

**2011 Hardhead (*Mylopharodon conocephalus*) Surveys  
in the  
South Fork American River,  
El Dorado Hydroelectric Project, FERC No. 184**

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## 1.0 INTRODUCTION

The El Dorado Irrigation District (District) owns and operates the El Dorado Hydroelectric Project (Project No. 184), which is licensed by the Federal Energy Regulatory Commission (FERC). The Project No. 184 Monitoring Program<sup>1</sup> requires monitoring of hardhead (*Mylopharodon conocephalus*) fish population in the South Fork American River (SFAR). The specific monitoring requirements for hardhead are defined in the Project 184 Hardhead Monitoring Plan (Plan; EID, 2007), which was approved by FERC on June 6, 2008.

Hardhead surveys were conducted in 2004, 2005, and 2007 (ECORP, 2005; GANDA, 2007; GANDA, 2008). The 2004, 2005, and 2007 survey results provided baseline biomass estimates. At least 3 years of post-license surveys for hardhead are required for hardhead; thereafter, monitoring may continue at 5-year intervals if the United States Forest Service (USFS), State Water Resources Control Board (SWRCB), and Project 184 Ecological Resources Committee (ERC) determine it is necessary. Hardhead surveys conducted in 2011 represent the second year of post-license surveys.

The District retained ECORP Consulting, Inc. (ECORP) to survey fish populations at the electrofishing site adjacent to Akin Powerhouse, and in the pools located upstream of the Akin Powerhouse in 2011. Results of the 2011 hardhead electrofishing and snorkel surveys are presented in this report.

## 2.0 STUDY AREA

The study area is located on the SFAR in the vicinity of Akin Powerhouse, and extending upstream for approximately 2.5 kilometers (Figure 1).

## 3.0 METHODS

A 100-meter (m) electrofishing site and eight pools located in the vicinity of Akin Powerhouse were surveyed on October 19 and 20, 2011 (Figure 2). ECORP conducted surveys consistent with the methods and level of effort utilized during the most recent monitoring effort in 2007 (GANDA, 2008).

ECORP collected data on all fish species encountered during the sampling efforts. In 2011, fall storm events resulted in higher streamflows than experienced during previous surveys. Stream discharge measurements for all surveys are provided in Table 1.

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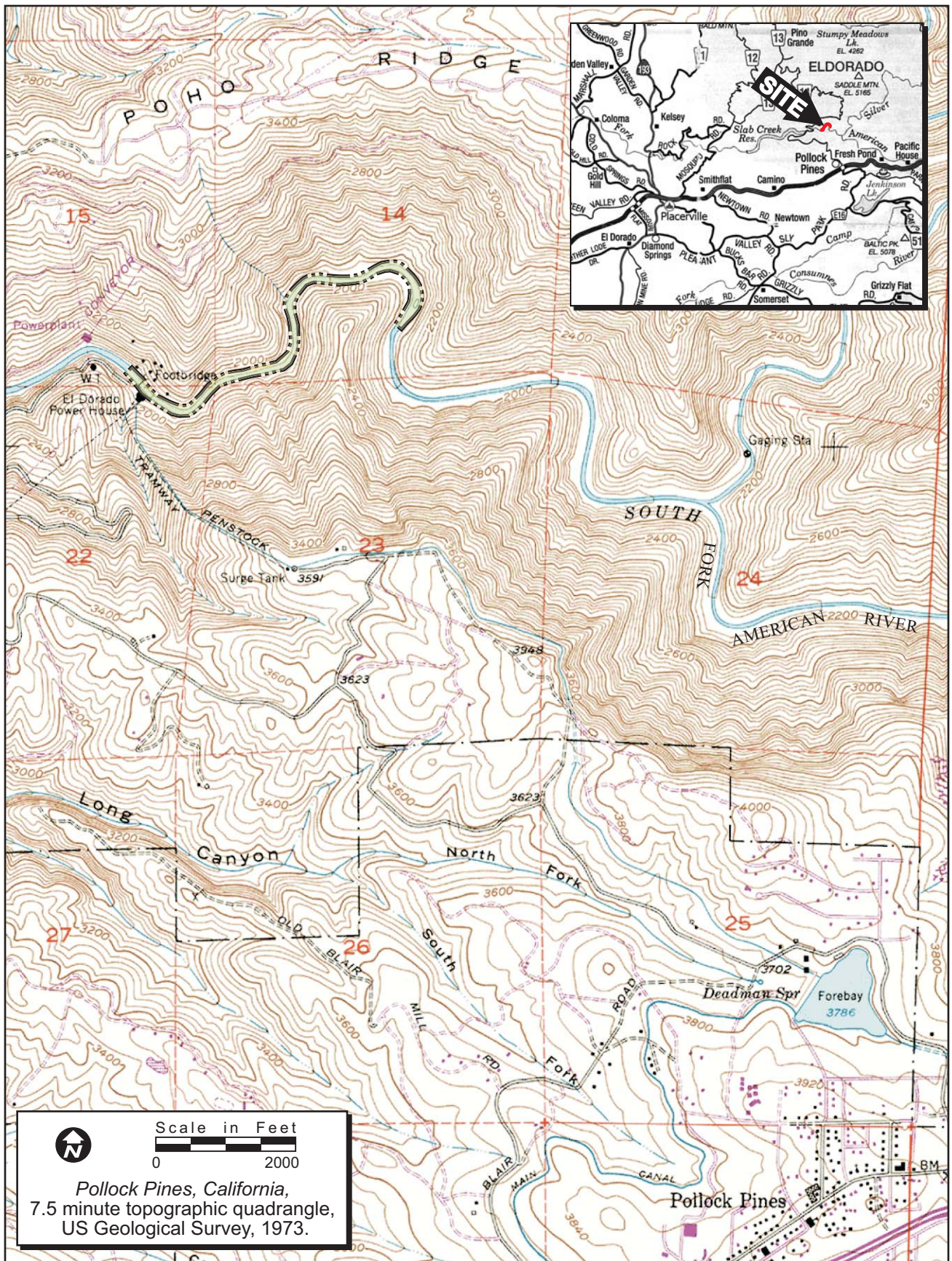
<sup>1</sup> Section 7 of the El Dorado Relicensing Settlement Agreement, U.S. Forest Service 4(e) Condition No. 37, and California State Water Resources Control Board Section 401 Clean Water Act Water Quality Certification Condition No. 13

**Table 1. Stream discharge measurements for 2004, 2005, 2007, and 2011 monitoring events**

Date	Flow (cfs) at electrofishing site	Flow (cfs) at SFAR gage downstream of Kyburz
October 13 - 14, 2004	77	48
October 18 - 19, 2005	N/A	52
October 18 - 19, 2007	N/A	42
October 19 - 20, 2011	168	121

High flows created deep water (non-wadeable) areas with high velocities within the electrofishing reach, especially at the downstream end of the established 120-m site. These conditions precluded setting the lower block net in the same position as previous surveys, as a result, the downstream end of the reach was relocated approximately 20-m upstream to a location where the block net could be safely set. The resulting 100-m reach was situated immediately downstream of Akin Powerhouse and was electrofished using a three-pass depletion method.

Visual surveys (snorkeling) were used to assess hardhead numbers and distribution in eight large pools located upstream of the powerhouse and downstream of the confluence with Silver Creek.





**FIGURE 1. Project Site and Vicinity**

**Figure 2. Project 184  
Hardhead Electrofishing  
and Snorkel Surveys  
South Fork American River**

**Map Features**

Survey Type

-  Electrofishing Survey
-  Snorkel Survey



Location: N:\2011\2011-112 EID-Project 184 Hardhead Monitoring Plan\WAP\SVSS\_Survey\_and\_Mapping\Hardhead\Mapsv1\HardheadSurveyAreas\_20111021.mxd (ekeethe, 1/4/2012)

Potential Migration Barrier



### 3.1 Electrofishing

On October 19, 2011 a team of nine biologists (ECORP and EID staff) conducted the electrofishing survey immediately downstream of Akin Powerhouse (see Figure 2). Four backpack electrofishing units and five netters / bucket carriers were used to survey this site. Each pass was initiated at the downstream block net and preceded upstream to the upper block net. Two of the electrofishers with two netters concentrated their efforts on the stream margins (approximately 50% of the wetted width) to specifically sample habitat for juvenile hardhead, while the other two electrofishers and three netters sampled the middle (approximately 50% of the wetted width) of the stream. Most of the thalweg areas within the site were deep (non-wadeable) with high water velocities (up to 3 ft/second), and were sampled simultaneously using two electrofishers and three netters positioned on opposite sides of the thalweg. Because of the unusually high flows, non-wadeable areas with high velocities were present throughout portions of the site making electrofishing extremely difficult. As a result, the total number of fish collected on each pass may have been reduced.

