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HARDHEAD FISHERY SURVEY DATA REPORT

EL DORADO IRRIGATION DISTRICT

Hydroelectric Project 184

(El Dorado County, California)

Version 1.0

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CONTENTS

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EL DORADO IRRIGATION DISTRICT
HYDROELECTRIC PROJECT 184

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

The El Dorado Hydroelectric Project, FERC 184-065 (Project 184) is a 21-megawatt (MW) project located on the South Fork American River (SFAR) in the counties of El Dorado, Alpine, and Amador, California. Project 184 components are set in both private lands and land administered by the El Dorado National Forest. Project 184 consists of four storage reservoirs, the El Dorado Diversion Dam, water conveyance facilities consisting of flumes and tunnels, several smaller diversions on tributaries to the SFAR, a forebay, penstock, and the Akin Powerhouse.

Water is released from the four storage reservoirs (Lake Aloha, Echo Lake, Silver Lake, and Caples Lake) at seasonally varying volumes. At full project load, up to 165 cubic feet per second (cfs) of SFAR streamflow is diverted at the El Dorado Diversion Dam, located near the community of Kyburz, at an elevation of 3,911 feet above sea level. Diverted water is conveyed by the 22.3 mile-long El Dorado Canal to the Forebay, where it is then passed through penstock to the El Dorado Irrigation District (EID) Akin Powerhouse, an elevation change of approximately 2,000 feet. Water is discharged to the SFAR through the Akin Powerhouse.

The EID contracted with ECORP Consulting, Inc. (ECORP) to conduct aquatic-oriented environmental studies in fulfillment of the Settlement Agreement (pages 52-53), Section 7.1 Fish Populations (USFS 4(e) Condition 37.1). This report presents an analysis of data collected pursuant to the objectives identified in Section 7.1, including a set of proposed hardhead minnow biomass indices for the SFAR in the vicinity of the Akin Powerhouse.

1.1 Background

During the Federal Energy Regulatory Commission (FERC) Collaborative Relicensing Process for EID's Project 184, it was determined that additional information was needed to establish hardhead biomass indices in the lower reach of the SFAR potential affected

by Project operations. The current distribution of hardhead in the SFAR is thought to be limited to suitable habitat downstream of the confluence with Silver Creek. The terms of the Settlement Agreement, and the U.S. Forest Service 4(e) relicensing condition number 37, required EID to conduct at least three years of monitoring in that reach to assist the Ecological Resources Committee (ERC), State Water Resources Control Board (SWRCB), and the U.S. Forest Service (USFS) in developing hardhead biomass indices. This report provides the results of the first year of monitoring for hardhead minnow at sites approved by the ERC, SWRCB, and USFS. Results obtained from monitoring years 2 and 3 will be integrated with the current dataset (Year 1) and analyzed to finalize hardhead biomass indices.

2.0 METHODS

Two types of sampling efforts were performed during two days in October 2004: electrofishing survey (October 13) and direct observation snorkel survey (October 14). Electrofishing was conducted in representative riffle, run, and shallow pool habitats in the SFAR upstream of Slab Reservoir, in the vicinity of the Akin Powerhouse. Snorkel surveys were performed in deep pool habitats upstream of Akin Powerhouse that could not be electrofished. These large, deep pools provide important habitat for hardhead (Figure 1).

2.1 Data Collection

2.1.1 Physical Habitat Data

Streamflow data were collected using standard (i.e., USGS transect methodology) field methods at the electrofishing site (Appendix A). Water quality data collected included temperature, dissolved oxygen, and conductivity, which were collected using a YSI Model 556 multi-parameter water quality meter. Instantaneous water and air

