary draft environmental assessment (PDEA) document, which is part of SMUD's application for a new license for the UARP. Similarly, an impacts discussion regarding the Chili Bar Project will be included in PG&E's Chili Bar Project license application. Development of PM&E 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 Fish Passage Barrier Study Plan

On September 9, 2003, the UARP Relicensing Plenary Group approved the Fish Passage Barrier Study Plan that was developed by the Relicensing Aquatic Technical Working Group (TWG) and approved by the TWG on August 26, 2003. The Fish Passage Barrier Study Plan was used, in part, to support other studies that address the following Aquatics Issue Question developed by the Plenary Group:

Issue Question 32 How are fish migrations and movements affected by the project?

The primary objective of the study was to assess how project operations and dams affect fish migration, with an emphasis on trout species.

The study area included all UARP dams, stream segments within reservoir fluctuation zones, regulated stream reaches below reservoirs, and major tributary confluences in regulated stream

reaches. The study area also included PG&E's Chili Bar Dam and the Reach Downstream of Chili Bar.

The approved study methods were divided into four areas:

- *Upstream Migration From Reservoirs* – The fish species in each reservoir were identified to determine which species are migratory and likely to require access to riverine spawning areas, and determine if migration barriers are present in the fluctuation zone of inflow areas. The general seasonal movements of all fish species present were assessed with regards to their ability to utilize adjoining habitats in the reservoir inflow areas.

- *Migration Within Stream Reaches* – The fish species present in each stream reach were identified to determine which species are migratory and likely to require access to riverine spawning areas. The distribution of potential spawning habitat and deep pool habitats were evaluated, where possible, to determine if barriers are preventing access to spawning or overwintering areas during periods of low flow.

- *Migration Barriers at Dams* – The fish species present in each stream reach above and below dams were identified to determine which species are migratory and likely to require access to spawning areas not available within adjoining habitats. The general movements of all fish species present were assessed in regards to their ability to utilize adjoining habitats within the stream reaches above and below the dams.

- *Migration Barriers at Tributary Confluences* – The fish species present in each stream reach were identified to determine which species are migratory and likely to require access to spawning areas in major tributaries in the reach. The general movements of all fish species present were assessed with regards to their ability to utilize tributary habitats. Potential barriers in the SFAR fluctuation zone (i.e., the portion of the streambank inundated between 200 and 2,000 cfs) at the mouths of major tributaries to the Reach Downstream of Chili Bar Dam were also assessed. Fish passage between the SFAR and major tributaries to the Reach Downstream of Chili Bar are also discussed in the *Flow and Fluctuation in the Reach Downstream of Chili Bar Technical Report.*

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 Fish Passage Barrier study was performed (2002-2003) are presented 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 study information they believed they needed to begin settlement discussions, with the understanding that additional information might be requested. The Fish Passage Barrier Study was not listed in the agencies' letter.

In a May 13, 2004 letter, the agencies stated in regards to the *Fish Passage Barriers Technical Report* (February 2004) the following:

- We have reviewed this study report and have no comments on the report.

3.0 METHODS

3.1 Study Sites

The Licensee's study methods conformed to those approved by the UARP Relicensing Plenary Group.

The Aquatic TWG identified 14 stream reaches affected by the UARP or the Chili Bar Project, 13 of which were surveyed from the air or by foot. The Rubicon Tunnel Outlet Reach was excluded from the study, because it is a partially constructed channel. Table 3.1-1 identifies the stream reaches surveyed during the study, methods used for each reach, and date of survey.

Table 3.1-1. UARP reach descriptions, coordinates, and methods used in the habitat mapping study.

Stream	Reach	Reach Description	Method	Date	UTM Coordinates (NAD 27)			
					Upstream (Easting/Northing)		Downstream (Easting/Northing)	
Rubicon River	Rubicon Dam	Rubicon Dam to downstream of Miller Creek confluence	On the ground mapping	8/14/02 - 8/15/02	0740600	4319000	0736374	4323911
Rubicon River	Rubicon Tunnel Outlet	Rubicon Tunnel Outlet Portal to Rockbound Lake	Not mapped		-	-	-	-
Highland Creek	Rockbound Dam	Rockbound Lake to Buck Island Reservoir	On the ground mapping	9/19/02	0738682	4320114	0738369	4320333
Little Rubicon River	Buck Island Dam	Buck Island Dam to Rubicon River	On the ground mapping	9/17/02 - 9/18/02	0737652	4320714	0736017	4324057
Gerle Creek	Loon Lake Dam	Loon Lake Dam to Gerle Reservoir	On the ground mapping	8/13/02 - 8/19/02	0732899	4320344	0726116	4316969
Gerle Creek	Gerle Creek Dam	Gerle Creek Dam to South Fork Rubicon River	On the ground mapping	8/13/02	0725861	4316054	0725439	4314713
SF Rubicon River	Robbs Peak Dam	Robbs Peak Dam to Rubicon River	Aerial videography	8/22/02	0726438	4313896	0719314	4316260
SF Silver Creek	Ice House Dam	Ice House Dam to Junction Reservoir	On the ground mapping	8/15/02 - 8/17/02	0729246	4300212	0721575	4303167
Silver Creek	Junction Dam	Junction Dam to Camino Reservoir	Aerial videography	8/22/03	0720742	4303275	0714302	4301119
Silver Creek	Camino Dam	Camino Dam to the South Fork American River	Aerial videography	8/21/03	0713915	4300425	0709347	4295959
SF American River	South Fork American River	Silver Creek confluence to Slab Creek Reservoir	Aerial videography	8/21/03	0709347	4295959	0705650	4296448
SF American River	Slab Creek Dam	Slab Creek Reservoir to Chili Bar Reservoir	Aerial videography	8/21/03	0700017	4293945	0692373	4292900
Brush Creek	Brush Creek Dam	Brush Creek Dam to Slab Creek Reservoir	On the ground mapping	8/14/03 - 8/15/03	0706505	4298325	0704186	4296627
SF American River	Downstream of Chili Bar	Chili Bar Dam to Folsom Reservoir	Aerial videography	10/21/02	0690067	4293478	672590	4293308

3.2 Barrier Identification and Characterization

Field surveys were conducted to identify fish passage barriers within stream reaches affected by the UARP and Chili Bar Project in August and September of 2002 and August of 2003. Barrier identification was conducted by survey teams on the ground or by aerial videography taken from a helicopter.

3.2.1 On the Ground Mapping

On the ground fish passage barrier surveys were conducted in seven of the 13 stream reaches where survey teams were able to safely hike more than 90 percent of the reach length. Survey teams consisted of two individuals who walked the stream channel and identified barriers to fish passage based on summer base-flow conditions, anticipated flows during spring runoff conditions, channel morphology, and water depth. The mouths of tributary confluences were also surveyed during on the ground surveys. Tributaries to the Reach Downstream of Chili Bar were surveyed when the discharge at Chili Bar Dam was approximately 200 cfs.

Fish barrier surveys were also conducted within reservoir fluctuation zones (i.e., the area below full pool elevation that is exposed under typical reservoir operation) at the mouths of tributaries to Loon Lake, Union Valley, Ice House, Junction, Slab Creek, and Chili Bar reservoirs. Other project reservoirs (i.e., Rubicon, Buck Island, Gerle Creek, and Brush Creek reservoirs) were not surveyed because they lacked accessible and perennial upstream habitat, or in the case of Gerle Creek Reservoir, are maintained at sufficient elevation to prevent migration barrier exposure.

Potential barriers to fish migration were structures at least three feet high with either vertical drops, high velocities, shallow flow, or a combination of these characteristics that prohibited upstream passage. Barriers were classified as either complete barriers to upstream passage, or seasonal barriers that were only passable at higher flow levels. Complete barriers were sites with high vertical drops that appeared to prohibit upstream passage regardless of stream flow levels. Seasonal barriers were sites where indicators of bank-full or greater stream flow, such as bank scour lines, changes in riparian vegetation, elevation of debris jams, and the presence of overflow channels, indicated that upstream fish passage would be possible during periods of spring run-off and/or winter storms.

All barriers were referenced by stream mile from the downstream boundary of each reach using standard hip chains with English graduations. Locations of some barriers were obtained from a handheld Garmin ETREX Venture GPS unit used to mark the coordinates (UTM-NAD 27), or using digitized topographical maps of the study area.

3.2.2 Aerial Mapping

Aerial videography was conducted in stream reaches that were not safely accessible by foot or where ground surveys were not feasible. A low elevation (tree-top height) video was taken from a helicopter flyover at a constant speed of approximately 20 knots. The video was then reviewed to identify barriers to fish passage. Aerial photographs and digitized topographical maps were

also used to locate and obtain coordinates (UTM-NAD 27) of barriers identified from videography.

Five of the 13 stream reaches (Robbs Peak, Junction Dam, Camino Dam, South Fork American River, and Slab Creek) and the Reach Downstream of Chili Bar were mapped using aerial videography. Additionally, aerial videography was used to assess fish barriers between Camino Reservoir and upstream riverine habitat. Except in the Reach Downstream of Chili Bar where roads permitted access to tributaries, an assessment of barriers at tributary mouths was not possible in reaches mapped using aerial videography. In general, however, high gradient channels and steep canyon walls that necessitated use of aerial survey methods in some reaches would presumably limit fish passage into tributaries in the same areas.

3.3 Analysis of Barrier Data

We reviewed the available literature on fish life histories to identify which fish species present in the UARP reaches and the Reach Downstream of Chili Bar are migratory and likely to require access to riverine spawning areas. Barrier mapping data were analyzed to assess the distribution, abundance, and relative frequency of fish passage barriers, including dams within the UARP Reaches and the Reach Downstream of Chili Bar. The potential effect of project dams on the distribution of fish species was assessed using fish distribution data from the Stream Fish and Reservoir Fish technical reports. Where relevant, an analysis of barrier locations was made in relation to longitudinal distributions of potential spawning and overwintering (deep pool) habitat in project reaches mapped on the ground. Spawning habitat in stream segments between barriers is necessary for the dominant species (i.e., trout species) to complete their life cycles. Overwintering habitat in stream segments between barriers is necessary for survival through winter when streams in some reaches are mostly frozen.

4.0 RESULTS

Survey teams mapped approximately 33.7 miles of stream habitat by foot in seven reaches during 2002 and 2003. An additional 50.7 river miles in six reaches were mapped using aerial videography.

In addition to dams, all of which are barriers to upstream fish passage, 51 barriers were identified and mapped on 1:24,000 scale USGS topographic maps (Appendix Figures B1-B8). These barriers, which were either vertical falls or high-gradient, high-velocity cascades, occurred in nine of 13 study reaches (Table 4.0-1). In addition, 28 sites appeared to present seasonal barriers that were only passable at relatively higher flow levels expected during periods of spring run-off and/or winter storms (Appendix C). No barriers to fish passage between project reaches and tributaries were observed in reaches mapped on the ground. No fish migration barriers were observed within the fluctuation zone (i.e., the area below full-pool elevation that is exposed under typical reservoir operation) at the mouths of tributaries to Loon Lake, Union Valley, Ice House, Junction, Camino, Slab Creek, and Chili Bar reservoirs.

The number of barriers ranged from 0 to 19 within the stream reaches and were most heavily concentrated in the short Rockbound Dam Reach. Table 4.0-1 summarizes reach and fish passage barrier data, excluding project dams, recorded from on the ground and aerial mapping.

Table 4.0-1. Relative abundance of fish passage barriers in stream reaches affected by the UARP and Chili Bar Project.

Reach	Reach Length	Number of Passage Barriers	Barriers/mile	Miles/Barrier
Rubicon Dam	5.8*	9	1.6	0.6
Rockbound Dam	0.4	4	10.0	0.1
Buck Island Dam	2.8	5	1.8	0.6
Loon Lake Dam	9.3	7	0.8	1.3
Gerle Creek Dam	1.1	0	0.0	1.1
Robbs Peak Dam	5.6	2	0.4	2.8
Ice House Dam	11.5	0	0.0	11.5
Junction Dam	8.3	3	0.4	2.8
Camino Dam	6	1	0.2	6.0
S F American River	2.8	1	0.4	2.8
Slab Creek Dam	8	0	0.0	8.0
Brush Creek Dam	2.3	19	8.3	0.1
Reach Downstream of Chili Bar	19.1	0	0.0	19.1

* Differs from established reach length because an additional 1.3 mi of stream channel were mapped below Miller Creek.

Fish species composition for project reaches is presented in Table 4.0-2. Fish species composition for project reservoirs is presented in Table 4.0-3. The fish migration barrier analysis focuses primarily on trout species because they are the most widely distributed and most abundant species within the UARP and Reach Downstream of Chili Bar, and the species most likely to exhibit migratory life histories. A species of concern, hardhead (*Mylopharodon conocephalu*s), is found only in reaches downstream of the natural barrier in the South Fork American River Reach (Section 4.10). Relatively poor swimming ability may prevent hardhead from moving up streams with natural or anthropogenic velocity barriers that permit the passage of salmonids (Moyle 2002). Therefore, hardhead may be a less appropriate analysis species because they are already restricted in their distribution by natural conditions that are unrelated to project effects.

The occurrence of fish passage barriers in each of the stream reaches and adjoining reservoir and tributary habitat is described below.

Table 4.0-2. Species composition for UARP reaches and the Reach Downstream of Chili Bar. [1]

	Species[2]														
Stream Reach	**RBT**	**BRN**	**BRK**	**RS**	**PS**	**SS**	**HH**	**SPM**	**GSH**	**CR**	**SD**	**GSF**	**BG**	**SB**	**References**
Rubicon Dam Reach	●o	o	●			o				o	o				USDA 1979a
Rubicon Tunnel Outlet Reach															No species composition data
Rockbound Dam Reach															No species composition data
Buck Island Dam Reach	o								o	o					No historical species composition data
Loon Lake Dam Reach	●o	●o	●							●					CDFG Gerle Creek surveys, various dates
Gerle Creek Dam Reach	●o	●o	●							●					Turney 1986; CDFG Gerle Creek surveys, various dates
S.F. Rubicon Upstream of Robbs Reservoir	o														No historical species composition data
Robbs Peak Dam Reach	o	o													No historical species composition data
Ice House Dam Reach	●o	●o				●o									USDA 1979b
Junction Dam Reach	●o	●o		●		●o									CDFG Silver Creek surveys, various dates
Camino Dam Reach	●o	●o		●		●o									Thomas 1994
South Fork American Reach	●o			●		●o	●o	●o		●o	●o				TRPA (1998). Survey at El Dorado Powerhouse, downstream of the falls 1 mile below Silver Creek. Sculpin cited were presumed to be riffle sculpin.
Brush Creek Dam Reach	●o	●o													CDFG Brush Creek surveys, various dates
Slab Creek Dam Reach	●o	●o		●o	o	●o	●o	●o		o	●o	●		●	WESCO 1980, Ramsey 1949
Downstream of Chili Bar	o	o		o	o	o		o			o	o	o	o	No historical species composition data.

[1] ● Historical data o 2002 and 2003 Surveys

[2] Species:
BG= Blue Gill
BRK=Brook trout
BRN=Brown trout
CR=California roach
GSF= Green sunfish
GSH=Golden shiner
HH=Hardhead
PS = Prickly sculpin
RBT=Rainbow trout
RS=Riffle sculpin
SPM= Sacramento pikeminnow
SD=Speckled dace
SB = Smallmouth bass
SS=Sacramento sucker

Table 4.0-3. Species composition for UARP and Chili Bar reservoirs.[1]

Reservoir	Species[2]																				
	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, ENF various dates
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				

[1] ● Historical data
o 2002 and 2003 Surveys

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

4.1 Rubicon Dam Reach

The Rubicon Dam Reach is located on the Rubicon River and extends from the base of Rubicon Dam to the Miller Creek confluence (Appendix A). The established reach is approximately 4.5 miles long, ranges in elevation from 6,510 to 6,100 feet, and has a mean gradient of about 100 feet per mile (1.9 percent). An additional 1.3 miles of the Rubicon River were surveyed below the confluence with Miller Creek. For the purposes of this report, stream miles in this reach refer to miles above the lowest extent surveyed in the Rubicon River (1.3 miles below Miller Creek).

Rubicon Dam is a 36-foot high concrete structure that prohibits upstream fish passage. Below the dam, rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), Sacramento sucker (*Catostomus occidentalis*), California roach (*Lavinia symmetricus*), and speckled dace (*Rhynicthys osculus*) were captured during fish surveys in 2002 and 2003 (Table 4.0-2).

Rainbow trout was the dominant species in upper portions of the reach and speckled dace and California roach were the dominant species in lower portions of the reach. Sacramento sucker, California roach, and speckled dace were the only species observed in the Rubicon Dam Reach that were not present in the reservoir above the dam (Table 4.0-3). No species information is available for the Rubicon River upstream of Rubicon Reservoir. Brook trout (*Salvelinus fontinalis*) and golden trout (*Oncorhynchus mykiss aguabonita)* were historically documented in the reservoir (CDFG surveys, various dates), but have not been observed in the Rubicon Dam Reach.

In addition to Rubicon Dam, nine barriers to fish passage were identified in the Rubicon Dam Reach (Appendix Figure B-1). Barriers were characterized by vertical drops ranging from 4 to 20 feet and were often associated with long, shallow, high-velocity chutes or cascades. Barriers occurred at a rate of 1.5 per mile (Table 4.0-1), but were clustered around river miles 2.0 and 5.0, respectively, rather than uniformly distributed. Additionally, six sites appeared passable only at higher flow levels expected during typical spring run-off and/or winter storms (Appendix C).

Because of the clustered pattern of barriers around stream miles 2.0 and 5.0, respectively, the reach consisted of relatively long, contiguous stream segments separated by several very short (<0.10 mi) segments. Deep pool habitat (≥3 feet) was well distributed among stream segments separated by barriers (Figure 4.1-1). Spawning habitat had a clustered distribution, but access to aggregations of spawning habitat was generally not limited by barriers (Figure 4.1-2). No perennial tributaries are present within this reach.

4.2 Rockbound Dam Reach

The Rockbound Dam Reach is located on Highland Creek and extends from the outlet of Rockbound Lake to the normal high water line of Buck Island Reservoir (Appendix A). This section of river is approximately 0.4 mile long, extends through a range of elevations from 6,520 to 6,440 feet, and has a mean gradient of about 200 feet/mile (3.8 percent).

Rockbound Dam is a 5-feet high concrete and masonry structure that prohibits upstream fish passage. Fish species information for the Rockbound Dam Reach is not available (except for incidental observations of "trout"), but fish resources are expected to include some combination of trout species found upstream in Rockbound Lake and downstream in Buck Island Reservoir, which historically has included rainbow trout, brown trout, and brook trout (*Salvelinus fontinalis*). No species information is available for Rockbound Lake or the Rubicon Tunnel Outlet Reach upstream of the Rockbound Dam Reach.

In addition to Rockbound Dam, four barriers to fish migration were identified in the Rockbound Dam Reach (Appendix Figure B-1). Besides the dam, barriers consisted of vertical falls and high velocity cascades over bedrock, and occurred at a rate of ten per mile (Table 4.0-1). Additionally, two sites appeared passable at higher flow levels expected during spring run-off and/or winter storms (Appendix C).

This short reach was separated into several very short (<0.10 mi) stream segments by fish passage barriers. Deep pool habitat (≥3 feet) was uniformly distributed among stream segments (Figure 4.2-1). Neither spawning habitat nor perennial tributaries were observed within this reach.

4.3 Buck Island Dam Reach

The Buck Island Dam Reach is located on the Little Rubicon River and extends from the base of Buck Island Dam to the confluence with the Rubicon River (Appendix A). This section of river is 2.8 miles long, extends through a range of elevations from 6,420 to 5,940 feet, and has a mean gradient of about 170 feet/mile (3.2 percent).

Buck Island Dam is a 32-foot high structure that prohibits upstream fish passage. Below the dam, rainbow trout, California roach, and golden shiner (*Notemigonus crysoleucas*) were captured during fish surveys in 2002 and 2003 (Table 4.0-2). Golden shiner was the dominant species in both years. California roach and golden shiner were the only species observed below Buck Island Dam that were not present in the reservoir above the dam. Brown trout and brook trout have been historically documented in the reservoir (CDFG surveys, various dates), but have not been observed in the Buck Island Dam Reach. No species information is available for the Rockbound Dam Reach upstream of Buck Island Reservoir.

In addition to Buck Island Dam, five barriers to fish migration were identified in the Buck Island Dam Reach (Appendix Figures B-1 and B-2). Besides the dam, barriers consisted of vertical falls ranging from 10 to 15 feet in height. Natural barriers occurred at a rate of 1.8 per mile, and were uniformly distributed throughout the reach. Additionally, three sites were passable only at higher flow levels expected during typical spring run-off and/or winter storms (Appendix C).