Fish collected during each electrofishing pass were processed immediately upon completion of the pass. All specimens were identified to species where possible, and measured to fork length (FL) using a metric measuring board. All fish species 60 mm or greater FL, were weighed to the nearest gram with an electronic balance. Weights of smaller fish (less than 30 mm), which were too small to weigh reliably as individuals, were recorded as 0.1 gram. During the remainder of the survey effort, fish from each pass were placed in an instream holding area located outside the survey reach. Following the three-pass depletion survey, all collected fish were redistributed throughout the survey reach.

Juvenile minnows (i.e., potentially hardhead and Sacramento pikeminnow [*Ptychoceilus grandis*]) collected during each pass were combined, since these species are extremely difficult to reliably differentiate when small. No positively identifiable hardhead were captured during the electrofishing effort.

### 3.2 Snorkeling

On October 20, 2011 a team of five biologists (ECORP and EID staff) conducted two-pass snorkel surveys in eight pools located upstream of Akin Powerhouse (see Figure 2). During the two-pass, quantitative snorkel sampling effort, snorkelers entered the water at the downstream end of each pool and moved upstream (parallel to each other) at a slow and deliberate pace. All snorkelers stayed in visual range of each other to ensure that they remained evenly spaced and proceeded at the same speed in a straight line. The center snorkelers looked ahead to locate fish on the fringe of vision and the two margin snorkelers carefully searched for juveniles in areas where bank vegetation was present, spaces between bedrock and boulders, under overhanging rock, and in other potential holding areas with slow moving water. Each fish was identified, counted, and categorized into predefined 3-inch (in) (76mm) length classes to be consistent with previous efforts. Snorkelers recorded data into a matrix on wrist-mounted underwater dive slates and verbally relayed data to a streamside observer after each pass. During the first pass, snorkelers began at Pool 1 and worked upstream through all the pools. Following completion of the first pass at Pool 8, snorkelers waited 30 minutes before returning



to Pool 8 to start the downstream second pass through each pool. Mean values from the two passes were used for estimating fish abundance and for estimating biomass.

### **3.3 Physical Habitat Data**

Physical habitat data at the electrofishing site was measured at 10-m intervals, beginning at the bottom of the site. At each perpendicular transect, total wetted channel width (m) was recorded and depth measurements (centimeters; cm) were recorded at 25%, 50% and 75% of the transect. Substrate composition and percentage of stream habitat type were recorded for the entire 100-m site. During the electrofishing survey, river flow was approximately 168 cfs.

Since the eight snorkel pools are bedrock controlled and defined, these large pool habitats do not change much from year to year, except for annual variations in the distribution and abundance of finer bottom sediments. As a result, maximum depth was the only physical habitat parameter measured within each of the eight pools. Maximum depths were visually estimated by each snorkeler for each lane.

Attachment A provides site habitat information and water quality data recorded during the survey effort. Survey locations were recorded using a hand-held Trimble Geo-XH GPS unit. Representative photographs of the sampling reaches are provided in Attachment B.

### **3.4 Data Analysis**

All fish and physical habitat data were entered into Microsoft Excel spreadsheets. Fish population estimates (for the electrofishing data) were calculated using the MicroFish 3.0 software package, which is based on the removal-depletion model (Van Deventer and Platts 1989). Biomass estimates will be determined from actual fish biomass measurements obtained during the electrofishing surveys. The number of individuals required to calculate a relevant biomass estimate is a minimum of 10 specimens of each species for each age class (although more is preferable). Snorkel survey biomass estimates will be determined using the length-weight regression calculated for each species using the results of the electrofishing effort.

Condition factor (the ratio of fish weight to length) is a commonly used metric among fisheries biologists as a general indicator of fish health. Condition factor was calculated for this effort using the formula:  $CF = [\text{Weight (g)} \times 100,000] / \text{length (millimeter [mm]}^3)$ , as described by Anderson and Gutreuter (1983). Condition factor is species-specific. For trout, a condition factor value greater than 1.0 is considered good. For most cyprinids (e.g., hardhead, Sacramento pikeminnow), slightly lower values would be expected since minnows tend to be thinner than trout for a given length. However, since condition factor is not usually calculated for cyprinids, a 'good' value for hardhead has not been established.

## **4.0 RESULTS**

### **4.1 Electrofishing Data**

A total of 66 fish were captured in the 100-m electrofishing site (Table 2). Riffle sculpin (*Cottus gulosus*) were the most abundant fish captured. Sacramento sucker (*Catostomus occidentalis*)

and Sacramento pikeminnow were the second and third most abundant species captured, respectively. Rainbow trout (*Oncorhynchus mykiss*) were the least abundant of the four fish species captured during the electrofishing survey. Neither hardhead nor speckled dace were captured during the electrofishing survey. Summaries of fish length-weight data are presented in Table 3 and field datasheets are provided in Attachment C.

**Table 2 – Catch data for fish collected within the electrofishing site located immediately downstream of Akin Powerhouse on the South Fork American River, October 2011.**

Species	Pass 1	Pass 2	Pass 3	Total	Population Estimate	Standard Error
Rainbow trout	3	7	2	12	19	13.5
Sacramento sucker	10	4	2	16	16	1.1
Sacramento pikeminnow	3	9	3	15	41	70.0
Riffle sculpin	11	10	2	23	25	3.0
Totals	27	30	9	66	88	15.3

**Table 3 – Summary of length and weight data for fish captured within the electrofishing site located immediately downstream of Akin Powerhouse on the South Fork American River, October 2011.**

Species	Length Range (mm)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor	Estimated Biomass (g)	Biomass/Area (g/acre)
Rainbow trout	58 - 212	124.9	38.2	1.1	*	*
Sacramento sucker	21 - 175	49.2	5.1	1.0	*	*
Sacramento pikeminnow	25 - 141	40.7	2.3	0.6	*	*
Riffle sculpin	39 - 127	75.6	7.5	1.1	*	*
* Biomass estimates not available due to low numbers of fish.						

Length-frequency histograms for fish captured during the electrofishing survey are presented in Attachment D.

No identified hardhead were captured during the electrofishing effort. Since individuals of all fish species (except for riffle sculpin) were limited primarily to age class 0+, the few adults (2+ and older) that were captured created biomass estimates equivalent to the standard error. As a result, biomass estimates are not provided.

#### 4.2 Snorkel Data

Quantitative snorkel surveys were conducted in eight pools on the SFAR upstream of Akin Powerhouse. No hardhead were positively identified during snorkel surveys. Juvenile minnows (0 to 3 in) were the most abundant fish observed in the lower three pools (pools 1 -3) and in Pool 8 (Attachment E: Tables 1a-1h). Rainbow trout was the next most abundant fish observed. Sacramento suckers, speckled dace, riffle sculpin, and brown trout were observed in small numbers. Estimated numbers of individuals per species are presented as averages of the two passes. The low numbers of juvenile and adult individuals of each species captured during

the electrofishing surveys did not allow for calculation of a length-weight regression or biomass estimates from the snorkel survey data.

### **4.3 Habitat Data**

A summary of the physical habitat data collected at 10-m intervals within the 100-m electrofishing site, and general habitat characteristics and depths within the eight pools are presented in Attachment A.

At the electrofishing site, instream habitat was composed of 5% pool, 40% riffle, and 55% run. Substrate composition within the site was comprised of 10% sand, 10% gravel, 30% cobble, 45% boulder, and 5% bedrock. Water quality data was measured at the electrofishing site on October 19, 2011, and is summarized in Attachment A.