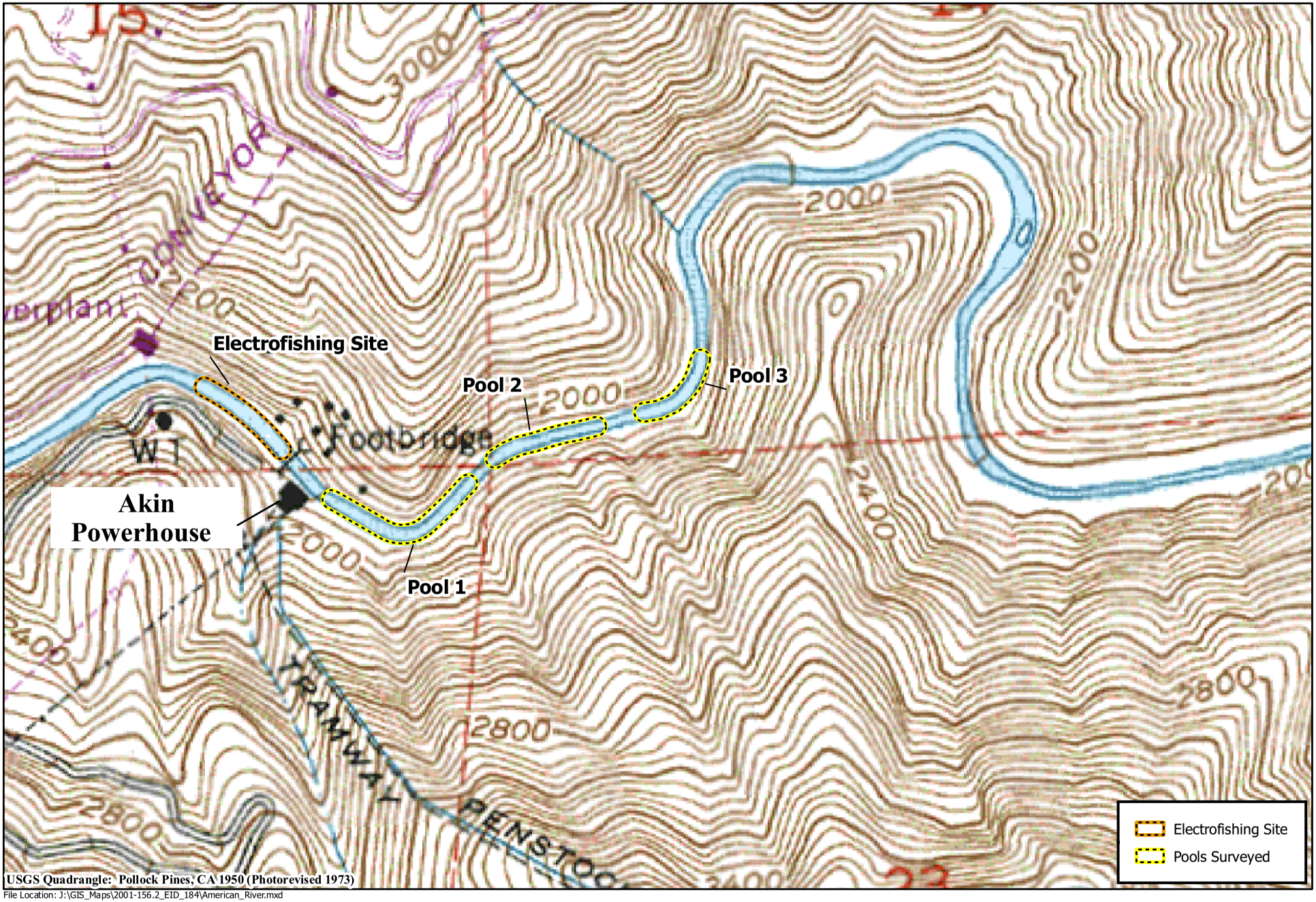

FIGURE 1. Location of hardhead electrofishing and snorkeling surveys conducted in October 2004

2001-156.2 EID

1:8,400
1 inch equals 700 feet
0 250 500 1,000 Feet

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temperatures were also measured using pocket thermometers for comparisons with meter readings.

Several physical habitat characteristics were recorded during the electrofishing survey effort. These parameters included substrate composition, percent instream cover, canopy cover, and habitat composition (percent of area represented by pools, riffles, and runs). In addition, stream widths were measured at 10 meter intervals to calculate a mean sampling site width, which was then be multiplied by the site length to calculate sampling area in meters-squared, and then expressed in acres.

2.1.2 Fish Population Data

Quantitative fish population sampling was conducted by backpack electrofishing (multi-pass depletion method). Prior to each sampling event, block nets were placed at the beginning and end of each site to prevent fish movement into or out of the study site during sampling. Block net locations were flagged with surveyor's tape on both sides of the stream for site identification purposes.

Fish were captured during two passes using Smith-Root backpack electroshockers in pulsed DC mode. Two backpack electroshockers were used due to the substantial width of the river. Captured fish were held in live cars outside the electrofishing station. After each pass, fish were processed and placed in a separate live car outside of the sampling site. All fish were carefully redistributed throughout the sampling site after fish collected during the final pass were processed.