Deep pool habitat was uniformly distributed throughout this reach and relatively abundant in all stream segments separated by barriers (Figure 4.3-1). Spawning gravel was minimal (<5 square feet total) throughout the reach. No perennial tributaries were observed.

4.4 Loon Lake Dam Reach

The Loon Lake Dam Reach is located on Gerle Creek and extends from the base of Loon Lake Dam to the normal high water line of Gerle Creek Reservoir (Appendix A). This section of river is approximately 9.3 miles long, extends from 6,310 to 5,231 feet, and has a mean gradient of about 122 feet/mile (2.3 percent). Tributaries to this reach include Jerrett Creek, Barts Creek, Dellar Creek, and Rocky Basin Creek.

Loon Lake Dam is a 108-foot high structure that prohibits upstream fish passage. Brown trout and rainbow trout were captured in this reach during fish surveys in 2002 and 2003 (Table 4.0-2). Brown trout was the dominant species in both years. No species were observed in the Loon Lake Dam Reach that were not present in the reservoir above the dam. Rainbow trout, brown trout, California roach, and Sacramento sucker were captured in Loon Lake Reservoir in 2002 and 2003 (see Table 4.0-3). California roach, Sacramento sucker, brook trout, unidentified cyprinid species ("chubs"), green sunfish (*Lepomis cyanellus*), and tule perch (*Hysterocarpus*

traski) have been historically documented in the reservoir (SMUD 2001; EDAW 1978), but have not been observed downstream of the dam in the Loon Lake Dam Reach. No perennial stream habitat is present above the Loon Lake Dam Reach.

In addition to Loon Lake Dam, seven barriers to fish migration were identified in the Loon Lake Dam Reach (Appendix Figures B-3 and B-4). Besides the dam, barriers consisted of high-gradient, high-velocity cascades or vertical falls. Barriers occurred at rate of 0.8 per mile but were concentrated in the upper third of this reach. Additionally, three sites appeared passable only at higher flow levels expected during typical spring run-off and/or winter storms (Appendix C).

Deep pool habitat was uniformly distributed throughout this reach and relatively abundant in all stream segments separated by barriers (Figure 4.4-1). A large amount of spawning gravel (approximately 36,500 square feet) was observed in this reach, with the majority located between river miles 4.0 and 7.0. Spawning habitat was available in all segments separated by barriers, except in short stream segments (i.e., 0.1-0.2 mi) around river miles 6.3 and 8.9 (Figure 4.4-2). Rocky Basin Creek was the only perennial tributary observed in this reach. No barriers to tributary access were observed in this reach.

4.5 Gerle Creek Dam Reach

The Gerle Creek Dam Reach is located on Gerle Creek, extending from the base of Gerle Creek Dam to the South Fork Rubicon River (Appendix A). This section of river is 1.1 miles long, extends through a range of elevations from 5,182 to 4,980 feet, and has a mean gradient of about 184 feet/mile (3.5 percent).

Gerle Creek Dam is a 58-foot high structure that prohibits upstream fish passage. Rainbow trout and brown trout were captured in this reach during fish surveys in 2002 and 2003 (Table 4.0-2). Rainbow trout was the dominant species in both years. Rainbow trout were not present in Gerle Creek Reservoir in 2002 and 2003 (only brown trout and California roach were captured; Table 4.0-3). However, historical surveys have documented rainbow trout in the reservoir. Rainbow trout were also captured in stream habitat above Gerle Creek Reservoir (i.e., Loon Lake Dam Reach) in 2002 and 2003 (Table 4.0-2). Gerle Creek Dam is operated to maintain water elevations in Gerle Creek Reservoir that allow brown trout to access tributary spawning habitat until October 31 (L. Maier, SMUD, personal communication).

Besides Gerle Creek Dam, no barriers to fish migration were identified during ground surveys in this study reach. No perennial tributaries were observed in this reach.

4.6 Robbs Peak Dam Reach

The Robbs Peak Dam Reach is located on the South Fork Rubicon River and extends from the base of Robbs Peak Dam to the confluence with the Rubicon River (Appendix A). This section of river is 5.6 miles long, extends through a range of elevations from 5,190 to 3,540 feet, and has a mean gradient of about 293 feet/mile (5.5 percent). Tributaries to this reach include Gerle Creek and South Creek.

Robbs Peak Dam is a 44-foot high structure that prohibits upstream fish passage. Rainbow trout and brown trout were captured in this reach during fish surveys in 2002 and 2003 (Table 4.0-2). Rainbow trout was the dominant species in both years. Both rainbow trout and brown trout were historically present in the reservoir above the dam (EA 1982, SMUD 2001). Rainbow trout were also observed in the South Fork Rubicon River upstream of Robbs Peak Reservoir in 2002 and 2003 (Table 4.0-2).

In addition to Robbs Peak Dam, two barriers to fish migration were identified in this reach of the South Fork Rubicon River using aerial videography (Appendix Figure B-5). Besides the dam, fish migration barriers consisted of vertical falls estimated at greater than six feet in height. Barriers occurred at a rate of 0.4 per mile and occurred primarily in the lower third of the reach. In addition, one site, located approximately 300 yards below the mouth of Gerle Creek, appeared passable only at higher flow levels expected during typical spring run-off and/or winter storms (Appendix C). An assessment of barriers at tributary mouths was not possible because this reach was not safely accessible by foot.

4.7 Ice House Dam Reach

The Ice House Dam Reach is located on South Fork Silver Creek and extends from the base of Ice House Dam to the normal high water line of Junction Reservoir (Appendix A). This section of river is 11.5 miles long, extends through a range of elevations from 5,290 to 4,450 feet, and has a mean gradient of about 73 feet/mile (1.4 percent). Tributaries to this reach include Peavine Creek, Winmiller Ravine, Chicken Hawk Springs, Bryant Springs, and Big Hill Canyon.

Ice House Dam is a 150-foot high structure that prohibits upstream fish passage. Below Ice House Dam, brown trout, rainbow trout, and Sacramento sucker were captured during fish surveys in 2002 and 2003 (Table 4.0-2). Rainbow trout was the dominant species in the upper portion of the reach and Sacramento sucker was the dominant species in the lower portion of the reach. Sacramento Sucker was the only species observed below Ice House Dam that was not present in the reservoir. Rainbow trout, brown trout, and California roach were captured in Ice House Reservoir in 2002 and 2003 (Table 4.0-3). In addition, historical surveys have documented brook trout, green sunfish, and kokanee salmon in the reservoir. No fisheries information is available for stream habitat above Ice House Reservoir. No barriers to upstream fish passage were observed in reservoir fluctuation zones at the mouths of tributaries to Ice House Reservoir.

Besides Ice House Dam, no barriers to fish migration were identified during ground surveys in this study reach of South Fork Silver Creek. Four sites, however, appeared passable only at higher flow levels expected during typical spring run-off and/or winter storms (Appendix C). No barriers to tributary access were observed in this reach.

4.8 Junction Dam Reach

The Junction Dam Reach is located on Silver Creek and extends from the base of Junction Dam to the normal high water line of Camino Reservoir (Appendix A). This section of river is 8.3

miles long, extends through a range of elevations from 4,300 to 2,195 feet, and has a mean gradient of about 167 feet/mile (3.2 percent). Tributaries to this reach include Gray House Creek, Bear Creek, Davis Creek, and Onion Creek.

Junction Dam is a 168-foot high structure that prohibits upstream fish passage. Below the dam, rainbow trout, brown trout, and Sacramento sucker were captured during fish surveys in 2002 and 2003 (Table 4.0-2). Rainbow trout was the dominant species throughout this reach. Rainbow trout were not observed in Junction Reservoir in 2002 and 2003 (only brown trout and Sacramento sucker were captured; Table 4.0-3). However, historical surveys documented rainbow trout in the reservoir (Thomas 1994). Rainbow trout were also captured in stream habitat above Junction Reservoir (i.e., Ice House Dam Reach) in 2002 and 2003 (Table 4.0-2). No barriers to upstream fish passage were observed in reservoir fluctuation zones at the mouths of tributaries to Junction Reservoir. In addition, no impassable barriers to upstream fish passage into tributaries were observed in the fluctuation zone of Union Valley Reservoir, immediately upstream of Junction Reservoir and the Junction Dam Reach.

In addition to Junction Dam, three barriers to fish migration were identified in this reach of Silver Creek using aerial videography (Appendix B Figure 6). Barriers consisted of vertical falls estimated at greater than six feet in height. Barriers occurred at a rate of 0.4 per mile and were concentrated in the upper half of this reach. In addition, one site, near the mouth of Bear Creek, appeared passable only at higher flow levels expected during typical spring run-off and/or winter storms (Appendix C). An assessment of barriers at tributary mouths was not possible because much of this reach was not safely accessible by foot.

4.9 Camino Dam Reach

Camino Dam Reach is located on Silver Creek from the base of Camino Dam to the South Fork American River (Appendix A). This section of river is 6.0 miles long, extends through a range of elevations from 2,785 to 2,060 feet, and has a mean gradient of about 121 feet/mile (2.3 percent). The only major tributary in this reach is Round Tent Canyon.

Camino Dam is a 133-foot high structure that prohibits upstream fish passage. Below the dam, rainbow trout, brown trout, and Sacramento sucker were observed during fish surveys in 2002 (Table 4.0-2). Rainbow trout were the dominant species throughout this reach. No species were observed in the Camino Dam Reach that were not present in the reservoir above the dam. Historical surveys have documented rainbow trout, brown trout, brook trout, California roach, Sacramento sucker, and riffle sculpin (*Cottus gulosus*) in Camino Reservoir (SMUC 2001; ENF Stream Survey, not dated). Rainbow trout, brown trout, and Sacramento sucker were also observed in stream habitat above Camino Dam Reservoir (i.e., Junction Dam Reach) during 2002 and 2003 (Table 4.0-3). No barriers to upstream fish passage were observed in reservoir fluctuation zones at the mouths of tributaries to Camino Reservoir.

In addition to Camino Dam, one barrier to fish migration was identified in this reach of Silver Creek using aerial videography (Appendix Figure B-7). The barrier consisted of a series of two

small falls and was located at approximately river mile 3.3. An assessment of barriers at tributary mouths was not possible because this reach was inaccessible by foot.

4.10 South Fork American River Reach

The South Fork American River Reach is located on the South Fork of the American River from the confluence with Silver Creek to the normal high water line of Slab Creek Reservoir (Appendix A). This section of river is approximately 2.8 miles long, ranging in elevation from 2,040 to 1,850 feet, and has a mean gradient of about 68 feet/mile (1.3 percent). No tributaries are present in this reach.

Rainbow trout, Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker, hardhead, speckled dace, and California roach were observed in this reach in 2003 (Table 4.0-2). California roach was the dominant fish species observed. Sacramento pikeminnow, hardhead, speckled dace, and California roach were the only species observed within the South Fork American River reach that were not found upstream in the Camino Dam Reach during fish surveys in 2002 and 2003 (Table 4.0-2).

One barrier, located at river mile 1.8, was identified in the South Fork American River Reach from aerial videography (Appendix Figure B-8). This barrier has been noted in other studies for El Dorado Irrigation District's Project 184, and may be the upstream limit of distribution for some fish species (e.g., hardhead, Sacramento pikeminnow).

4.11 Brush Creek Dam Reach

The Brush Creek Dam Reach is located on Brush Creek from the base of Brush Creek Dam to the normal high water line of Slab Creek Reservoir (Appendix A). This section of river is 2.3 miles long, extends through a range of elevations from 2,710 to 1,850 feet, and has a mean gradient of about 406 feet/mile (7.7 percent), although much of the reach is steeper than that. There are no major tributaries to this reach.

Brush Creek Dam is a 213-foot high structure that prohibits upstream fish passage. Below the dam, rainbow trout and brown trout were observed during fish surveys in 2003 (Table 4.0-2). Rainbow trout was the dominant fish species observed. Historical surveys have documented the presence of rainbow trout and brown trout in Brush Creek Reservoir (Eldorado National Forest, unpublished stream survey 1974). Previous stream inventories indicate that Brush Creek and tributaries to Brush Creek (e.g., Incline Creek) contain resident brown trout and rainbow trout populations, but that there is probably little upstream migration from Brush Creek Reservoir due to the steepness of the stream and occurrence of natural barriers (Eldorado National Forest, unpublished stream survey 1974).

In addition to Brush Creek Dam, 21 barriers to fish passage were identified in Brush Creek (Appendix Figure B-8). Besides the dam, barriers consisted of high-gradient, high-velocity cascades or vertical falls. Barriers occurred at a rate of 8.3 per mile and were uniformly distributed throughout the reach. Additionally, eight sites appeared passable only at higher flow levels expected during typical spring run-off and/or winter storms (Appendix C).

Deep pool habitat was uniformly distributed throughout this reach and relatively abundant in all stream segments separated by barriers (Figure 4.11-1). Spawning gravel was most abundant in the lower third of this reach, but aggregations of spawning gravel were available in all segments separated by barriers, except in very short stream segments (≤ 0.1 mi) around river miles 0.8 and 1.2 (Figure 4.11-2). No perennial tributaries were observed in this reach.

4.12 Slab Creek Dam Reach

The Slab Creek Dam Reach is located on the South Fork of the American River from the base of Slab Creek Reservoir to the normal high water line of Chili Bar Reservoir (Appendix A). This section of river is 8.0 miles long, extends from 1,620 to 990 feet, and has a mean gradient of about 79 feet/mile (1.5 percent). Major inflows to this reach include Redbird Creek, Iowa Canyon, South Canyon, Mosquito Creek, Jaybird Creek, Rock Creek, and White Rock Creek.

Slab Creek Dam is a 250-foot high structure that prohibits upstream fish passage. Below the dam, rainbow trout, brown trout, Sacramento sucker, riffle sculpin, prickly sculpin (*Cottus asper*), speckled dace, hardhead, Sacramento pikeminnow, and California roach were captured during fish surveys in 2002 and 2003 (Table 4.0-2). Hardhead and Sacramento pikeminnow were the dominant species in this reach. Riffle sculpin and prickly sculpin were the only species observed below Slab Creek Dam that were not observed above Slab Creek Dam, although historical surveys indicated the presence of riffle sculpin above the dam (TRPA 1998). No barriers to upstream fish passage were observed in reservoir fluctuation zones at the mouths of tributaries to Slab Creek Reservoir.

Besides Slab Creek Dam, no barriers to fish migration were identified in the Slab Creek Dam Reach using aerial videography. An assessment of barriers at tributary mouths was not possible because parts of this reach are not safely accessible by foot.

4.13 Reach Downstream of Chili Bar

The Reach Downstream of Chili Bar is located on the South Fork of the American River and extends from the base of Chili Bar Dam to the normal high water line of Folsom Lake (Appendix A). This section of river is 19.1 miles long. Elevations range from 960 feet to approximately 470 feet, with a mean gradient of approximately 25 feet/mile (0.5 percent). Tributaries include Dutch Creek, Granite Creek, Greenwood Creek, Hastings Creek, Jacobs Creek, Norton Ravine, and Weber Creek.

Chili Bar Dam is a 120 feet high structure that prohibits upstream fish passage. Below the dam, rainbow trout, brown trout, Sacramento sucker, Sacramento pikeminnow, speckled dace, riffle sculpin, prickly sculpin, green sunfish, bluegill (*Lepomis macrochirus*), and smallmouth bass (*Micropterus dolomieiui*) were observed during fish surveys in 2003 (Table 4.0-2). Rainbow trout, Sacramento pikeminnow, and Sacramento sucker were the dominant species in this reach. Rainbow trout are dominant in the upper and lower portions of the reach; Sacramento pikeminnow and Sacramento Sucker are dominant in the middle of the reach. Green sunfish and bluegill were the only species observed below Chili Bar Dam that were not present in either

reservoir or stream habitat above the dam during fish surveys in 2002 and 2003 (Tables 4.0-2 and 4.0-3). However, green sunfish were historically documented in the Slab Creek Dam Reach (WESCO 1980). No barriers to upstream fish passage were observed in reservoir fluctuation zones at the mouths of tributaries to Chili Bar Reservoir.

Besides Chili Bar Dam, no barriers to fish passage were identified in the reach below Chili Bar Dam using aerial videography. No passage barriers were observed in tributaries near their confluence with South Fork American River during ground surveys. A detailed assessment of fish passage between South Fork American River and major tributaries is provided in the *Flow and Fluctuation in the Reach Downstream of Chili Bar Technical Report*.

5.0 TROUT MOVEMENT PATTERNS

Movement is relatively common in populations of stream-resident salmonids (Gowan et al. 1994, Northcote 1997), but the extent and timing of fish movements are highly variable and specific to the individual, the species, and the watershed. This section provides a review of stream-resident trout movement patterns, with an emphasis on rainbow trout and brown trout because of their abundance in the UARP and Reach Downstream of Chili Bar. In addition, factors thought to influence trout movement and characteristics of barriers that prevent their movement are discussed. In this report, the term "movement" refers to directed movement and is synonymous with "migration" as defined by Northcote (1978):

> "movements resulting in an alternation between two or more separate habitats (i.e., a movement away from one habitat followed eventually by a return again) occurring with regular periodicity . . . and involving a large fraction of the population."

Trout require various types of habitat during different stages of their life history: spawning and incubation habitat, nursery or rearing habitat, adult habitat, and overwintering habitat (Behnke 1992). Spawning and incubation habitat consists of pockets of gravel with sufficient permeability to bring oxygen to eggs and remove metabolic wastes (Meehan 1991). After hatching and during the first months of life, trout need rearing habitat with protective cover and low water velocity (Behnke 1992). Such habitats typically occur along the margins of stream, in springs seeps, side channels, and small tributaries (Behnke 1992). Later, juveniles will establish territories in riffle areas (Behnke 1992). Adult trout prefer habitats where slow waters for resting are juxtaposed with fast waters that carry food and where protective cover is provided by boulders, logs, overhanging vegetation, or undercut banks (Behnke 1992). Overwintering habitat is important for both juvenile and adult life stages and typically consists of deep water with low current velocity and protective cover (Bjornn 1971; Jakober et al. 1998). Such habitat is usually provided by deep pools with large boulders and root wads (Behnke 1992).

Northcote (1984) observed that migratory behavior arises from spatial, seasonal, and ontogenetic separation of optimal habitats for growth, survival, and reproduction. In a more recent paper, Northcote (1997) described seasonal movements as a cyclic sequence of migrations (trophic, refuge, and eventually reproductive) among three critical habitats (feeding, wintering, and spawning). He cautioned that the apparent simplicity of this conceptual model of fish movement

is deceiving because habitat needs change as fish grow and seasons change. Even within a season, for a given life stage, several different feeding habitats may be used by an individual (Clapp et al. 1990; Young et al. 1997). Therefore, the physical arrangement and proximity of critical habitats will affect the extent of movement required by salmonids. Some trout may need to move only a few hundred feet or less to locate suitable spawning, feeding, or winter habitats (Northcote 1992). Others may undergo extensive migrations to find critical habitat. For example, in small tributary streams exposed to severe winter conditions, trout may make extensive downstream movements to overwinter in larger, deeper habitats (Cunjak and Power 1986). Resident trout in Idaho's Salmon River drainage may make overwintering migrations of more than 100 miles (Bjorn and Mallet 1964, Bjornn 1971). Behnke (1992) suggested that in high elevation streams with low productivity and harsh environmental regimes trout are likely to encounter food shortages and may need to move to areas of greater food abundance. Factors influencing movement, or lack thereof, are likely to be site specific (Behnke 1992). Table 5.0-1 lists some widely recognized movements of resident stream salmonids.

Table 5.0-1. Some widely recognized movements of resident stream salmonids (modified from Gowan et al. 1994).