### **4.4 Species Summaries**

#### *Riffle Sculpin*

Riffle sculpin were the most abundant fish collected during the electrofishing survey with a total of 23 individuals captured. The length-frequency histogram (see Attachment E) indicates the presence of young-of-the-year, age 1+, and age 2+ fish. Juvenile fish were the most abundant year class with only one age 1+ and one age 2+ fish.

During the snorkel survey, one sculpin was observed in Pool 1 during both passes and seven fish were observed in Pool 3 during pass 1.

#### *Sacramento Sucker*

The Sacramento sucker was the second most abundant fish captured during the electrofishing survey, however, few were observed in the pools during the snorkel surveys. The majority of Sacramento suckers captured during electrofishing were juveniles ranging in length from 1 to 3 in (2.1 to 6.8 cm) (see Attachment E).

One juvenile Sacramento sucker was observed in pool 3 and another in pool 7 during pass 2. Three suckers in three size classes: 6 to 9 in (15 to 23 cm), 12 to 15 in (30 to 38 cm), and 15 to 18 in (38 to 46 cm) were observed in Pool 4. Four 9 to 12 in (23 to 30 cm) suckers were observed during pass 2 in Pool 8.

#### *Hardhead and Sacramento Pikeminnow*

Sacramento pikeminnow were the third most abundant fish captured during the electrofishing effort. A total of 15 pikeminnow were captured, most specimens were young-of-the-year ranging in size from 1 to 1.7 in (2.7 to 4.2 cm). Scale analysis indicated that the two larger fish were age 1+ at 3 in (8.2 cm) and age 2+ at 5.5 in (14.1 cm). No adult Sacramento pikeminnow were observed during either survey effort.

No hardhead were identified in the specimens captured during the electrofishing effort. The juvenile minnows all appeared to be Sacramento pikeminnow, since a frenum was not visible on the upper jaw of any of the specimens.

Mixed minnow juveniles 1 to 3 in (2.1 to 6.8 cm) FL were the most abundant fish observed during the snorkel surveys in pools 1 through 3 and in Pool 8. Mixed minnow juveniles were also observed in small numbers in pools 4, 6, and 7. Pikeminnow juveniles ranging in size from 3 to 6 in (6.8 to 15 cm) FL were observed in pools 1 and 8. No identifiable hardhead were observed during the snorkel survey.

#### *Rainbow Trout*

Rainbow trout were the least abundant fish captured during the electrofishing survey, but the second most abundant fish observed during the snorkel surveys. Half of the rainbow trout collected during the electrofishing survey were young-of-the-year with the remainder consisting of one age 1+ fish and five age 2+ fish. All of these fish were in good condition with a combined condition factor of 1.12 (Table 2). The length-frequency histogram for rainbow trout is presented in Attachment E.

Rainbow trout were observed in all pools during the snorkel survey, with the majority of fish located near the head of the pools. Snorkelers indicated that the larger trout (>12 in) were cruising in the upper portion of the pools, and not holding at a station. Rainbow trout observed ranged from a few young-of-the-year in pools 4 and 6, to large adults in pools 1, 3, 4, and 8. The majority of the observed trout were 6 to 12 in (15 to 30 cm) FL and ranged in age from age 1+ to possibly age 5+ for the 15 to 18 in (38 – 46 cm) trout.

#### *Brown Trout*

Brown trout were not captured during the electrofishing survey but a few individuals were observed in the pools during the snorkel surveys.

Brown trout were observed in pools 3, 4, and 7. One 3 to 6 in (6.8 to 15 cm) fish was observed in both pools 3 and 4, and two 6 to 9 in (15 to 23 cm) were observed in Pool 7 on pass 2.

#### *Speckled Dace*

Speckled dace were not captured during the electrofishing survey but a few were observed in the pools during the snorkel surveys.

All speckled dace were observed during the second pass through the eight pools. One fish was observed in Pool 2, three fish in Pool 4, and two fish in Pool 6. Based on the length-frequency histogram (see Attachment E), all of the speckled dace were young-of-the-year in the 1 to 3 in (2.1 to 6.8 cm) size class.

## 5.0 DISCUSSION

Hardhead were not captured during the electrofishing survey at Akin Powerhouse and no identifiable hardhead were observed in any of the eight pools surveyed upstream of the powerhouse. Fall storm events resulted in higher streamflows during the 2011 hardhead surveys than have been experienced during previous survey efforts in 2004, 2005, or 2007. These high flows created relatively high (and potentially unfavorable) water velocities within the established electrofishing site at Akin Powerhouse and within the pools located upstream of the powerhouse relative to the slower velocities observed during previous survey efforts. Within the electrofishing site, only a few small isolated areas along the river margin provided slow water habitat that would be suitable for hardhead. Within the pools, where water velocities have been typically slow during previous surveys, higher flows in 2011 resulted in a noticeable reduction in the amount and extent of slow water habitat, even along the margins.

The preferred habitat for hardhead consists of undisturbed larger, low to mid-elevation streams and also lakes and reservoirs, with summer water temperatures in excess of 20° C (Moyle 2002). Within streams, hardhead tend to prefer warmer temperatures than salmonids and are often found associated with Sacramento pikeminnow and Sacramento suckers (Moyle 2002). Preferred stream habitats consist of pools and slow runs with average depths of 40 -140 cm and flow velocities in the range of 20 to 40 cm/s (Moyle 2002), but may also occur along vegetated margins with slow water velocities. Alley and Li (1977) found that hardhead preferred water velocities of 30 cm/s (1 ft/s) or less.

In general, the late spring runoff in 2011 resulted in above normal summer flows and below normal water temperatures on the SFAR as well as on many other west slope Sierra rivers. During the 2011 hardhead surveys, the SFAR water temperature was 12° C, considerably cooler than the preferred temperature regime for hardhead. In addition, even in the late fall, measured and estimated flow velocities exceeded 1 ft/s in most habitats including the pools. Due to the lack of suitable habitat conditions for hardhead within both the electrofishing site and the eight upstream pools, it is not surprising that hardhead were not observed or captured during the surveys. It is possible that young-of-the-year hardhead could have been present in the large schools classified as mixed minnows; however, the unsuitable habitat conditions present during the survey effort (and possibly throughout most or all of the summer) combined with the absence of adult hardhead at either survey location makes this unlikely. According to Moyle (2002), the relatively poor swimming ability of hardhead at low water temperatures (< 17° C) may keep them from moving up streams with natural or human-made velocity barriers. Since flows on the SFAR were unusually high during the summer and fall of 2011 (with associated increased water velocities and reduced water temperatures), it is possible that hardhead were not able to move upstream out of Slab Creek Reservoir in 2011 to upstream spawning habitat.

## 6.0 SUMMARY

In October 2011, ECORP surveyed the SFAR fish community at the established electrofishing site located immediately downstream of Akin Powerhouse, and in eight deep pools located upstream of the powerhouse using snorkel techniques. All of the minnow species captured and

identified during the electrofishing survey were Sacramento pikeminnow, and no identifiable hardhead were observed during the snorkel survey.

Schools of primarily juvenile minnows were observed in some of the pools during snorkel surveys. However, a positive identification could not be made due the small size of the minnows observed and the fact that juvenile Sacramento pikeminnow and hardhead are extremely difficult to visually differentiate underwater. Therefore, for data analysis purposes, all juvenile minnows observed in the pools were combined. Several larger minnows were also observed with the schools of juvenile fish, but these were positively identified as Sacramento pikeminnow. It is possible that some of the juvenile minnows present in the schools of minnows observed during the snorkel survey could have been hardhead; however, the lack of several key habitat characteristics (i.e., low-velocity, warm water areas) makes this unlikely. In 2011, the unusually wet hydrologic conditions and associated increased water velocities and cooler water temperatures present may have limited hardhead movements in the SFAR.

All of the fish captured during the electrofishing survey and the majority of the fish observed during the snorkel survey were native to the SFAR. The few brown trout observed in the upstream pools was the only non-native species, and was the least abundant fish recorded during the two surveys. All fish captured and observed during the surveys visually appeared to be in good condition.