During the electrofishing effort, the fork length of each fish was measured to the nearest millimeter. Individual fish weight was measured directly (to 0.1 gram) using a portable digital scale.

Snorkel surveys consisted of four biologists with snorkel gear, moving upstream in separate lanes from the bottom to the top of each pool. When a fish or school of fish was sighted, the snorkeler called out the species, relative length, and number of each species to a shore-based observer who recorded all data. Only those fish that passed downstream of each individual snorkeler were counted. Results were tallied when the effort was completed for each pool. Since only qualitative data were collected during the snorkel surveys, population estimates were not calculated using this dataset.

2.2 Data Analysis

All biological and physical habitat data were entered into a spreadsheet. Error checking procedures were performed, as well as data exploration analysis (e.g., minimum/maximum values and frequency tables). Species-specific population estimates were calculated from the electrofishing dataset using the USFS Microfish Maximum Likelihood Program **(**Van Deventer and Platts 1986)**.** Species-specific length-frequency histograms were also developed from the electrofishing dataset and were used to determine age classes.

The condition factor of each fish was also calculated, using the following formula:

$$\text{Condition Factor} = \frac{\text{Length}^3}{\text{Weight} \times 100{,}000}$$

Where length is measured in mm, weight is measured in grams, 100,000 is a unit conversion factor, and condition factor is dimensionless. In general, the closer the ratio is to 1.0, the healthier the fish. This relationship is useful for relative comparison of health between medium-sized fish populations; but it tends to be less applicable for very small and very large fish.

Biomass indices were generated using grams of species-specific biomass per acre (gm/ac). Initially, fish weights from the electrofishing dataset were summed for each species. Mean species-specific biomass values were then calculated and multiplied by the population estimate for each species. Results were then standardized to biomass per unit area (i.e., grams per acre).

Hardhead minnow in the age class 0+ (i.e., young-of-the-year) were treated separately from age class 1+ hardhead, because age class 0+ fish cannot be captured in a quantitative manner without experiencing significant mortality. By convention, the actual catch, and therefore actual biomass of the age class 0+ hardhead was summed with the population estimate derived age class 1+ hardhead biomass to determine the total hardhead biomass index.

3.0 RESULTS

Due to the sensitivity of hardhead, especially age class 0+ hardhead to electrofishing, only two sampling passes were conducted. As a result, mortalities due to electrofishing were not observed. Electrofishing was conducted prior to the snorkeling surveys to ensure that individual fish could be identified to species, and differences between hardhead and Sacramento pikeminnow, in particular, could be determined.

3.1 Physical Data Collection

Water quality data and a summary of physical habitat characteristics measured at hardhead electrofishing sites are provided in tables 1 and 2, respectively. The 120-meter electrofishing station was sited to begin and end at natural habitat unit boundaries. The dominant substrate type was boulder (40 percent) followed by equal percentages of cobble and gravel (20 percent each). In addition, three large pools upstream from Akin Powerhouse were snorkeled, ranging from 0.7 to 4.6 acres in area. These pools were up to 12 feet in depth, with substrates that ranged from sand to large boulders. In general,

through-pool streamflow velocities were relatively low. Streamflow was calculated to be 76.8 cfs at the time of the electrofishing survey.

3.2 Electrofishing Data

A total of seven fish species were collected during the electrofishing survey (Table 3). The most abundance species was hardhead minnow, accounting for 49.4 percent of the catch. Riffle sculpin accounted for 14.1 percent of the catch, followed by Sacramento sucker (11.5 percent), rainbow trout (10.9 percent), Sacramento pikeminnow (10.3 percent), speckled dace (2.6 percent), and brown trout (1.3 percent). All species collected were native to the SFAR, except for brown trout. All fish appeared to be in good condition, with condition factor values ranging from 1.07/1.08 (rainbow trout, hardhead minnow, and Sacramento pikeminnow) to 1.48 (speckled dace).

The population estimate for hardhead was 385 fish (Table 3); however, this estimate is questionable, due to the high standard error. The high standard error results from combining the age class 0+ hardhead with the base (age class 1+) population. As stated earlier, age class 0+ cannot be quantitatively collected without resulting in significant mortality. Additionally, natural mortality of age class 0+ fish is highly variable. For this reason, a population estimate was calculated only for the base population, to which the actual age class 0+ catch was added, for a total hardhead minnow population estimate of 80 fish. Population estimates for other species are reported in Table 3.

