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)

STREAM HABITAT MAPPING
TECHNICAL REPORT

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TABLE OF CONTENTS

Section & Description **Page**

LIST OF TABLES

Table No. & Description **Page**

LIST OF FIGURES
(Located after text)

Figure No. & Description

LIST OF FIGURES
(Located after text)

Figure No. & Description

LIST OF FIGURES
(Located after text)

Figure No. & Description

LIST OF FIGURES
(Located after text)

Figure No. & Description

LIST OF APPENDICES

Appendix & Description

APPENDIX A — UARP PROJECT AREA MAPS

- 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 — HABITAT SUMMARY TABLES

- Table B-1. Habitat percentage (by length) in study reaches surveyed by foot and by air (frequency of observation), 2002 and 2003.
- Table B-2. Relative percentage of cover, dominant and subdominant substrates, and spawning gravel within the seven study reaches surveyed by foot, 2002 and 2003.
- Table B-3. Habitat, potential migration barriers, and tributary information for the seven study reaches surveyed by foot, 2002 and 2003.
- Table B-4. Large woody debris abundance and spatial distribution in the seven study reaches surveyed by foot, 2002 and 2003.

APPENDIX C — 2002 AND 2003 HABITAT MAPPING DATA (PROVIDED ON CD BY REQUEST)

LIST OF APPLICABLE STUDY PLANS

Description

- Stream Habitat Mapping Study Plan

4.10 Habitat Mapping Study Plan

This study is designed to provide information regarding stream habitat types and conditions for use in instream flow, geomorphology, aquatic bioassessments, riparian vegetation, and fish survey studies. This information is being developed now to provide the Aquatic TWG a better understanding of habitat types in the various reaches affected by the Sacramento Municipal Utility District's (SMUD) Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project. It is anticipated that the information will be used to select reaches in which PHABSIM modeling will be conducted, and to select appropriate transects.

4.10.1 Pertinent Issue Questions

The Habitat Mapping Study Plan will be used, in part, to support other studies that address the following Aquatics/Water Issue Questions:

20. What effect do flows have on species during critical life stages?
25. How do sport fishing releases affect native species and the ability to manage them?
31. How does spill water affect aquatic resources?
35. How are Project releases into Chili Bar affecting aquatic resources?
36. What are the limiting features of a natural (unimpaired/pre-project) hydrograph on aquatic species?
37. Are the minimum stream flows defined under the existing license adequate for protecting aquatic resources?

As described above, this Habitat Mapping Study Plan provides preliminary information for the development of the Instream Flow Study Plan and other study plans (e.g., aquatic bioassessment, fish surveys, and channel morphology). In and of itself, it does not answer the above issue questions.

4.10.2 Background

Habitat mapping information can be used for many purposes, including assessment of channel conditions, substrate characterization, and habitat type assessment. In support of instream flow studies, habitat mapping is typically used to quantify habitat types in a given reach in order to help determine study site locations and transect placement. Following analysis of habitat mapping data, the proportion and type of habitats to place transects in can be determined with greater precision. Weighting of instream flow study results can then be based on the proportion of habitat types in an entire stream reach, rather than just on a representative reach (Morhardt, et al. 1983).

As identified by the Aquatic TWG, the projects contain 14 reaches. A summary of each reach can be found on the UARP Relicensing webpage. Some key characteristics, including gradient and ease of access, of each reach are provided below.

- **Rubicon Dam Reach** - Rubicon River from the base of Rubicon Dam to Miller Creek. This section of river is about 4.1 miles long, extends through a range of elevations from 6,510 feet to 6,100, and has a mean gradient of about 100 feet per mile (1.9%). There are no major tributary inflows. Parts of this river sections are reasonably accessible by foot or by helicopter, and the section is expected to be walkable along the river corridor.
- **Rockbound Dam Reach** - Highland Creek from the outlet of Rockbound Lake to the normal high water line of Buck Island Reservoir. This section of river is 0.4 miles long, extends through a range of elevations from 6,520 feet to 6,440, and has a mean gradient of about 200 feet per mile (3.8%). There are no major tributary inflows. This river section is reasonably accessible by foot or by helicopter, and the section is expected to be walkable along the river corridor.
- **Buck Island Dam Reach** – Little Rubicon River from the base of Buck Island Dam to the Rubicon River. This section of river is 2.8 miles long, extends through a range of elevations from 6,420 feet to 5,940, and has a mean gradient of about 170 feet per mile (3.2%). There are no major tributary inflows. This river section is reasonably accessible by foot or by helicopter, and the section is expected to be walkable along the river corridor.
- **Rubicon Tunnel Outlet Reach** – Rubicon Tunnel Outlet portal to the normal high water line of Rockbound Lake. This section is a partially constructed channel, approximately 0.3 miles long, beginning at an elevation of approximately 6,560 feet. The gradient from the outlet to the lake is relatively flat, estimated to be less than 37

feet per mile (<1%). The reach is located south of the Fox Lake area, but has no direct hydrological connection to Fox Lake. The outlet channel intersects an unnamed lake along its course to Rockbound Lake, but there are no named tributaries to this reach. This river section is reasonably accessible by foot or by helicopter, and the section is expected to be walkable along the river corridor.

- **Loon Lake Dam Reach** - Gerle Creek from the base of Loon Lake Dam to the normal high water line of Gerle Reservoir. This section of river is 8.9 miles long, extends through a range of elevations from 6,310 feet to 5,231, and has a mean gradient of about 122 feet per mile (2.3%). Major inflows to this reach include Jerrett Creek, Barts Creek and Dellar Creek. Parts of this section are reasonably accessible by foot or vehicle, and the section is expected to be walkable along the river corridor.
- **Gerle Creek Dam Reach** - Gerle Creek from the base of Gerle Creek Dam to the South Fork Rubicon River. This section of river is 1.1 miles long, extends through a range of elevations from 5,182 feet to 4,980, and has a mean gradient of about 184 feet per mile (3.5%). There are no major tributary inflows. This section is reasonably accessible by foot or vehicle, and the section is expected to be walkable along the river corridor.
- **Robbs Peak Dam Reach** - South Fork Rubicon River from the base of Robbs Peak Dam to the Rubicon River. This section of river is 5.6 miles long, extends through a range of elevations from 5,190 feet to 3,540, and has a mean gradient of about 293 feet per mile (5.5%). Major inflows to this reach include Gerle Creek and South Creek. This section is largely inaccessible by foot or vehicle, and many areas are not expected to be safely walkable along the river corridor.
- **Ice House Dam Reach** - South Fork Silver Creek from the base of Ice House Dam to the normal high water line of Junction Reservoir. This section of river is 11.5 miles long, extends through a range of elevations from 5,290 feet to 4,450, and has a mean gradient of about 73 feet per mile (1.4%). Major inflows to this reach include Peavine Creek, Winmiller Ravine, and Big Hill Canyon. This section is reasonably accessible by foot or vehicle, and is expected to be walkable along the river corridor.
- **Junction Dam Reach** - Silver Creek from the base of Junction Dam to the normal high water line of Camino Reservoir. This section of river is 8.3 miles long, extends through a range of elevations from 4,300 feet to 2,195, and has a mean gradient of about 167 feet per mile (3.2%). Major inflows to this reach include Gray House Creek, Bear Creek, Davis Creek, and Onion Creek. This section is largely inaccessible by foot or vehicle, and many areas are not expected to be walkable along the river corridor.
- **Camino Dam Reach** - Silver Creek from the base of Camino Dam to the South Fork American River. This section of river is 6.0 miles long, extends through a range of elevations from 2,785 feet to 2,060, and has a mean gradient of about 121 feet per mile (2.3%). The major inflow to this reach is Round Tent Canyon. This section is largely inaccessible by foot or vehicle, and many areas are not expected to be walkable along the river corridor.
- **South Fork American River Reach** – South Fork of the American River from the confluence with Silver Creek to the normal high water line of Slab Creek Reservoir. 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 per mile (1.3%). There are no named tributaries in this reach. This section is largely inaccessible by foot or vehicle, and many areas are not expected to be walkable along the river corridor.
- **Brush Creek Dam Reach** - Brush Creek from the base of Brush Creek Dam to the normal high water line of Slab Creek Reservoir. This section of river is 2.1 miles long, extends through a range of elevations from 2,710 feet to 1,850, and has a mean gradient of about 406 feet per mile (7.7%), although much of the reach is steeper than that. There are no major inflows. Parts of this section are likely to be too steep for safe access along the river corridor, but the upper and lower sections of the reach are lower gradient and may be walkable along the river corridor.
- **Slab Creek Dam Reach** – South Fork of the American River from the base of Slab Creek Reservoir to the normal high water line of Chili Bar Reservoir. This section of river is 8.0 miles long, extends through a range of elevations from 1,620 feet to 990, and has a mean gradient of about 79 feet per mile (1.5%). Major inflows to this reach include Redbird Creek, Iowa Canyon, South Canyon, Mosquito Creek, Jaybird Creek, Rock Creek, and White Rock Creek. This section is largely inaccessible by foot or vehicle, and many areas are not expected to be walkable along the river corridor.
- **Reach Downstream of Chili Bar Dam** – South Fork of the American River from the base of Chili Bar Dam to the normal high water line of Folsom Lake. This section of river is approximately 20 miles long. Elevations range from 960 feet to approximately 470 feet, with a mean gradient of approximately 25 feet per mile (0.5%). There are numerous minor tributaries in this reach, and other small tributaries include Kelsey Canyon Creek,

Dutch Creek, Shingle Creek, Greenwood Creek, Hastings Creek, Norton Ravine, and Weber Creek. There are several vehicular access points at the top and bottom and in the middle third of the reach. Helicopter access may be possible in several locations in the upper and lower sections that are not accessible by vehicle. However, much of the reach is not expected to be safely walkable, particular during periods of flow fluctuation.

4.10.3 Study Objectives

The study objectives are to:

1. Describe the distribution, frequency, and length of different habitat types in reaches of the UARP project area.
2. Characterize various habitat parameters such as substrate, cover, estimated pool depth, and spawning gravel percentage and distribution.
3. Note habitat features such as migration barriers and tributary flows.

4.10.4 Study Area

The study area includes the 14 stream reaches described above.

4.10.5 Information Needed From Other Studies

No information is needed from other studies. Information developed in this study will be useful to the Instream Flow, Fish Surveys, Channel Morphology, Aquatic Bioassessment, Riparian Vegetation and other studies.

4.10.6 Study Methods And Schedule

Two different study methods will be employed.

On-the-Ground Mapping - For those stream reaches where a person can reasonably hike on foot (reasonably means a hiker would be safe, not entering property without a landowners approval, and can complete the survey in one to two days between access points) along the reach for more than 90 percent of the length of the reach, habitat mapping will be conducted on foot by a team of two individuals using a hip chain. For each habitat type described in Table 1, the individuals will record the length of each habitat type unit, which can be referenced back to a known starting point or landmark. Habitat units will be separately identified when the unit length is at least equal to the active channel width (McCain et al. 1990, Flosi and Reynolds 1994), or if the unit is otherwise distinctive. The mapping will be continuous: each habitat unit will abut with another unit. In addition, the individuals will note the following features, record their locations on a topo map or using GPS, and describe them where appropriate: 1) apparent barriers to upstream fish movement, 2) trout spawning habitat, 3) tributaries (for each, estimate inflow to the reach and measure water temperature), and 4) pieces of large wood as defined in the Channel Morphology Study Plan. Relevant incidental observations (fish, vegetation, wildlife, amphibians, amphibian habitat, etc.) will be recorded as well. The reaches where On-the-Ground Mapping will be conducted include 1) Rubicon Dam Reach, 2) Rockbound Dam Reach, 3) Buck Island Dam Reach, 4) Rubicon Tunnel Outlet Reach, 5) Loon Lake Dam Reach, 6) Gerle Creek Dam Reach, 7) and Ice House Dam Reach.

Helicopter Mapping - For those stream reaches where a person can not reasonably hike on foot (a hiker would be safe and can complete the survey in one to two days between access points) along the reach for more than 90 percent of the length of the reach, habitat mapping will be conducted using video from a helicopter and any available low altitude aerial photographs. In this method, a low elevation (tree-top height) video of the reach will be taken from downstream to upstream at a constant slow speed of about 40 knots. In the office, the staff would view the video, and using any available aerial photos and maps, habitat map the reach by identifying habitat unit types, dominant substrates, and other features. Habitat types would be the same as those for On-the-Ground Mapping. Ground-truthing would be conducted in accessible areas, where necessary, to provide supplemental detail (e.g., identify likely trout spawning habitat, etc.). The reaches where Helicopter Mapping will be done include 1) Robbs Peak Dam Reach, 2) Junction Dam Reach, 3) Camino Dam Reach, 4) South Fork American River Reach, 5) Brush Creek Dam Reach, 6) Slab Creek Dam Reach, and 7) the Reach Downstream of Chili Bar Dam. One advantage of the helicopter

mapping is that the Aquatic TWG and Plenary Group will be able to view each reach to confirm the habitat mapping, to assist in initial transect selection for instream flow studies, and for the selection of sampling sites for the Aquatic Bioassessment, Channel Morphology and Fish Survey studies. In addition, other groups can use the helicopter video as a reference tool.

TABLE 1. Habitat types to be used for the UARP Relicensing Habitat Mapping Study. (Adapted from McCain et al. 1990, Armantrout 1998, Payne 1992)

Habitat Type	***Description***
Low Gradient Riffle	Shallow with swift flowing, turbulent water. Partially exposed substrate dominated by cobble Gradient moderate (less than 4%)
High Gradient Riffle	Moderately deep with swift flowing, turbulent water. Partially exposed substrate dominated by boulder. Gradient steep (greater than 4%). Generally not modelable.
Cascade	Steep "riffle" consisting of small waterfalls and shallow pools or pockets, substrate usually composed of bedrock and boulders. Gradient high (more than 4%). Not modelable.
Run/Glide	Fairly smooth water surface, low gradient, and few flow obstructions. Mean column velocity generally greater than one foot per second (fps).
Pocket Water	Swift flowing water with large boulder or bedrock obstructions creating eddies or scour holes. Gradient low to moderate.
Pool	Slow flowing, tranquil water with mean column water velocity less than one fps.

It is anticipated that habitat mapping will begin at the end of August 2002, and a presentation will be made to the Aquatic TWG in fall 2002. During the presentation, needs for additional data collection or analysis will be determined in consultation with the Aquatic TWG.

4.10.7 Analysis

Analytical tasks will include a description of existing aquatic habitat in the project reaches. Frequency distributions of habitat types, by reach, will be presented, along with pertinent habitat parameter values. An appendix will include printouts of sequential habitat units and selected data (unit type, unit length, maximum depth, etc.).
The location of trout spawning habitat, fish barriers and tributaries will be noted on the printouts.

4.10.8 Study Output

The study output will be the habitat printouts for each reach, which will be used in the various studies as described above. It is anticipated that the mapping data will be available by fall 2002.

4.10.9 Preliminary Estimated Study Cost

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

4.10.10 Plenary Group and Aquatic TWG Endorsement

The Aquatics TWG approved this plan, as amended, on August 5, 2002. The participants at the meeting who said they could "live with" this study plan were California Sportfishing Protection Alliance, US Forest Service, Pacific Gas and Electric, National Marine Fisheries Service, State Water Resources Control Board and SMUD. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group gave approval of this plan at the August 7, 2002 Plenary Group meeting. The participants at the meeting who said they could "live with" this study plan were Taxpayers of El Dorado County, USFS, El Dorado County Water Agency, State Water Resources Control Board, El Dorado County Citizens for Water, National Park Service, US Bureau of Land Management, Placer County Water Agency, City of Sacramento, PG&E and SMUD. None of the participants at the meeting said they could not "live with" the study plan.

4.10.11 Literature Cited

Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society, Bethesda, Maryland.

Flosi, G., and F.L. Reynolds. 1994. California Salmonid Stream Habitat Restoration Manual. Second Edition. California Department of Fish and Game, Inland Fisheries Division. Sacramento. October.

McCain, M., D. Fuller, L. Decker, and K. Overton. 1990. Stream Habitat Classification and Inventory Procedures for Northern California. FHR Currents, Volume 1. USDA Forest Service, Pacific Southwest Region. June.

Morhardt, J. E., D.F. Hanson, and P.J. Coulston. 1983. Instream Flow Analysis: Increased Accuracy Using Habitat Mapping. Waterpower 83- An International Conference on Hydropower. Conference Proceedings Vol 3: 1294-1304.

Payne, T.R. 1992. Stratified random selection process for the placement of Physical Habitat Simulation (PHABSIM) transects. Paper presented at AFS Western Division Meeting, July 13-16, in Fort Collins, CO.

STREAM HABITAT MAPPING TECHNICAL REPORT

SUMMARY

This study provides information regarding stream habitat characterization and environmental conditions for use in geomorphology, instream flow, aquatic bioassessment, riparian vegetation, and fish survey studies that have been or will be conducted as part of the Sacramento Municipal Utility District's (SMUD) Upper American River Project (UARP) and Pacific Gas and Electric Company's Chili Bar Project. This information was developed to provide a better understanding of habitat conditions in the various reaches affected by the UARP and Pacific Gas and Electric Company's Chili Bar Project. Habitat mapping information was used for various purposes, including assessment of channel conditions, substrate characterization, and habitat type assessment.

A total of 34 miles of riverine habitat were mapped during the 2002 and 2003 studies using on-the-ground mapping techniques. In project 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.

Contained within the project reaches is a diverse array of habitat types suitable for use by fish and other aquatic organisms. In and of itself, this study does not answer the pertinent issue questions of the overall UARP study (e.g., effects of flow changes and spill-water, minimum stream flows, etc.) but provides background information that will facilitate other analyses of potential effects of the two projects.

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 (jointly referred to as the Licensees) to support the relicensings 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 stream habitat in UARP reaches and the Reach Downstream of Chili Bar. 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 stream habitat, 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 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 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 Stream Habitat Mapping Study Plan

On August 5, 2002, the UARP Relicensing Plenary Group approved the Stream Habitat Mapping Study Plan that was developed by the relicensing Aquatic TWG and approved by the TWG on August 5, 2002. The Stream Habitat Mapping Study Plan was used, in part, to support other studies that address the following Aquatics/Water Issue Questions developed by the Plenary Group:

Issue Question 20.	What effect do flows have on species during critical life stages?
Issue Question 25.	How do sport fishing releases affect native species and the ability to manage them?
Issue Question 31.	How does spill water affect aquatic resources?
Issue Question 35.	How are project releases into the Reach Downstream of Chili Bar affecting aquatic resources?
Issue Question 36.	What are the limiting features of a natural (unimpaired/pre-project) hydrograph on aquatic species?
Issue Question 37.	Are the minimum stream flows defined under the existing license adequate for protecting aquatic resources?

As described above, this Stream Habitat Mapping Study Plan provided information for the development of the Physical Habitat Simulation Study Plan and other study plans (e.g., aquatic

bioassessment, fish surveys, and channel morphology). In and of itself, the study does not answer the above issue questions.

The objectives of this study were to:

- Describe the distribution, frequency, and length of different habitat types in reaches affected by the UARP and Chili Bar Project,
- Characterize stream habitat parameters such as substrate, cover, pool depth, spawning gravel abundance, and distribution and abundance of large woody debris (LWD); and
- Note habitat features such as migration barriers and tributary inflows.

The study area included all UARP reaches and the Reach Downstream of Chili Bar.

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 Stream Habitat Mapping 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 2001-2003.*

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

*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 Stream Habitat Mapping Study was not listed in the agencies' letter.

3.0 METHODS

3.1 Study Sites

The Aquatic TWG subdivided the streams within the study area into 14 stream reaches, 13 of which were mapped from the air or by foot. The Rubicon Tunnel Outlet Reach was excluded from mapping as it is comprised of a partially constructed channel. Table 3.1-1 identifies the reaches surveyed during the study, methods used for each reach, and date of mapping.

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 End (Easting/Northing)		Downstream End (Easting/Northing)	
Rubicon River	Rubicon Reservoir 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

All reaches were mapped at minimum summer flows, (except the Reach Downstream of Chili Bar, where habitat was mapped in October and flows may fluctuate at any time of the year).

3.2 Habitat Identification and Characterization

Field mapping efforts were conducted to characterize habitat within the UARP reaches in August and September of 2002 and August of 2003; the Reach Downstream of Chili Bar was surveyed in October of 2003. Mapping was conducted by survey teams on the ground or by aerial videography taken from a helicopter. Table 3.2-1 identifies the habitat typing classifications used to delineate habitat types in the field.

Table 3.2-1. Habitat classification key used for the UARP and Chili Bar Project relicensings stream habitat mapping study (Adapted from McCain et al. 1990, Armantrout 1998, Payne 1992).

Habitat Type	Description
Low Gradient Riffle	Shallow with swift flowing, turbulent water. Partially exposed substrate dominated by cobble. Gradient moderate (less than 4 percent).
High Gradient Riffle	Moderately deep with swift flowing, turbulent water. Partially exposed substrate dominated by boulder. Gradient steep (greater than 4 percent).
Cascade	Steep "riffle" consisting of small waterfalls and shallow pools or pockets, substrate usually composed of bedrock and boulders. Gradient high (greater than 4 percent).
Run/Glide	Fairly smooth water surface, low gradient, and few flow obstructions. Mean column velocity generally greater than one foot per second (fps).
Pocket Water	Swift flowing water with large boulder or bedrock obstructions creating eddies or scour holes. Gradient low to moderate.
Pool	Slow flowing, tranquil water with mean column water velocity less than one fps.

3.2.1 On the Ground Mapping

On the ground habitat mapping was conducted in the UARP reaches where survey teams were able to safely hike more than 90 percent of the reach length. Reaches that were mapped using this method are identified in Table 3.1-1. Habitats were classified by type (e.g., run, riffle, or pool), numbered sequentially, and measured by two-person teams. Mapping was continuous, with each habitat unit abutting the next. To be classified as an independent unit, the unit had to contain a distinctly different habitat type, with its length equal to or greater than the active channel width (McCain et al. 1990, Flosi and Reynolds 1994). All habitat information was referenced back to a known starting point or landmark. Standard hip chains with English graduations were used to measure habitat lengths, while channel widths and depths were visually estimated. Survey teams physically measured the width of every tenth habitat unit to calibrate visual estimates.

Additionally, the amount of available spawning gravel for trout (0.25 to 2.5 inches mean diameter) was measured (square feet), as were the locations of potential amphibian habitat that was ecologically different from the mainstem channel (such as high terrace pools, large shallow backwater areas, and shallow grassy edgewater areas). Presence of stream cover for fish was recorded by identifying the dominant component (e.g., boulders, vegetation, or wood) within each unit.