## **7.0 REFERENCES**

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## **LIST OF ATTACHMENTS**

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Attachment A – Habitat Data Collected at Survey Sites Including Associated Water Quality Data

Attachment B – Representative Site Photographs

Attachment C – Field Datasheets

Attachment D – Length-Frequency Histograms for Fish Captured During the Electrofishing Survey

Attachment E – Number of Fish Observed (by Species and Length) During Snorkel Surveys Conducted in Pools 1 Through 8



## **ATTACHMENT A**

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Habitat Data Collected at Survey Sites Including Associated Water Quality Data

Attachment A Table 1 - Physical habitat for FERC Project 184 Hardhead minnow electrofishing site downstream of Akin Powerhouse, 19 October 2011.

Transect (m)	0	10	20	30	40	50	60	70	80	90	100	Mean Width / Depth (m)	Maximum Width / Depth (m)
<b>Width (m)</b>	31.1	22.3	22.3	24.1	25.3	24.7	24.4	24.4	25.9	27.4	24.7	25.1	31.1
Depth - Left center (cm)	3.0	22.9	20.3	61.0	71.1	73.7	88.9	43.2	83.8	43.2	91.4	0.6	0.9
Depth - Center (cm)	66.0	88.9	91.4	61.0	61.0	73.7	86.4	88.9	104.1	35.6	61.0	0.7	1.0
Depth - Rt center(cm)	97.8	68.6	22.9	68.6	47.0	63.5	83.8	68.6	88.9	94.0	88.9	0.7	1.0

Attachment A. Table 2 - Habitat types and substrate composition at the FERC Proj 184 Hardhead minnow electrofishing site, 19 October 2011.

	<b>Habitat type (%)</b>			<b>Substrate Composition (%)</b>				
Habitat type/substrate	Pool	Riffle	Run	Sand	Gravel	Cobble	Boulder	Bedrock
Percent	5	40	55	10	10	30	45	5

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Attachment A Table 3 - Estimated maximum depths in snorkel pools by lane for FERC Project 184  
Hardhead snorkel surveys in pools upstream of Akin Powerhouse, 20 October 2011.

Pool No.	Left (ft)	Lt center (ft)	Center (ft)	Rt center (ft)	Right (ft)
1	6.1	6.1	7.6	4.6	4.6
2	1.2	2.4	2.4	2.1	1.5
3	6.1	6.1	7.6	4.6	4.6
4	1.2	2.4	2.4	2.1	1.5
5	0.9	4.3	1.5	1.2	0.9
6	5.5	7.6	6.1	6.1	3.6
7	2.4	2.4	3.6	2.7	3.0
8	0.9	2.1	2.4	2.4	0.9

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Attachment A Table 4 - Water quality parameters recorded at the FERC Project 184 Hardhead minnow electrofishing survey, 19 October 2011.

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Parameter	Value
Air Temperature (°C)	24
Water Temperature (°C)	12.1
pH	8.3
Conductivity (µS/cm)	51
Dissolved Oxygen (mg/L)	8.8
Total dissolved solids (gm/L)	0.033
Stream flow (cfs)	167.8

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## **ATTACHMENT B**

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Representative Site Photographs



Pool 1: looking downstream, 10/20/11.



Pool 2: looking upstream, 10/20/11.



Pool 3: looking upstream, 10/20/11.



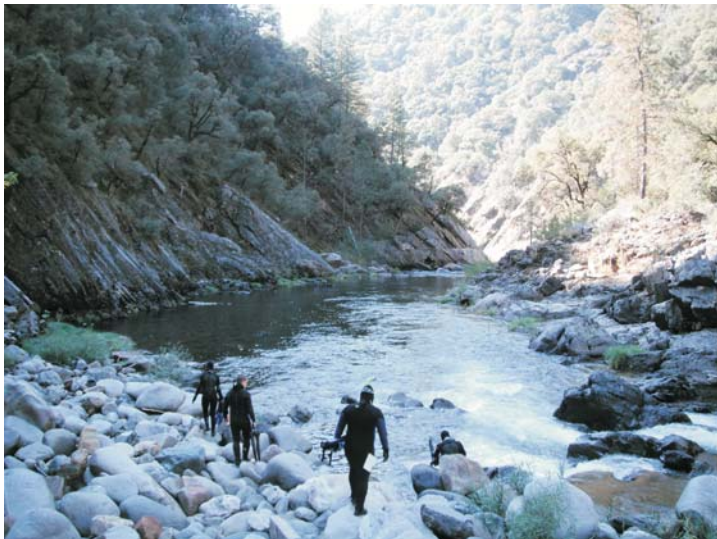
Pool 4: looking upstream, 10/20/11.



Pool 5: looking upstream, 10/20/11.



Pool 6: looking upstream, 10/20/11.



Pool 7: looking downstream, 10/20/11.



Pool 8: looking upstream, 10/20/11.





Electrofishing Site: looking downstream, 10/19/11.



Electrofishing Site: upstream block net, 10/19/11.



Electrofishing Site: downstream block net, 10/19/11.

## **ATTACHMENT C**

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Field Datasheets

Project Number: 2011-112/001 Site Location: AKINS Power plant  
 Date: 10/14/11 Field Crew: 1m, LT, TW, PW, AS, CS, NS, TS, SD  
 County: El Dorado State: CA Sample Type: 'E'-fishing  
 Stream: SF American River Reach:                       
 GPS (UTM) Elevation (m):                       
 Lower Net:                      Upper Net:                     

Duration:

1st Pass				2nd Pass				3rd Pass				4th Pass			Total	Grand Total
1st	2nd	3rd	Total	1	2	3	Total	1	2	3	Total					
2634	3801	3940	1789	1768	2596	1344	1404	786	918	1250	1175	-	-	-		

Air Temp (°C): 24 Water Temp (°C): 12.45 pH: 8.30 Conductivity: 51 Staff Gauge: - Flow: -  
 D.O.: 8.80 g/mL; %saturation: 81.2 TDS: 0.033 Reach Length: - Total # of Passes: 3  
 Time Begin:     :    :     Time End:     :    :     Average Width: 82 Feet Total # of Shockers: 4

*(FF) meters*

	0m	10m	20m	30m	40m	50m	60m	70m	80m	90m	100m	Site End
WIDTH (m)	102	73	73	79	83	81	80	80	85	90	81	/
DEPTH - Left (cm)	6	9	8	24	28	29	35	17	33	17	36	/
DEPTH - Center (cm)	26	35	36	24	24	29	34	35	41	14	24	/
DEPTH - Right (cm)	38.5	27	9	27	18.5	25	33	27	35	37	35	/

*feet inches*

PHOTOS:

1	6
2	7
3	8
4	9
5	10

% Bottom Type							% Area					
Clay	Silt	Sand	Gravel	Rubble Cobble	Boulder	Bedrock	% Canopy	% Grad	Est. Flow (cfs)	Pool	Riffle	Run
/	/	10	10	30	45	5				5	40	55

COMMENTS:

Cover Type Rating (1: poor, 2: fair, 3: good)				
Surface Turbulence	Object Cover	Under-cut Bank	Over-hang Veg	Spawn Habitat Rating

*Flow data on back of sheet.*

Project Number: 2011-112/001 Site Location: Akins Power House  
 Date: 10/19/11 Field Crew: Lmr, LT, TS, TW, PW, AS, CS, NB, BD  
 Pass 1 County: Eldorado State: CA Sample Type: E-fishing  
 Stream: SF American River Reach: \_\_\_\_\_

3804sec  
 3940sec  
 1789sec  
 2634sec  
 Pass 2  
 1768  
 2596  
 1344  
 1404  
 Pass 3  
 786  
 918  
 1250  
 1175