Behavior and observed characteristics	Sources
1. Active fry dispersal, possibly mediated by social dominance effects	Kalleberg 1958; Chapman 1962; Solomon and Templeton 1976; Elliot 1987; Heggenes 1988; Elliott 1990; Crisp and Hurley 1991
2. Limited fry dispersal in closely juxtaposed habitats	June 1981; Moore and Gregory 1988a, 1988b; Trotter 1989; Beard and Carline 1991
3. Specialized patterns of fry and juvenile dispersal in unique habitats (e.g. above and below waterfalls)	Northcote 1962, 1969, 1981; Northcote and Kelso 1981; Northcote and Hartman 1988
4. Movements related to ontogenetic shifts in microhabitat use, possibly to increase rate of food intake or avoid competition by habitat segregation	Newman 1956; Saunders and Smith 1962a; Hartman 1965; Egglishaw 1967; Shetter 1968; Chapman and Bjornn 1969; Solomon and Templeton 1976; Alexander 1977; Stauffer 1980; Fausch and White 1981; Bachman 1982; Moore and Gregory 1988a, 1988b; Clapp et al. 1990; Young 1994
5. Movements related to fish having different microhabitats preferences at different water temperatures	Chapman and Bjornn 1969; Bjornn et al. 1977; Smith and Li 1983; Campbell and Neuner 1985; Moyle and Vondracek 1985; Sheppard and Johnson 1985; Baltz et al. 1987
6. Seasonal movements between summer and winter habitat locations (distances moved may be short if summer and winter habitats are closely juxtaposed, or extensive (>100 mi) if required habitats are widely dispersed)	Cooper 1953; Smith and Saunders 1958, 1967; Hartman 1963, 1965; Chapman and Bjornn 1969; Hunt 1969; Bjornn 1971; Bustard and Narver 1975; Craig and Poulin 1975; Solomon and Templeton 1976; Gibson 1978; Leclerc and Power 1980; Montgomery et al. 1983; Rimmer et al. 1983; Campbell and Neuner 1985; Sheppard and Johnson 1985; Chisholm et al. 1987; Hartman and Brown 1987; Hillman et al. 1987; Cunjak 1988; Cunjack et al. 1989; Craig 1989; Trotter 1989; Clapp et al. 1990; Nakano et al. 1990; Näslund 1990; Baltz et al. 1991; Meyers et al. 1992; West et al. 1992; Brown et al. 2001; Burrell et al. 2000; Henderson et al. 2000; Muhlfeld et al. 2001; Ovidio et al. 2002; Simpkins et al. 2000; Young 1998; Young 1994
7. Spawning movements predominantly upstream over relatively long distances	McFadden 1961; Harden-Jones 1968; Solomon and Templeton 1976; Craig 1978; Leclerc and Power 1980; Meyers et al. 1992; Swanberg 1997
8. Spawning movements in all directions over	Northcote and Hartman 1988; Moore and Gregory 1988a;

Table 5.0-1. Some widely recognized movements of resident stream salmonids (modified from Gowan et al. 1994).	
Behavior and observed characteristics	**Sources**
relatively short distances (when spawning and rearing habitats are interspersed)	Trotter 1989; Nakano et al. 1990; Beard and Carline 1991; Burrell et al. 2000; Henderson et al. 2000
9. Homing movements following displacement	Miller 1954; Saunders and Smith 1962b; Harcup et al. 1984; Halvorsen and Stabell 1990; Belanger and Rodriguez 2001

Recent advances in radio telemetry have resulted in more detailed information on trout movement patterns. While studying brown trout in the southern Appalachian Chattanooga River, Bunnell et al. (1998) found that adult trout moved up to 260 feet during a twenty-four hour period, with larger trout having the widest diel ranges. These results agree with Young (1994), who found larger brown trout moved greater distances during a twenty-four hour period. Clapp et al. (1990) found that large brown trout in the South Branch Au Sable River, Michigan, moved up to one mile between feeding habitats during spring and summer and made seasonal movements up to 6.2 miles to reach overwintering habitats. Meyers et al. (1992) documented long-range movements (4.5 to 12.5 miles) between seasonal habitats during the spring and fall in a Wisconsin brown trout population. Spring upstream movements were related to rising water temperatures. Upstream movement may also correlate with increased stream flow that permits access to areas above seasonal barriers (Arnold et al. 1987, as cited in Meyers et al. 1992).

The migratory cycle between feeding, spawning, and winter habitats is not well known for river rainbow trout populations (Northcote 1997). In an Alaskan population, the predominant migratory pattern was upstream movement during spawning and post-spawning seasons, with subsequent return to the lower reaches of the Alagnak River for overwintering (Meka et al. 2003). Short-distance migrations to feeding habitats have been recorded for headwater populations above waterfalls (Northcote et al. 1970; Northcote 1981; Northcote and Hartman 1988). Downstream migration to wintering habitat was noted in the Lemhi River, Idaho by Bjornn (1971). Short (< 0.5 mi) upstream and downstream movements to overwintering habitats were documented for rainbow trout in a headwater stream in Montana (Muhlfeld et al. 2001). Rainbow trout have been shown to change their use of habitat, using deeper and faster water, as they grow (Baltz et al. 1991). Baltz et al. (1991) also showed that rainbow trout used different microhabitats during different seasons throughout the year.

While studies have demonstrated that stream-dwelling trout are mobile, very few studies have compared movement patterns of sympatric trout species. However, Young et al. (1997) used radiotelemetry to simultaneously monitor positions of brown trout and rainbow trout in Silver Creek, Idaho. Their biweekly observations from May to September indicated that rainbow trout had larger home ranges (median=0.4 miles) and moved greater distances (median=0.7 miles) than brown trout. Additionally, rainbow trout occupied more positions than brown trout over this interval.

In addition to differential movements between species and watersheds, substantial variation in movement patterns can occur within the same population. Based on evidence that some fish move very little and others move a great deal, Funk (1955) proposed the concept of "sedentary"

and "mobile" fractions of fish populations. Several studies have applied this approach to trout populations (Solomon and Templeton 1976; Flick and Webster 1975; Jackson 1980; Cargill 1980; Hesthagen 1988). The sedentary versus mobile concept implies that individual fish fit into one category or the other (Gowan et al. 1994). However, Harcup et al. (1984) provide data to suggest that this is not necessarily true. When tracking individually tagged fish over two years, they found frequent switching behavior in which formerly sedentary fish moved, and formerly mobile fish became sedentary. In their study, the size of the mobile fraction in an English brown trout population was partially influenced by sampling techniques, ranging from 17 to 71%, depending on the time interval between observations. A median of 33% (range 17-66%) of recaptured fish had switched behaviors between surveys. This suggests that variation in migration exists along a spectrum, as individual fish respond to variable environmental conditions, rather than in deterministic mobile and sedentary subsets of a population (Gowan et al. 1994).

While mobility may be advantageous in some environments, natural and anthropogenic barriers can limit the extent of fish movements. The ability of trout to pass over impediments depends on the swimming ability of the fish, the horizontal and vertical distances to be jumped, and the angle to the top of the barrier (Powers and Orsborn 1985). Swimming and leaping capabilities are not well documented for stream resident salmonids, although Reiser and Peacock (1985) reported that "average size" brown trout are capable of leaping 2.6 feet. Several other factors, such as water velocity, water depth, and water turbulence, influence the ability of fish to pass obstructions in a stream channel and these factors may change dramatically throughout the year. The presence of a launch pool below a barrier structure is a particularly important factor determining upstream migration opportunities (Stuart 1962). Kruse et al. (1997), and Dunham et al. (1997) classified vertical geological structures greater than five feet high to be dispersal barriers for resident trout, although trout are capable of surmounting much larger vertical heights depending on the geometry of the structure (Dunham 1996). Adams et al. (2000) found brook trout ascended a four-foot-high complex falls in an Idaho stream. The falls had a 1.6-foot-high upper step where the water passed over and through boulders and woody debris and a lower step of 2.3 feet over boulders and bedrock. A small, high velocity "pool" less than six inches deep separated the two steps. In contrast, no marked fish were found upstream of a 3.6 feet vertical falls over a large log. Adams et al. (2000) also observed brook trout as small as 3.5 inches ascending a 2.3 feet high, nearly vertical falls over boulders and bedrock. In Wyoming, artificial barriers built to exclude non-native trout species from upstream populations of native cutthroat trout (*Oncorhynchus clarki*) are at least three feet high with a downstream apron typically extending over six feet (Young et al. 1996).

Overall, movement behavior in trout appears to be extremely plastic and presumably advantageous in a wide variety of environmental situations (Gowan et al. 1994). Movement may be more common in variable or harsh systems and less common in more constant or benign ones such as spring-fed streams or large rivers (Belanger and Rodriguez 2001). Movement is also likely to be more prevalent in interconnected drainages, and restricted in fragmented environments. Northcote (1981) reported that heritable differences in rheotaxis by rainbow trout from populations upstream and downstream of a waterfall were genetically coded, suggesting that these populations had evolved to persist in naturally restricted habitats. Dunham et al.

(1997) found that Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) adopt migratory lifestyles in interconnected drainages, but become sedentary in small, isolated habitats. Likewise, Shepard et al. (1998) found that the proportion of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) movement of 0.3 miles or longer was negatively correlated to the level of isolation experienced by the population. While some fish populations have persisted for extended periods in small habitat patches isolated by natural barriers (Northcote 1992), it is not clear how population losses are aggravated by habitat fragmentation and isolation (Rieman and McIntyre 1995). However, the above studies suggest that trout have at least some ability to adapt their movement behavior to local environmental conditions.

6.0 ANALYSIS

Analysis of habitat data from reaches that were mapped on the ground suggests that barriers do not prohibit access to critical habitat needed for spawning, rearing, and overwintering of salmonids. A review of the available literature on trout movement patterns suggests that migratory behavior is highly variable and partially determined by the physical arrangement of critical habitats. The observed distribution of habitat in the UARP and the Reach Downstream of Chili Bar and information from the available literature suggest that relatively short migrations are necessary to find critical habitat within stream reaches.

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FIGURES

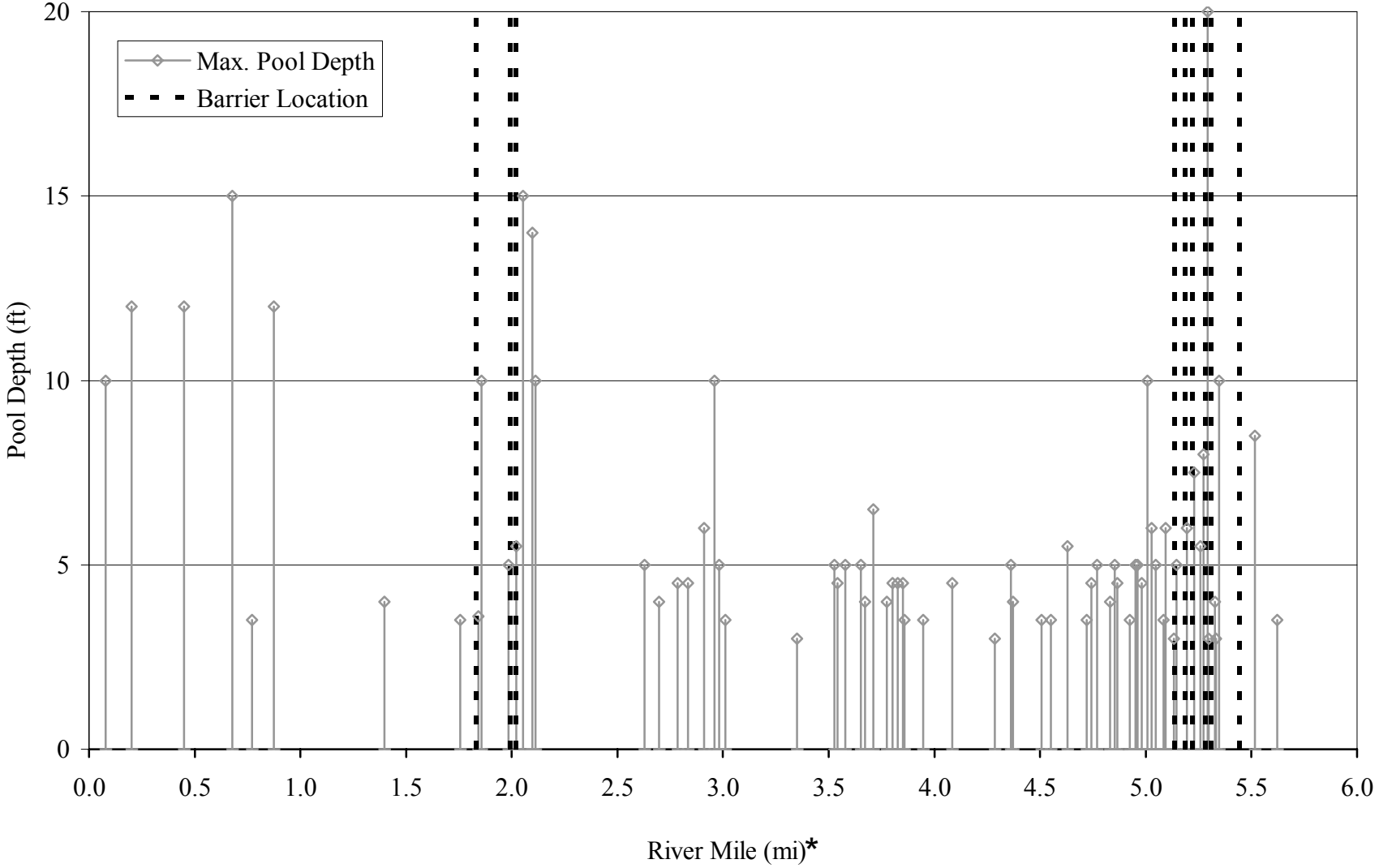


Figure 4.1-1. Location and maximum depth of pools (≥ 3 ft max depth) and barrier locations in Rubicon Dam Reach. *Note that river miles in this reach refer to miles above the lowest extent surveyed in the Rubicon River (1.3 miles below Miller Creek). See section 4.1 for explanation.

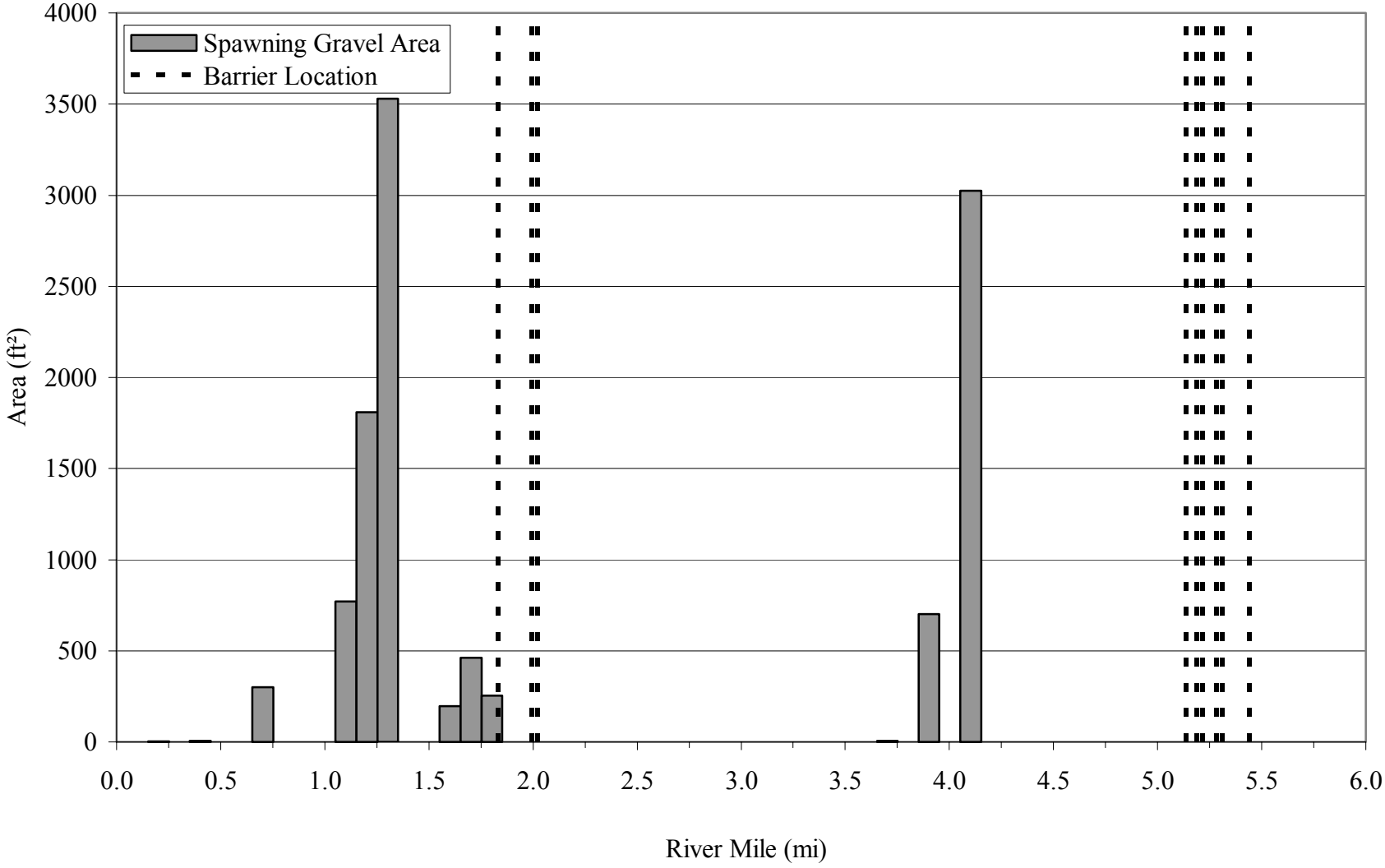


Figure 4.1-2. Distribution of spawning gravel area and barrier locations in Rubicon Dam Reach.

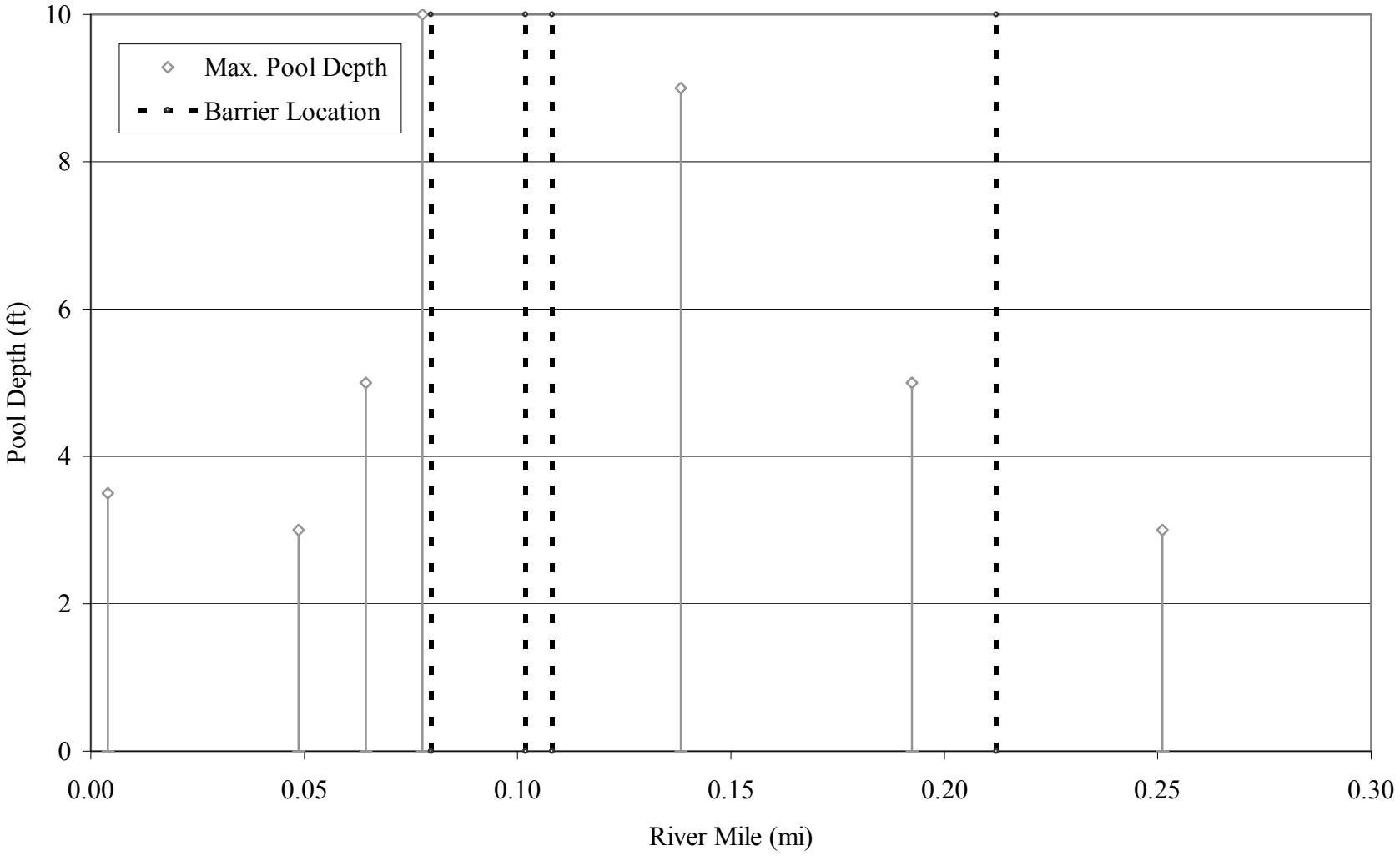


Figure 4.2-1. Location and maximum depth of pools (≥ 3 ft max depth) and barrier locations in Rock Bound Dam Reach.