In each habitat unit, the dominant and subdominant substrates were identified based on the length of the intermediate axis of the dominant particle size. Substrates were classified as bedrock, boulder (>10 inches), cobble (2.5 to 10 inches), gravel (0.12 to 2.5 inches), sand (<0.12 inch), or silt. Pool tail-out embeddedness was approximated by removing several sediment particles (gravel or larger) to determine what percent of the vertical axis had been buried in sand or silt. A slight discoloration of the particles was apparent above and below the level of embeddedness.

All LWD within the stream bankfull width was classified into 20 size categories and tallied as the survey progressed. The minimum requirements used to define LWD were six inches in diameter and three feet in length (where the total length was greater than or equal to one-half the channel width).

The discharge and temperature of all tributaries were measured to assess their hydrologic and thermal contribution to the mainstem streams. Tributary discharge was estimated from average depth, width, and velocity estimates. Potential barriers to fish migration were identified based on anticipated flows during spring runoff conditions, vertical drop, discharge, and water depth. Incidental observations of wildlife were noted and relayed to the appropriate Technical Lead.

In order to characterize daily and longitudinal stream temperature changes throughout the project reaches, water temperature was recorded in every fifth habitat unit. These data are not as comprehensive as those collected by thermographs, as reported in the *Water Temperature Technical Report*, and are restricted to the dates when fieldwork was being conducted. However, they do illustrate variations in temperature throughout the day and along the entire length of the study reach.

To ensure accurate relocation of habitats for use in future studies, a handheld Garmin ETREX Venture GPS unit was used to mark the coordinates (UTM-NAD 27) of every fifth unit. GPS handheld units were also used to mark the location of inflowing tributaries, navigational landmarks (e.g., bridges, road crossings, campgrounds), and potential barriers to fish migration. Brightly colored, semi-permanent flagging and permanent aluminum labels were placed along the stream corridor using a line-of-sight methodology. Generally, these markers were placed on saplings or shrubs close to the water's edge. Labels with pertinent information (e.g. date, unit #, unit type) were placed in every fifth or tenth unit.

3.2.2 Aerial Mapping

Aerial videography was conducted in reaches that were not safely accessible by foot or where ground surveys were not feasible. Habitat parameters that require on the ground measurements, such as LWD or subdominant substrates, were not quantified for reaches mapped by aerial videography. Five of the 13 UARP reaches (Robbs Peak, Junction Dam, Camino Dam, South Fork American River, and Slab Creek) and the Reach Downstream of Chili Bar were mapped using this method (Table 3.1-1). 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, and habitat types identified at five-second increments throughout the entire reach. This resulted

in a frequency distribution of habitat types that is related to the cumulative length of the respective habitat types in each reach.

Aerial mapping results were summarized by quartiles (i.e., the reach was divided into four sections of equal flight time), in order to allow for a more detailed analysis of habitat spatial distribution. Historical aerial photographs and topographic maps were incorporated into the aerial habitat mapping effort to identify access points and potential study sites.

3.3 Analysis of Habitat Data

All data were analyzed to assess the distribution, abundance, and relative frequency of habitat types within each stream reach. Additionally, an analysis of pertinent habitat variables was conducted to assess the physical conditions of the stream reaches mapped on the ground. Where relevant data were available, the following analyses were completed:

- Relative frequency of habitat type and length;
- Relative frequency of dominant and subdominant substrates;
- Distribution and abundance of spawning gravel;
- Relative percentage of stream cover available for fish;
- Longitudinal distribution of habitat widths;
- Spatial distribution of LWD; and
- LWD abundance.

For purposes of evaluating potential study sites for the instream flow studies, habitat mapping data were also analyzed by subreach. Results of subreach analyses are included in the *Physical Habitat Simulation Technical Report.*

4.0 RESULTS

Survey teams mapped approximately 33.7 miles of stream habitat by foot in seven reaches during the 2002 and 2003 field efforts. Run, pool, and low gradient riffle were the dominant habitat types in all reaches surveyed on the ground (Appendix B, Table B-1). Smaller proportions of cascade, high gradient riffle, and pocket water were found throughout the project reaches. An additional 50.7 river miles in six reaches were mapped using aerial videography. In reaches surveyed from the air, pool and run habitats were observed most frequently, although cascade and low gradient riffle habitat were also common. Smaller components of high gradient riffle and pocket water were also noted (Appendix B, Table B-1).

Spawning gravel pockets were commonly found in four of the seven ground-mapped reaches; total spawning gravel area in these reaches ranged from 1,606 to 3,932 square feet/mile. Large amounts of spawning gravel were not observed in the Rockbound Dam, Ice House Dam, or Buck Island Dam reaches. Substrates in the reaches surveyed were dominated by boulders and bedrock, while subdominant substrates were highly variable. Instream cover was found in all reaches surveyed and varied considerably in composition and abundance from reach to reach. Appendix B, Table B-2 presents a summary of the different physical and geomorphic parameters

observed in the seven UARP reaches surveyed on the ground, as well as the relative abundance of spawning gravel available for trout.

Average daily water temperatures ranged from 10.9°C in the Brush Creek Dam Reach to 20.6°C in the Rubicon Dam Reach. Stream widths were relatively constant in all reaches, as were average and maximum pool depths. The majority of pools observed (90 percent) had an average depth greater than or equal to three feet. Average maximum pool depth ranged from 3.8 feet in the Brush Creek Dam Reach to 5.7 feet in the Rubicon Dam Reach. Appendix Table B-3 presents a summary of the various hydrologic parameters observed during the study.

Potential fish migration barriers were most heavily concentrated in the small Rockbound Dam Reach and ranged from zero to 28 occurrences in the seven reaches mapped by foot. These will be discussed in more detail in the *Fish Passage Barriers Technical Report*. Average tributary temperatures ranged from 12.2° to 19°C. The majority of tributaries in the Rubicon Dam and Rockbound Dam reaches were dry at the time of mapping. Appendix Table B-3 presents a summary of the tributary and fish migration barrier data recorded during the ground surveys.

The abundance and spatial distribution of large woody debris found in the seven reaches mapped on the ground are shown in Appendix Table B-4. LWD abundance was greatest in the Gerle Creek portion of the Loon Lake Dam Reach (n=1,792) although density (LWD/river mile) was highest in the Rockbound Dam Reach. The majority of LWD fell into the 10-25 foot length and 12-24 inch diameter size classes.

Data for both aerial and ground mapping is presented in Appendix C. The habitat in each of the reaches mapped by foot or by aerial video is described below.

4.1 Rubicon Reservoir Dam Reach

The Rubicon Reservoir Dam Reach is located on the Rubicon River and extends from the base of Rubicon Dam to the Miller Creek confluence. This section of river is approximately 4.1 miles long, ranges in elevation from 6,510 to 6,100 feet, and has a mean gradient of about 100 feet/mile (1.9 percent).

Of the 184 habitat units identified in this reach, the majority of the habitat was composed of pools and runs (Figure 4.1-1). Substrates consisted primarily of boulder, bedrock, and sand (Figure 4.1-2). A moderate amount of gravel for spawning trout was found in this reach (11,000 square feet), the majority of which was located downstream of Rubicon Springs. Boulder, instream vegetation, and overhanging vegetation were the dominant stream cover types, covering 75 percent of the reach (Figure 4.1-3). Stream width averaged 30 feet, and ranged from 5 to 100 feet (Figure 4.1-4). Water temperature showed no distinct trend and ranged from 16.5 °C to 23 °C (Figure 4.1-5). Ninety-three percent (N=71) of the pools observed had depths greater than or equal to three feet (Appendix Table B-3). Nine tributaries were noted within the reach.

A bi-modal distribution of LWD (n=789) was found in this reach, with the majority of wood located in the upper-most river portion (Figure 4.1-6). LWD was predominantly between 25 and 75 feet length with a diameter between 12 and 24 inches (Figure 4.1-7).

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/miles (3.8 percent).

Of the 25 habitat units identified, pool and low gradient riffle were the dominant habitat types found in this reach (Figure 4.2-1). The dominant and subdominant substrates were boulder and bedrock (Figure 4.2-2). Gravel and stream cover for fish were not prevalent in this small reach (Figures 4.2-2 and 4.2-3). Stream width averaged 20 feet, and ranged from 2 to 50 feet (Figure 4.2-4). Water temperature ranged between 11° and 14°C during the survey (Figure 4.2-5). All pools had depths greater than or equal to three feet and no tributaries to this reach were observed (Appendix Table B-3).

LWD was most abundant in the upper-portion of this small reach (Figure 4.2-6). The majority of LWD observed (n=84) was in the 10-25 foot length and 6-12 inch diameter size classes (Figure 4.2-7).

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).

Pool habitat was predominate in this reach; although, run and low gradient riffle habitats were also frequent (Figure 4.3-1). The majority of substrates in the units were comprised of bedrock and boulder (Figure 4.3-2). Spawning gravel for trout was minimal (<5 square feet). Stream cover was provided primarily by instream or overhanging vegetation and boulders (Figure 4.3-3). Of the 48 pools identified, 75 percent (n=36) were deeper than or equal to three feet (Appendix Table B-3). Stream width averaged 17 feet, and ranged from 2 to 83 feet (Figure 4.3-4). Stream temperature ranged from 13.5° to 17.5°C, and there was a slight increase in average daily water temperature noted upstream (Figure 4.3-5). Five tributaries were identified, although four were dry at the time of sampling (Appendix Table B-3).

The majority of LWD (n=241) was located between river mile 1 and 2 (Figure 4.3-6) and was predominantly in the 10-25 foot length and 6-12 inches diameter size classes (Figure 4.3-7).

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). Major inflows to this reach include Jerrett Creek, Barts Creek, Dellar Creek, and Rocky Basin Creek.

The Loon Lake Dam Reach was split into an upper and lower section at river mile 3.0 for additional analysis for IFIM studies. Habitat in the lower section varied considerably and was not dominated by any one type (Figure 4.4-1). Pool and run were the dominant habitat types between river mile 3.0 and Loon Lake Dam (Figure 4.4-2). Boulder and sand were the two most prevalent substrates, while the subdominant substrate was primarily cobble (Figure 4.4-3). A large amount of spawning gravel (approximately 36,500 square feet) was observed in this project reach, with the majority located between river mile 4.0 and 7.0 (Appendix Table B-2). Stream cover was found in 70 percent of the reach in the form of instream or overhanging vegetation, boulder, and wood (Figure 4.4-4). Of the 131 pools sampled, ninety percent (n=118) were equal to or deeper than three feet (Appendix Table B-3). The average stream width was 27 feet and ranged from a 5 to 80 feet (Figure 4.4-5). Stream temperature ranged from 11.5° to 21°C, and declined significantly as the survey continued upstream with additional daily fluctuations up to 5°C (Figure 4.4-6).

A bi-modal distribution of LWD (n=1,792) was identified in this reach, with much of the LWD located in the upper section of the river (Figure 4.4-7). The reach was dominated by LWD 10-25 feet long and 6-12 inches in diameter (Figure 4.4-8).

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).

In this reach, the majority of habitat was pocket water and pool (Figure 4.5-1). Boulder and bedrock were the dominant substrates (Figure 4.5-2). Approximately 1,900 square feet of spawning gravel for trout was identified, the majority of which was located below river mile 1 (Appendix Table B-2). Stream cover was mostly boulder and vegetation (Figure 4.5-3). All 25 pools had a depth greater than or equal to three feet (Appendix Table B-3). Stream width averaged 24 feet and ranged from 6 to 45 feet (Figure 4.5-4). Stream temperature ranged from 14° to 17°C. Significant temperature change along the reach was observed. Daily water temperatures fluctuated by 3°C (Figure 4.5-5). There are no major tributary inflows (Appendix Table B-3).

The few pieces of LWD encountered in this short reach (n=8) were evenly distributed (Figure 4.5-6). The majority fell within the 10-25 foot length class and 12 to 36 inches diameter size classes (Figure 4.5-7).

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). Major inflows to this reach include Gerle Creek and South Creek.

This reach was mapped using aerial videography. Results of analysis are shown in Table 4.6-1. Pool, cascade, and low gradient riffle were the predominant habitat types identified in this reach (Figure 4.6-1). The majority of pools were found in the upper half of the reach, whereas cascades primarily occurred in the middle of the reach (Table 4.6-1).

Table 4.6-1. Habitat distribution and frequency in South Fork Rubicon River, Robbs Dam Reach, August and September 2002.

Habitat Type	No. of Observations	Frequency (percent) of Habitat	Relative Abundance per Quarter (percent) Downstream to Upstream				
			1	2	3	4	Total
Low Gradient Riffle	44	18.8	13.6	38.6	15.9	31.8	**100**
High Gradient Riffle	27	11.5	77.8	11.1	11.1	0.0	**100**
Cascade	59	25.2	11.9	30.5	40.7	16.9	**100**
Run/Glide	37	15.8	27.0	27.0	16.2	29.7	**100**
Pocket Water	8	3.4	0.0	87.5	0.0	12.5	**100**
Pool	59	25.2	16.9	13.6	50.8	18.6	**100**
Total	**234**	**100**	-	-	-	-	-

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.

A total of 528 distinctive habitat units were identified and mapped within this reach. Low gradient riffle and run were the primary habitat types identified (Figure 4.7-1). Bedrock and cobble were dominant substrates, with subdominant substrates consisting of all sediment sizes (Figure 4.7-2). Approximately 5,000 square feet of gravel for spawning trout was identified in this reach, the majority of which was located between river mile 10 and 11 (Appendix Table B-2). Stream cover was insignificant for 68 percent of the stream due to the Cleveland Fire in 1992

(Figure 4.7-3). The remaining cover was primarily instream, or overhanging vegetation. A nominal amount of boulder cover was observed. Of the 53 pools sampled, all were deeper or equal to three feet (Appendix Table B-3). Stream width averaged 30 feet and ranged from 7 to 65 feet (Figure 4.7-4). Average stream temperature measured during the survey was 13.1°C and ranged from 5.5° to 20°C. Average water temperature decreased significantly from downstream to upstream, with significant daily fluctuations as well (Figure 4.7-5). Twenty-five intermittent tributaries were identified within the reach (Appendix Table B-3).

A majority of the LWD (n=803) was located in the lower half of the river (Figure 4.7-6). The reach was dominated by LWD of 10-25 foot lengths and 6 to 24 inches in diameter (Figure 4.7-7).

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). Major inflows to this reach include Gray House Creek, Bear Creek, Davis Creek, and Onion Creek.

This reach was mapped using aerial videography. Results of analysis are shown in Table 4.8-1. Run/glide, pool, and cascade were found to be the predominant habitat types within this reach (Figure 4.8-1). These habitat types were distributed equally throughout the reach. Low gradient riffles were most concentrated in the upper half of the reach (Table 4.8-1).

Table 4.8-1. Habitat distribution and frequency in Silver Creek, Junction Dam Reach, August and September 2002.

Habitat Type	No. of Observations	Frequency (percent) of Habitat	Relative Abundance per Quarter (percent) Downstream to Upstream				
			1	2	3	4	Total
Low Gradient Riffle	48	17.4	18.8	18.8	33.3	29.2	**100**
High Gradient Riffle	11	4.0	54.5	0.0	27.3	18.2	**100**
Cascade	66	23.9	24.2	37.9	18.2	19.7	**100**
Run/Glide	76	27.5	30.3	11.8	28.9	28.9	**100**
Pocket Water	9	3.3	33.3	33.3	22.2	11.1	**100**
Pool	66	23.9	21.2	33.3	22.7	22.7	**100**
Total	**276**	**100**	-	-	-	-	**-**

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 primary tributary inflow to this reach is from Round Tent Canyon.

This reach was mapped using aerial videography. Results of analysis are shown in Table 4.9-1. Pools were the most abundant habitat type identified in this reach, followed by cascade and run/glide (Figure 4.9-1). Pool and run habitats were distributed evenly throughout the reach. Cascades and high gradient riffles were concentrated in the upper half of the reach (Table 4.9-1).

Table 4.9-1. Habitat distribution and frequency in Silver Creek, Camino Dam Reach, August and September 2002.

Habitat Type	No. of Observations	Frequency (percent) of Habitat	Relative Abundance per Quarter (percent) Downstream to Upstream				
			1	2	3	4	Total
Low Gradient Riffle	4	2.3	0.0	50.0	0.0	50.0	**100**
High Gradient Riffle	5	2.8	20.0	0.0	60.0	20.0	**100**
Cascade	29	16.3	13.8	17.2	34.5	34.5	**100**
Run/Glide	25	14.0	32.0	16.0	28.0	24.0	**100**
Pocket Water	10	5.6	70.0	20.0	0.0	10.0	**100**
Pool	105	59.0	21.0	30.5	26.7	21.9	**100**
Total	**178**	**100**	-	-	-	-	**-**

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).

This reach was mapped using aerial videography. Results of analysis are shown in Table 4.10-1. Pools were the most abundant habitat type in the reach, followed by run/glide and cascade (Figure 4.10-1). Pools were fairly evenly distributed throughout the reach although their abundance decreased slightly upstream. The primary concentration of run/glide habitat was found within the center of the reach; cascades were found throughout the reach with the heaviest concentration appearing in the upper section of the reach (Table 4.10-1).

Table 4.10-1. Habitat distribution and frequency in South Fork American River, South Fork American River Reach, August and September 2002.

Habitat Type	No. of Observations	Frequency (percent) of Habitat	Relative Abundance per Quarter (percent) Downstream to Upstream				
			1	2	3	4	Total
Low Gradient Riffle	4	6.8	0.0	50.0	25.0	25.0	**100**
High Gradient Riffle	4	6.8	50.0	0.0	25.0	25.0	**100**
Cascade	10	16.9	10.0	30.0	20.0	40.0	**100**
Run/Glide	14	23.7	14.3	35.7	35.7	14.3	**100**
Pocket Water	0	0.0	0.0	0.0	0.0	0.0	**0**
Pool	27	45.8	37.0	22.2	25.9	14.8	**100**
Total	**59**	**100**	-	-	-	-	-

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 (Appendix Table B-3).

A total of 265 distinctive habitat units were identified and mapped within this reach. Low gradient riffle, run, and pool were the most dominant habitat types identified with several high gradient riffles and cascades in this reach as well (Figure 4.11-1). Bedrock and boulder were the most prevalent dominant substrates, with subdominant substrates including cobble and gravel (Figure 4.11-2). Approximately 308 square feet of gravel for spawning trout was identified in this reach, the majority of which was located within the lowermost half mile (Appendix Table B-2). Stream cover was significant in most of the reach due to dense overhanging or instream vegetative cover (Figure 4.11-3). Of the 83 pools delineated, most were at least three feet deep (Appendix Table B-3). Stream width averaged less than 20 feet and ranged from 3 to 100 feet (Figure 4.11-4). Average stream temperature measured during the survey was 10.9 °C and ranged from 9.5° to 12.5 °C with a temperature change approximately 3 °C per day (Figure 4.11-5).

LWD was distributed throughout the reach (n=400) (Figure 4.11-6). The reach was dominated by LWD in 10-25 foot length and 6-12 inch diameter size classes (Figure 4.11-7).

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). Tributaries to this reach include Redbird Creek, Iowa Canyon, South Canyon, Mosquito Creek, Jaybird Creek, Rock Creek, and White Rock Creek.

This reach was mapped using aerial videography. Results of analysis are shown in Table 4.12-1. Run/glides and pools were the most abundant habitat types in the reach, followed by both low and high gradient riffles (Figure 4.12-1). Run/glides and pools were evenly distributed throughout the reach, although the abundance of pools diminished upstream. The concentration of low gradient riffles was found predominantly in the lower half of the reach. High gradient riffle, pocket water, and cascade were more frequent in the upper half of the reach (Table 4.12-1).

Table 4.12-1. Habitat distribution and frequency in South Fork American River, Slab Creek Dam Reach, August and September 2002.

Habitat Type	No. of Observations	Frequency (percent) of Habitat	Relative Abundance per Quarter (percent) Downstream to Upstream				
			1	2	3	4	Total
Low Gradient Riffle	50	18.9	38.0	46.0	10.0	6.0	**100**

Table 4.12-1. Habitat distribution and frequency in South Fork American River, Slab Creek Dam Reach, August and September 2002.							
			Relative Abundance per Quarter (percent) Downstream to Upstream				
Habitat Type	No. of Observations	Frequency (percent) of Habitat	1	2	3	4	Total
High Gradient Riffle	35	13.3	8.6	14.3	31.4	45.7	**100**
Cascade	13	4.9	0	23.1	53.8	23.1	**100**
Run/Glide	76	28.8	31.6	26.3	17.1	25.0	**100**
Pocket Water	21	8.0	0	4.8	47.6	47.6	**100**
Pool	69	26.1	30.4	23.2	29.0	17.4	**100**
Total	**264**	**100**	-	-	-	-	-

4.13 Reach Downstream of Chili Bar

The Reach Downstream of Chili Bar is located on the South Fork of the American River 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.

This reach was mapped using aerial videography. Results of analysis are shown in Table 4.13-1. Run/glide were the dominant habitat types in this reach with lesser amounts of low gradient, high gradient, and pool habitat as well (Figure 4.13-1). The lower sections of this reach contained higher percentages of low gradient riffle, runs, and pool. The uppermost segment of this reach contained the highest frequency of high gradient riffle, cascade and pocket water.