	Pass	Species Code	Length (mm)	Biomass (g)		Pass	Species Code	Length (mm)	Biomass (g)		Pass	Species Code	Length (mm)	Biomass (g)
	1	<del>88</del> 60	88	8.6	26	1	11	77	5.9	51	2	33	21	0.1
	2	60	127	32.6	27	1	33	32	0.1	52	2	11	212	9.6
	3		82	6.7	28	2	34	32	0.1	53	2	11	58	2.1
	4		97	13.3	29	2	34	27	0.1	54	2	11	196	81.3
	5		101	13.3	30	2	60	96	14.9	55	2	11	200	9.1
	6		89	10.2	31	2	60	47	1.0	56	2	11	203	90.7
	7		103	13.8	32	2	60	90	10.3	57	2	*33	175	66.7 M
	8	✓	77	5.7	33	2	60	74	4.8	58	3	60	50	1.3
	9	60	58	2.0	34	2	34	37	0.4	59	3	60	46	0.3
	10	33	32	0.8	35	2	34	26	0.1	60	3	33	37	0.5
	11	60	52	1.1	36	2	34	26	0.1	61	3	33	62	2.9
	12	60	49	1.2	37	2	34	28	0.1	62	3	34	25	.1
	13	34	37	0.3	38	2	34	27	0.1	63	3	34	26	.1
	14	34	28	0.1	39	2	60	84	6.3	64	3	34	141	26.6
	15	33	48	1.1	40	2	60	102	14.6	65	3	11	185	68.8
	16	33	52	1.8	41	2	33	62	2.5	66	3	11	80	4.9
	17	33	37	0.5	42	2	60	47	1.0	67				
	18	33	27	0.1	43	2	60	93	9.0	68				
	19	34	27	0.1	44	2	34	82	5.6	69				
	20	33	37	0.4	45	2	60	47	1.3	70				
	21	33	37	0.5	46	2	34	42	0.1	71				
	22	33	31	0.3	47	2	11	68	3.0	72				
	23	33	29	0.1	48	2	11	72	3.7	73				
	24	*M	11	75	6.6	49	2	60	39	0.1	74			
	25	1	11	73	4.9	50	2	33	68	3.0	75			

Comments: \* Mort

- Species Codes:**
- 11 Rainbow trout
  - 12 Cutthroat trout
  - 13 Brook trout
  - 14 Brown trout
  - 15 Chinook salmon
  - 23 California roach
  - 24 Speckled dace
  - 26 Tule perch
  - 27 Hitch
  - 28 Golden shiner
  - 29 Hardhead minnow
  - 31 Goldfish
  - 32 Carp
  - 33 Sacramento sucker
  - 34 Sacramento pikeminnow
  - 49 Bluegill
  - 50 Redear sunfish
  - 51 Green sunfish
  - 53 Largemouth bass
  - 54 Smallmouth bass
  - 57 Black bullhead
  - 58 Brown bullhead
  - 59 Prickly sculpin
  - 60 Riffle sculpin
  - 85 Wakasagi
  - 90 Gambusia
  - 99 Hatchery R. trout
  - 200 Crayfish
  - 300 Bullfrog

VISCHNORDE MEASUREMENT SPARK 10/19/11 @ 12:30 pm (DOWNSTREAM AQUATH)  
 STREAM WIDTH = 77 FT; MEASUREMENTS EVERY ~~2.5~~ 4.0 FT BY CRAIG + ADAM, RECORDER - BRIAN

STATION	DEPTH ft	VELOCITY ft/sec	DIST
1	0.0	0.00	0
2	1.0	0.15	
3	2.5	1.76	
4	2.1	0.91	
5	1.9	0.84	
6	0.7	1.71	
7	2.7	1.70	
8	2.6	1.32	
9	2.1	1.83	
10	1.6	1.87	
11	1.2	2.02	
12	2.1	0.58	
13	2.2	0.26	
14	1.4	1.67	
15	1.2	2.62	
16	1.7	2.23	
17	1.9	1.25	
18	1.6	0.84	
19	1.9	0.19	
20	0.8	0.46	77

Project/Site: EID FERC Proj 184 Hardhead Surveys Date: 10/20/11 Field Crew: PW, TW, AS, EK, NS, LI, BD

County: El Dorado State: CA Quad(s): \_\_\_\_\_

Stream: SFAR Reach: us Akin P1 Sample Type: snorkel

Air Temp (°C): \_\_\_\_\_ Water Temp (°C): \_\_\_\_\_ pH: \_\_\_\_\_ Conductivity: \_\_\_\_\_

Staff Gauge: \_\_\_\_\_ Flow: \_\_\_\_\_ D.O.: \_\_\_\_\_ Reach Length: \_\_\_\_\_

Time Begin: \_\_\_\_\_ Time End: \_\_\_\_\_ Average Width: \_\_\_\_\_

Comments:  
 Photo 1, 2 run (bottom) between P1 #1, #2  
 #3 = Bottom Pool 2 1k us

Pool 1 9:26 - 9:50 - P1

Pool 2 P1 9:55 - 10:10

Transect	Species Code	Size range	Sex	Comments	Transect	Species Code	Size range	Sex	Comments		
1	MM	29/34	0-3	-	572	21	MM	29/34	0-3	-	1
2						22					
3		34	3-6		1	23		11	3-6		1
4		60	0-3		1	24		11	6-9		3
5			3-6		1	25					
6		11	6-9		2	26	Two Snorkelers; no fish				
7			9-12		2	27					
8			12+15		1	28					
9	(Two Snorkelers; no fish)				29		P2 &	1537-1553			
10					30						
11		P2 &	1600-1612		31	MM	29/34	0-3			83
12	MM	29/34	0-3		700	32		24	0-3		1
13						33		33	9-12		1
14		11	3-6		2	34		11	6-9		2
15		11	9-12		11	35		11	9-12		1
16		11	12+15		1	36					
17		11	15-18		1	37					
18						38					
19						39					
20						40					

**Species Codes:**

- 11 Rainbow trout
- 12 Cutthroat trout
- 13 Brook trout
- 14 Brown trout
- 15 Chinook Salmon

- 16 Coho salmon
- 23 California roach
- 24 Speckled dace
- 26 Tule perch
- 27 Hitch
- 28 Golden shiner

- 29 Hardhead minnow
- 31 Goldfish
- 32 Carp
- 33 Sacramento sucker
- 34 Sacramento pikeminnow
- 49 Bluegill

- 50 Redear sunfish
- 51 Green sunfish
- 53 Largemouth bass
- 54 Smallmouth bass
- 58 Brown bullhead
- 59 Prickly sculpin

- 60 Rifle sculpin
- 85 Wakasagi
- 99 Hatchery R. trout

MM - mixed minnow

MAX Depth LB 12'  
 ↓ 20'  
 35'  
 RB 25'  
 40'

MAX Depth LB 15'  
 ↓ 14'  
 15'  
 RB 20'  
 20'

Project/Site: EID FERC Proj 184 Headhead Surveys Date: 10/20/11 Field Crew: PW TW AS EK NS LT  
 County: El Dorado State: CA Quad(s): \_\_\_\_\_ 30

Stream: SFAR Reach: us Akin PH Sample Type: Snorkel

Air Temp (°C): \_\_\_\_\_ Water Temp (°C): \_\_\_\_\_ pH: \_\_\_\_\_ Conductivity: \_\_\_\_\_  
 Staff Gauge: \_\_\_\_\_ Flow: \_\_\_\_\_ D.O.: \_\_\_\_\_ Reach Length: \_\_\_\_\_  
 Time Begin: \_\_\_\_\_ Time End: \_\_\_\_\_ Average Width: \_\_\_\_\_

Comments: Plc 4 - Top Pl 2 1k ds  
Plc 5 - Pool 3, bottom 1k us  
Plc 6, 7 - Pl 4 1k us, but  
Pl 4 1k ds - top

Pool 3 - Pl 1 → 1026-1052

Pool 4 - Pl 1 1110-1130

Transect	Species Code	Size range (in)	Sex	Comments	Transect	Species Code	Size range	Sex	Comments
1	mm	29/34		436	21	mm	29/34	0-3	0
2					22		33	15-18	1
3		34		3	23		11	0-3	3
4		60		7	24		11	6-9	14
5		11		1	25		11	9-12	15
6		11		3	26		11	12-15"	5
7		11		7	27				
8		11		1	28				
9					29				
10					30				
11	Pass	2 ds	15:20 - 15:30		31	Pass	2 ds	15:05 - 15:10	
12	mm	29/34		740	32		29	0-3	2
13		33		1	33		24	0-3	3
14		29		4	34		33	6-9	1
15		11		1	35		33	12-15	1
16		11		3	36		11	3-6	2
17		11		10	37		11	6-9	17
18		11		3	38		11	9-12	2
19		14		1	39		14	3-6	1
20					40				