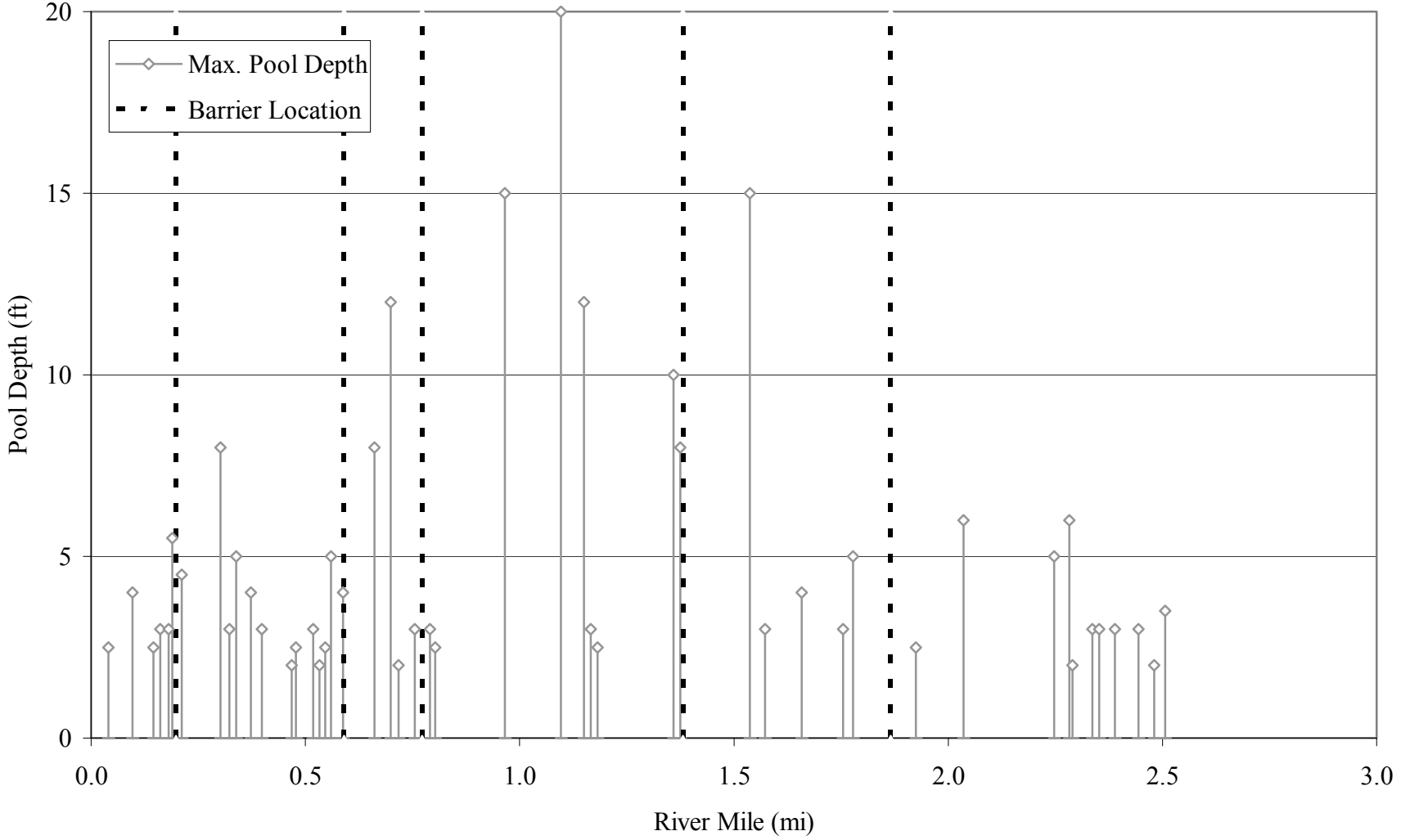


Figure 4.3-1. Location and maximum depth of pools (≥ 3 ft max depth) and barrier locations in Buck Island Dam Reach.

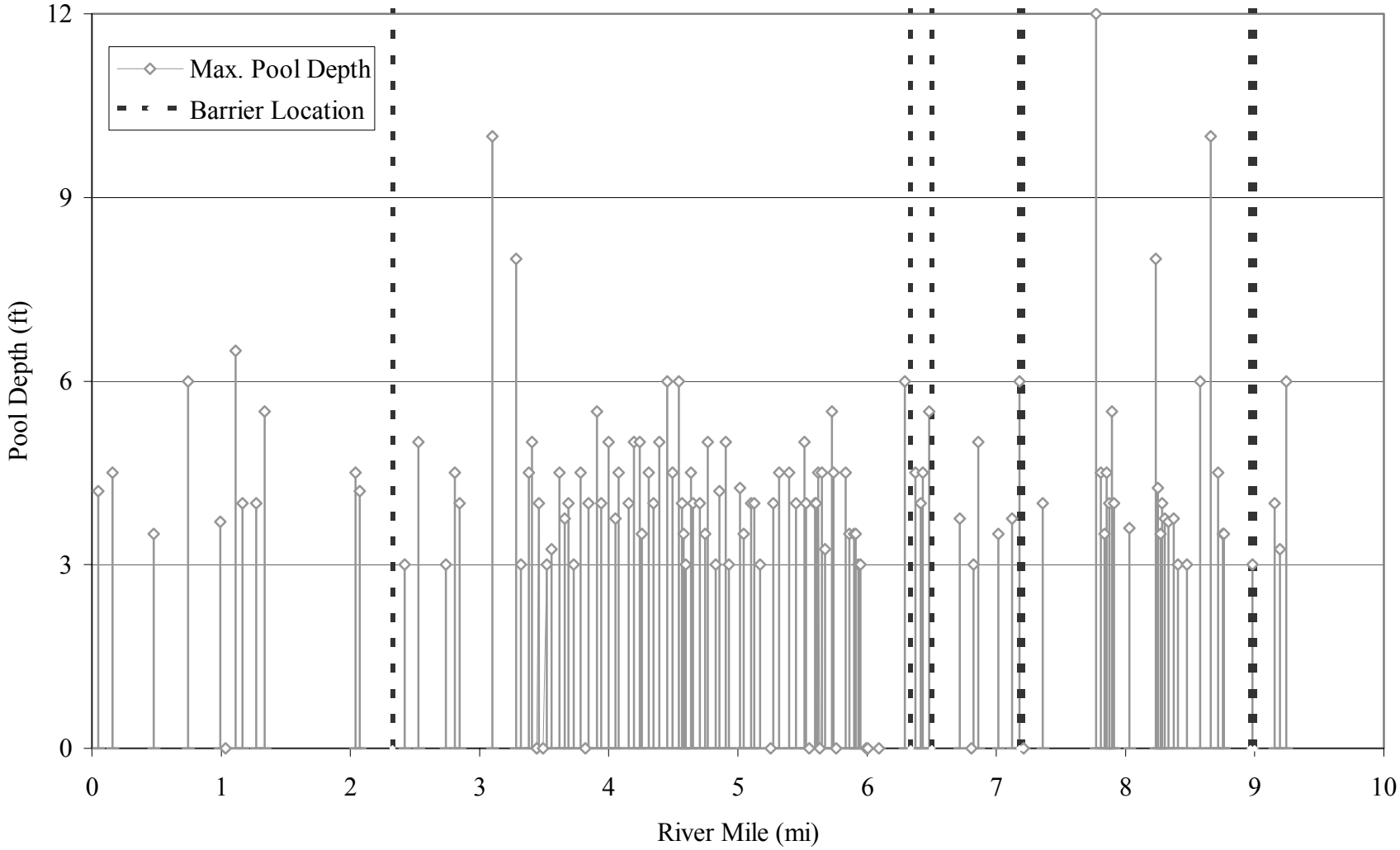


Figure 4.4-1. Location and maximum depth of pools (≥ 3 ft max depth) and barrier locations in Loon Lake Dam Reach.

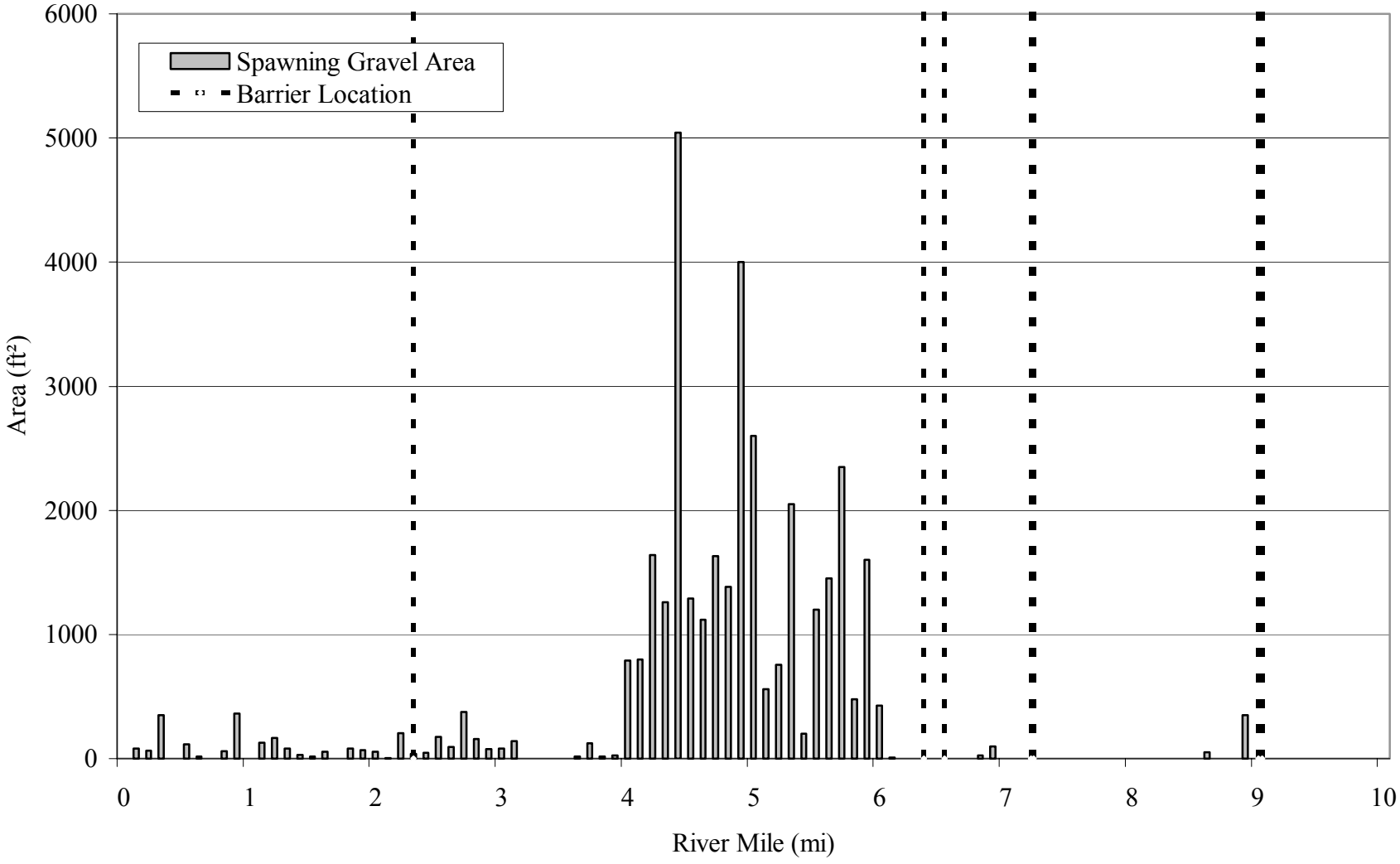


Figure 4.4-2. Distribution of spawning gravel area and barrier locations in Loon Lake Dam Reach.

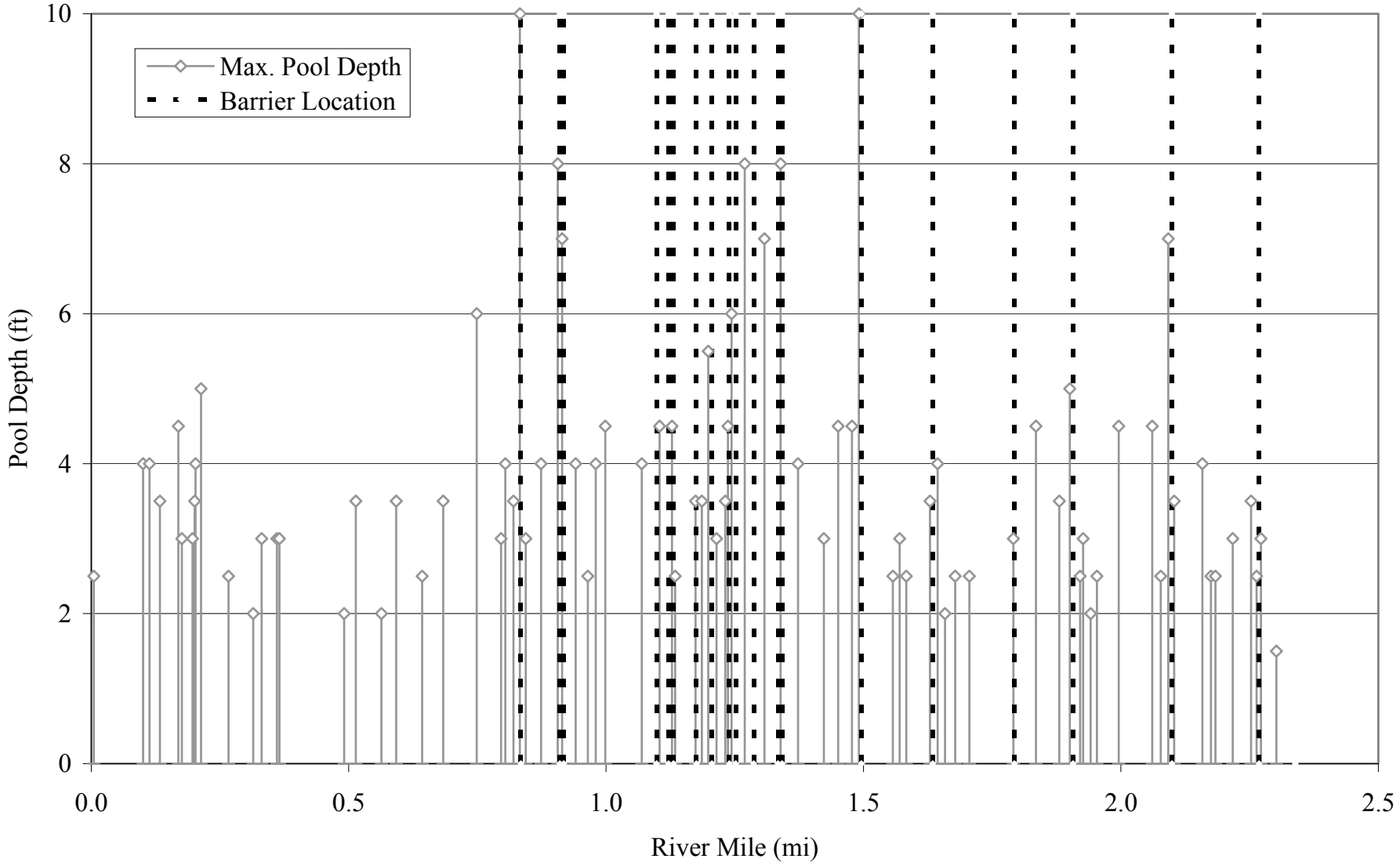


Figure 4.11-1. Location and maximum depth of pools (≥ 3 ft max depth) and barrier locations in Brush Creek Dam Reach.

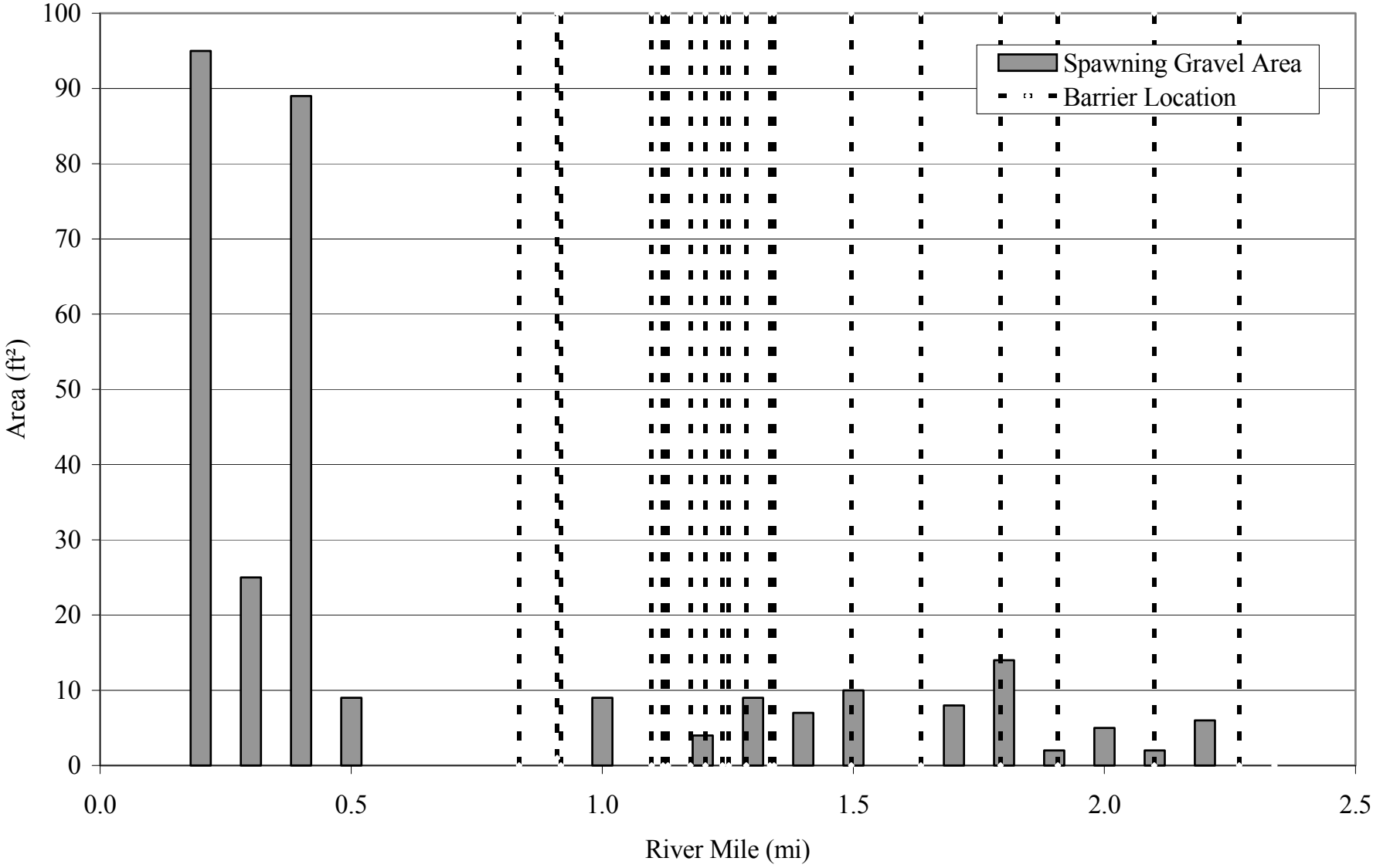


Figure 4.11-2. Distribution of spawning gravel area and barrier locations in Brush Creek Dam Reach.

APPENDIX A

UARP AND CHILI BAR PROJECT AREA MAP

- Map (NE) of the SMUD Upper American River Project.
- Map (SE) of the SMUD Upper American River Project.
- Map (West) of the SMUD Upper American River Project.
- Map (SW) of the SMUD Upper American River Project.