Table 4.13-1. Habitat distribution and frequency in South Fork American River, Reach Downstream of Chili Bar, October 2002.							
			Relative Abundance per Quarter (percent) Downstream to Upstream				
Habitat Type	No. of Observations	Frequency (percent) of Habitat	1	2	3	4	Total
Low Gradient Riffle	162	21.7	35.2	34.8	21.0	9.3	**100**
High Gradient Riffle	117	15.7	11.1	18.0	19.7	51.3	**100**
Cascade	60	8.1	8.3	1.7	15.0	75.0	**100**
Run/Glide	275	37.0	32.0	23.3	32.0	12.7	**100**
Pocket Water	9	1.2	22.2	22.2	11.1	44.4	**100**
Pool	121	16.3	23.1	37.2	31.4	8.3	**100**
Total	**744**	**100**	-	-	-	-	-

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FIGURES

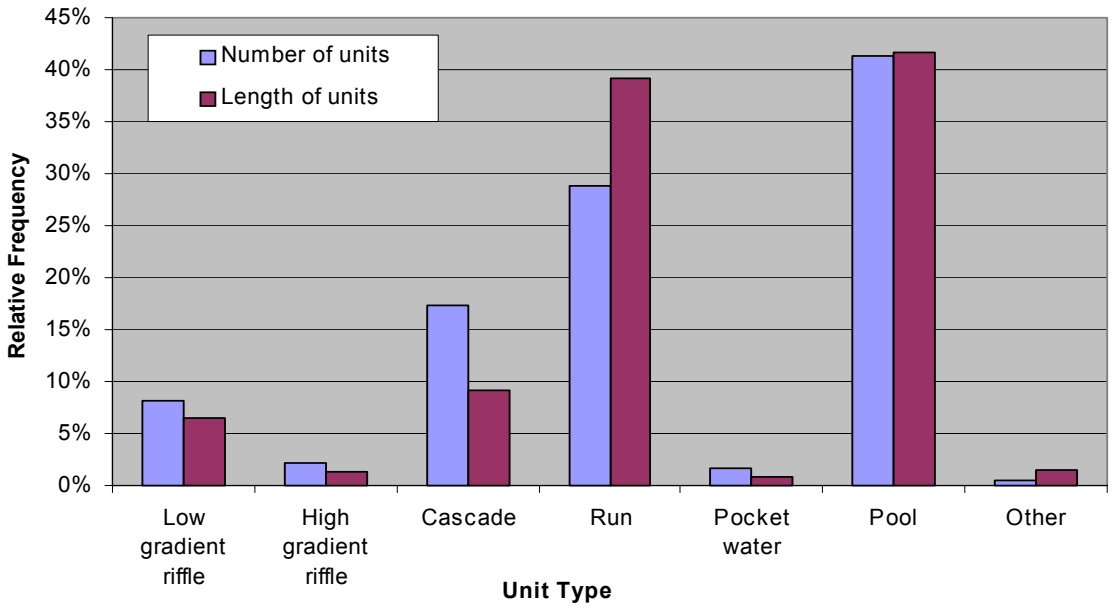

Figure 4.1-1. Relative frequency of habitat types and cumulative habitat lengths in Rubicon Reservoir Dam Reach, August 2002.

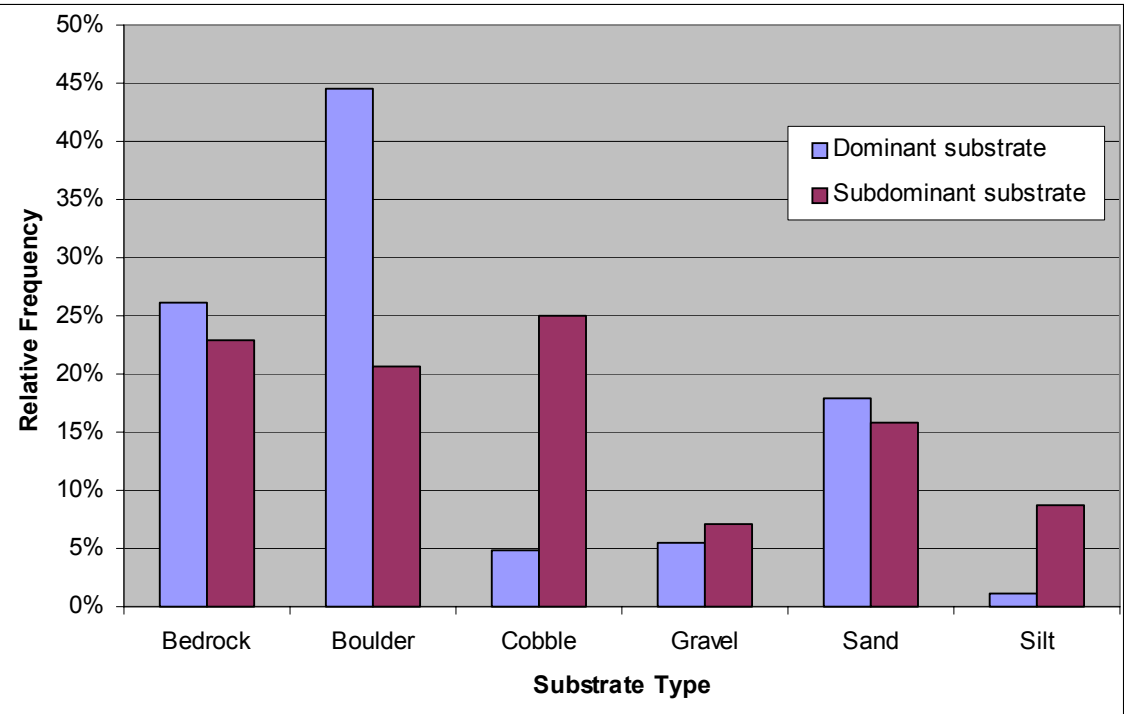

Figure 4.1-2. Relative frequency of dominant and subdominant substrates in Rubicon Reservoir Dam Reach, August 2002.

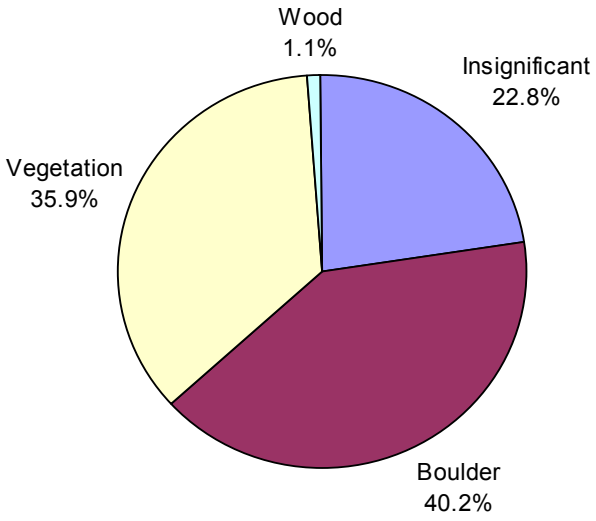

Figure 4.1-3. Percentage of stream cover types in Rubicon Reservoir Dam Reach, August 2002.

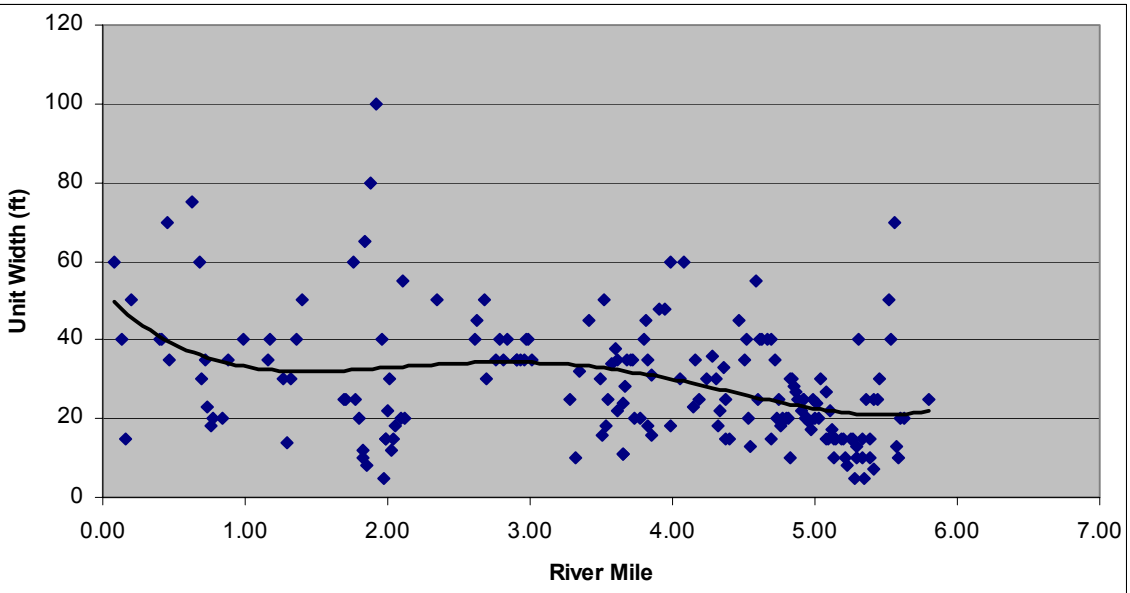

Figure 4.1-4. Longitudinal distribution of habitat unit widths in Rubicon Reservoir Dam Reach, August 2002.

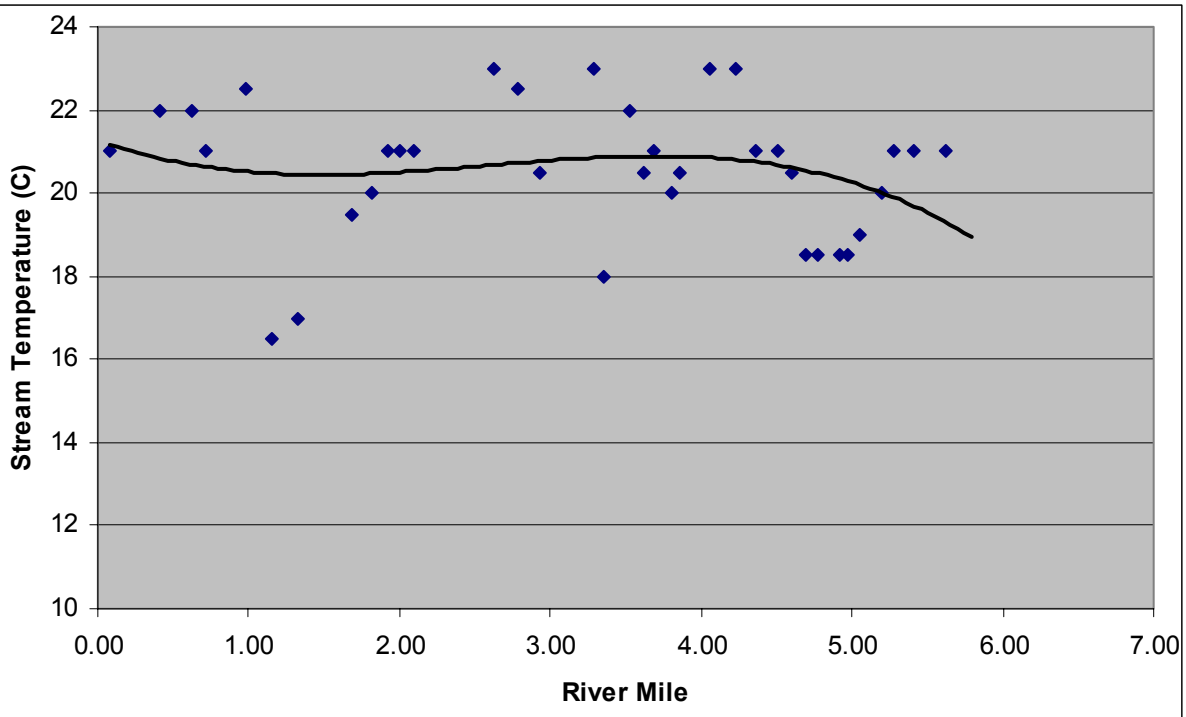

Figure 4.1-5. Temperature gradient in Rubicon Reservoir Dam Reach, August 2002.

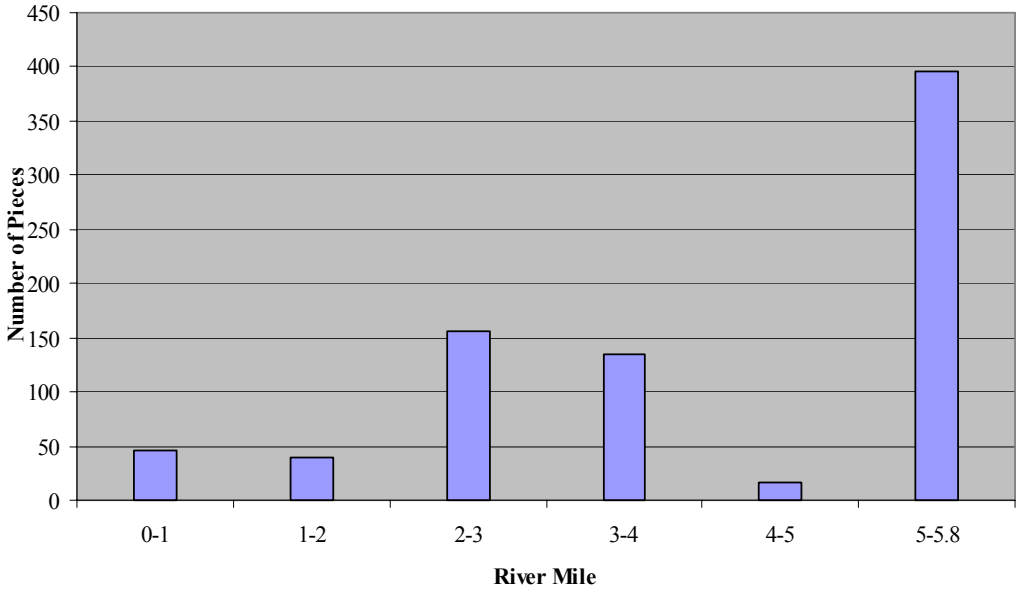

Figure 4.1-6. Spatial distribution of LWD (all size classes) in Rubicon Reservoir Dam Reach, August 2002.

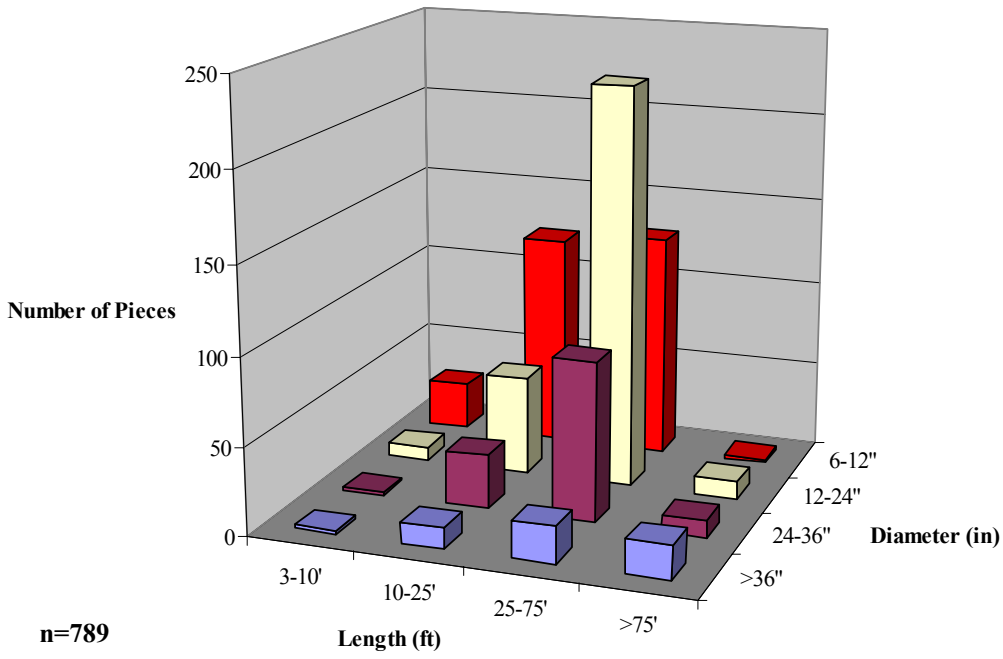

Figure 4.1-7. Relative abundance of LWD size classes in Rubicon Reservoir Dam Reach, August 2002.

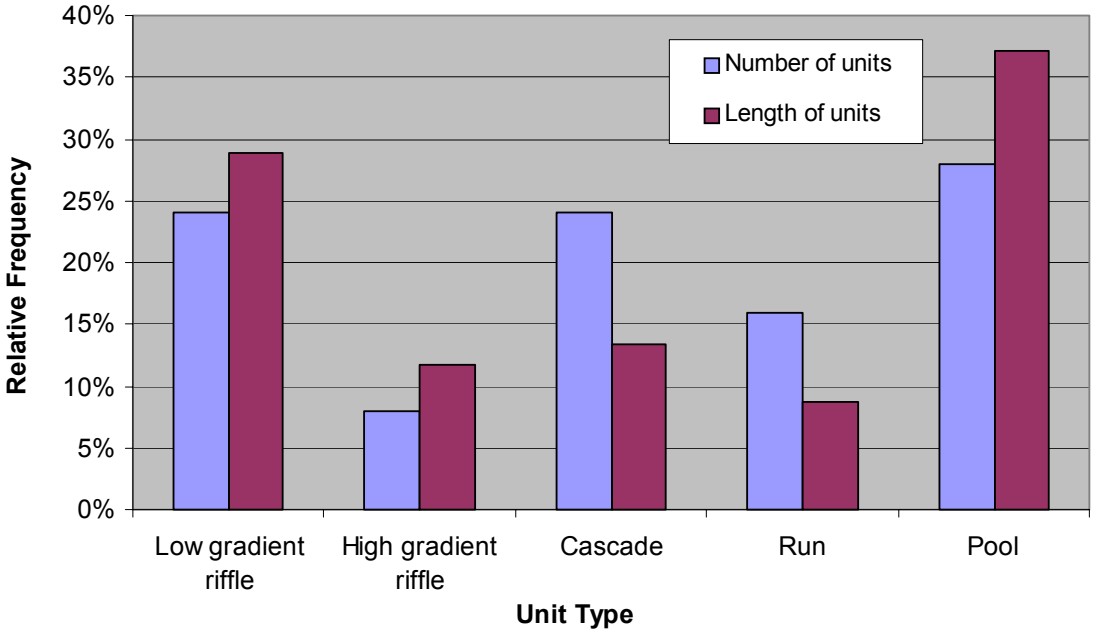

Figure 4.2-1. Relative frequency of habitat types and cumulative habitat lengths in Rockbound Dam Reach, September 2002.

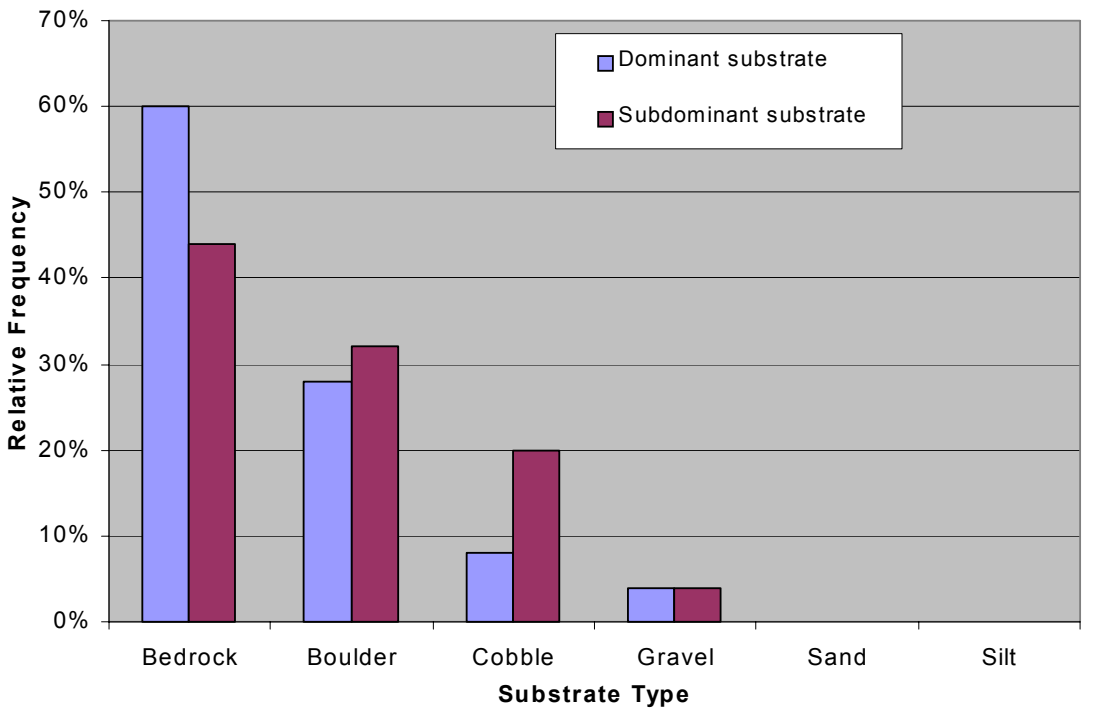

Figure 4.2-2. Relative frequency of dominant and subdominant substrates in Rockbound Dam Reach, September 2002.

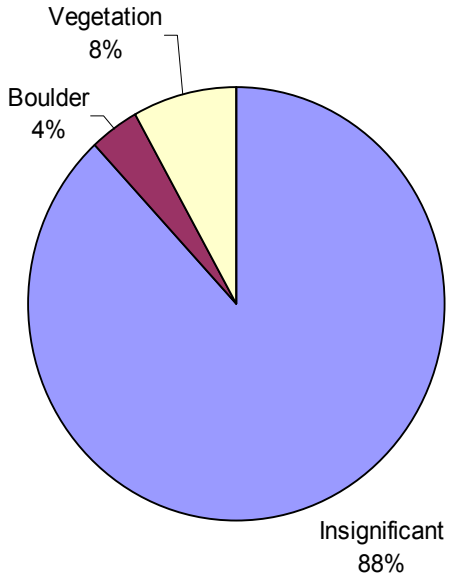

Figure 4.2-3. Percentage of stream cover types in Rockbound Dam Reach, September 2002.

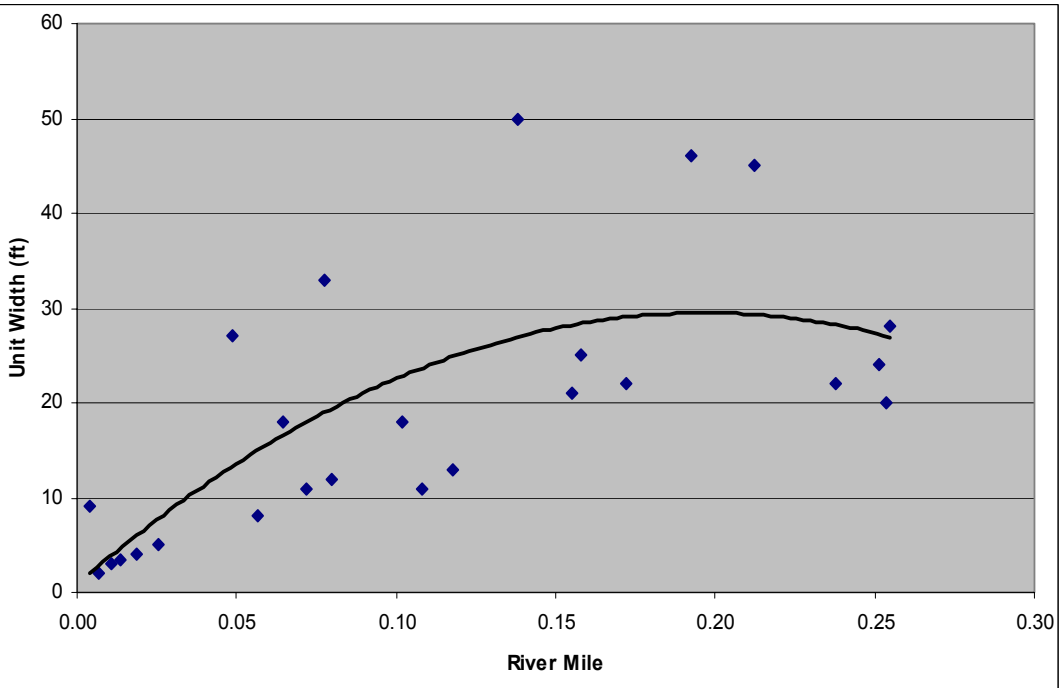

Figure 4.2-4. Longitudinal distribution of habitat unit widths in Rockbound Dam Reach, September 2002.