**Species Codes:**

- |                  |                    |                |                |                   |                |                     |                  |               |          |                  |                    |             |         |                      |                          |             |                   |                  |                    |                    |                   |                    |                   |             |                      |
|------------------|--------------------|----------------|----------------|-------------------|----------------|---------------------|------------------|---------------|----------|------------------|--------------------|-------------|---------|----------------------|--------------------------|-------------|-------------------|------------------|--------------------|--------------------|-------------------|--------------------|-------------------|-------------|----------------------|
| 11 Rainbow trout | 12 Cutthroat trout | 13 Brook trout | 14 Brown trout | 15 Chinook Salmon | 16 Coho salmon | 23 California roach | 24 Speckled dace | 26 Tule perch | 27 Hitch | 28 Golden shiner | 29 Hardhead minnow | 31 Goldfish | 32 Carp | 33 Sacramento sucker | 34 Sacramento pikeminnow | 49 Bluegill | 50 Redear sunfish | 51 Green sunfish | 53 Largemouth bass | 54 Smallmouth bass | 58 Brown bullhead | 59 Prickly sculpin | 60 Riffle sculpin | 85 Wakasagi | 99 Hatchery R. trout |
|------------------|--------------------|----------------|----------------|-------------------|----------------|---------------------|------------------|---------------|----------|------------------|--------------------|-------------|---------|----------------------|--------------------------|-------------|-------------------|------------------|--------------------|--------------------|-------------------|--------------------|-------------------|-------------|----------------------|

MAX Depth  
 LB 20'  
 20'  
 25'  
 15'  
 RB 15'

MAX Depth  
 LB 4'  
 8'  
 8'  
 7'  
 RB 5'

Project/Site: EID FERC Res 184 Hardhead Springs Date: 10/20/04 Field Crew: PW, TW, AS, ER, NS, LT, PD

County: El Dorado State: CA Quad(s): \_\_\_\_\_

Stream: SFAR Reach: \_\_\_\_\_ Sample Type: \_\_\_\_\_

Air Temp (°C): \_\_\_\_\_ Water Temp (°C): \_\_\_\_\_ pH: \_\_\_\_\_ Conductivity: \_\_\_\_\_

Staff Gauge: \_\_\_\_\_ Flow: \_\_\_\_\_ D.O.: \_\_\_\_\_ Reach Length: \_\_\_\_\_

Time Begin: \_\_\_\_\_ Time End: \_\_\_\_\_ Average Width: \_\_\_\_\_

Comments:

Pool 5 PI - 1150 - 1205

Pool 6 PI 1215 - 1225

Transect	Species Code	Size range	Sex	Comments	Transect	Species Code	Size range	Sex	Comments
1	11	3-6		2	21	11	0-3		2
2		6-9		2	22	11	3-6		0
3					23	11	6-9		8
4	<u>P15</u>				24	11	9-12		4
5	<u>P2</u>	<u>-DS</u>		<u>1432 - 1437 ds</u>	25				
6	11	3-6		1	26				
7	11	6-9		5	27				
8					28	<u>Pass 2</u>	<u>1422 - 1427 ds</u>		
9					29	<u>MIN</u>	<u>29/34</u>	<u>0-3</u>	<u>9</u>
10					30		<u>24</u>	<u>0-3</u>	<u>2</u>
11					31		11	6-9	22
12					32		11	9-12	6
13					33				
14					34				
15					35				
16					36				
17					37				
18					38				
19					39				
20					40				

**Species Codes:**

- 11 Rainbow trout
- 12 Cutthroat trout
- 13 Brook trout
- 14 Brown trout
- 15 Chinook Salmon

- 16 Coho salmon
- 23 California roach
- 24 Speckled dace
- 26 Tule perch
- 27 Hitch
- 28 Golden shiner

- 29 Hardhead minnow
- 31 Goldfish
- 32 Carp
- 33 Sacramento sucker
- 34 Sacramento pikeminnow
- 49 Bluegill

- 50 Redear sunfish
- 51 Green sunfish
- 53 Largemouth bass
- 54 Smallmouth bass
- 58 Brown bullhead
- 59 Prickly sculpin

- 60 Riffle sculpin
- 85 Wakasagi
- 99 Hatchery R. trout

Max Depth LB 3'  
↓ 14'  
RO 5'  
4'  
3'

Max Depth LB 18'  
↓ 25'  
20'  
20'  
RP 12'



Project/Site: EID FERS Proj 184 Hardhead Survey Date: 10/20/11 Field Crew: PW, TW, AS, ER, NS, LT, RD

County: El Dorado State: CA Quad(s): \_\_\_\_\_

Stream: SFAR - 43 Akin PH Reach: \_\_\_\_\_ Sample Type: \_\_\_\_\_

Air Temp (°C): \_\_\_\_\_ Water Temp (°C): \_\_\_\_\_ pH: \_\_\_\_\_ Conductivity: \_\_\_\_\_

Staff Gauge: \_\_\_\_\_ Flow: \_\_\_\_\_ D.O.: \_\_\_\_\_ Reach Length: \_\_\_\_\_

Time Begin: \_\_\_\_\_ Time End: \_\_\_\_\_ Average Width: \_\_\_\_\_

Comments:

Pool 7 Pass 1 12:35-1250

Pool 8 P1 1302-1320

Transect	Species Code	Size range	Sex	Comments	Transect	Species Code	Size range	Sex	Comments
1	24	3-6		0	21	29/34	0-3		98
2	11	3-6		6	22				
3		6-9		7	23	34	3-6		18
4					24				
5					25	11	3-6		
6					26		6-9		10
7					27		9-12		2
8	Pass 2	14:06 - 14:12 ds			28				
9	MM	29/34	0-3	20	29				
10	33	0-3		1	30	Pass 2	13:31 - 13:47 ds		
11					31	29/34	0-3		240
12	11	0-3			32	34	3-6		3
13	11	3-6			33	33	9-12		4
14	11	6-9		8	34	11	6-9		19
15	11	9-12		9	35	11	9-12		21
16	14	6-9		2	36	11	12-15		13
17					37	11	15-18		3
18					38				
19					39				
20					40				

- Species Codes:**
- 11 Rainbow trout
  - 12 Cutthroat trout
  - 13 Brook trout
  - 14 Brown trout
  - 15 Chinook Salmon
  - 16 Coho salmon
  - 23 California roach
  - 24 Speckled dace
  - 26 Tule perch
  - 27 Hitch
  - 28 Golden shiner
  - 29 Hardhead minnow
  - 31 Goldfish
  - 32 Carp
  - 33 Sacramento sucker
  - 34 Sacramento pikeminnow
  - 49 Bluegill
  - 50 Redear sunfish
  - 51 Green sunfish
  - 53 Largemouth bass
  - 54 Smallmouth bass
  - 58 Brown bullhead
  - 59 Prickly sculpin
  - 60 Riffle sculpin
  - 85 Wakasagi
  - 99 Hatchery R. trout

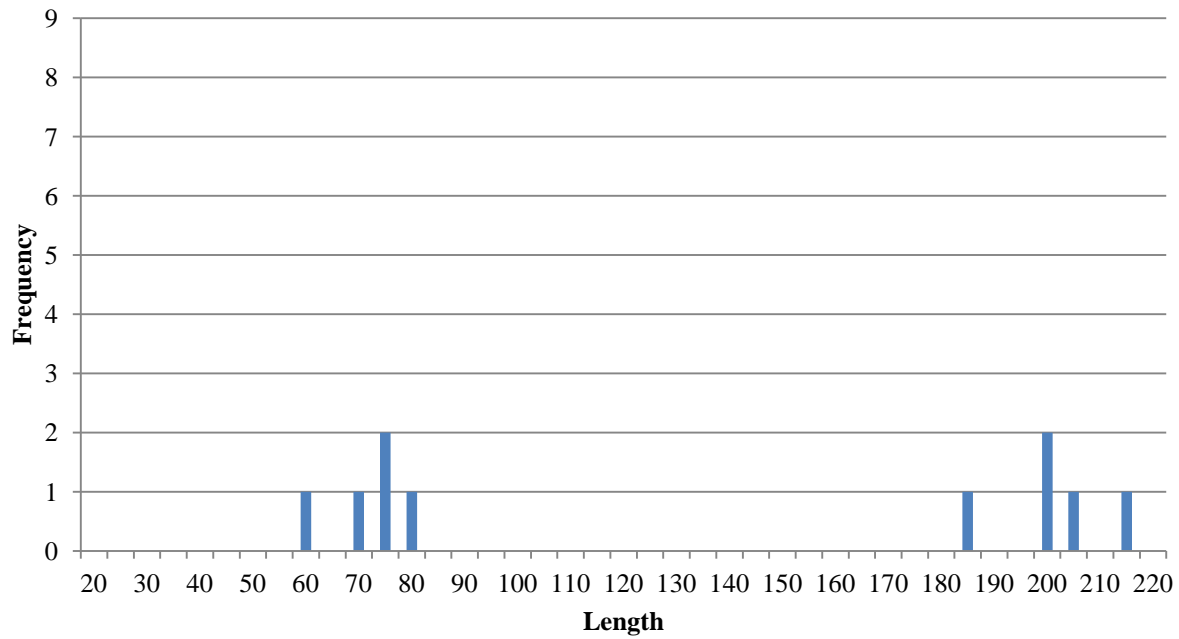
max Dpth LB 8' ft  
 8'  
 12'  
 9'  
 RB 10'