APPENDIX B

FISH PASSAGE BARRIER STUDY LOCATIONS MAPS

- Figure B-1 Fish migration barriers: Rockbound Dam Reach (Highland Creek), Rubicon River Dam Reach (Rubicon River), and upper Buck Island Dam Reach (Little Rubicon River). Buck Island Dam Reach is continued on Figure B-2. Rockbound Valley Quad.
- Figure B-2 Fish migration barriers: Buck Island Dam Reach (Little Rubicon River) and lower Rubicon Reservoir Dam Reach (Rubicon River). Rubicon Dam Reach is continued on Figure B-1. Homewood Quad and Wentworth Springs Quad.
- Figure B-3 Fish migration barriers: lower Loon Lake Dam Reach, Gerle Creek. Wenworth Springs Quad and Bunker Hill Quad.
- Figure B-4 Fish migration barriers: upper Loon Lake Dam Reach, Gerle Creek. Wentworth Springs Quad and Loon Lake Quad.
- Figure B-5 Fish migration barriers: Robbs Peak Dam Reach, South Fork Rubicon River. Robbs Peak Quad.
- Figure B-6 Fish migration barriers: Junction Dam Reach, Silver Creek. Pollock Pines Quad.
- Figure B-7 Fish migration barriers: Camino Dam Reach, Silver Creek. Pollock Pines Quad.
- Figure B-8 Fish migration barriers: Brush Creek Dam Reach, Brush Creek and South Fork American River Reach. Slate Mountain Quad.

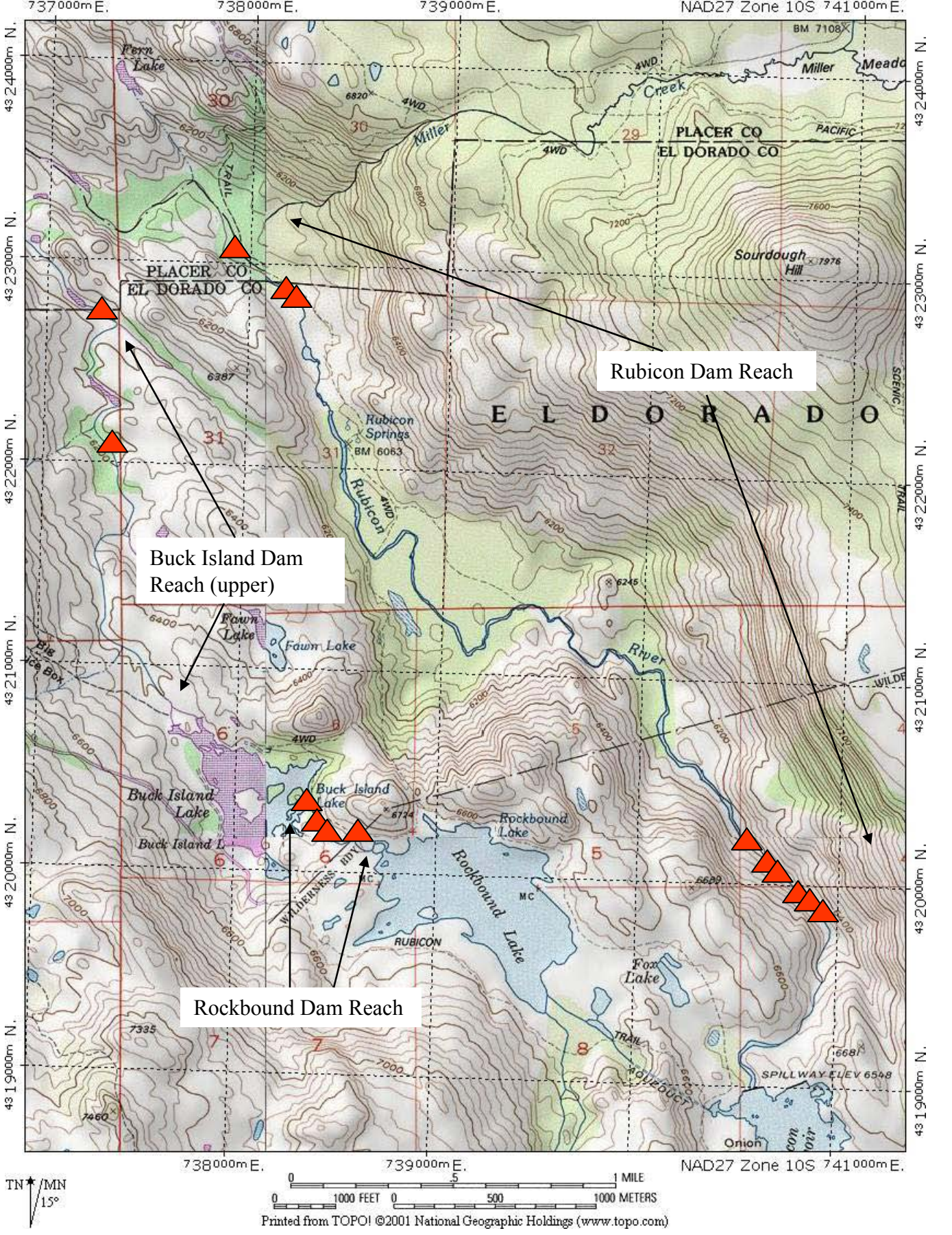


Figure B-1. Fish migration barriers: Rockbound Dam Reach (Highland Creek), Rubicon River Dam Reach (Rubicon River), and upper Buck Island Dam Reach (Little Rubicon River). Buck Island Dam Reach is continued on Figure B-2. Rockbound Valley Quad.

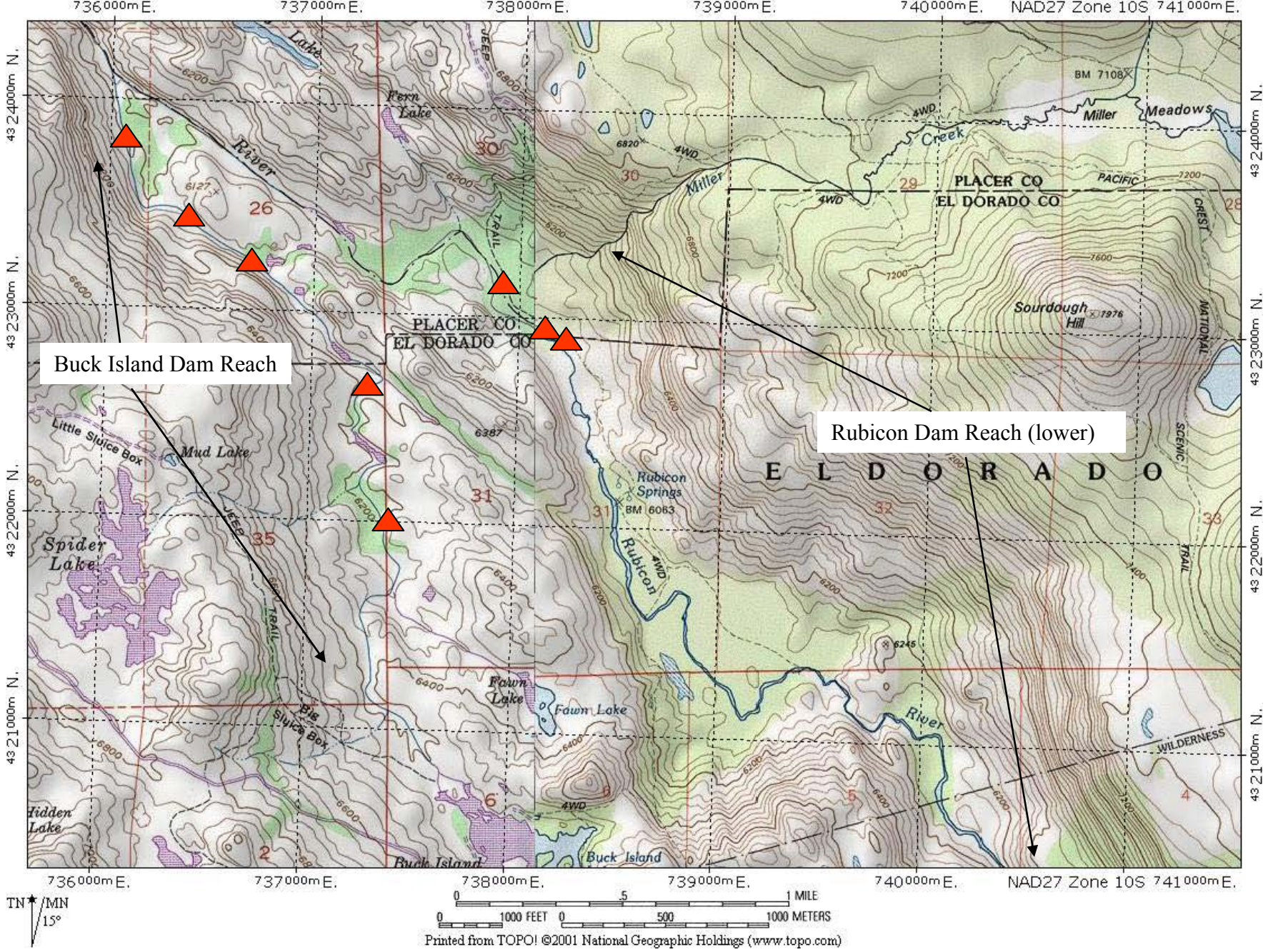


Figure B-2. Fish migration barriers: Buck Island Dam Reach (Little Rubicon River) and lower Rubicon Reservoir Dam Reach (Rubicon River). Rubicon Dam Reach is continued on Figure B-1. Homewood Quad and Wentworth Springs Quad.

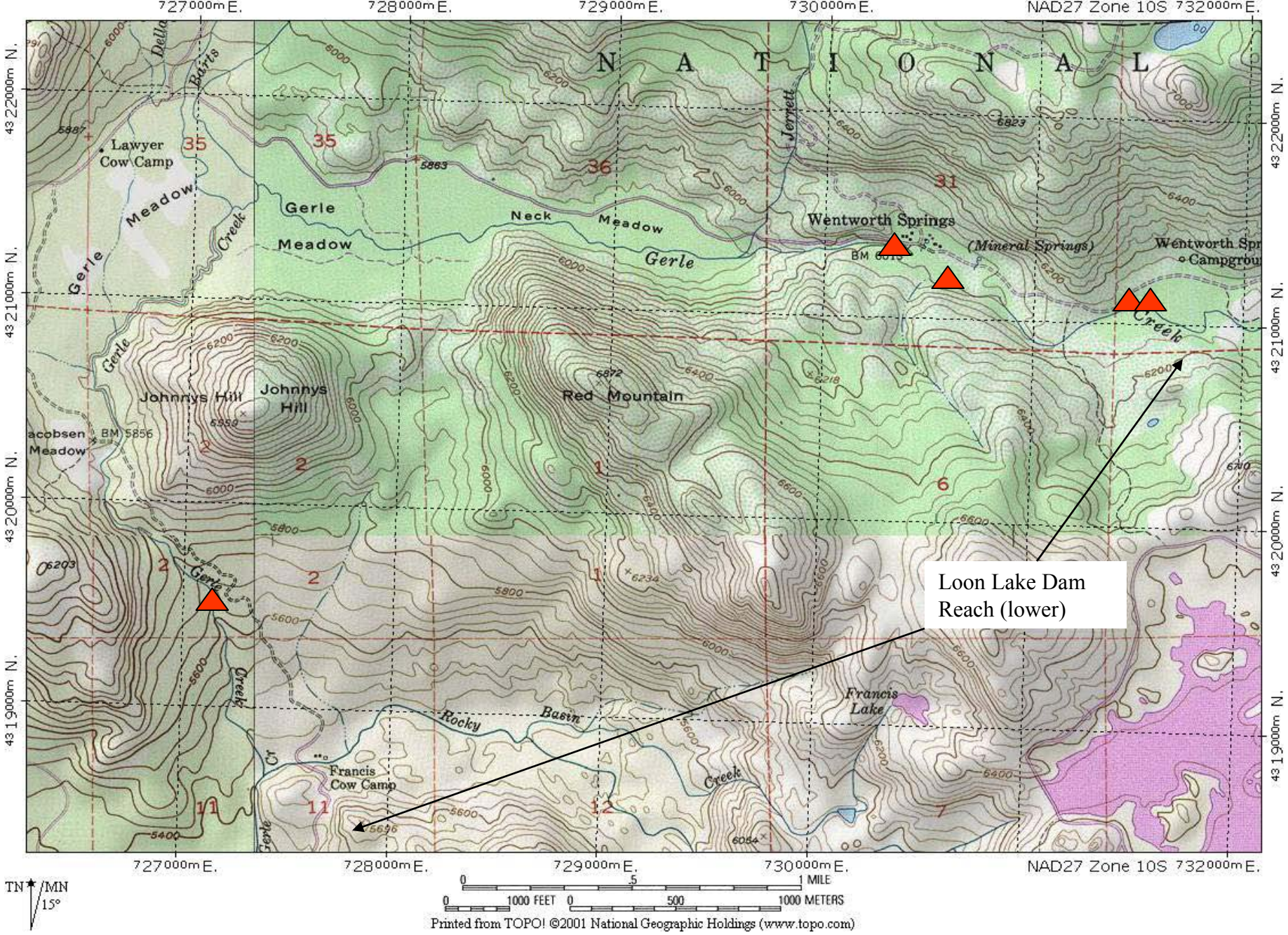


Figure B-3. Fish migration barriers: lower Loon Lake Dam Reach, Gerle Creek. Wenworth Springs Quad and Bunker Hill Quad.

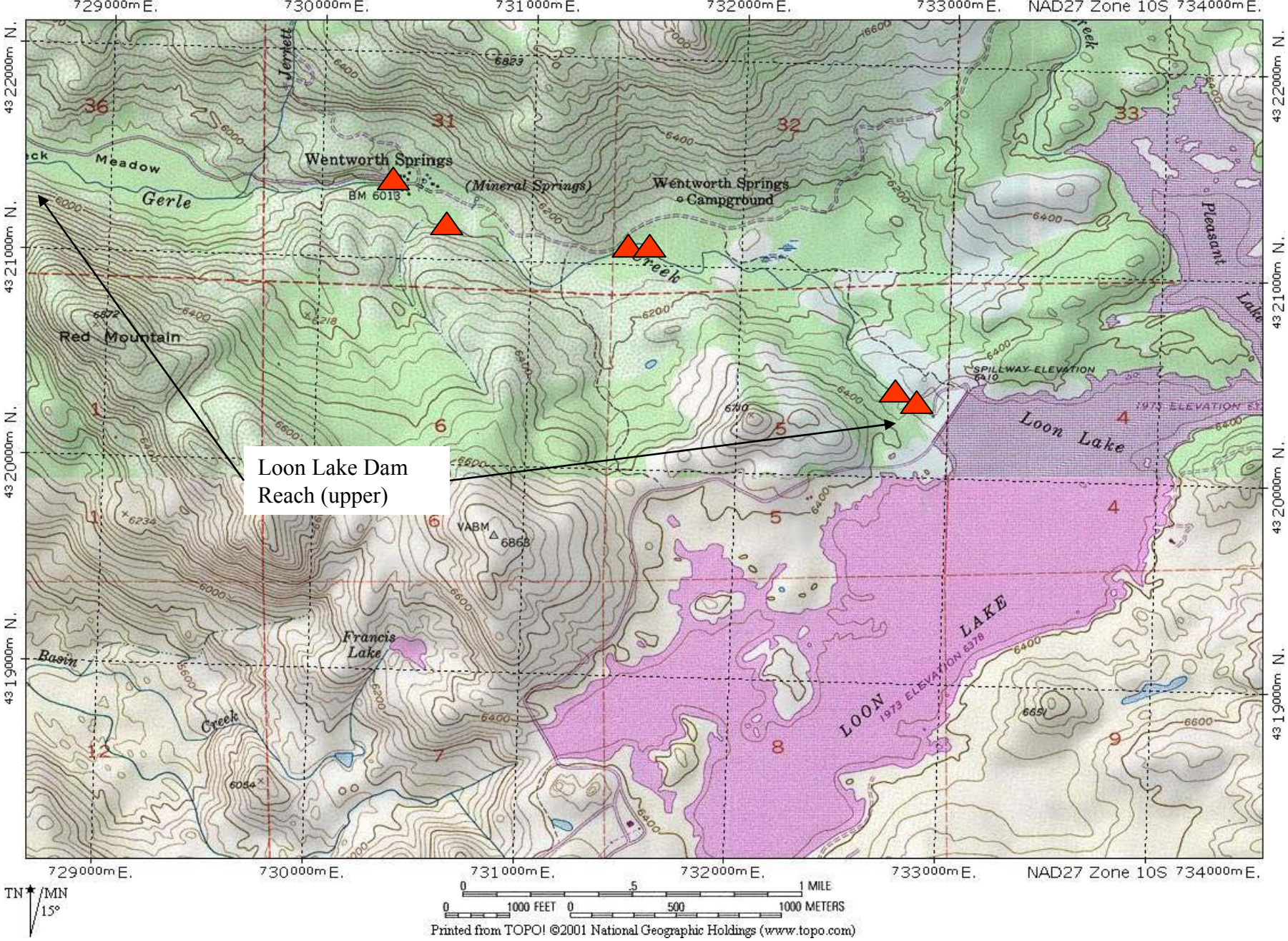


Figure B-4. Fish migration barriers: upper Loon Lake Dam Reach, Gerle Creek. Wentworth Springs Quad and Loon Lake Quad.

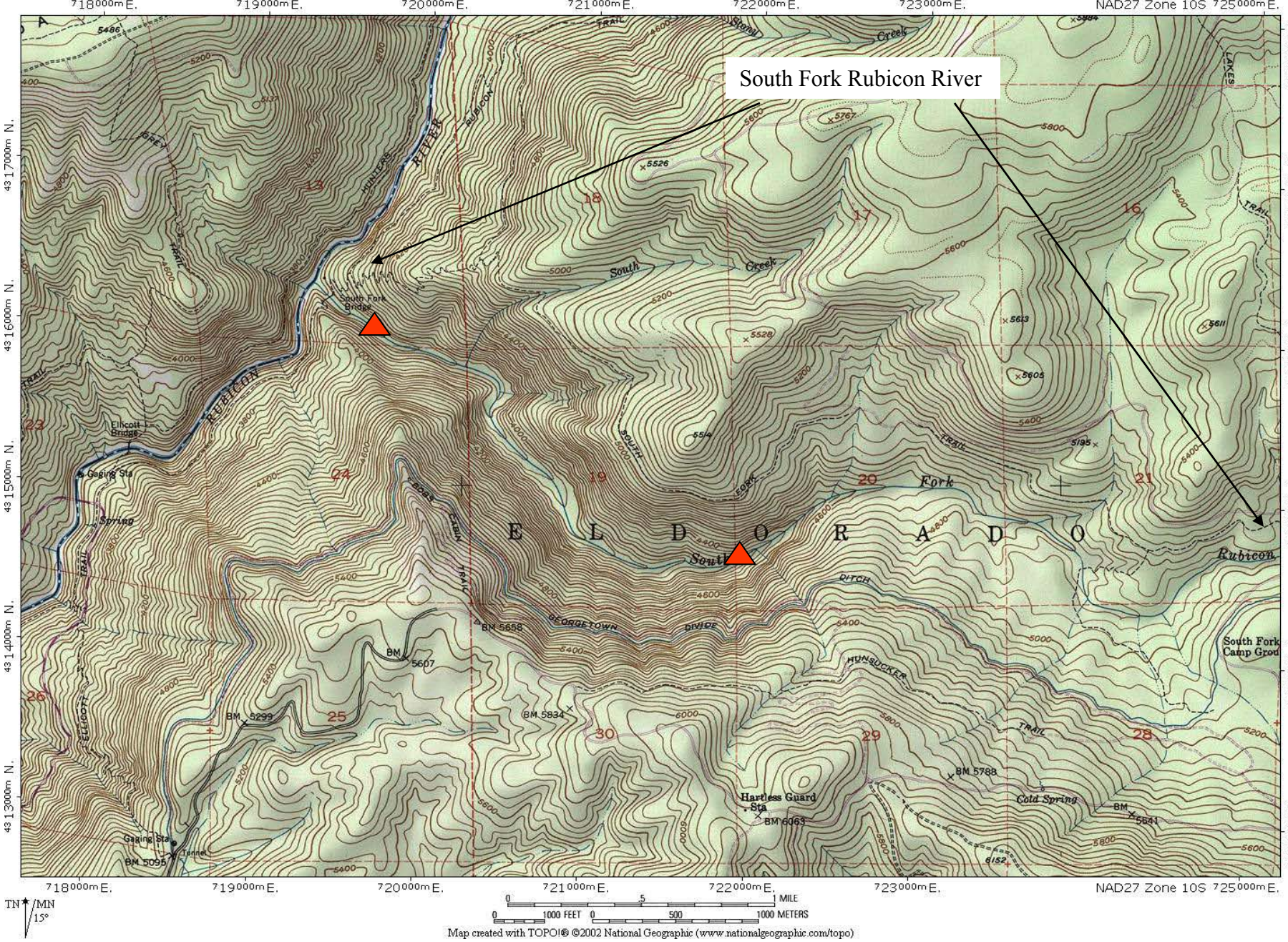


Figure B-5. Fish migration barriers: Robbs Peak Dam Reach, South Fork Rubicon River. Robbs Peak Quad.