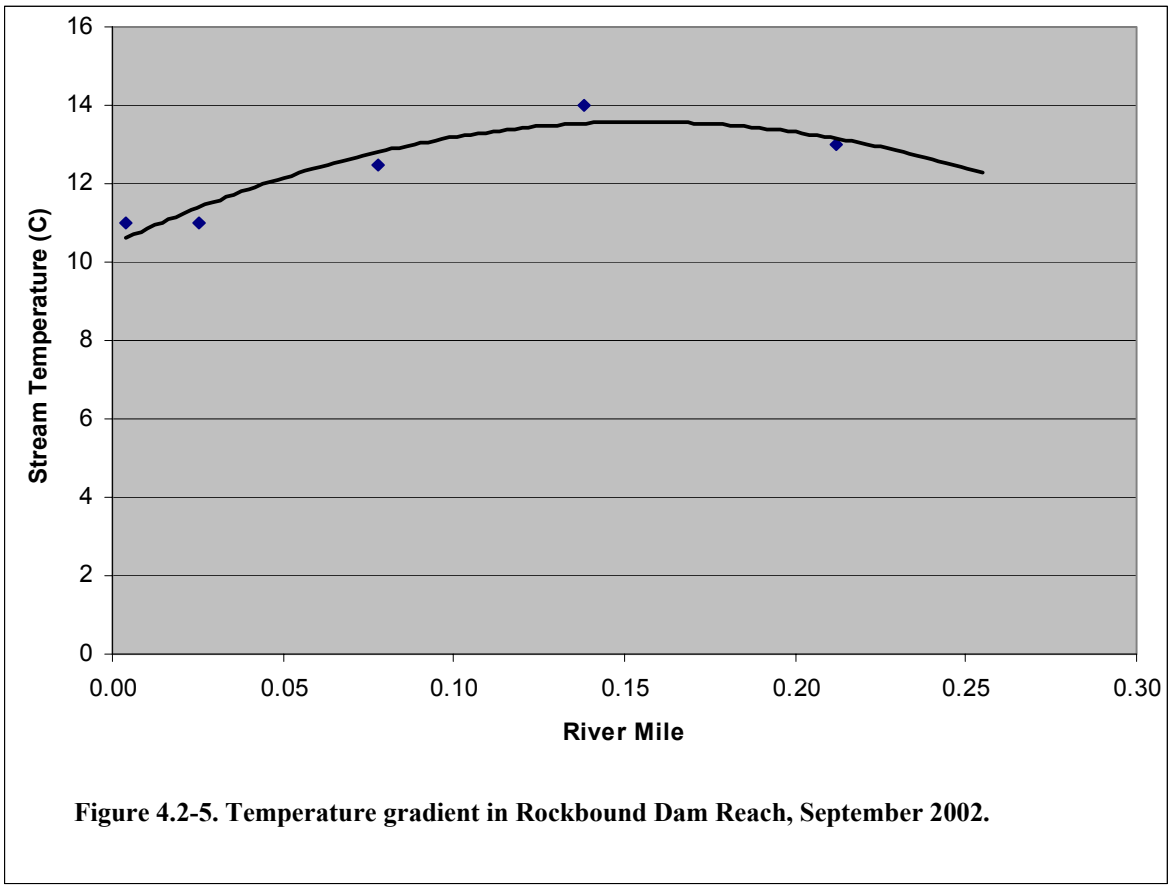

Figure 4.2-5. Temperature gradient in Rockbound Dam Reach, September 2002.

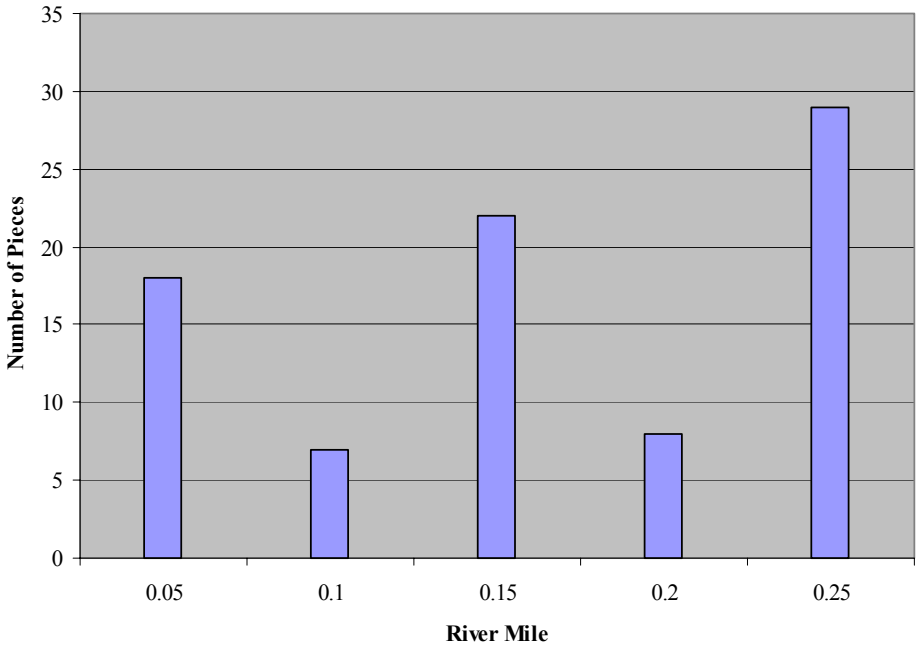

Figure 4.2-6. Spatial distribution of LWD (all size classes) in Rockbound Dam Reach, September 2002.

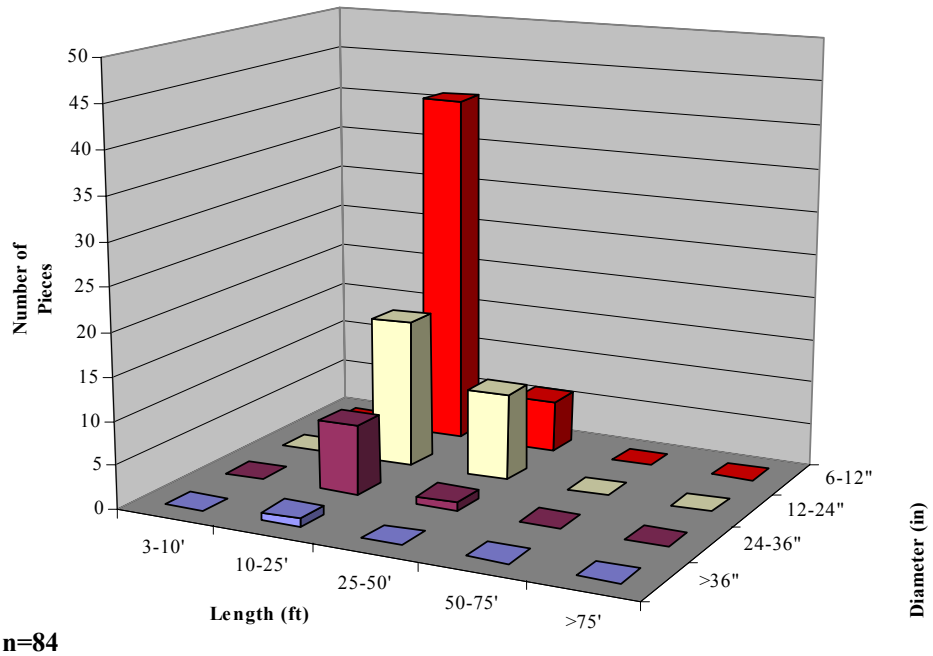

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Figure 4.2-7. Relative abundance of LWD size classes in Rockbound Dam Reach, September 2002.

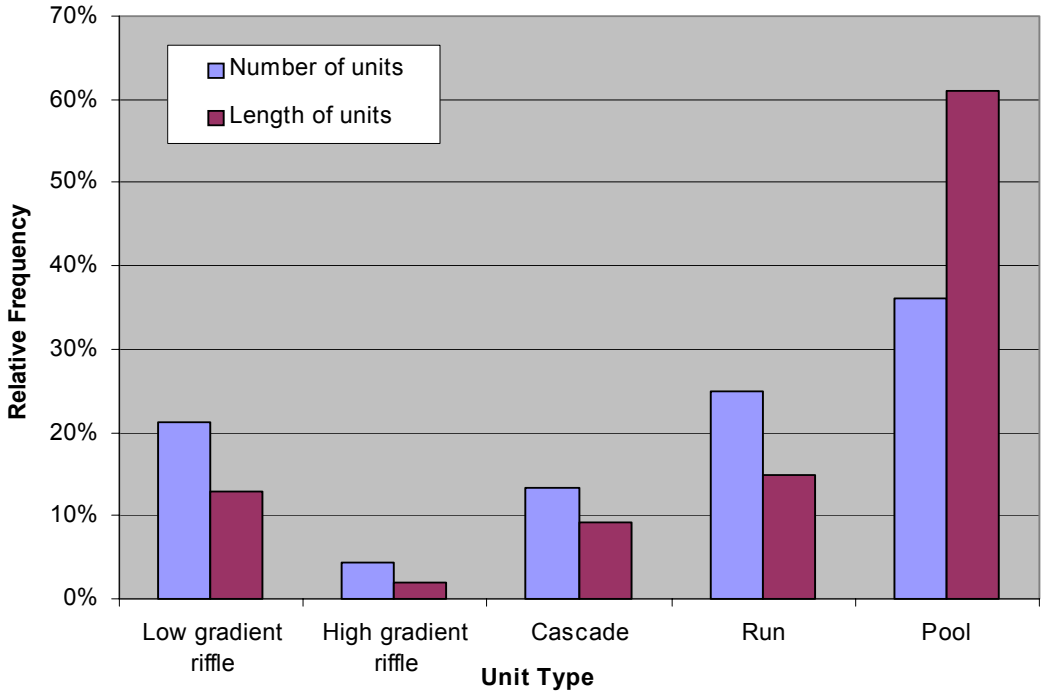


Figure 4.3-1. Relative frequency of habitat types and cumulative habitat lengths in Buck Island Dam Reach, September 2002.

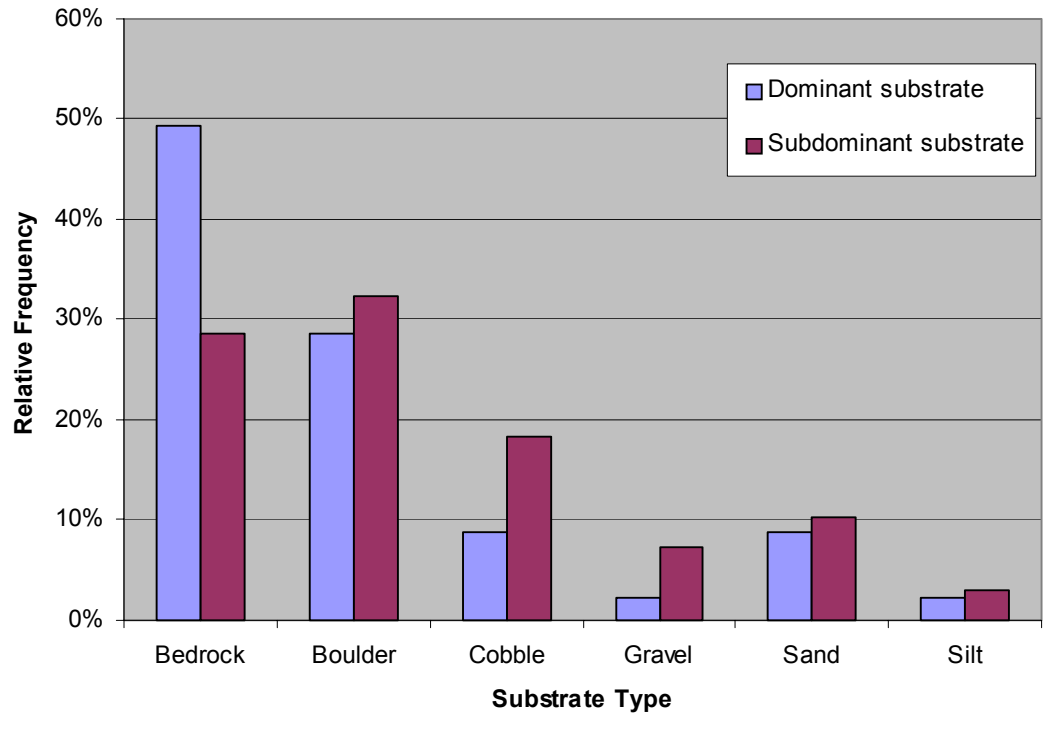


Figure 4.3-2. Relative frequency of dominant and subdominant substrates in Buck Island Dam Reach, September 2002.

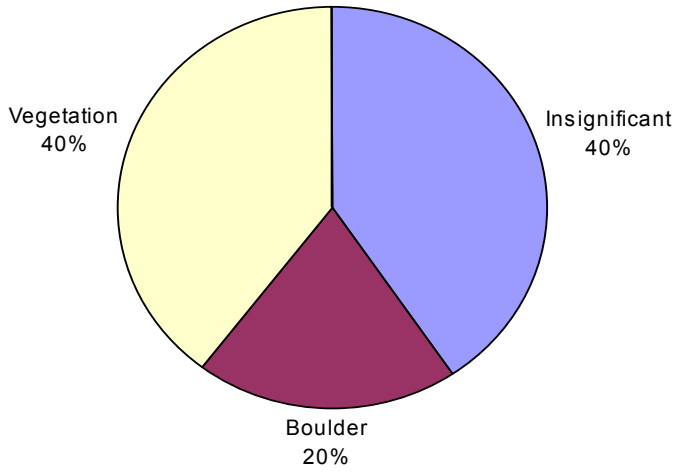


Figure 4.3-3. Percentage of stream cover types in Buck Island Dam Reach, September 2002.

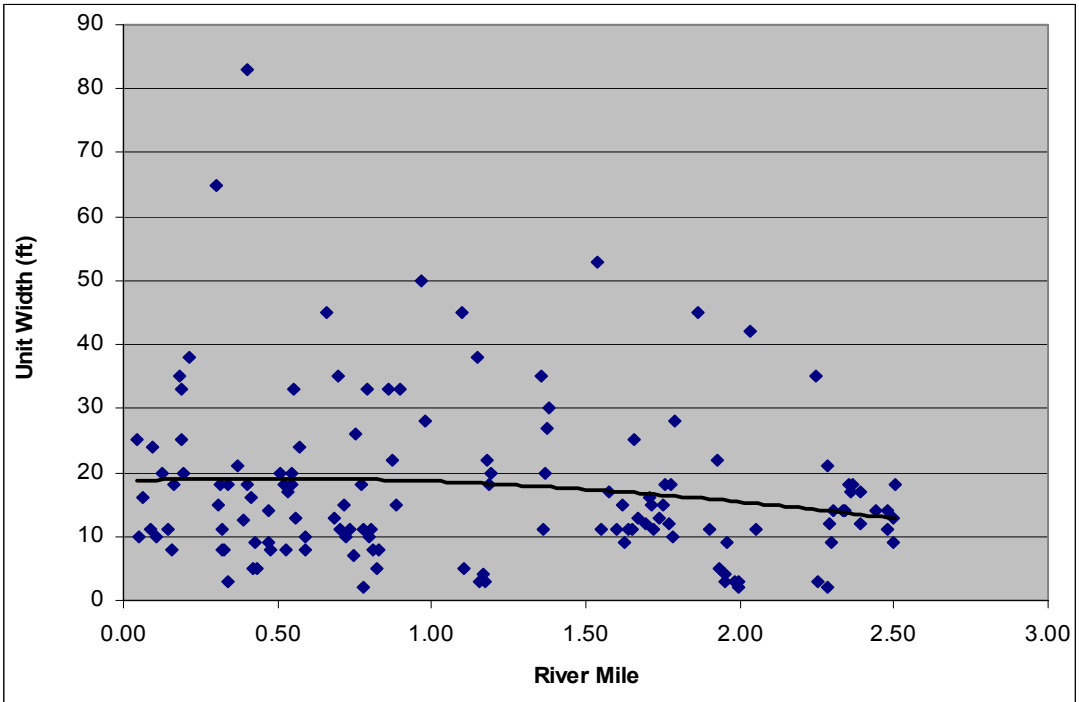


Figure 4.3-4. Longitudinal distribution of habitat unit widths in Buck Island Dam Reach, September 2002.

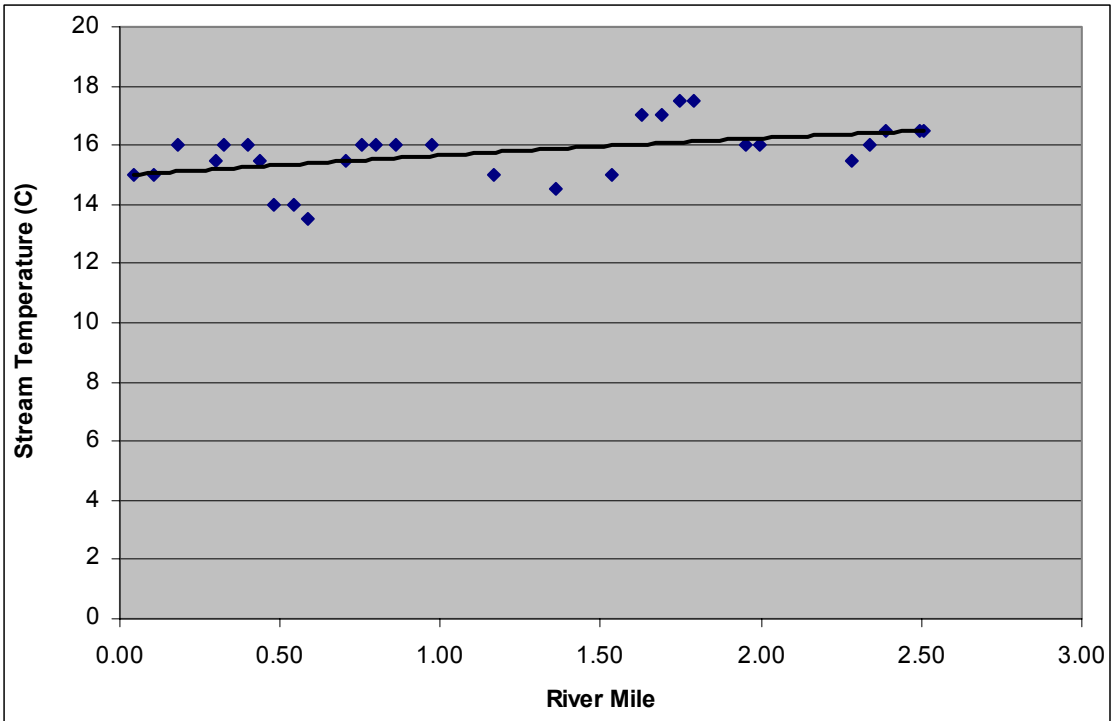


Figure 4.3-5. Temperature gradient in Buck Island Dam Reach, September 2002.

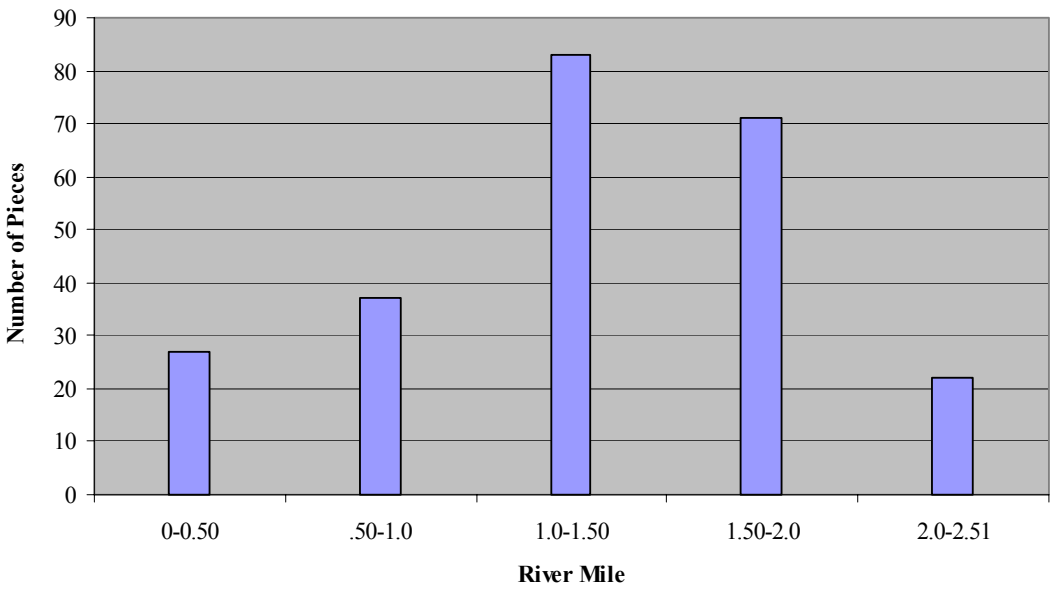


Figure 4.3-6. Spatial distribution of LWD (all size classes) in Buck Island Dam Reach, September 2002.