MAX Dpth LB 3'  
 ↓ 7'  
 ↓ 8'  
 ↓ 8'  
 RB 3'

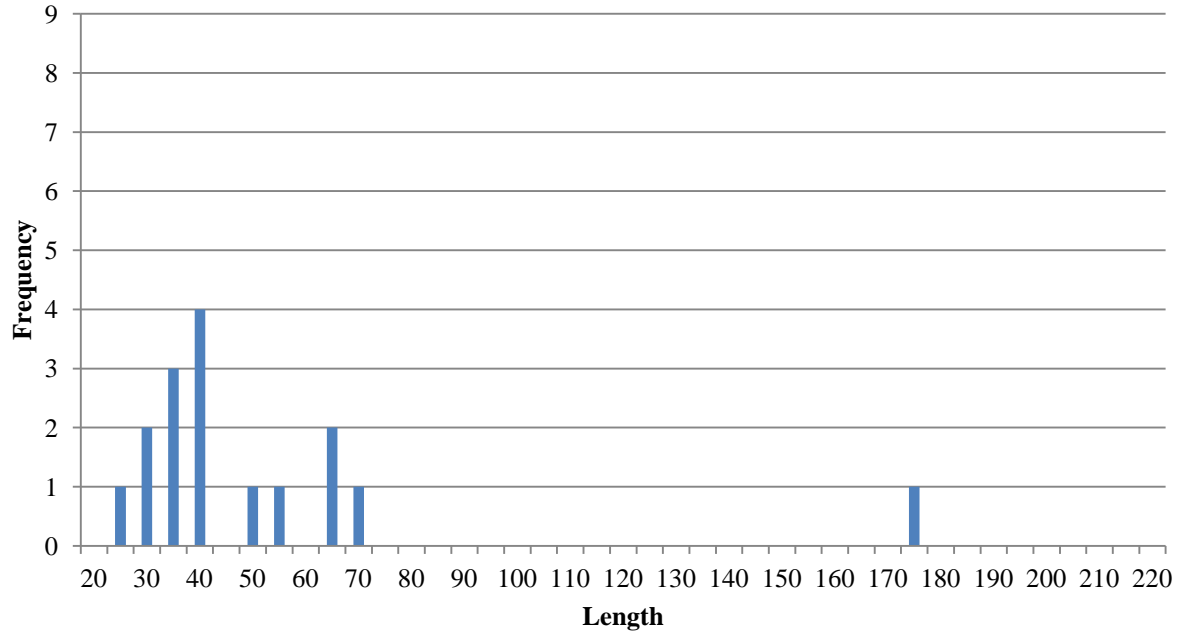
## **ATTACHMENT D**

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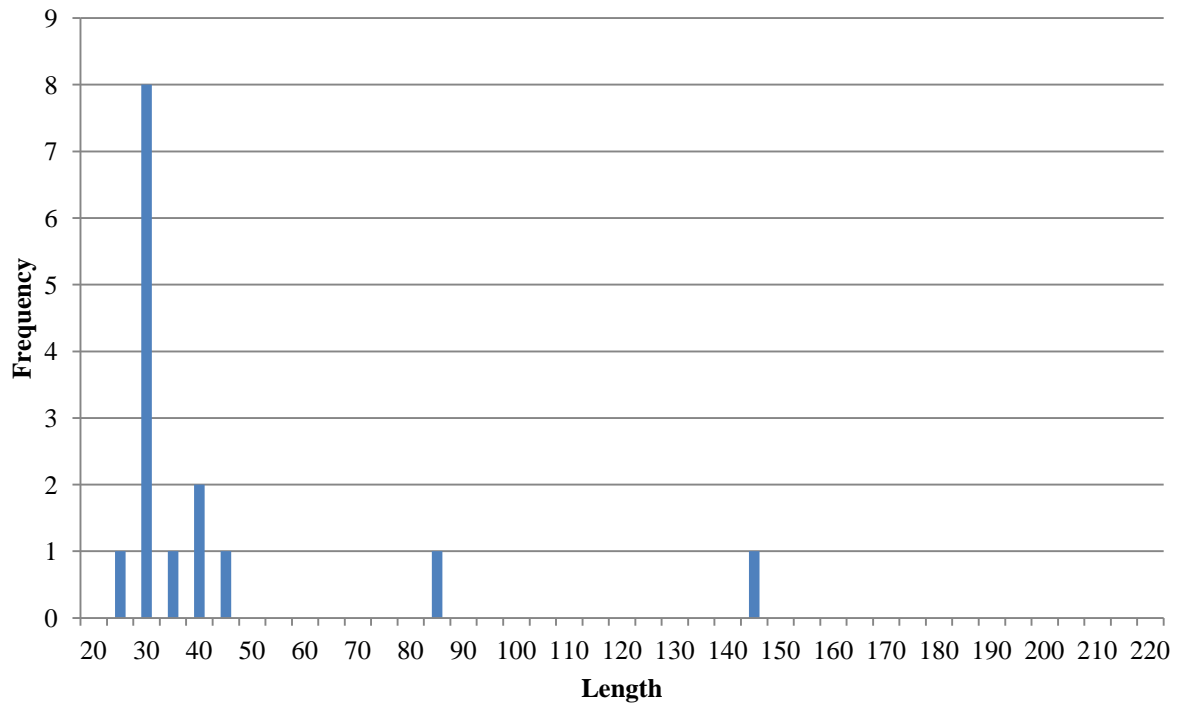
Length-Frequency Histograms for Fish Captured During the Electrofishing Survey



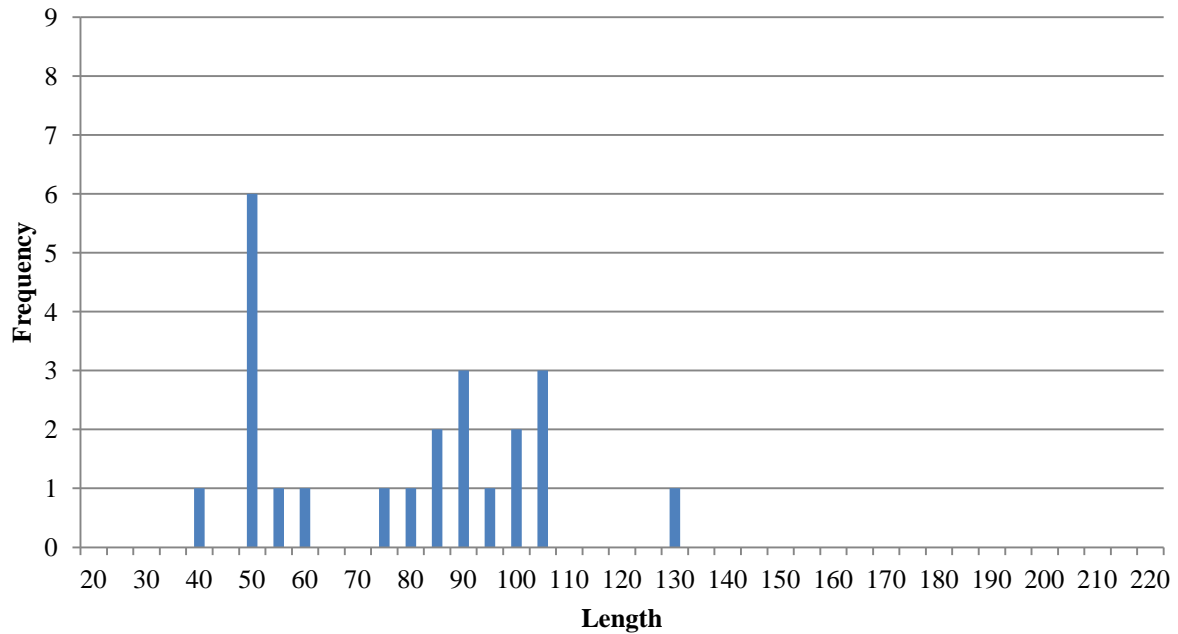
**Attachment D. Figure 1. Rainbow trout length-frequency histogram, South Fork American River electrofishing site at Akin Powerhouse, 19 October 2011.**