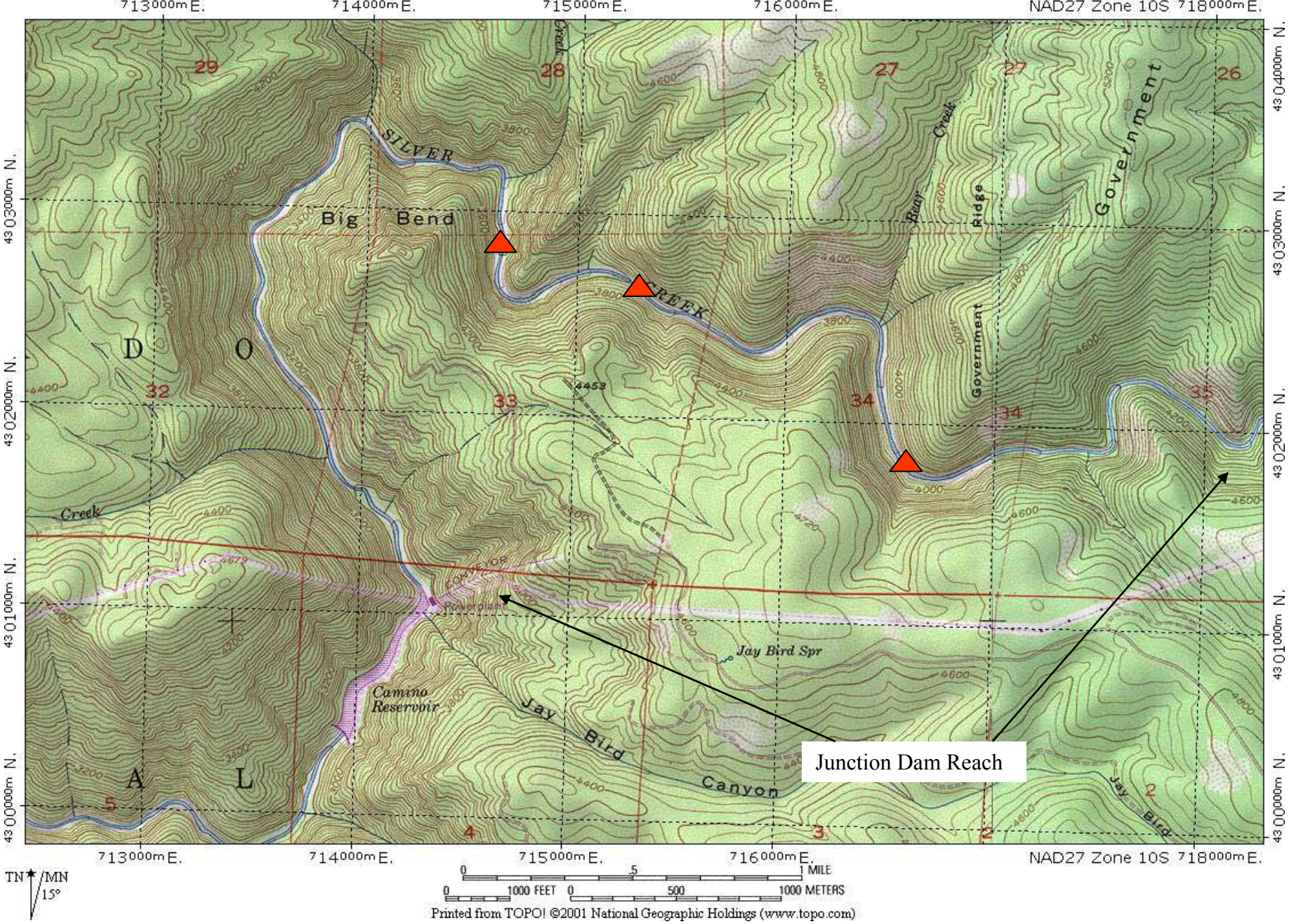


Figure B-6. Fish migration barriers: Junction Dam Reach, Silver Creek. Pollock Pines Quad.

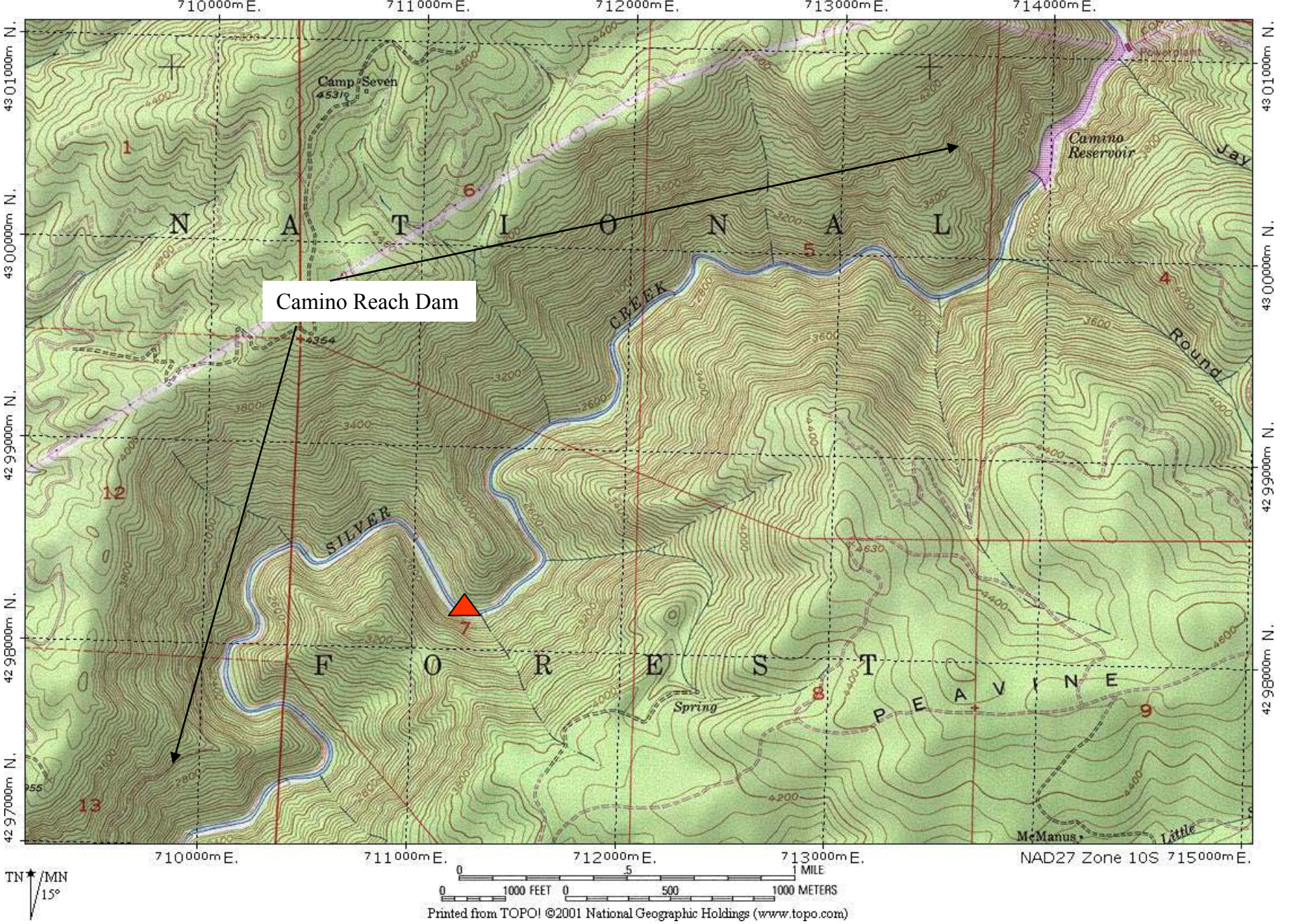


Figure B-7. Fish migration barriers: Camino Dam Reach, Silver Creek. Pollock Pines Quad.

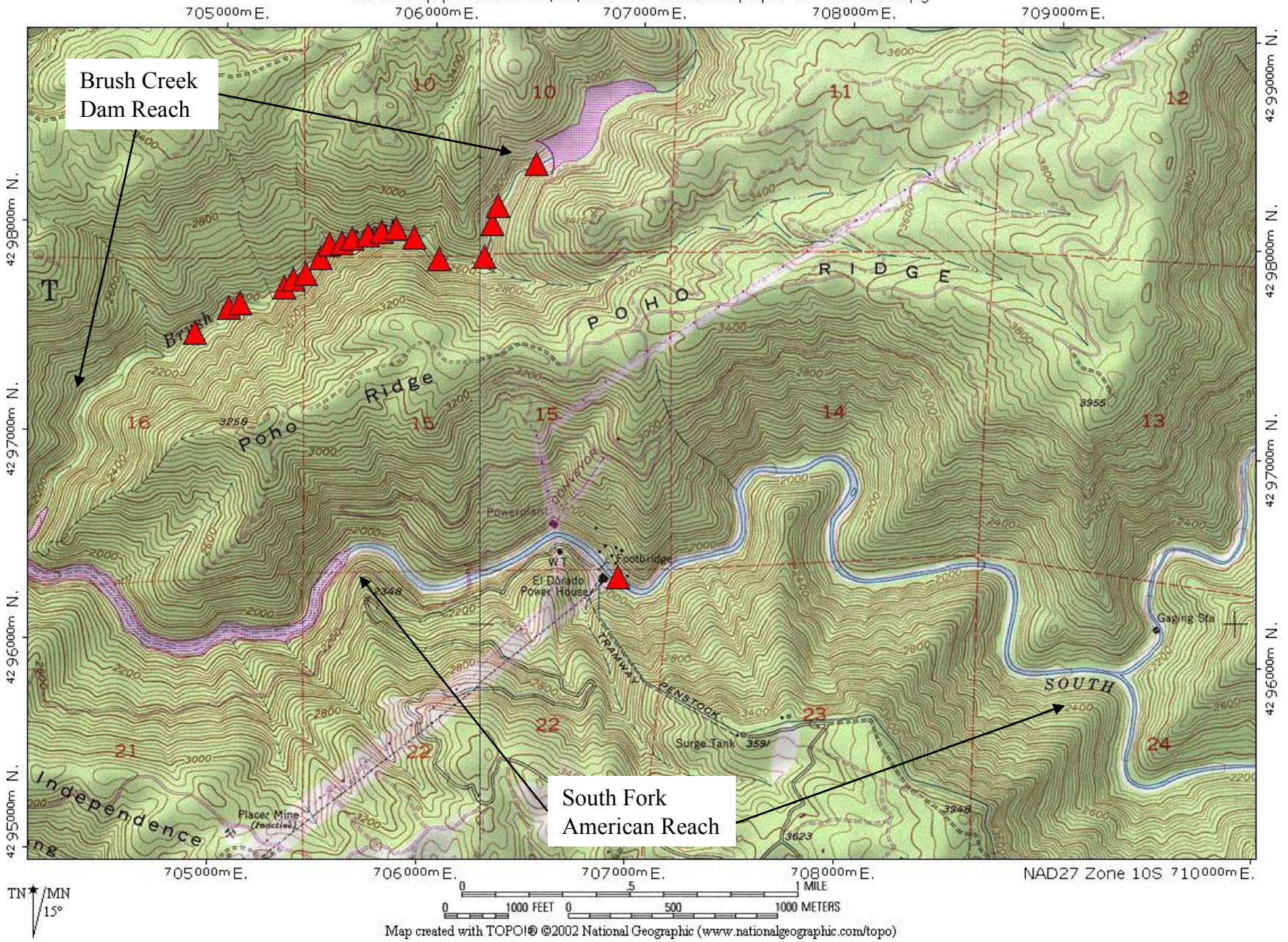


Figure B-8. Fish migration barriers: Brush Creek Dam Reach, Brush Creek and South Fork American River Reach. Slate Mountain Quad.

APPENDIX C

FISH PASSAGE BARRIER LOCATIONS

Table C-1. Fish passage barrier type (C= complete, S=seasonal) and location by river mile and UTM (NAD 27), excluding project dams.

Reach	Barrier Type	River Mile	UTM
Rubicon Dam	C	1.83	N4322729, 10s0738263
Rubicon Dam	C	1.99	N4322889, 10s0738170
Rubicon Dam	C	2.02	N4322852, 10s0738209
Rubicon Dam	C	5.14	N4320299, 10s0740468
Rubicon Dam	C	5.19	N4320220, 10s0740541
Rubicon Dam	C	5.22	N4320220, 10s0740541
Rubicon Dam	C	5.28	N4320215, 10s0740563
Rubicon Dam	C	5.31	N4320130, 10s0740541
Rubicon Dam	C	5.44	N4320299, 10s0740468
Rubicon Dam	S	1.86	N4322672, 10s0738255
Rubicon Dam	S	3.62	NA
Rubicon Dam	S	3.65	N4321252, 10s0739609
Rubicon Dam	S	4.70	NA
Rubicon Dam	S	5.08	NA
Rubicon Dam	S	5.13	NA
Rockbound Dam	C	0.08	N4320293, 10s0738392
Rockbound Dam	C	0.10	N4320208, 10s0738449
Rockbound Dam	C	0.11	N4320187, 10s0738471
Rockbound Dam	C	0.21	N4320164, 10s0738596
Rockbound Dam	S	0.00	NA
Rockbound Dam	S	0.10	NA
Buck Island Dam	C	0.20	N4323776, 10s0736082
Buck Island Dam	C	0.59	N4323391, 10s0736435
Buck Island Dam	C	0.77	N4323247, 10s0736694
Buck Island Dam	C	1.38	N4322640, 10s0737265
Buck Island Dam	C	1.87	N4321992, 10s0737355
Buck Island Dam	S	0.42	NA
Buck Island Dam	S	0.82	NA
Buck Island Dam	S	1.67	NA
Loon Lake	C	2.33	N4319425, 10s0727131
Loon Lake	C	6.34	N4321342, 10s0729711
Loon Lake	C	6.50	N4321160, 10s0730501
Loon Lake	C	7.18	N4321008, 10s0730895
Loon Lake	C	7.20	N4321008, 10s0730895
Loon Lake	C	8.90	N4320704, 10s0730542
Loon Lake	C	9.00	N4320378, 10s0736082
Loon Lake	S	0.87	N4317922, 10s0726572
Loon Lake	S	5.05	N4321300, 10s0727964
Loon Lake	S	0.27	N4317305, 10s0726176
Robs Peak Dam	C	0.30	N4316335, 10s0719406
Robs Peak Dam	C	2.20	N4315951, 10s0719710
Robs Peak Dam	S	4.20	N4314913, 10s0724886
Ice House Dam	S	3.76	NA

Table C-1 (continued). Fish passage barrier type (C= complete, S=seasonal) and location by river mile and UTM (NAD 27), excluding project dams.

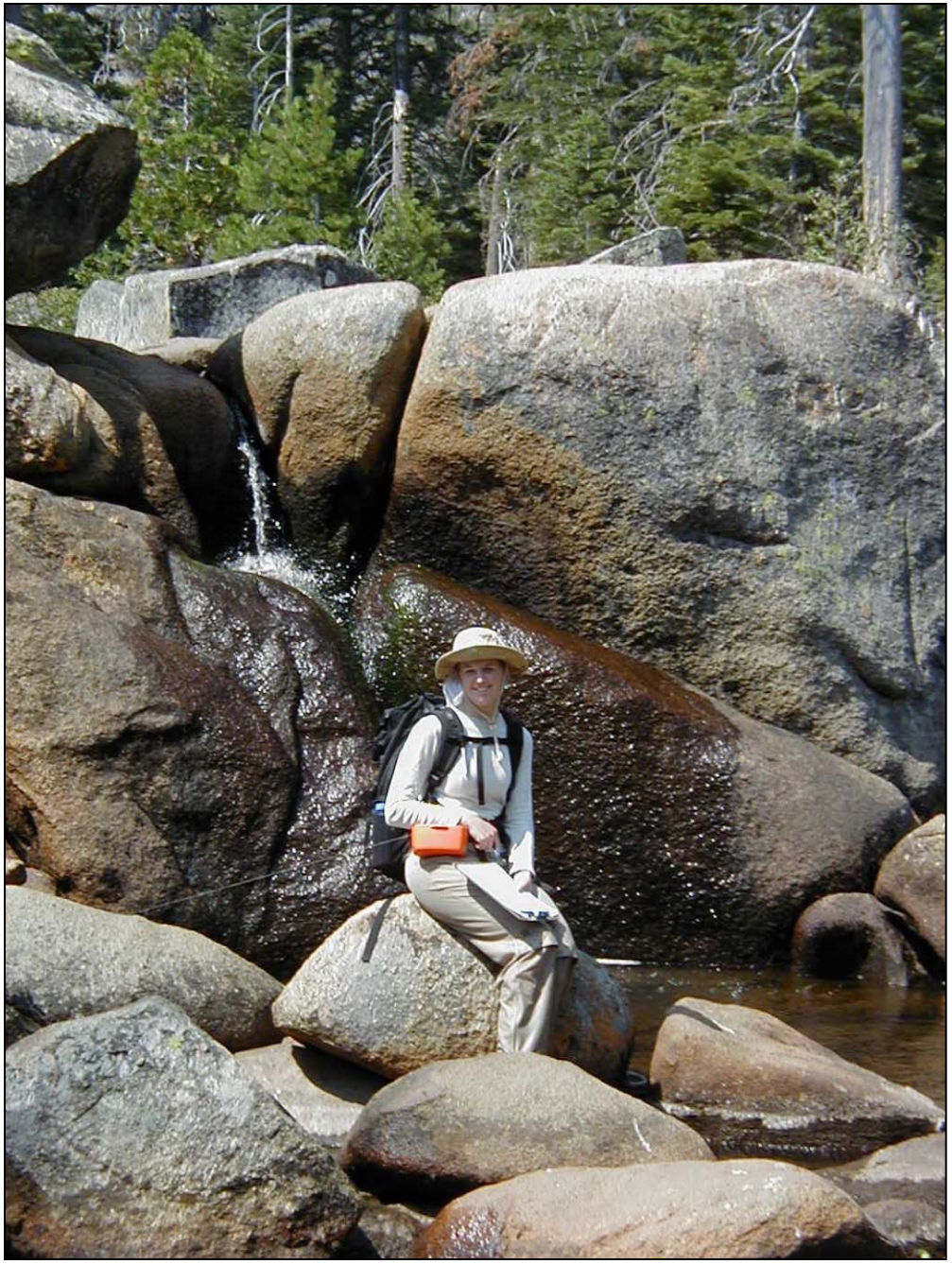
Ice House Dam	S	10.05	N4299046, 10s0726885
Ice House Dam	S	11.72	NA
Ice House Dam	S	11.86	NA
Junction Dam	C	2.80	N4302986, 10s0714528
Junction Dam	C	3.20	N4302901, 10s0714951
Junction Dam	C	4.20	N4302683, 10s0716340
Junction Dam	S	4.70	N4301988, 10s0716480
Camino Dam	C	3.30	N4298175, 10s0711303
SF American River	C	0.80	N4296493, 10s0706771
Brush Creek Dam	C	0.83	N4297525, 10s0704944
Brush Creek Dam	C	0.91	N4297375, 10s0704794
Brush Creek Dam	C	0.92	N4297593, 10s0705056
Brush Creek Dam	C	1.10	N4297663, 10s705244
Brush Creek Dam	C	1.12	N4299749, 10s0705308
Brush Creek Dam	C	1.13	N4297702, 10s0705276
Brush Creek Dam	C	1.18	N4297747, 10s0705367
Brush Creek Dam	C	1.21	N4297792, 10s0705409
Brush Creek Dam	C	1.24	N4297835, 10s0705413
Brush Creek Dam	C	1.25	N4297846, 10s0705418
Brush Creek Dam	C	1.29	N4297870, 10s0705499
Brush Creek Dam	C	1.33	N4297909, 10s0705541
Brush Creek Dam	C	1.34	N4297909, 10s0705552
Brush Creek Dam	C	1.50	N4297980, 10s0705762
Brush Creek Dam	C	1.63	N4297937, 10s0705979
Brush Creek Dam	C	1.79	N4297861, 10s0706193
Brush Creek Dam	C	1.91	N4297999, 10s0706281
Brush Creek Dam	C	2.10	N4298278, 10s0706388
Brush Creek Dam	C	2.27	N4298370, 10s0706575
Brush Creek Dam	S	0.03	NA
Brush Creek Dam	S	0.10	NA
Brush Creek Dam	S	0.11	NA
Brush Creek Dam	S	0.20	NA
Brush Creek Dam	S	0.59	NA
Brush Creek Dam	S	1.38	NA
Brush Creek Dam	S	2.17	NA
Brush Creek Dam	S	2.30	NA