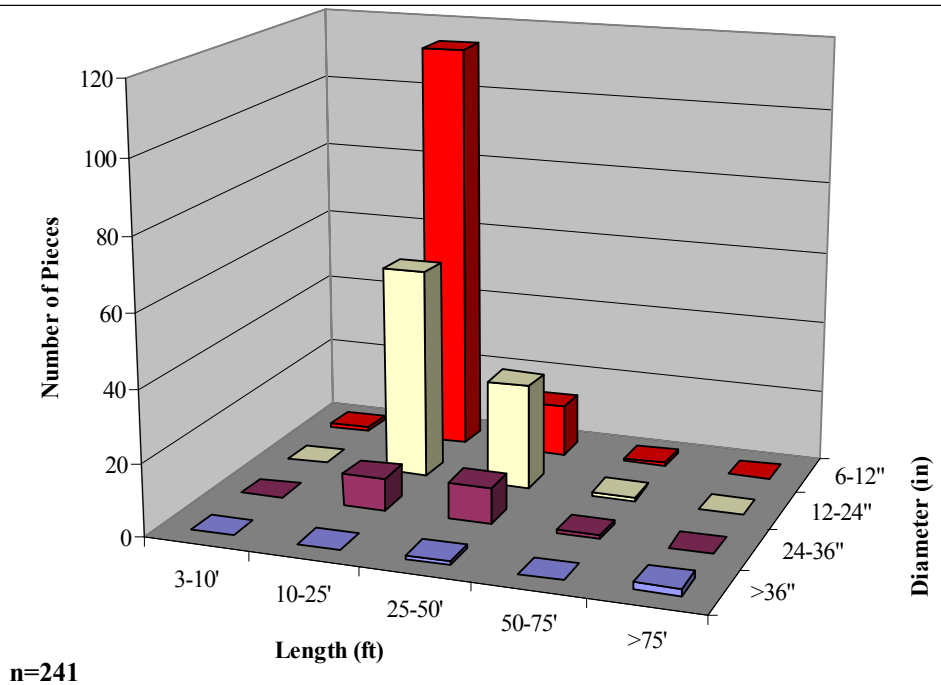


Figure 4.3-7. Relative abundance of LWD size classes in Buck Island Dam Reach, September 2002.

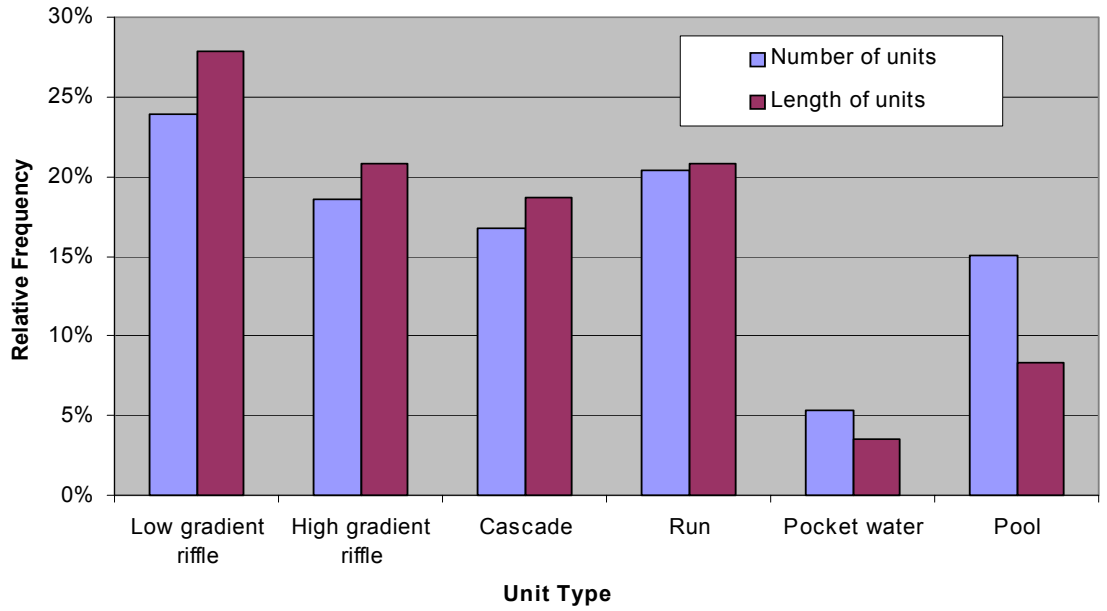


Figure 4.4-1. Relative frequency of habitat types and cumulative habitat lengths in Loon Lake Dam Reach between Gerle Reservoir and river mile 3, August 2002.

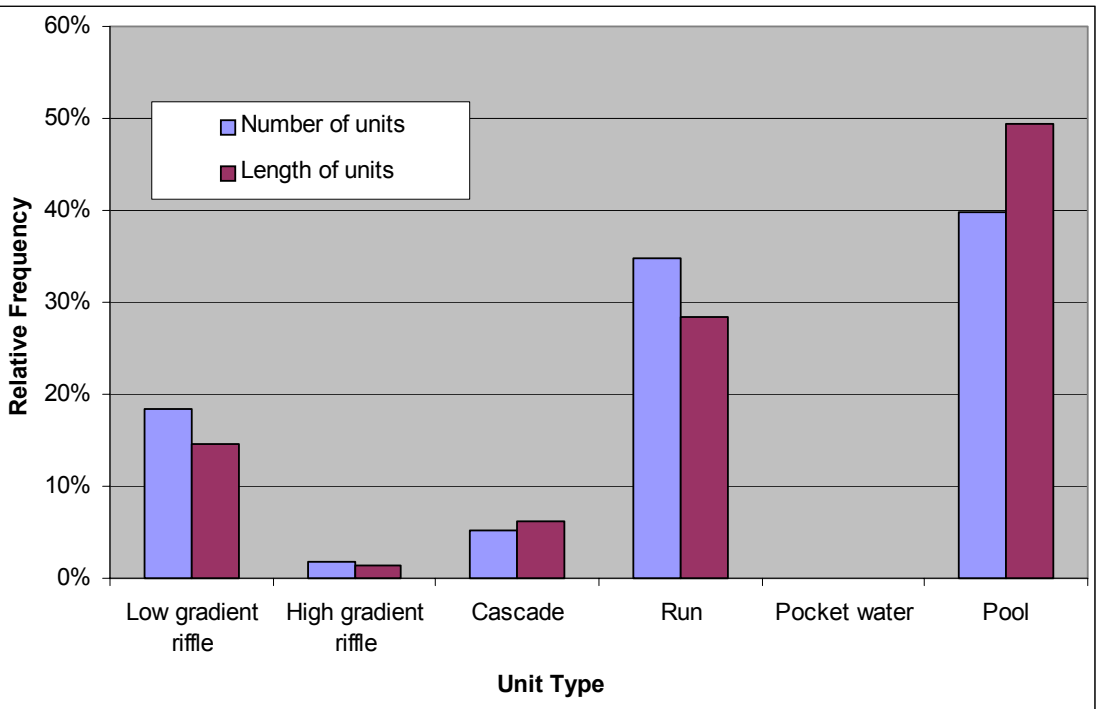


Figure 4.4-2. Relative frequency of habitat types and cumulative habitat lengths in Loon Lake Dam Reach between river mile 3 and Loon Lake Dam, August 2002.

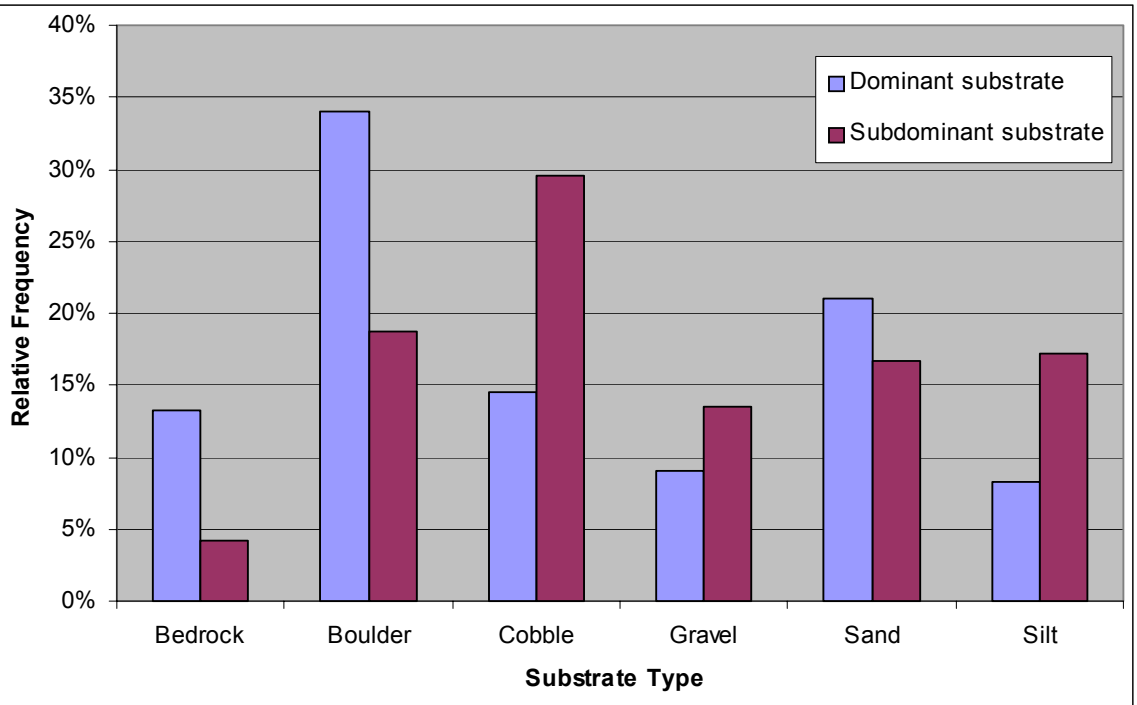


Figure 4.4-3. Relative frequency of dominant and subdominant substrates in Loon Lake Dam Reach, August 2002.

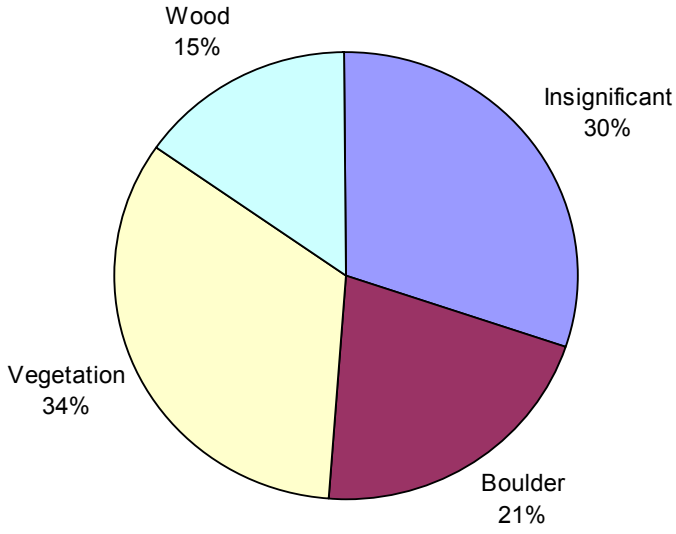


Figure 4.4-4. Percentage of stream cover types in Loon Lake Dam Reach, August 2002.

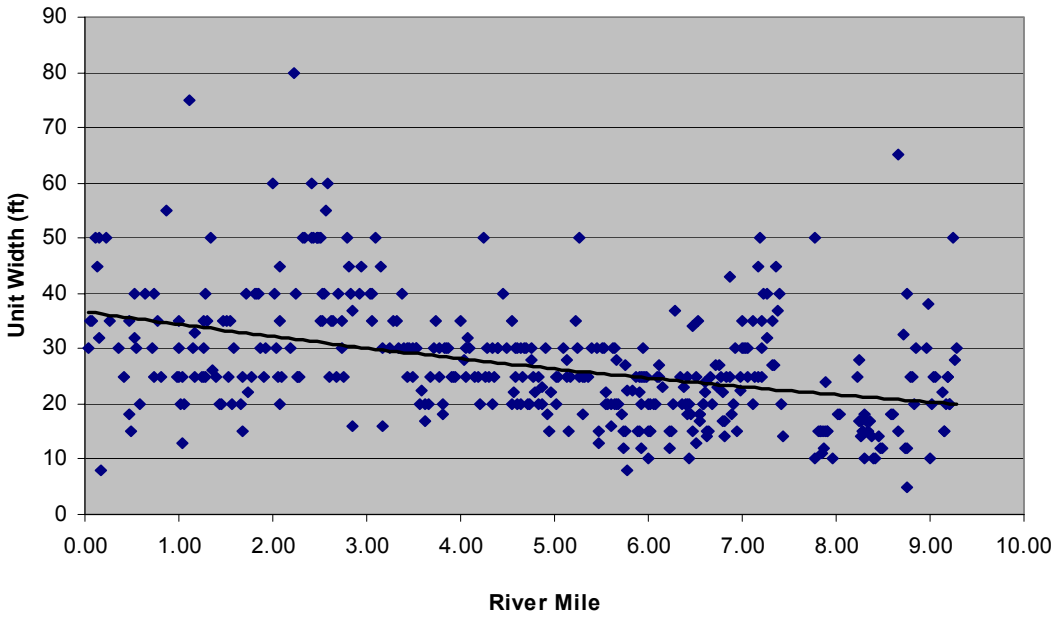


Figure 4.4-5. Longitudinal distribution of habitat unit widths in Loon Lake Dam Reach, August 2002.

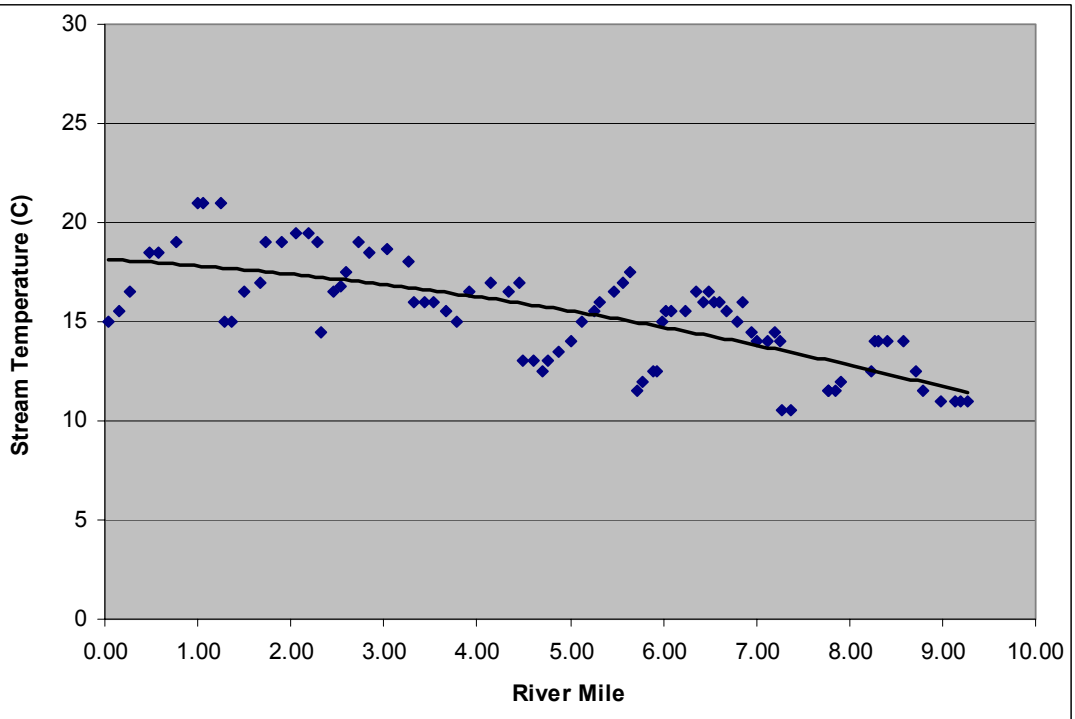


Figure 4.4-6. Temperature gradient in Loon Lake Dam Reach, August 2002.

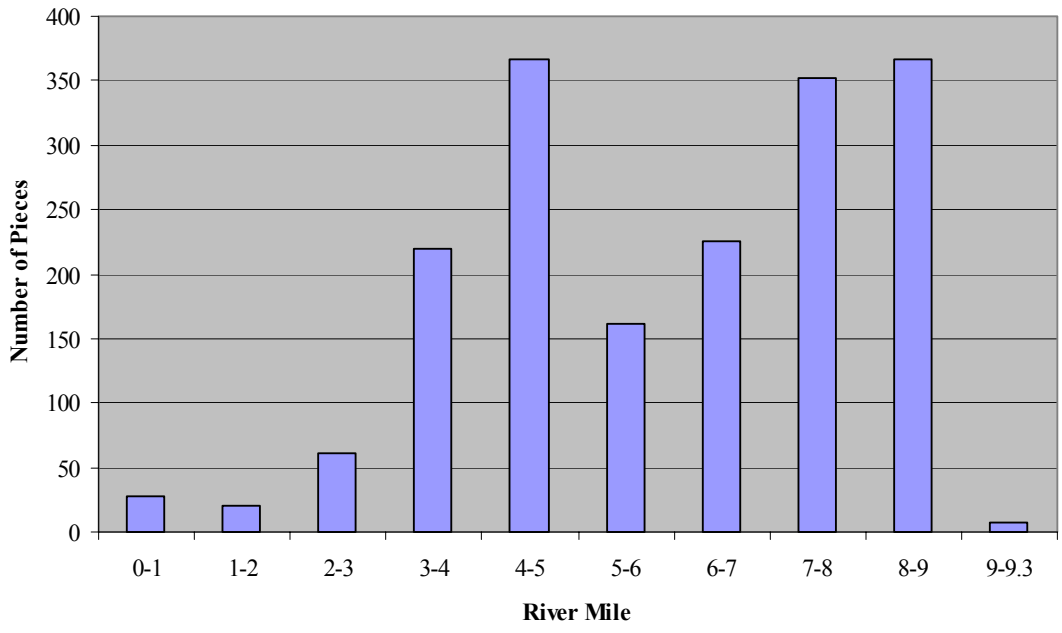


Figure 4.4-7. Spatial distribution of LWD (all size classes) in Loon Lake Dam Reach, August 2002.

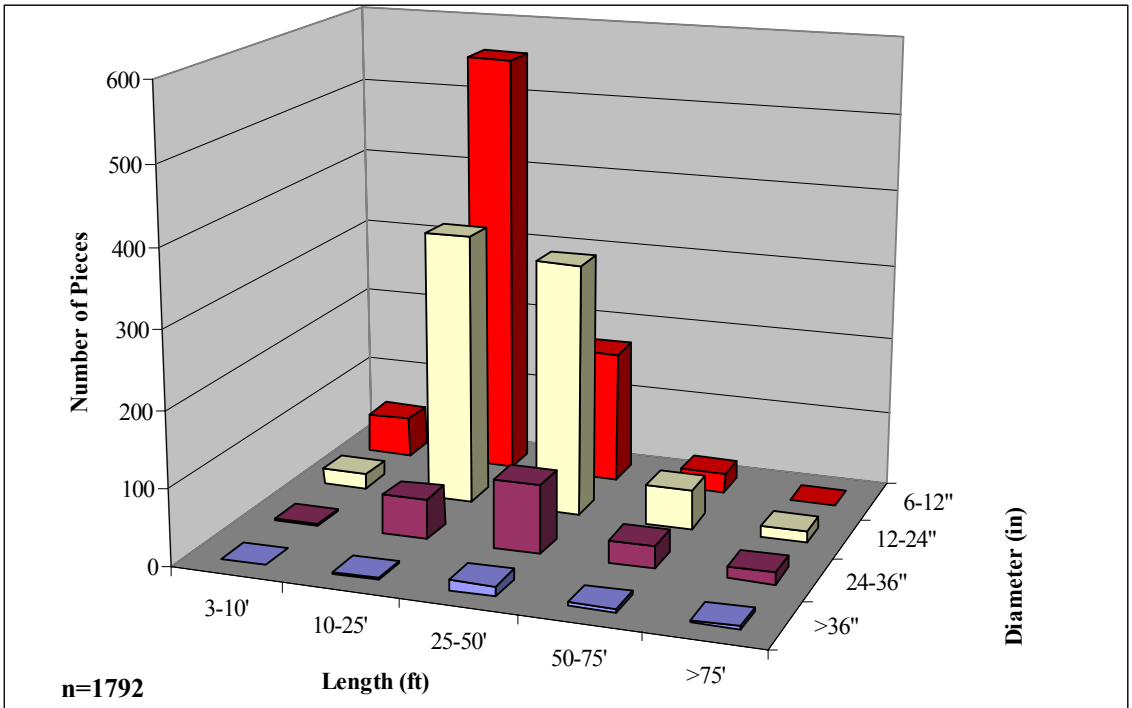


Figure 4.4-8. Relative abundance of LWD size classes in Loon Lake Dam Reach, August 2002.

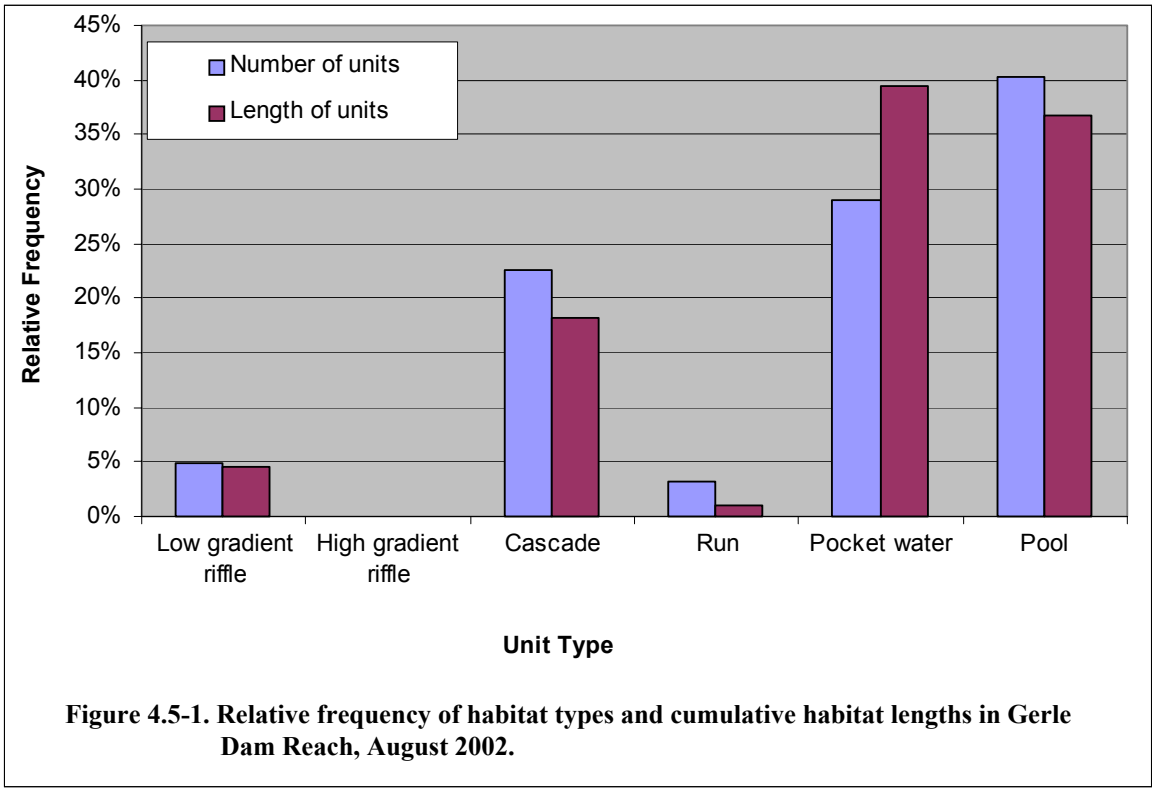


Figure 4.5-1. Relative frequency of habitat types and cumulative habitat lengths in Gerle Dam Reach, August 2002.