**Attachment D. Figure 2. Sacramento sucker length-frequency histogram, South Fork American River electrofishing site at Akin Powerhouse, 19 October 2011.**



**Attachment D. Figure 3. Sacramento pikeminnow length-frequency histogram, South Fork American River electrofishing site at Akin Powerhouse, 19 October 2011.**



**Attachment D. Figure 4. Riffle sculpin length-frequency histogram, South Fork American River electrofishing site at Akin Powerhouse, 19 October 2011.**

## **ATTACHMENT E**

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Number of Fish Observed (by Species and Length) During Snorkel Surveys Conducted in Pools 1 Through 8

Attachment E - Number of Fish Observed (by Species and Length) During Snorkel Surveys Conducted in Pools 1 Through 8

Attachment E. Table 4a. Numbers of fish by species and length observed during snorkel surveys in Pool 1, October 2011

Pool 1	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	0 0, 0	1 0, 2	1 2, 0	6.5 2, 11	1 1, 1	0.5 0, 1	10	*	*
Brown trout (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Hardhead / pikeminnow (first pass, second pass)	636 572, 700	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	636	*	*
Pikeminnow (first pass, second pass)	0 0, 0	0.5 1, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0.5	*	*
Sacramento sucker (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Riffle Sculpin (first pass, second pass)	0.5 1, 0	0.5 1, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	1	*	*
Speckled dace (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Total observed / size	636.5	2	1	6.5	1	0.5	647.5	*	*

Attachment E. Table 4b. Numbers of fish by species and length observed during snorkel surveys in Pool 2, October 2011

Pool 2	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	0 0, 0	0.5 1, 0	2.50 3, 2	0.5 0, 1	0 0, 0	0 0, 0	3.5	*	*
Brown trout (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Hardhead / pikeminnow (first pass, second pass)	42 1, 83	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	42	*	*
Pikeminnow (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Sacramento sucker (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0.5 0, 1	0 0, 0	0 0, 0	0.5	*	*
Riffle Sculpin (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Speckled dace (first pass, second pass)	0.5 0, 1	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0.5	*	*
Total observed / size	42.5	0.5	2.5	1	0	0	46.5	*	*

Attachment E. Table 4c. Numbers of fish by species and length observed during snorkel surveys in Pool 3, October 2011

Pool 3	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	0 0, 0	1 1, 1	3 3, 3	8.5 7, 10	2 1, 3	0 0, 0	14.5	*	*
Brown trout (first pass, second pass)	0 0, 0	0.5 0, 1	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0.5	*	*
Hardhead / pikeminnow (first pass, second pass)	590 436, 744	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	590	*	*
Pikeminnow (first pass, second pass)	1.5 3, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	1.5	*	*
Sacramento sucker (first pass, second pass)	0.5 0, 1	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0.5	*	*
Riffle Sculpin (first pass, second pass)	3.5 7, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	3.5	*	*
Speckled dace (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Total observed / size	595.5	1.5	3	8.5	2	0	610.5	*	*

\* = Due to lack of specimens collected during electrofishing surveys, estimates not available.

Attachment E - Number of Fish Observed (by Species and Length) During Snorkel Surveys Conducted in Pools 1 Through 8  
 Attachment E. Table 4d. Numbers of fish by species and length observed during snorkel surveys in Pool 4, October 2011

Pool 4	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	1.5 3, 0	1 0, 2	15.5 14, 17	8.5 15, 2	2.5 5, 0	0 0, 0	29	*	*
Brown trout (first pass, second pass)	0 0, 0	0.5 0, 1	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0.5	*	*
Hardhead / pikeminnow (first pass, second pass)	1 0, 2	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	1	*	*
Pikeminnow (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Sacramento sucker (first pass, second pass)	0 0, 0	0 0, 0	0.5 0, 1	0 0, 0	0.5 0, 1	0.5 1, 0	1.5	*	*
Riffle Sculpin (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Speckled dace (first pass, second pass)	1.5 0, 3	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	1.5	*	*
Total observed / size	3	1.5	16	8.5	3	0.5	32.5	*	*

Attachment E. Table 4e. Numbers of fish by species and length observed during snorkel surveys in Pool 5, October 2011

Pool 5	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	0 0, 0	1.5 2, 1	3.5 2, 5	0 0, 0	0 0, 0	0 0, 0	5	*	*
Brown trout (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Hardhead / pikeminnow (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Pikeminnow (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Sacramento sucker (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Riffle Sculpin (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Speckled dace (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Total observed / size	0	1.5	3.5	0	0	0	5	*	*

Attachment E. Table 4f. Numbers of fish by species and length observed during snorkel surveys in Pool 6, October 2011.

Pool 6	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	1 2, 0	0 0, 0	15 8, 22	5 4, 6	0 0, 0	0 0, 0	21	*	*
Brown trout (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Hardhead / pikeminnow (first pass, second pass)	4.5 0, 9	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	4.5	*	*
Pikeminnow (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Sacramento sucker (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Riffle Sculpin (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Speckled dace (first pass, second pass)	1 0, 2	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	1	*	*
Total observed / size	6.5	0	15	5	0	0	26.5	*	*

Attachment E - Number of Fish Observed (by Species and Length) During Snorkel Surveys Conducted in Pools 1 Through 8  
 Attachment E. Table 4g. Numbers of fish by species and length observed during snorkel surveys in Pool 7, October 2011

Pool 7	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	0 0, 0	3 6, 0	7.5 7, 8	4.5 0, 9	0 0, 0	0 0, 0	15	*	*
Brown trout (first pass, second pass)	0 0, 0	0 0, 0	1 0, 2	0 0, 0	0 0, 0	0 0, 0	1	*	*
Hardhead / pikeminnow (first pass, second pass)	10 0, 20	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	10	*	*
Pikeminnow (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Sacramento sucker (first pass, second pass)	0.5 0, 1	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0.5	*	*
Riffle Sculpin (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Speckled dace (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Total observed / size	10.5	3	8.5	4.5	0	0	26.5	*	*

Attachment E. Table 4h. Numbers of fish by species and length observed during snorkel surveys in Pool 8, October 2011

Pool 8	Length Categories (inches)						Estimated # of Fish	Estimated Biomass (g)	Grams/acre
	0 - 3	3 - 6	6 - 9	9 - 12	12 -15	15 - 18			
Rainbow trout (first pass, second pass)	0 0, 0	0 0, 0	14.5 10, 19	11.5 2, 21	6.5 0, 13	1.5 0, 3	34	*	*
Brown trout (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Hardhead / pikeminnow (first pass, second pass)	169 98, 240	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	169	*	*
Pikeminnow (first pass, second pass)	0 0, 0	10.5 18, 3	0 0, 0	0 0, 0	0 0, 0	0 0, 0	10.5	*	*
Sacramento sucker (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	2 0, 4	0 0, 0	0 0, 0	2	*	*
Riffle Sculpin (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Speckled dace (first pass, second pass)	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0 0, 0	0	*	*
Total observed / size	169	10.5	14.5	13.5	6.5	1.5	215.5	*	*

\* = Due to lack of specimens collected during electrofishing surveys, estimates not available.