APPENDIX D

UARP AND CHILI BAR PROJECT
BARRIER PHOTO DOCUMENTATION

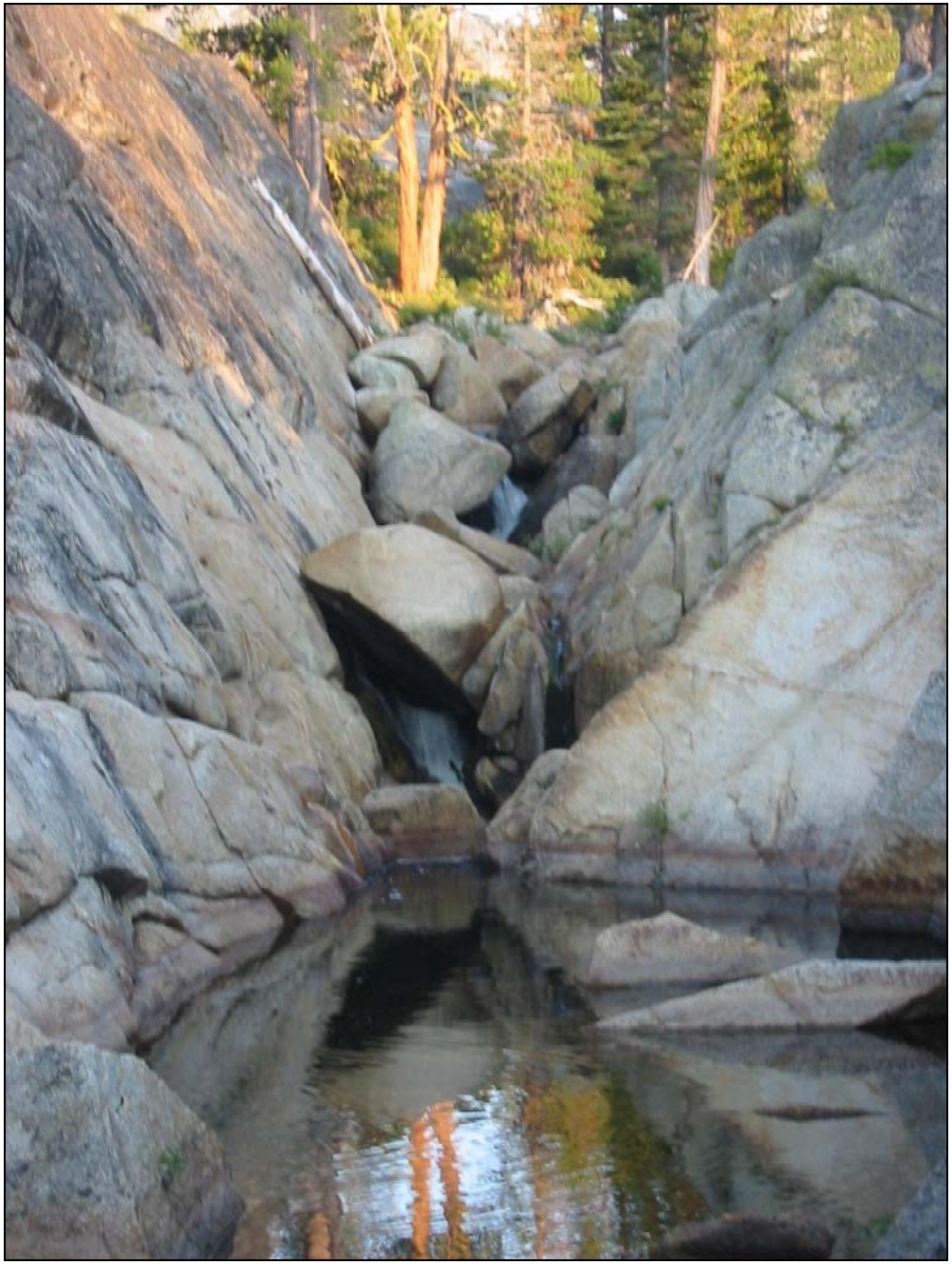
- Rubicon Dam Reach
- Loon Lake Reach
- Robbs Peak Dam Reach
- Ice House Dam Reach
- Junction Dam Reach
- Camino Dam Reach
- South Fork American River Reach
- Brush Creek Dam Reach