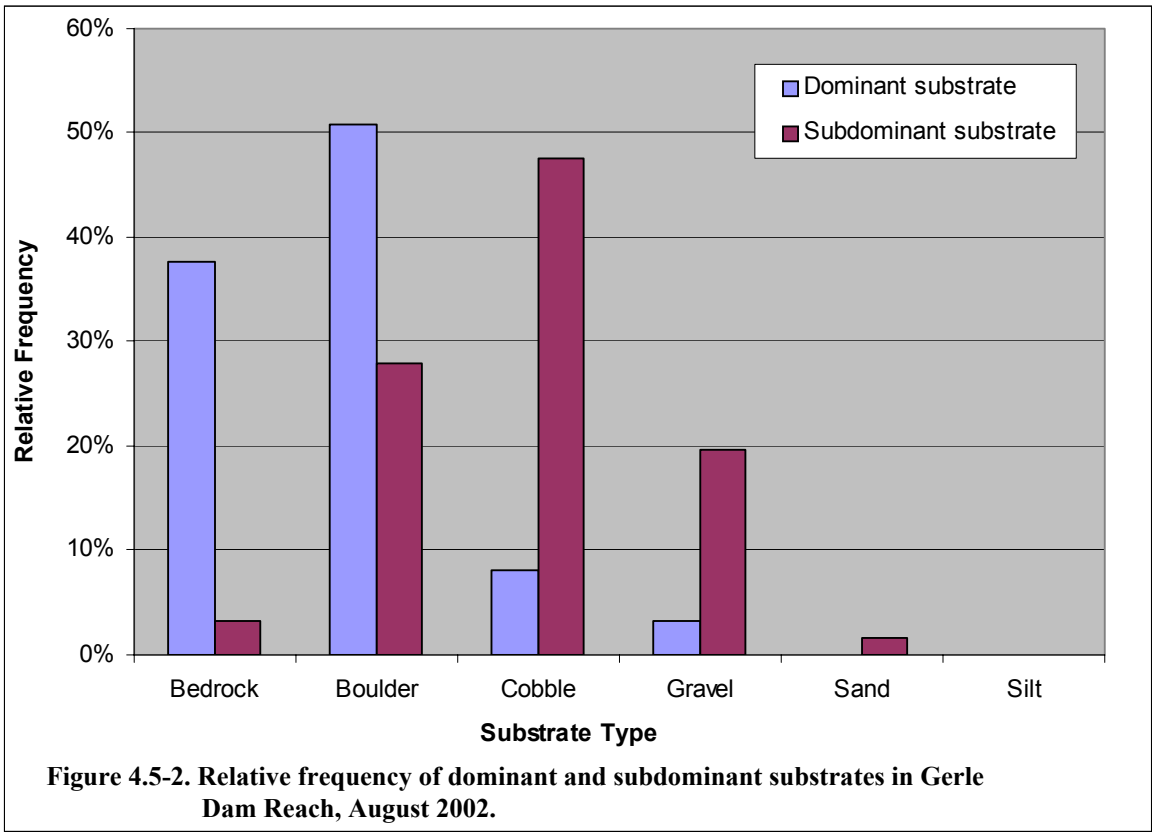


Figure 4.5-2. Relative frequency of dominant and subdominant substrates in Gerle Dam Reach, August 2002.

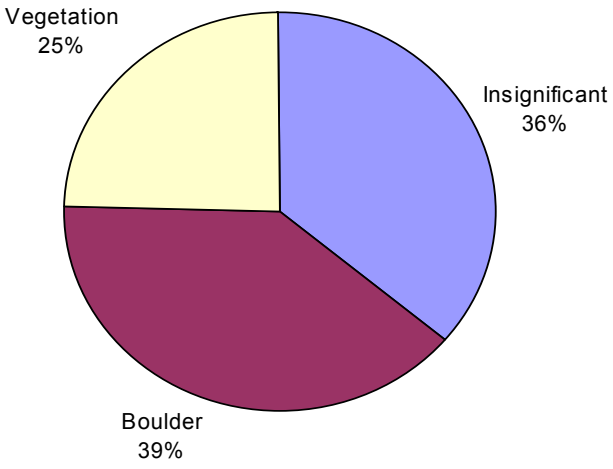


Figure 4.5-3. Percentage of stream cover types in Gerle Dam Reach, August 2002.

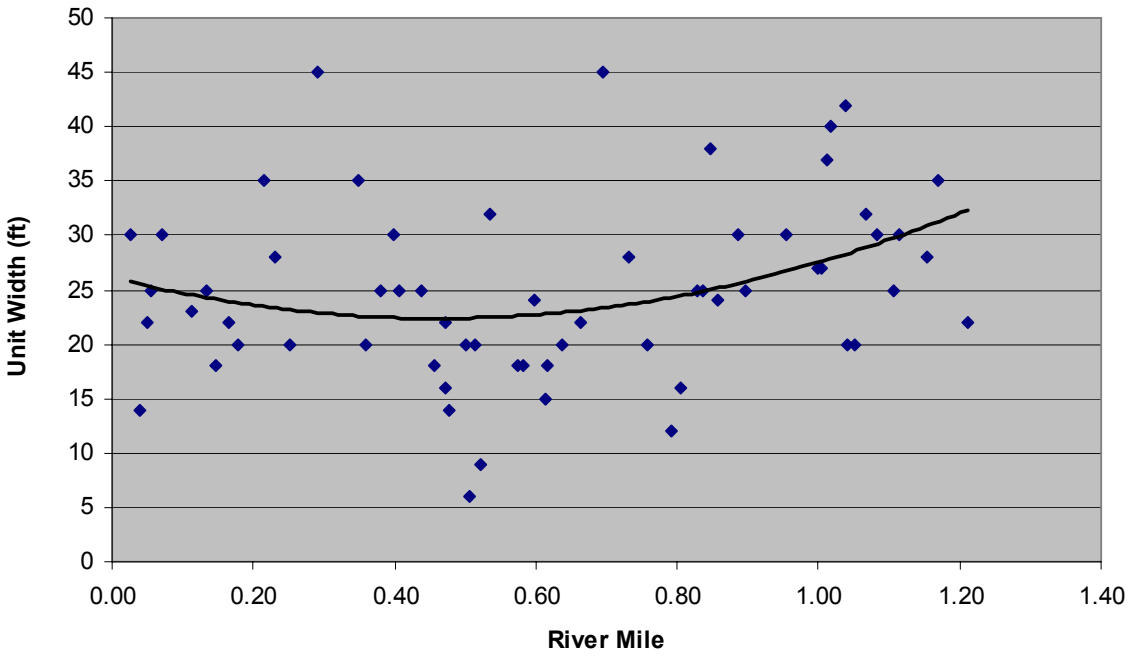


Figure 4.5-4. Longitudinal distribution of habitat unit widths in Gerle Dam Reach, August 2002.

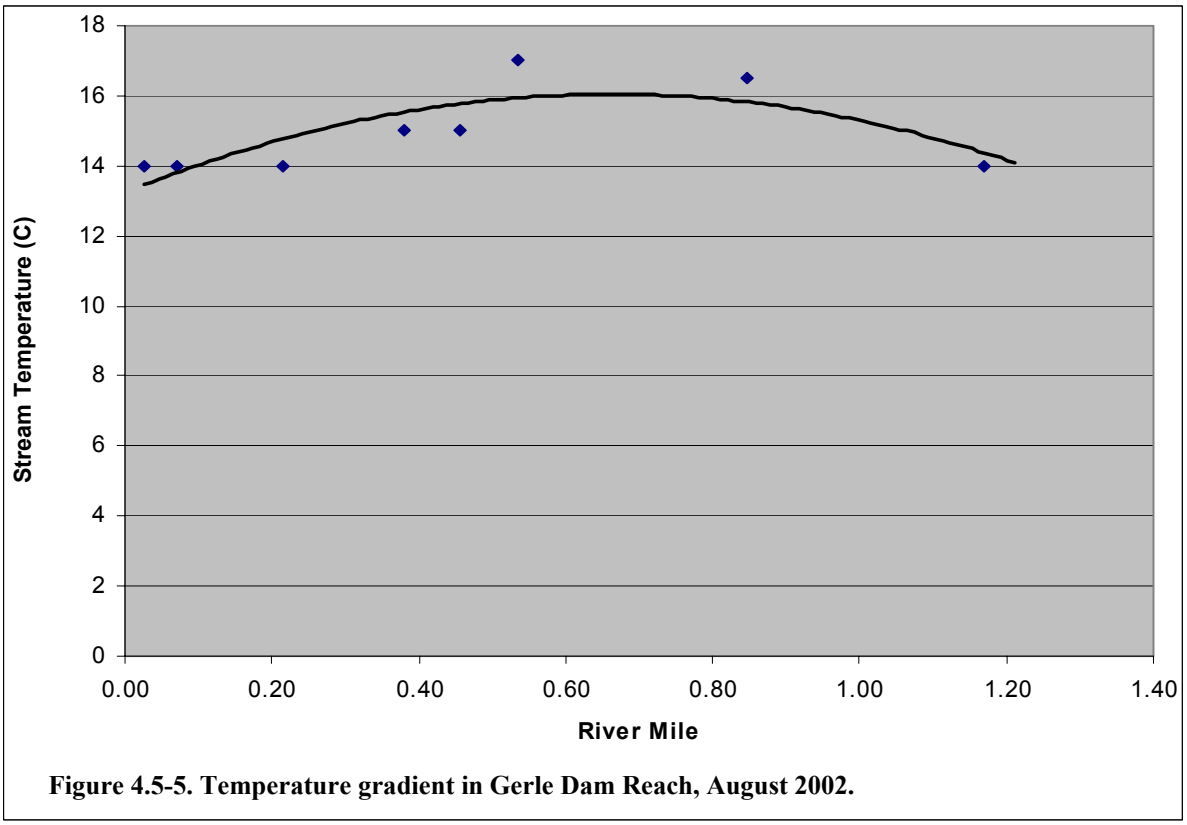


Figure 4.5-5. Temperature gradient in Gerle Dam Reach, August 2002.

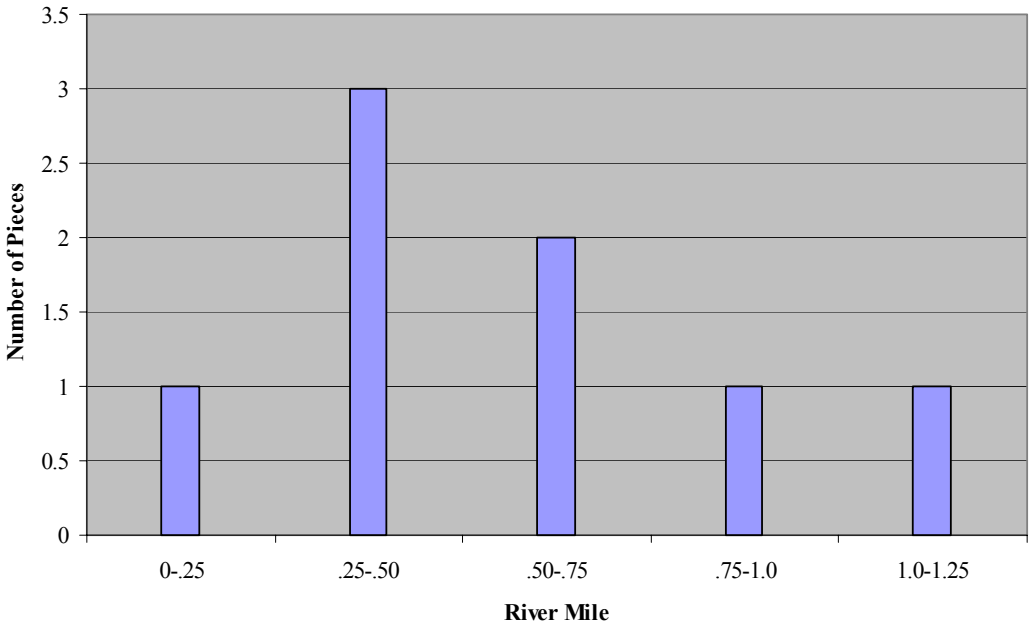


Figure 4.5-6. Spatial distribution of LWD (all size classes) in Gerle Dam Reach, August 2002.

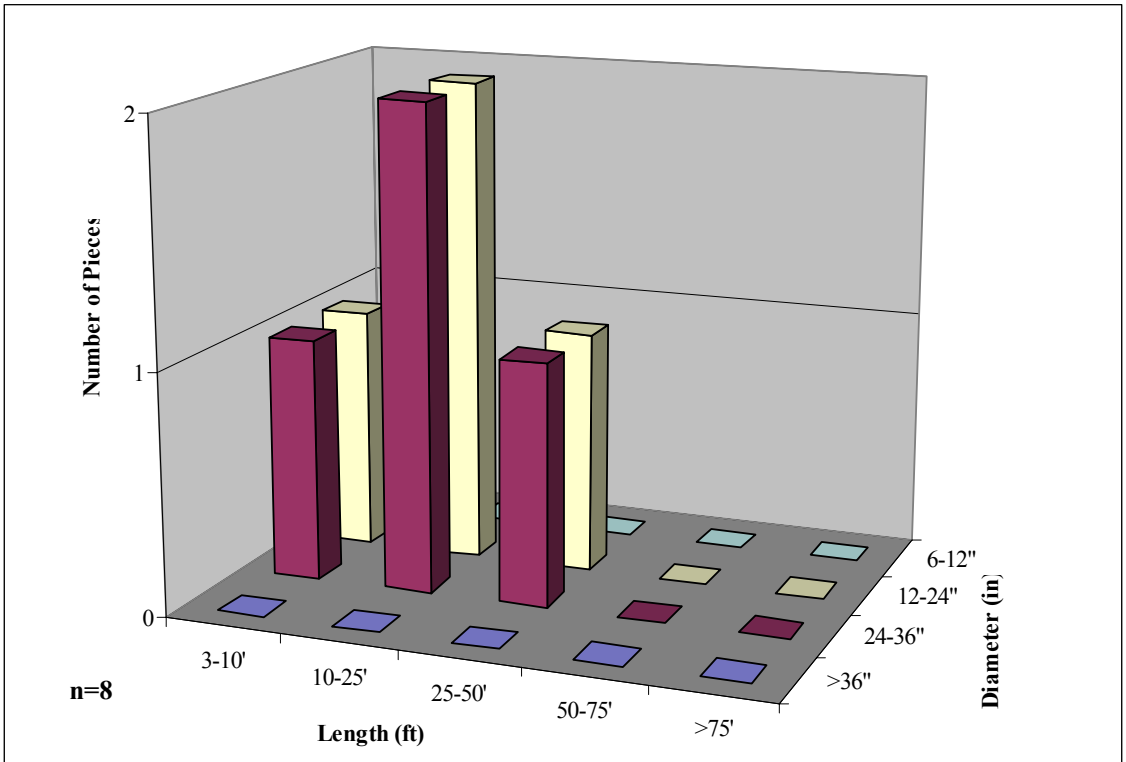


Figure 4.5-7. Relative abundance of LWD size classes in Gerle Dam Reach, August 2002.

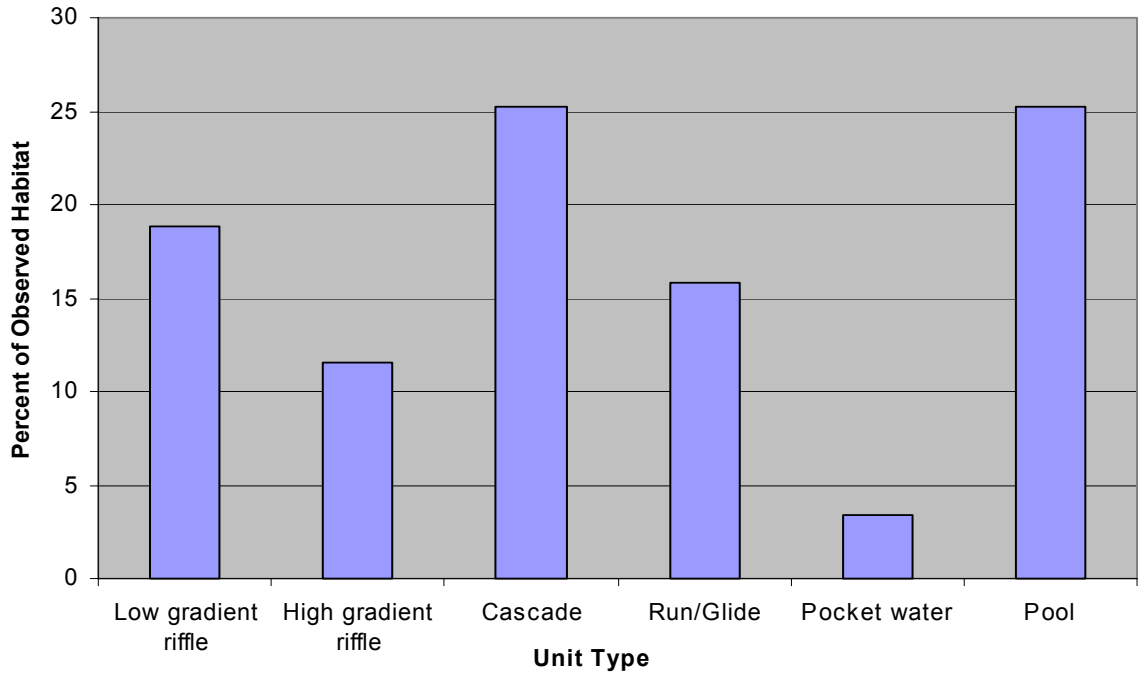


Figure 4.6-1. Relative frequency of habitat types in the Robbs Peak Dam Reach, August 2002.

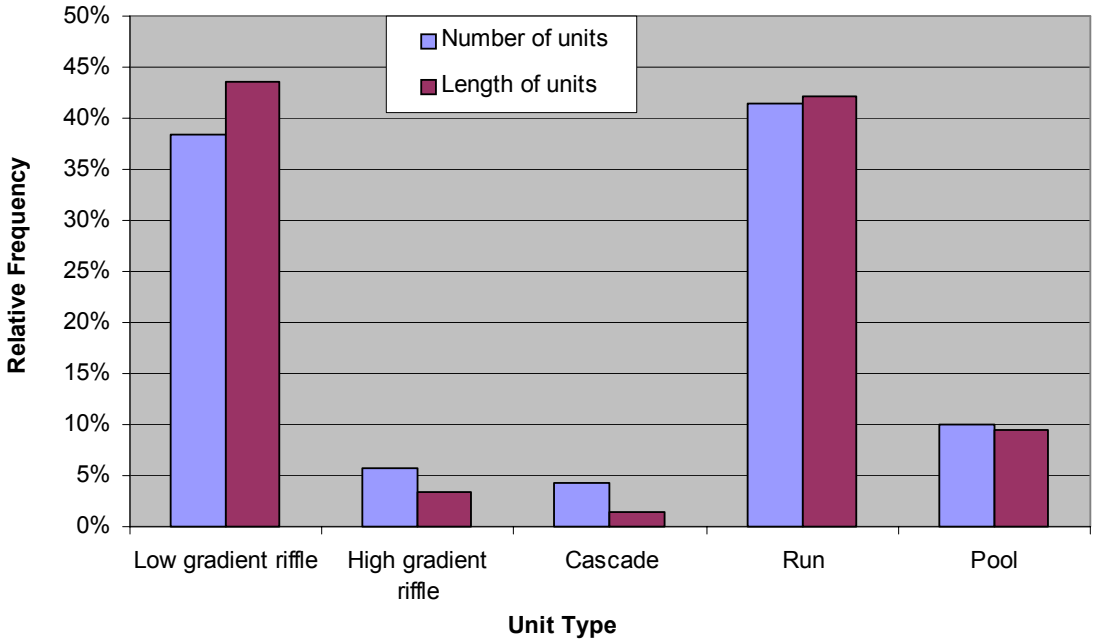


Figure 4.7-1. Relative frequency of habitat types and cumulative habitat lengths in Ice House Dam Reach, August and September 2002.

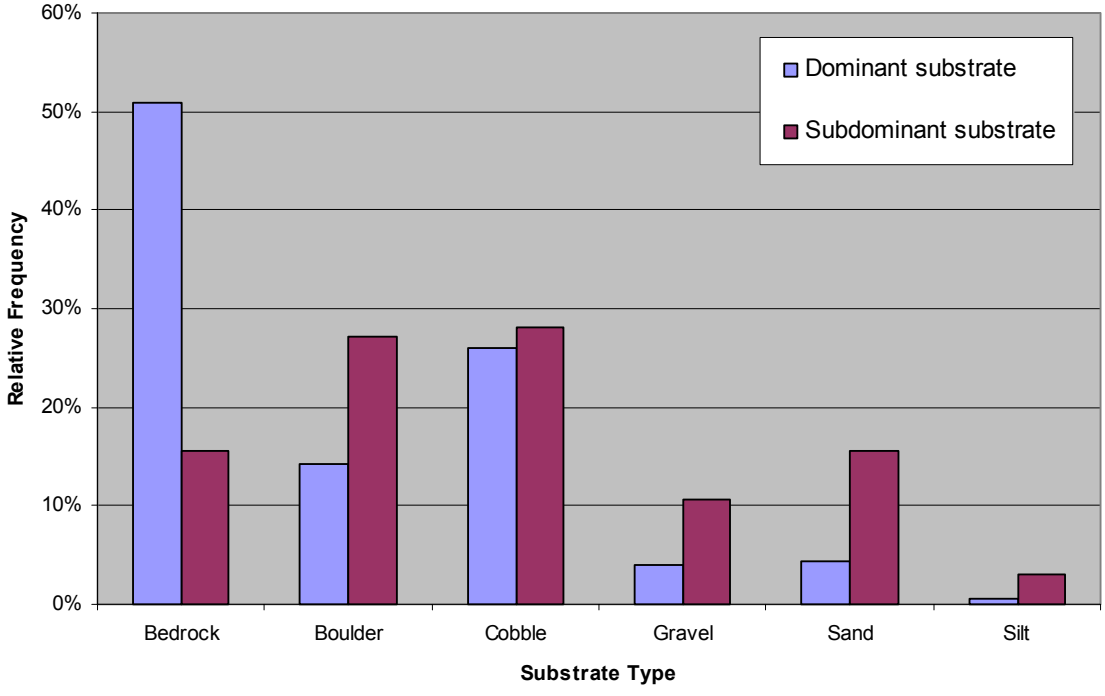


Figure 4.7-2. Relative frequency of dominant and subdominant substrates in Ice House Dam Reach, August and September 2002.

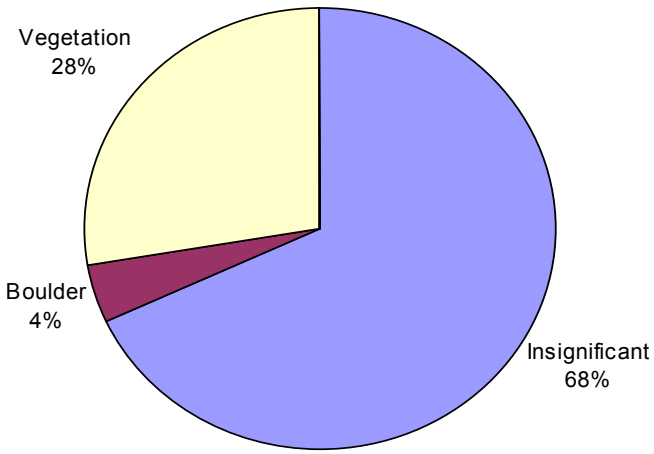


Figure 4.7-3. Percentage of stream cover types in Ice House Dam Reach, August and September 2002.

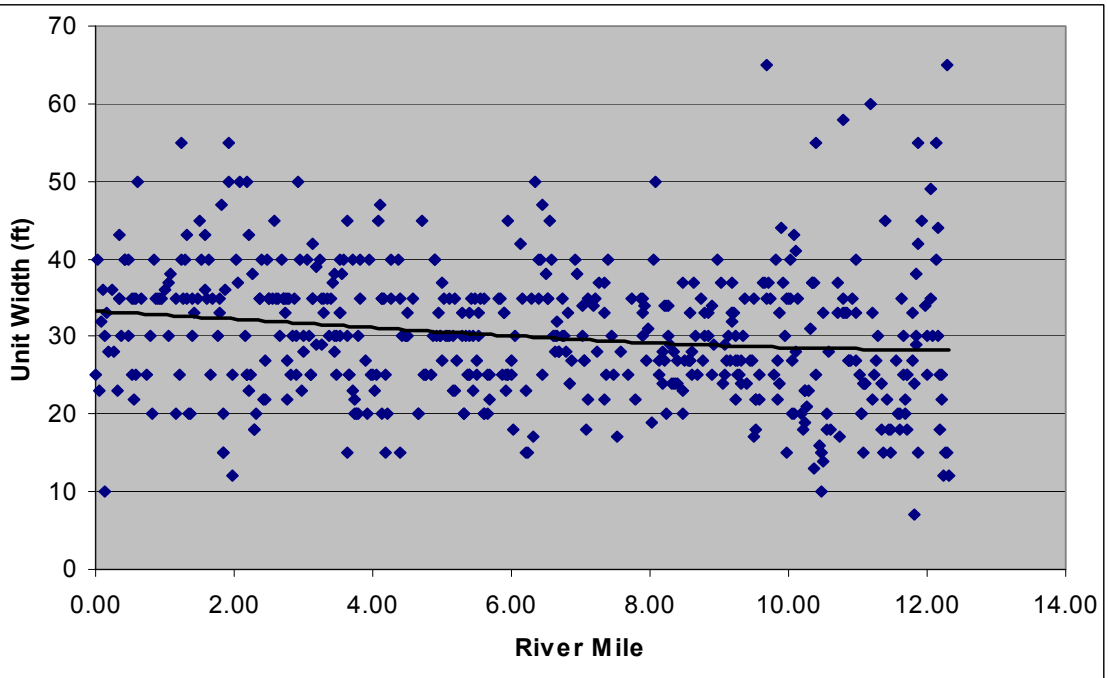


Figure 4.7-4. Longitudinal distribution of habitat unit widths in Ice House Dam Reach, August and September 2002.

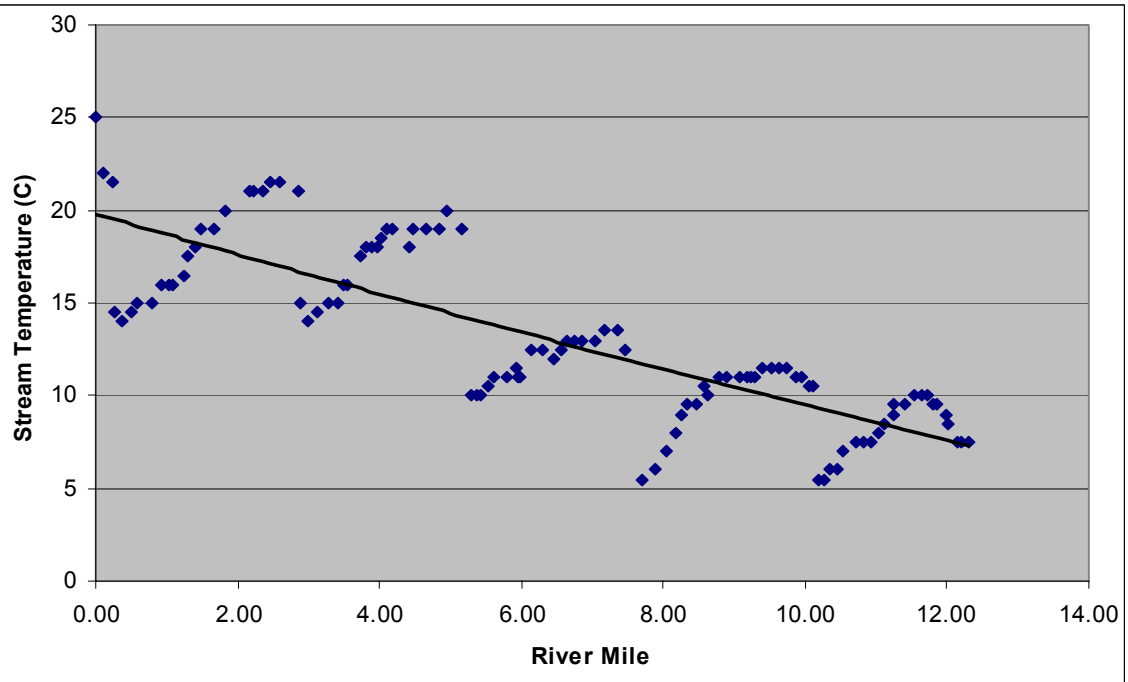


Figure 4.7-5. Temperature gradient in Ice House Dam Reach, August and September 2002.

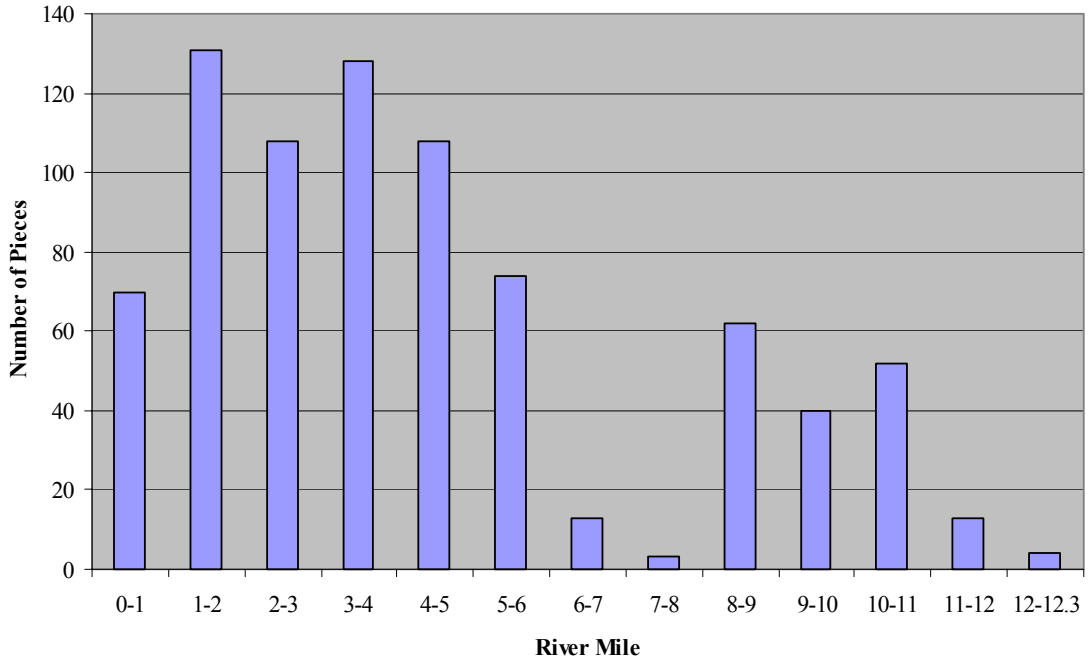


Figure 4.7-6. Spatial distribution of LWD (all size classes) in Ice House Dam Reach, August and September 2002.

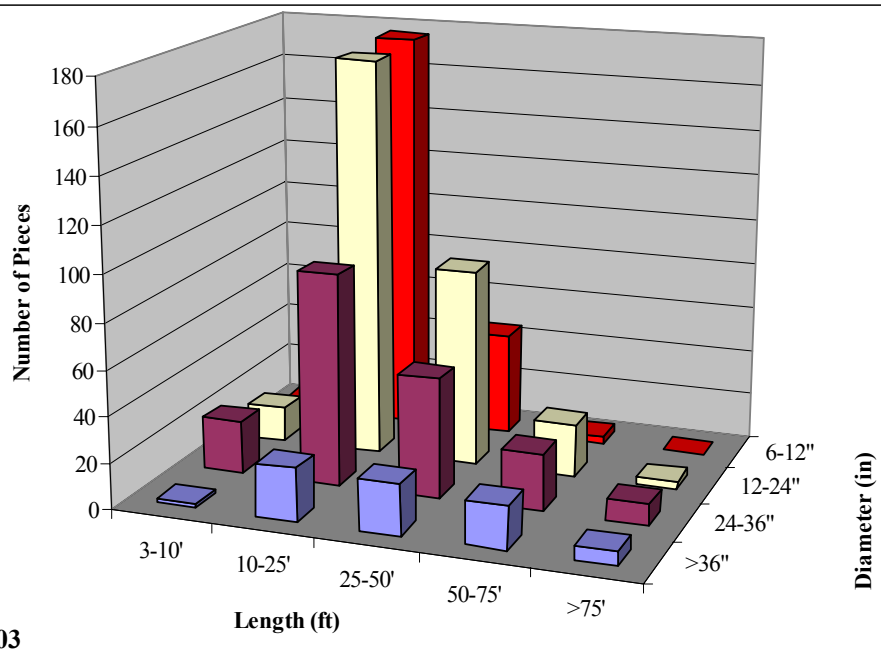


Figure 4.7-7. Relative abundance of LWD size classes in Ice House Dam Reach, August and September 2002.

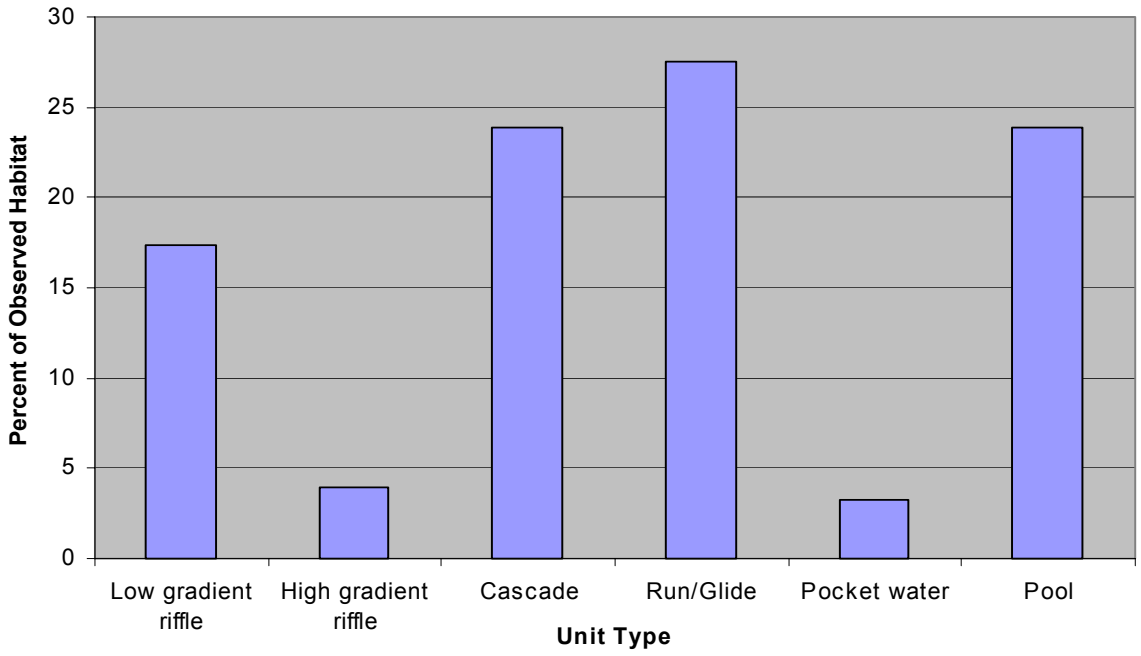


Figure 4.8-1. Relative frequency of habitat types in the Junction Dam Reach, August 2002.

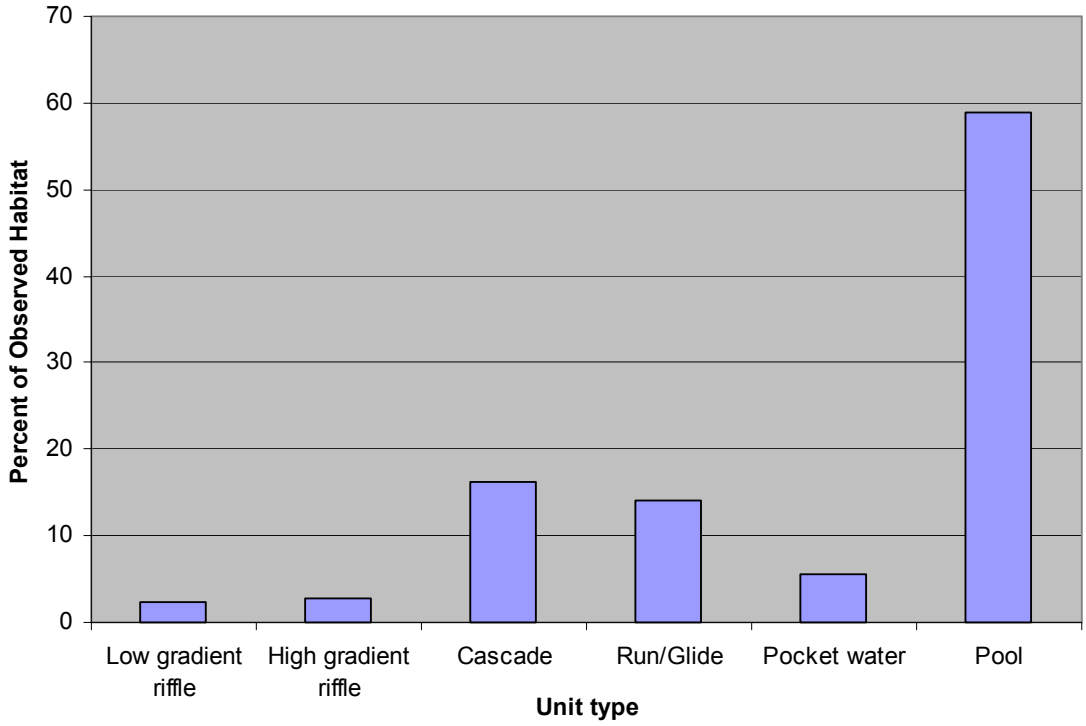


Figure 4.9-1. Relative frequency of habitat types in the Camino Dam Reach, August 2002.

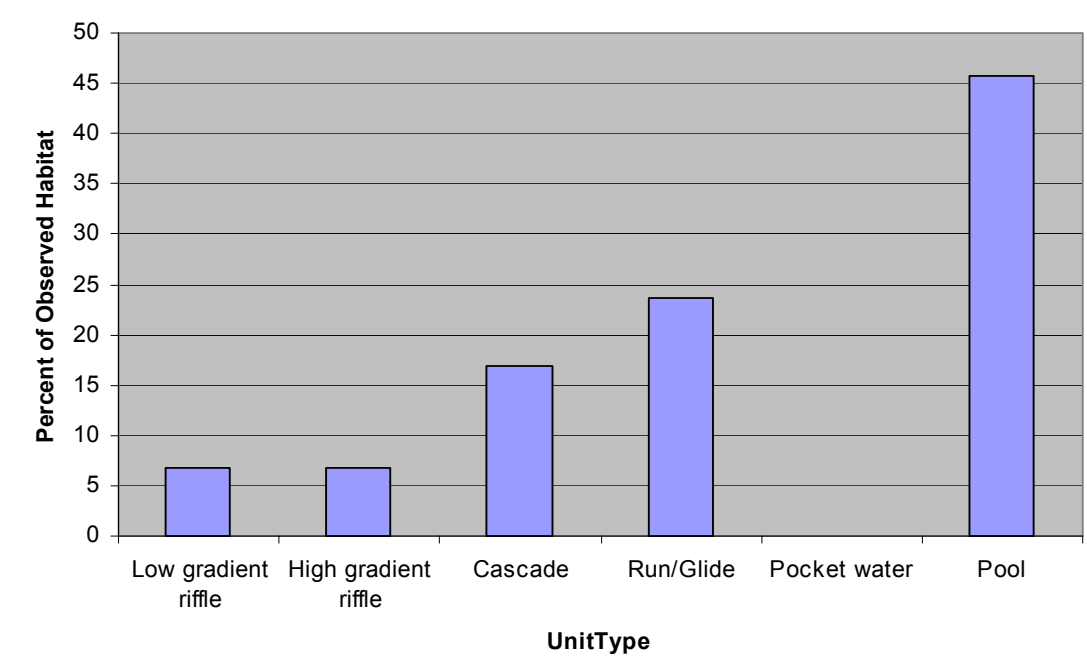


Figure 4.10-1. Relative frequency of habitat types in the South Fork American Reach, August 2002.

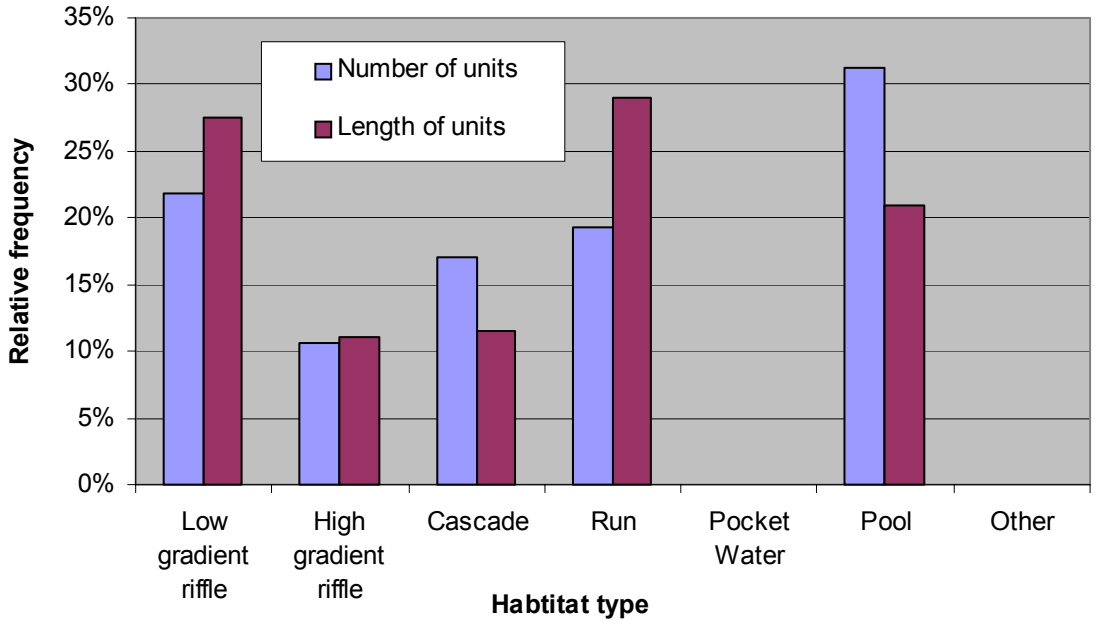


Figure 4.11-1. Relative frequency of habitat types and cumulative habitat lengths in Brush Creek Dam Reach, August 2003.

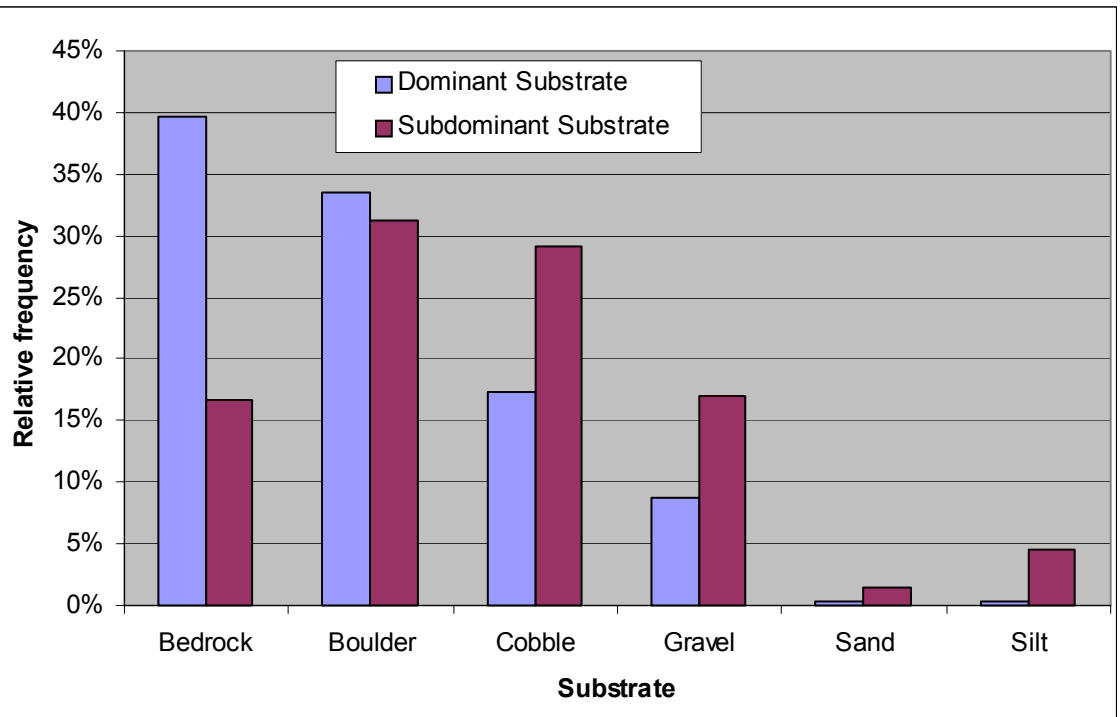


Figure 4.11-2. Substrate characteristics in Brush Creek Dam Reach, August 2003.