Rubicon Dam Reach – river mile 1.83

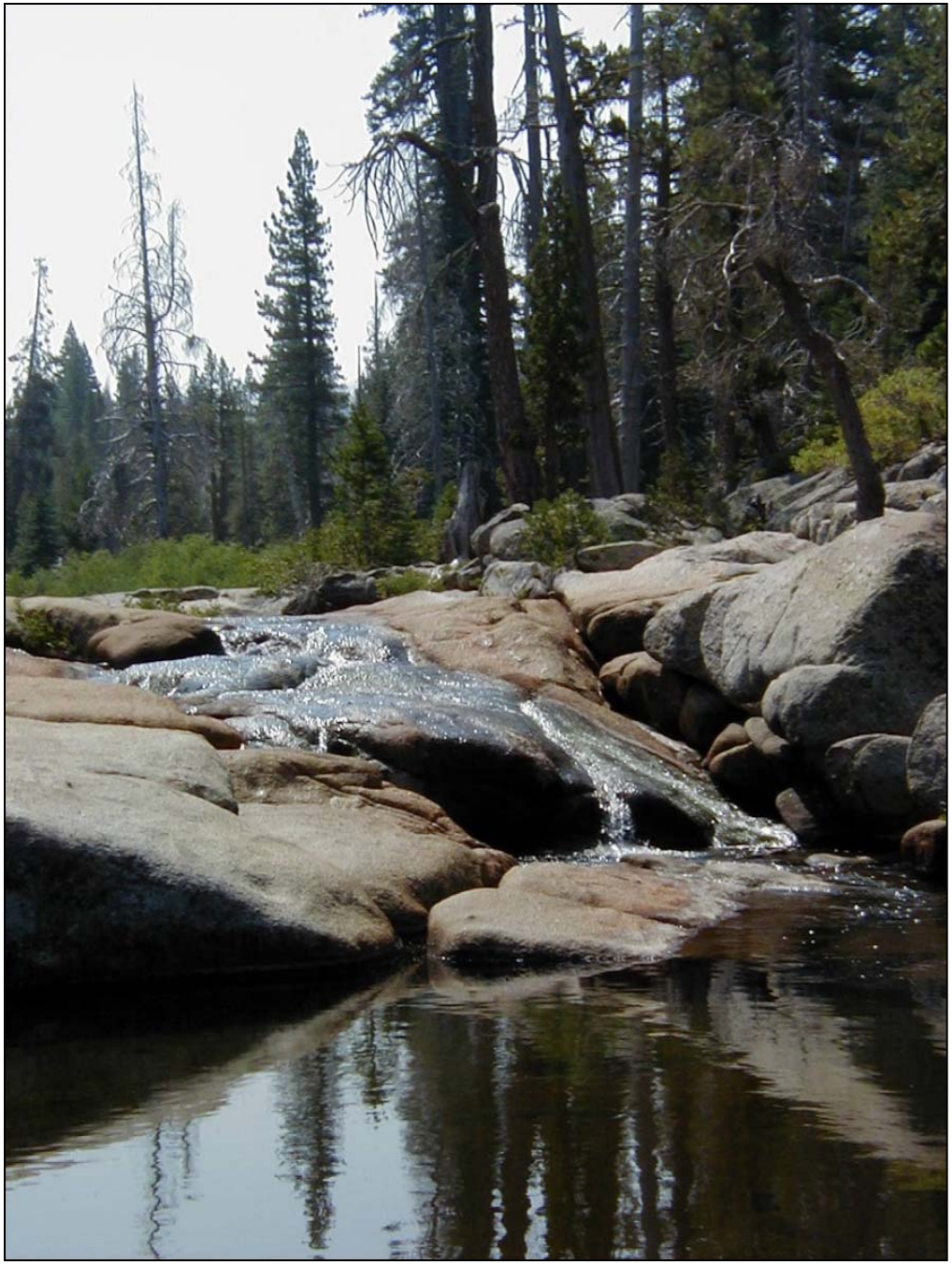


Rubicon Dam Reach
– river mile 1.83

Rubicon Dam
Reach – river mile
5.14



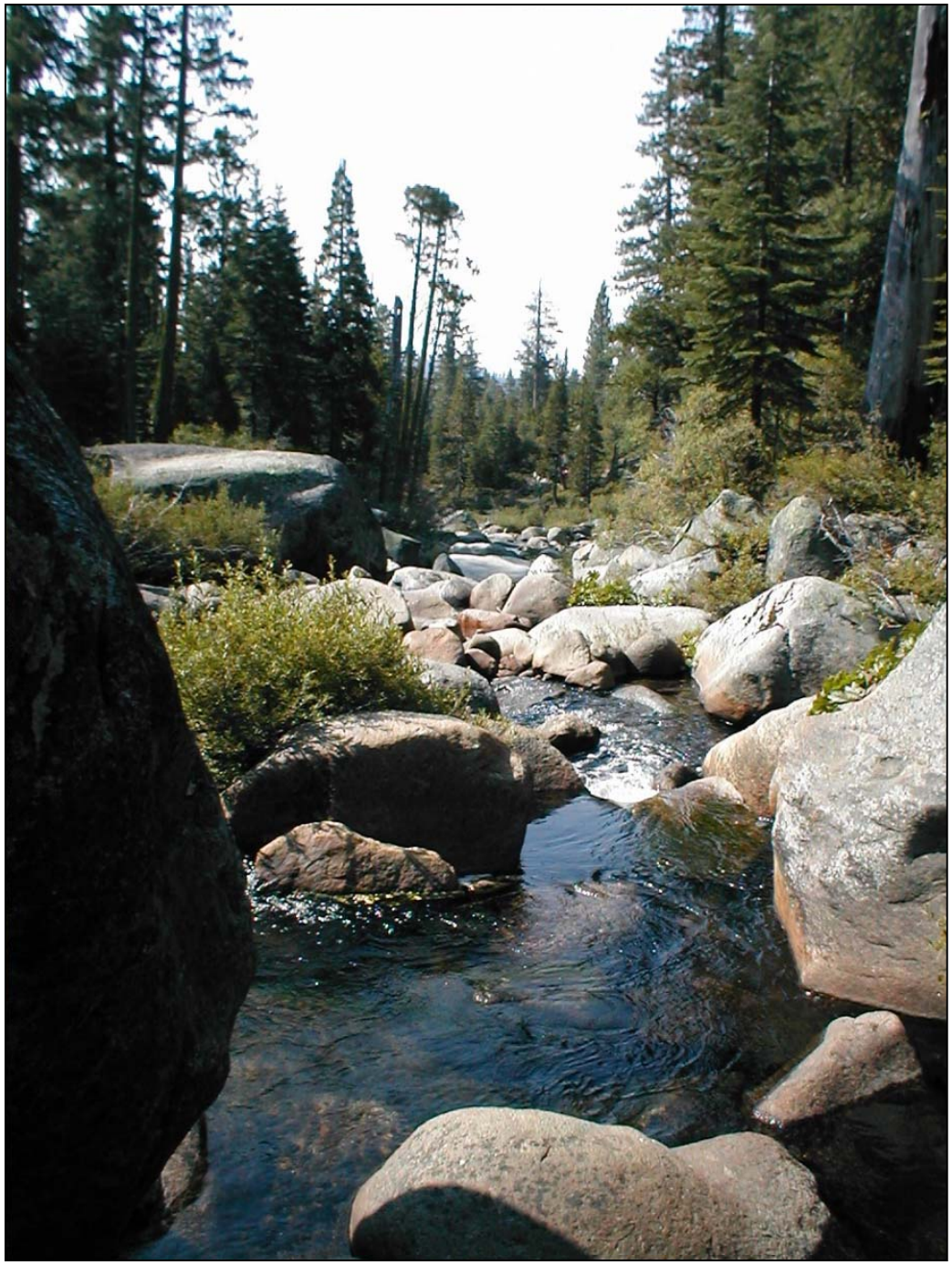
Rubicon Dam Reach – river mile 5.14



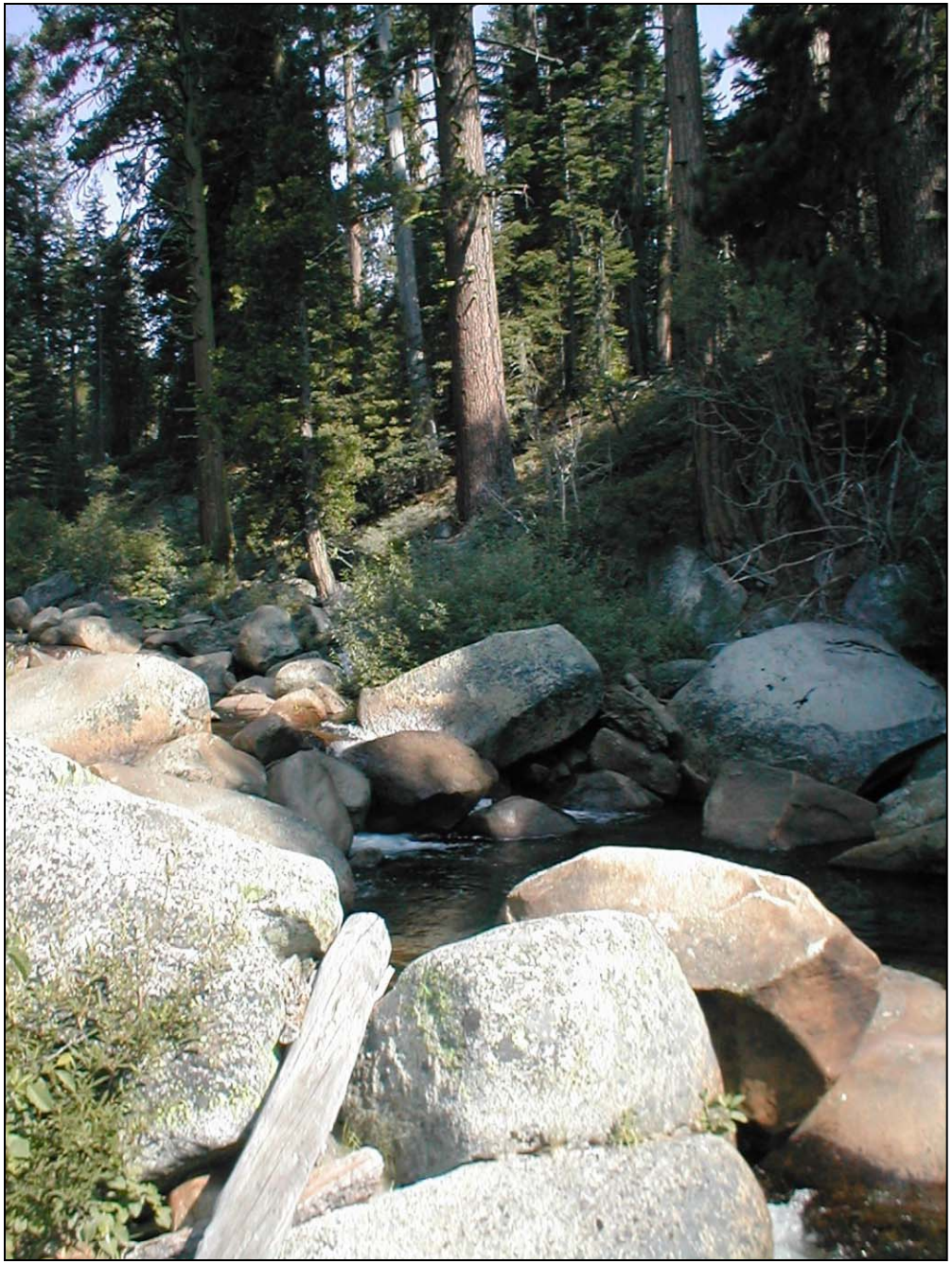
Rubicon Dam Reach – river mile 1.86

Loon Lake Reach – river mile 2.33

Loon Lake Reach – river mile 2.33



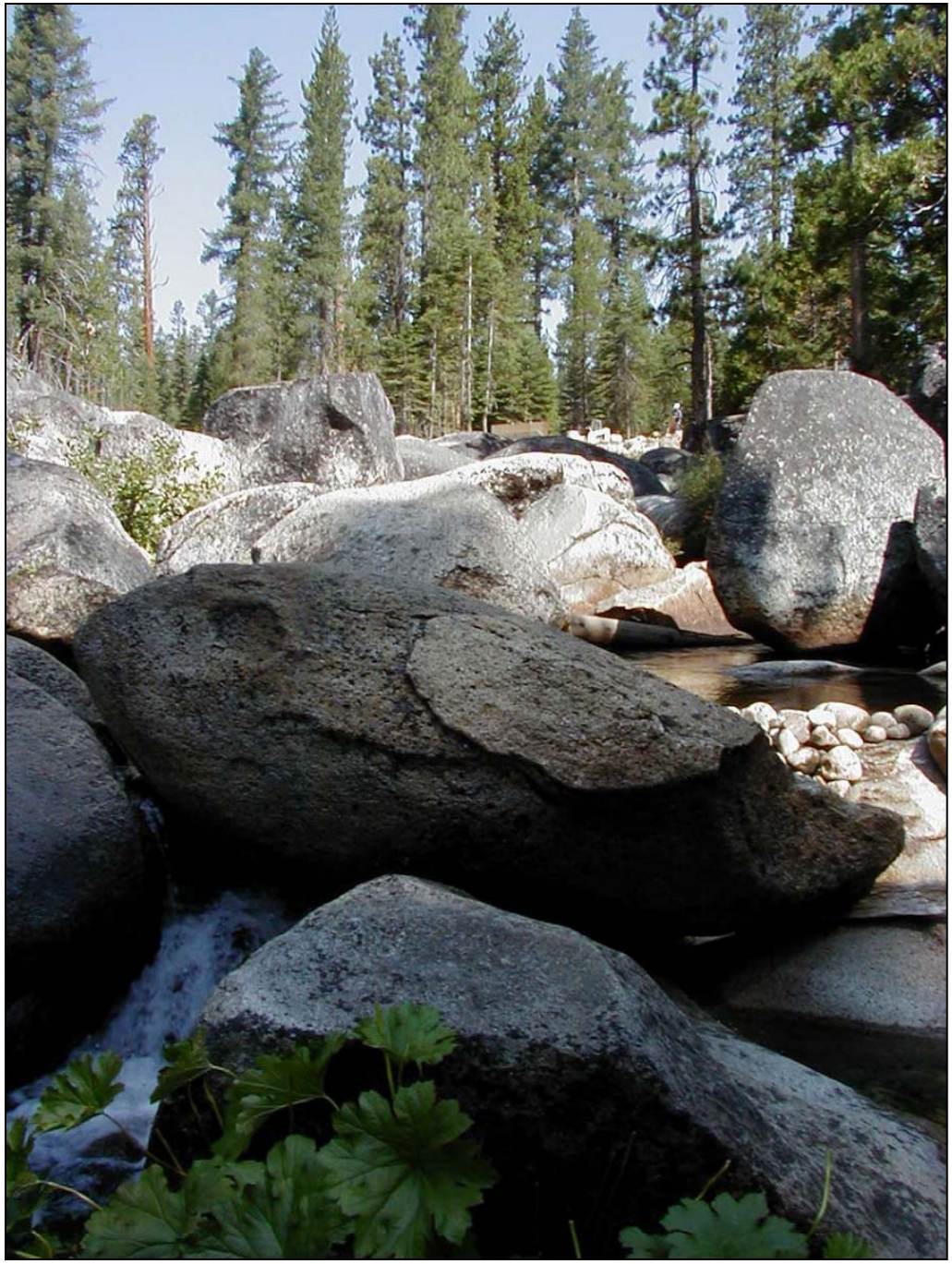
Loon Lake Reach – river mile 9.00



Loon Lake Reach
– river mile 9.00

Loon Lake Reach – river mile 0.87

Loon Lake Reach – river mile 0.87



Loon Lake Reach – river mile 0.27

Loon Lake Reach – river mile 0.27

Robbs Peak Dam Reach – river mile 0.30

Robbs Peak Dam Reach – river mile 2.20

Robbs Peak Dam Reach – river mile 4.20

Ice House Dam Reach – river mile 10.05

Ice House Dam Reach – river mile 11.86

Junction Dam Reach – river mile 2.80

Junction Dam Reach – river mile 3.20

Junction Dam Reach – river mile 3.20

Junction Dam Reach – river mile 4.20

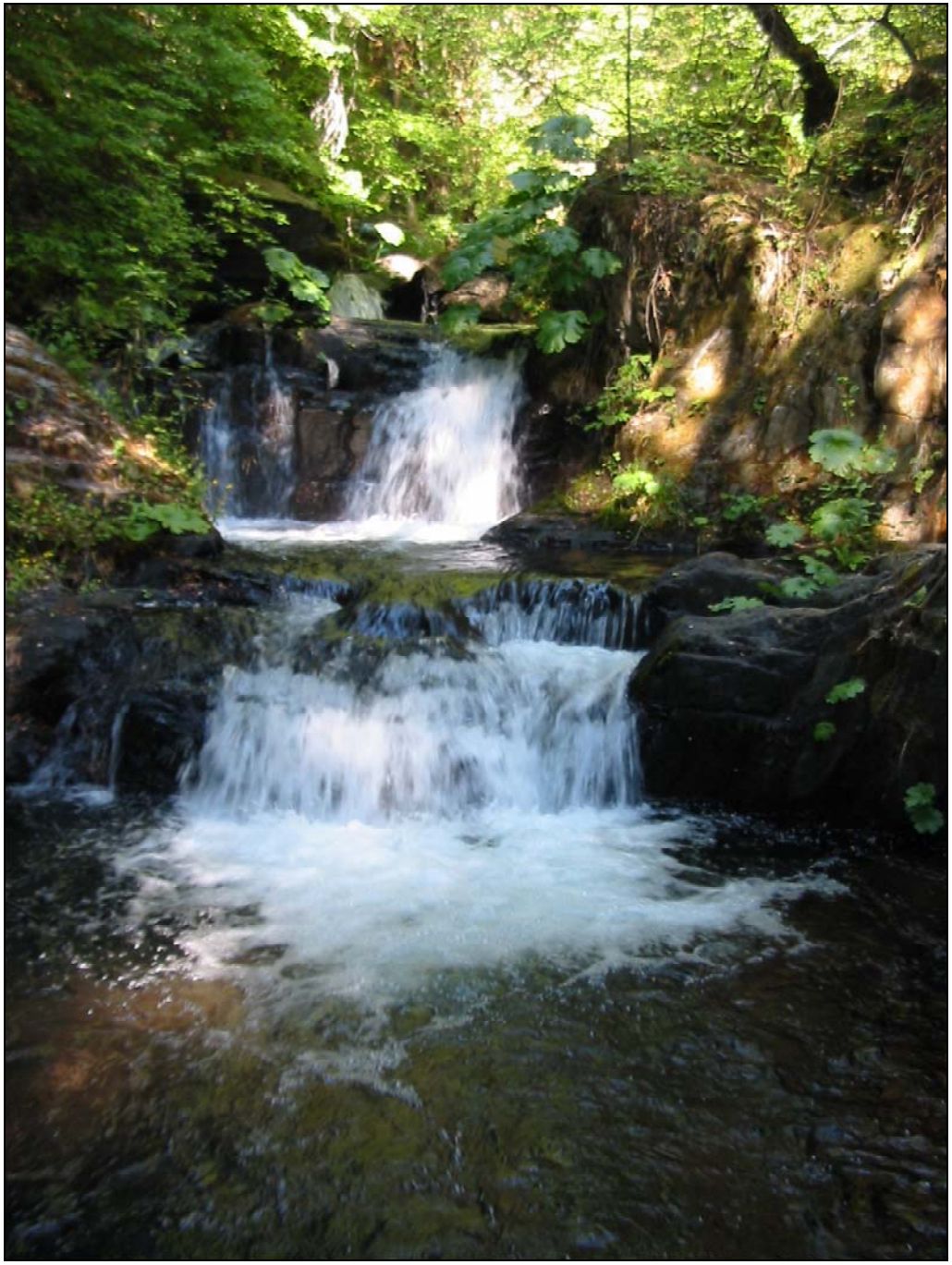
Junction Dam Reach – river mile 4.70

Camino Dam Reach – river mile 3.30

South Fork American River Reach – river mile 0.80

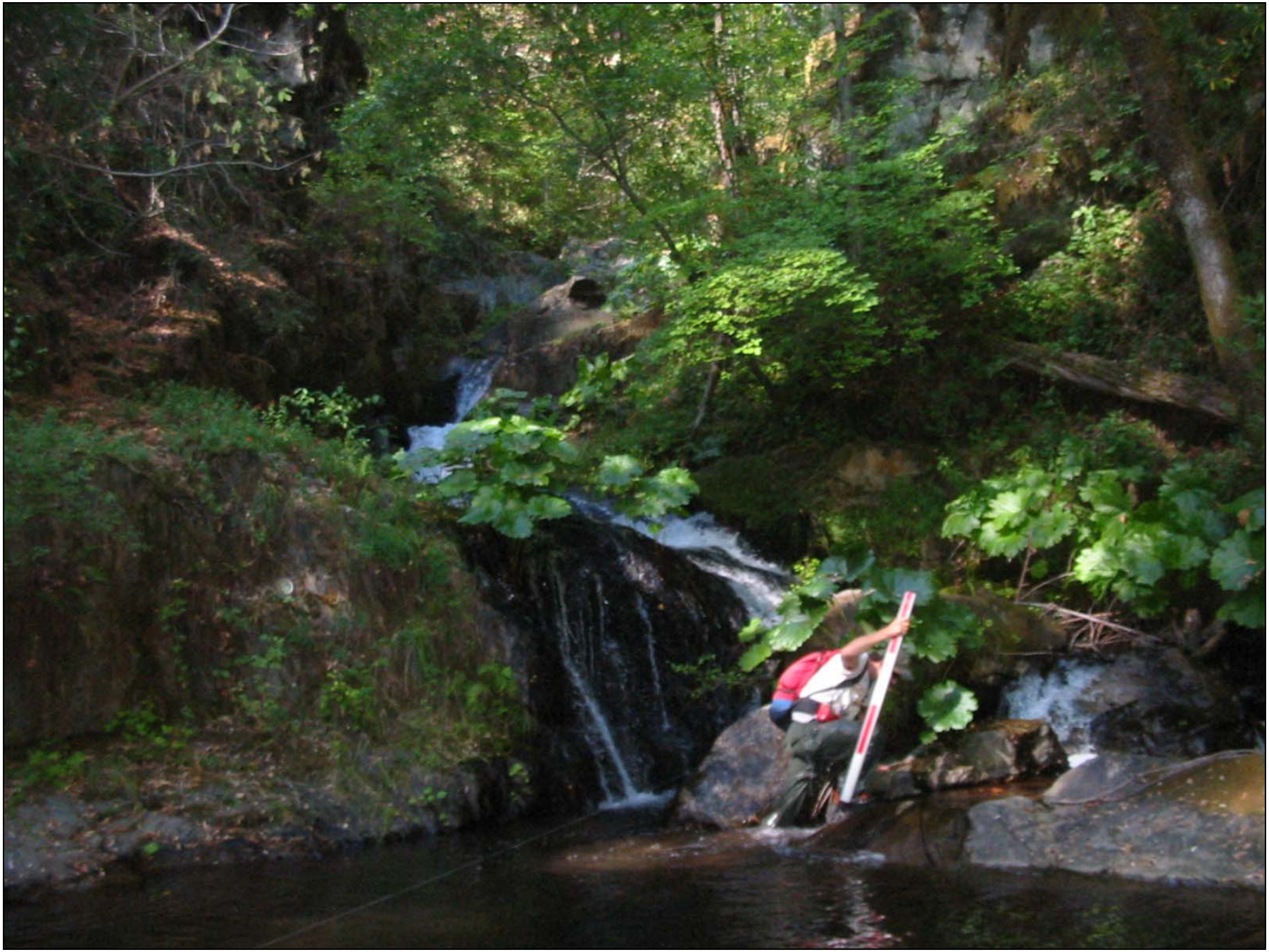
Brush Creek Dam Reach – river mile 0.91

Brush Creek Dam Reach – river mile 0.91



Brush Creek
Dam Reach –
river mile 1.10

Brush Creek Dam Reach – river mile 1.10

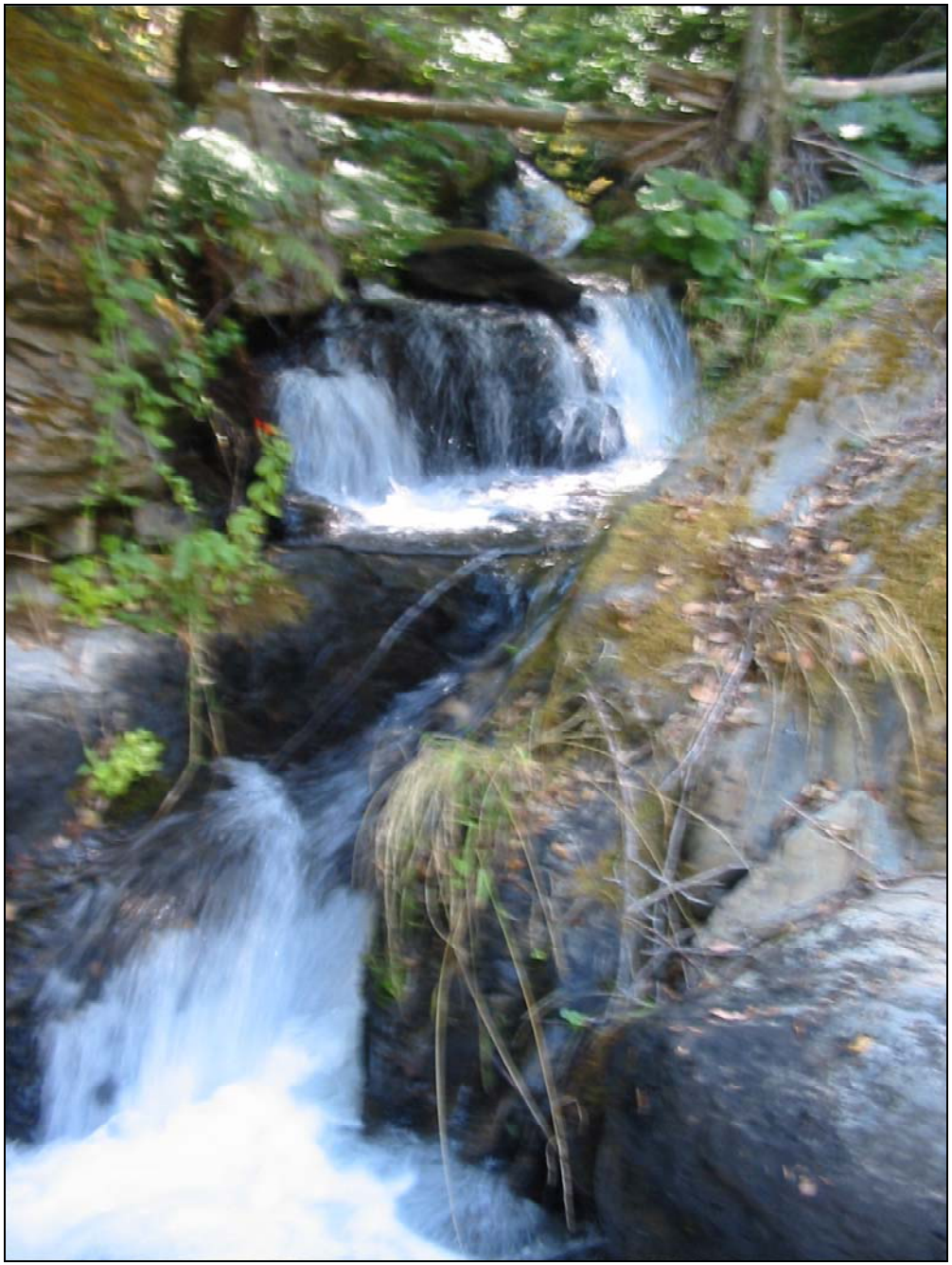


Brush Creek Dam Reach – river mile 1.12

Brush Creek Dam Reach – river mile 1.12

Brush Creek
Dam Reach –
river mile 1.25

Brush Creek Dam Reach – river mile 1.29

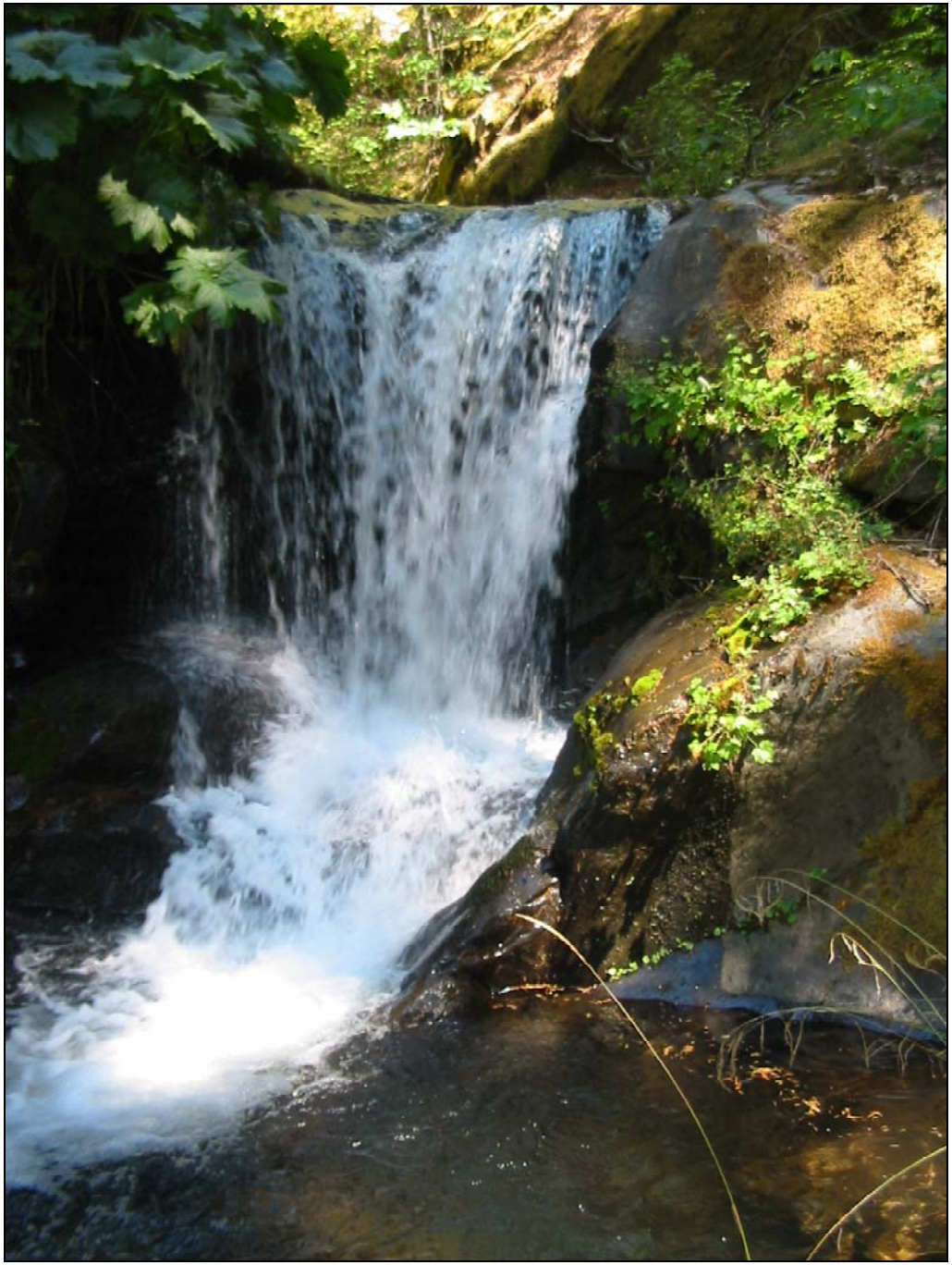


Brush Creek Dam Reach – river mile 1.29

Brush Creek Dam Reach – river mile 1.50

Brush Creek Dam Reach – river mile 1.50

Brush Creek
Dam Reach –
river mile 1.50

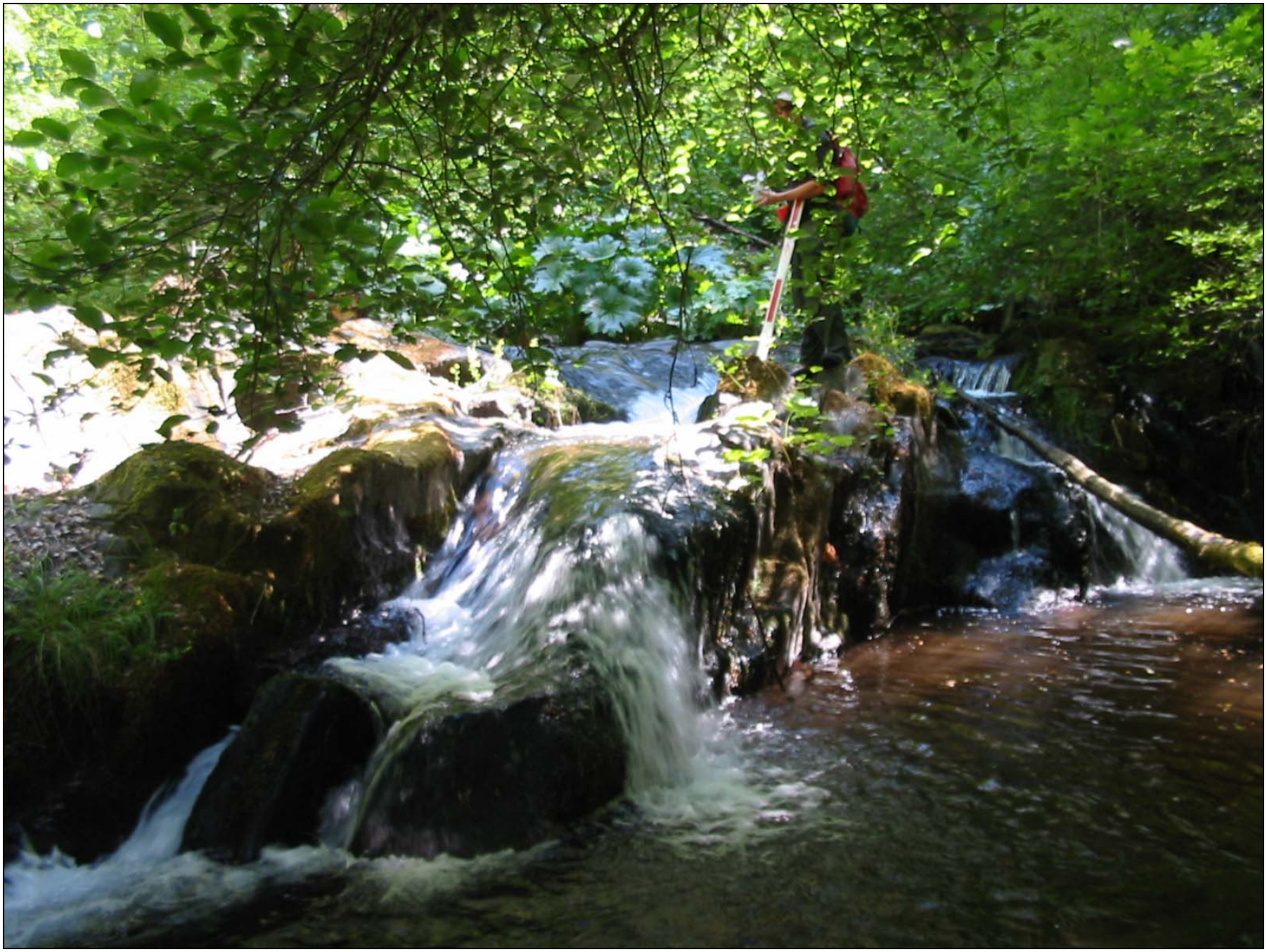


Brush Creek Dam
Reach – river mile
1.63

Brush Creek Dam Reach – river mile 1.91

Brush Creek Dam Reach – river mile 2.27

Brush Creek Dam Reach – river mile 0.20



Brush Creek Dam Reach – river mile 0.59