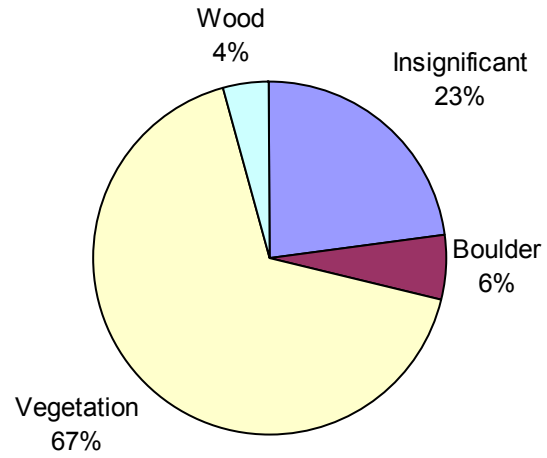


Figure 4.11-3. Percentage of cover types in Brush Creek Dam Reach, August 2003.

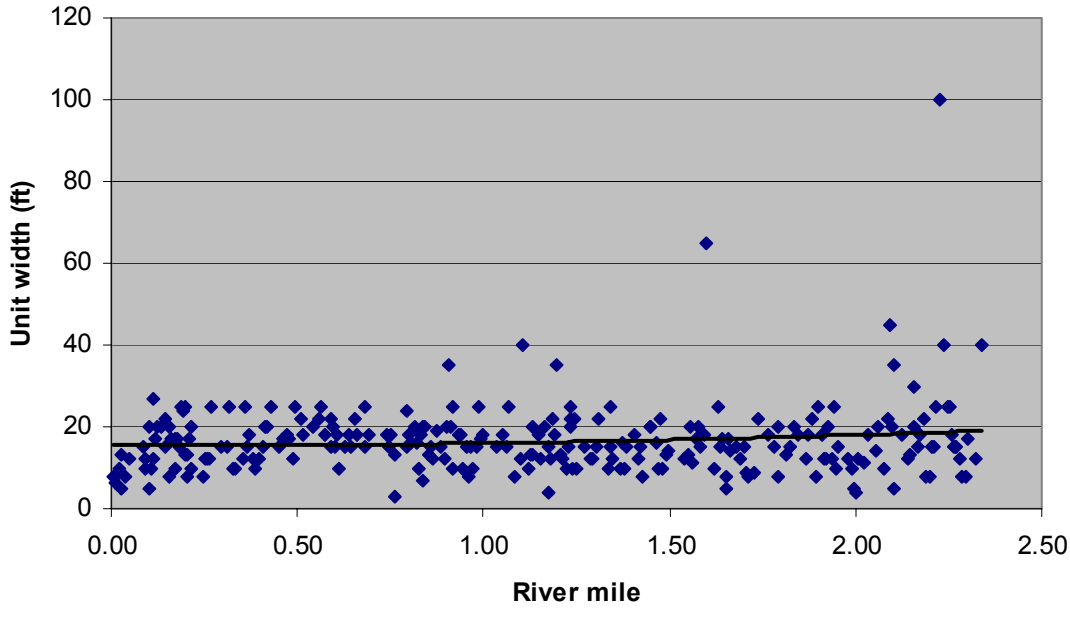


Figure 4.11-4. Longitudinal distribution of unit widths in Brush Creek Dam Reach, August 2003.

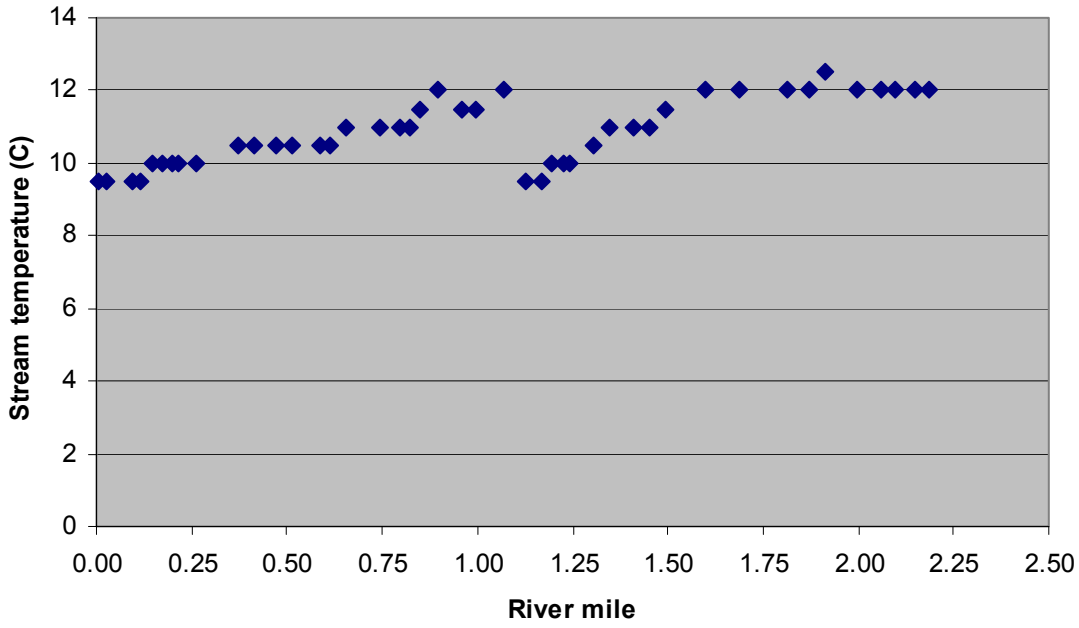


Figure 4.11-5. Temperature gradient in Brush Creek Dam Reach, August 2003.

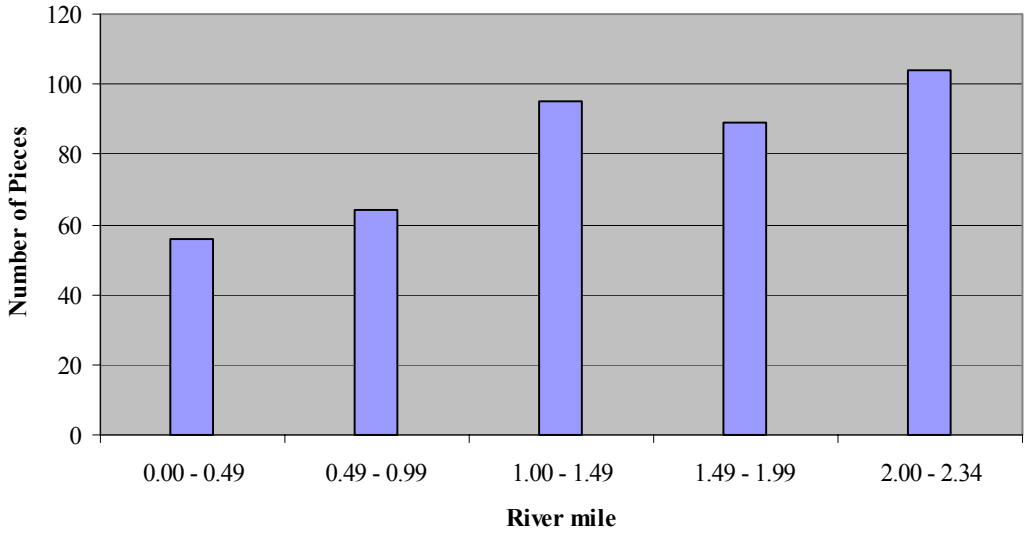
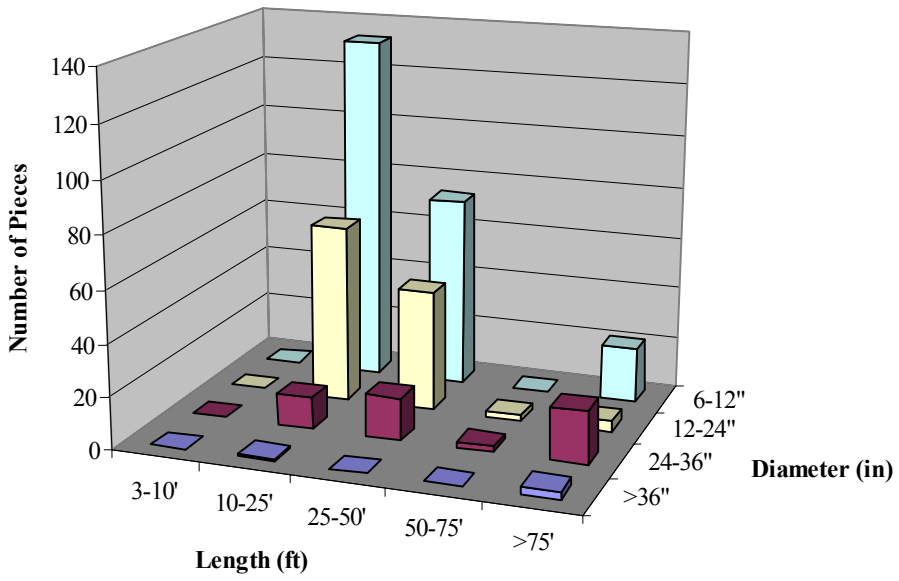


Figure 4.11-6. Spatial distribution of LWD (all size classes) in Brush Creek Dam Reach, August 2003.



n=400

Figure 4.11-7. Relative abundance of LWD size classes in Brush Creek Dam Reach, August 2003.

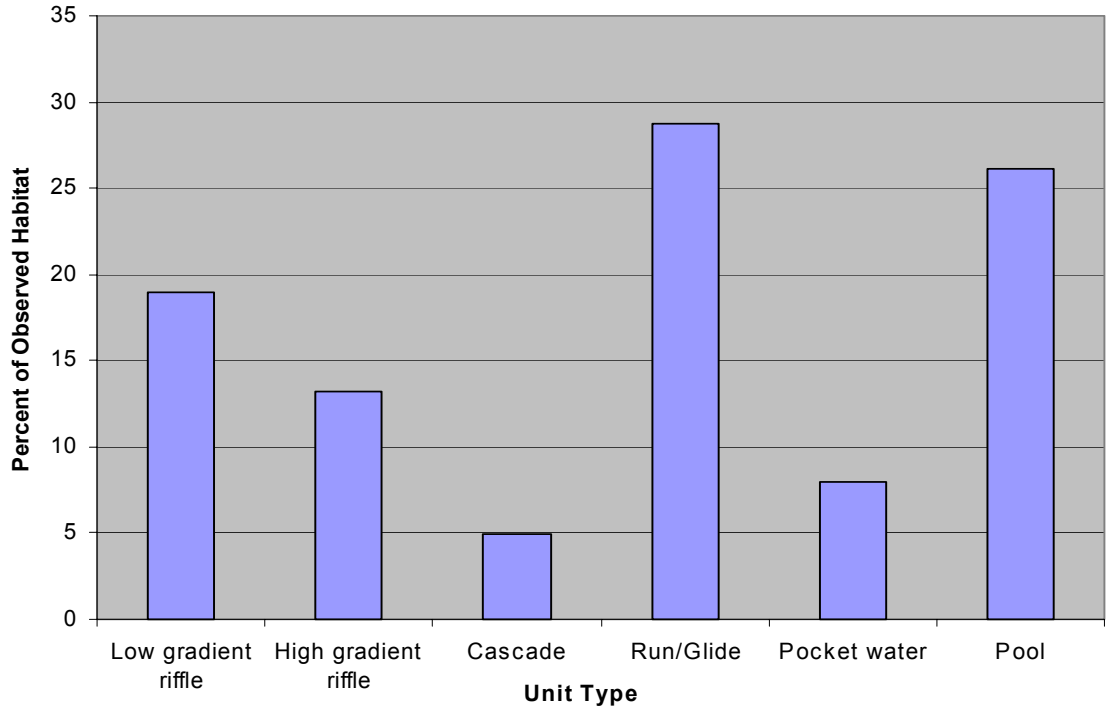


Figure 4.12-1. Relative frequency of habitat types in the Slab Creek Dam Reach, August 2002.

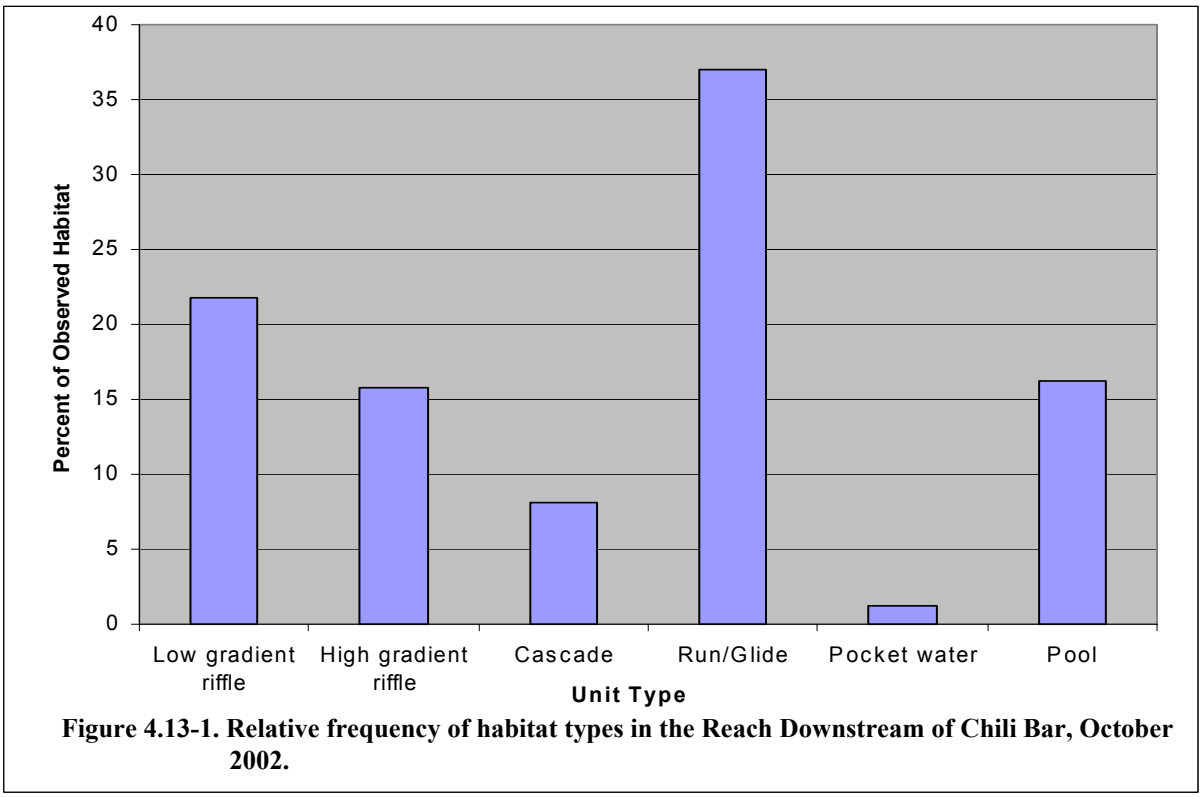


Figure 4.13-1. Relative frequency of habitat types in the Reach Downstream of Chili Bar, October 2002.

APPENDIX A

UARP PROJECT AREA MAPS

- 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

HABITAT SUMMARY TABLES

- Table B-1 Habitat percentage (by length) in study reaches surveyed by foot and by air (frequency of observation), 2002 and 2003.
- Table B-2 Relative percentage of cover, dominant and subdominant substrates, and spawning gravel within the seven study reaches surveyed by foot, 2002 and 2003.
- Table B-3 Habitat, potential migration barriers, and tributary information for the seven study reaches surveyed by foot, 2002 and 2003.
- Table B-4 Large woody debris abundance and spatial distribution in the seven study reaches surveyed by foot, 2002 and 2003.

Table B-1.	**Habitat percentage (by length) in study reaches surveyed by foot and by air (frequency of observation), 2002 and 2003.**							
Stream	**Reach**	**Reach length (mi)**	**Low gradient riffle**	**High gradient riffle**	**Cascade**	**Run**	**Pocket water**	**Pool**
On the ground mapping - Percentage by habitat type length								
Rubicon River	Rubicon Reservoir Dam	5.8	6.6	1.3	9.1	39.2	0.8	41.6
Highland Creek	Rockbound Dam	0.3	28.9	11.7	13.5	8.8	0.0	37.2
Little Rubicon River	Buck Island Dam	2.5	12.9	2.0	9.3	14.8	0.0	61.0
Gerle Creek	Loon Lake Dam	9.3	18.9	7.8	10.4	25.9	1.1	35.9
Gerle Creek	Gerle Creek Dam	1.2	4.6	0.0	18.1	1.1	39.4	36.7
South Fork Silver Creek	Ice House Dam	12.3	43.6	3.3	1.4	42.2	0.0	9.5
Brush Creek	Brush Creek Dam	2.3	21.9	10.6	17.0	19.2	0.0	31.3
Total		***33.7***						
Aerial mapping – Percentage by habitat type frequency								
South Fork Rubicon River	Robbs Peak Dam	5.6	18.8	11.5	25.2	15.8	3.4	25.2
Silver Creek	Junction Dam	8.3	17.4	4.0	23.9	27.5	3.3	23.9
Silver Creek	Camino Dam	6.0	2.6	2.8	16.3	14.0	5.6	59.0
South Fork American River	South Fork American River	2.8	6.8	6.8	17.0	23.7	0.0	45.8
South Fork American River	Slab Creek Dam	8.0	18.9	13.3	4.9	28.8	8.0	26.1
South Fork American River	Downstream of Chili Bar	20	21.8	15.7	8.1	37.0	1.2	16.3
Total		***50.7***						

Table B-2.	Relative percentage of cover, dominant and subdominant substrates, and spawning gravel within the seven study reaches surveyed by foot, 2002 and 2003.						
	Rubicon Reservoir Dam	**Rockbound Dam**	**Buck Island Dam**	**Loon Lake Dam**	**Gerle Dam**	**Ice House Dam**	**Brush Creek Dam**
Cover type (percent)							
Insignificant	23	88	40	30	35	68	23
Boulder	40	4	20	21	39	4	6
Vegetation	36	8	40	34	24	28	67
Wood	1	0	0	15	0	0	4
Other	0	0	0	0	2	0	0
TOTAL	100	100	100	100	100	100	100
Dominant substrate (percent)							
Bedrock	26	60	49	13	38	51	40
Boulder	45	28	29	34	51	14	34
Cobble	5	8	9	15	8	26	17
Gravel	5	4	2	9	3	4	9
Sand	18	0	9	21	0	4	0
Silt	1	0	2	8	0	1	0
TOTAL	100	100	100	100	100	100	100
Subdominant substrate (percent)							
Bedrock	23	44	29	4	3	16	17
Boulder	21	32	32	19	28	27	31
Cobble	25	20	18	30	48	28	29
Gravel	7	4	7	14	20	11	17
Sand	16	0	10	17	2	16	2
Silt	9	0	3	17	0	3	4
TOTAL	100	100	100	100	100	100	100
Spawning gravel (ft^2)							
Total	11,059	0	5	36,474	1,946	5,014	308
Gravel/mile	1,908	0	2	3,932	1,606	407	134

Table B-3.	Habitat, potential migration barriers, and tributary information for the seven study reaches surveyed by foot, 2002 and 2003.						
	Rubicon Reservoir Dam	**Rockbound Dam**	**Buck Island Dam**	**Loon Lake Dam**	**Gerle Dam**	**Ice House Dam**	**Brush Creek Dam**
Habitat conditions							
Average water temp. (C)	20.6	12.3	15.7	15.3	14.9	13.1	10.9
Average width (ft)	28.9	19.2	17.4	27	24.8	30.2	19.0

Table B-3.	**Habitat, potential migration barriers, and tributary information for the seven study reaches surveyed by foot, 2002 and 2003.**						
	Rubicon Reservoir Dam	**Rockbound Dam**	**Buck Island Dam**	**Loon Lake Dam**	**Gerle Dam**	**Ice House Dam**	**Brush Creek Dam**
Habitat conditions							
Average pool depth (ft)	3.2	3.1	2.6	3.0	3.1	2.8	2.3
No. of pools less than 3 ft deep	5	0	12	13	0	0	21
No. of pools greater than or equal to 3 ft	71	7	36	118	25	53	62
Percent of deep pools	93	100	75	90	100	100	75
Average maximum pool depth (ft)	5.7	5.5	4.9	4.2	5.2	4.9	3.8
Potential migration barriers							
Number of potential migration barriers	14	7	9	10	0	6	28
Number of potential barriers/mile	2.4	27.5	3.6	1.1	0	0.5	12.2
Tributaries							
Number of tributaries	9	0	5	2	4	25	0
Average water temp. (^{o}C)	dry	n/a	dry	19	15.3	12.2	n/a
Average flow	dry	n/a	dry	0.5	0.8	0.5	n/a

Table B-4.	**Large woody debris abundance and spatial distribution in the seven study reaches surveyed by foot, 2002 and 2003.**				
Reach	**Number of pieces**	**Number of pieces /mile**	**Primary distribution**	**Dominant length class (ft)**	**Dominant diameter class (in)**
Rubicon Reservoir Dam Reach	789	136	river mile 5.0 to 5.8	25-75	12-24
Rockbound Dam Reach	84	329	even	10-25	12-24
Buck Island Dam Reach	241	96	river mile 1.0 to 1.5	10-25	6-12

Table B-4. Large woody debris abundance and spatial distribution in the seven study reaches surveyed by foot, 2002 and 2003.

Reach	Number of pieces	Number of pieces /mile	Primary distribution	Dominant length class (ft)	Dominant diameter class (in)
Loon Lake Dam Reach	1,792	194	river mile 7.0 to 7.9	10-25	12-24
Gerle Creek Dam Reach	8	7	river mile 0.25 to 0.50	10-25	12-24 and 24-36
Ice House Dam Reach	803	66	river mile 1.0 to 6.0	10-25	12-24 and 24-36
Brush Creek Dam Reach	401	42	ever-increasing moving upstream	10-25	6-12

APPENDIX C

UARP 2002 AND 2003 HABITAT MAPPING DATA

(Provided on CD by Request)