The largest individual fish collected were Sacramento sucker (averaging 54.9 grams per individual) and rainbow trout (averaging 24.6 grams). The remaining fish averaged between 1.9 grams (hardhead minnow) and 8.9 grams (brown trout).

Table 1. Water Quality Measurements at Electrofishing and Snorkeling Stations.

Location	Site	Date	Temperature (°C)	pH	Conductivity (µS/cm)	Salinity (ppt)	DO (mg/L)	DO (%)	TDS (g/L)	GPS	
										10 S	UTM
SFAR	Electrofishing Site	10/13/2004	11.5	7.02	36	0.02	10.4	95.4	0.032		
SFAR	Snorkel Pool No. 1	10/14/2004	12.33	7.77	35	0.02	10.1	94.6	0.030	0707306	4296463
SFAR	Snorkel Pool No. 2	10/14/2004	12.33	7.77	35	0.02	10.1	94.6	0.030	0707184	4296413
SFAR	Snorkel Pool No. 3	10/14/2004	12.33	7.77	35	0.02	10.1	94.6	0.030	0706900	4296400

Table 2. Habitat Measurements of the South Fork American River (SFAR), EID Akin Powerhouse Electrofishing Site, October 14, 2004.

	Station No. (10 foot Increments - downstream end to upstream end)												
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**
Stream Width (m):	22.7	26.5	26.5	23.4	23.7	24.3	23.4	21.3	20.6	21.7	22.5	23.6	21
Depth (cm)													
Right:	63	68	67	0	57	34	47	21	69	60	42	12	24
Center:	65	53	52	72	77	58	10	56	34	68	51	31	50
Left:	24	66	48	50	64	45	27	12	18	21	42	68	43

Substrate Composition:	**Silt**	**Sand**	**Gravel**	**Cobble**	**Boulder**	**Bedrock**
Percent	3	15	20	20	40	2

Table 3. Electrofishing Catch Summary Data in the vicinity of the EID Akin Powerhouse, October 13, 2004.

Species	Pass Number		Actual Catch	Population Estimate	Standard Error	Length Range (mm)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor
	Pass 1	Pass 2							
Brown trout	1	1	2	2	1.0	85 - 101	93.0	8.9	1.08
Rainbow trout	9	8	17	33	32.3	64 - 298	102.1	25.7	1.19
Sacramento sucker	10	8	18	30	20.8	48 - 295	106.4	54.9	1.28
Riffle sculpin	18	4	22	22	1.0	45 - 115	74.3	7.0	1.30
Speckled dace	1	3	4	20	168.3	45 - 87	57.5	4.1	1.48
Sacramento pikeminnow	7	9	16	80	326.1	37 - 105	58.4	3.2	1.07
Hardhead minnow	37	40	77	385	709.9	34 - 94	52.8	2.4	1.08
Hardhead Age 0+	30	35	65	65 *	NA	34 - 60	47.5	1.2	1.11
Hardhead Age 1+	7	5	12	15	6.0	65 - 94	81.3	5.7	1.02
Total	**83**	**73**	**156**						

* Hardhead population estimate for Age 0+ is actual catch

3.3 Snorkeling Data

Snorkelers observed a total of 1,456 fish in the three pools; 85.5 percent of these fish were observed in the first deep pool upstream from the Akin Powerhouse (Table 4). The next two distinct pools comprised 14.0 (Pool 2) and 0.5 (Pool 3) percent of all fish observed, respectively. Hardhead minnow were only observed in Pool 1 and Pool 2.

It was difficult to discern during snorkeling whether the cyprinids observed to be less than 3 inches in length were hardhead minnow or Sacramento pikeminnow. No Sacramento pikeminnow greater than 3 inches were observed during the snorkeling surveys. Based upon physical characteristics (head shape, snout shape, coloration, and the triangular spot on the caudal peduncle) most, if not all, of the smaller fish appeared to be juvenile hardhead. However, if the cyprinids less than 3 inches in length are removed from consideration, then 93.6 percent of all fish observed were hardhead minnow, followed by 5.5 percent rainbow trout. Sacramento sucker, riffle sculpin, and crayfish were incidentally observed.

3.4 Biomass Indices

Biomass indices from the electrofishing dataset reflect conditions present in generally shallow water habitat (riffle, run, and shallow pool), and ranged from 2,396.2 gm/ac for Sacramento sucker, to 25.8 gm/ac for brown trout (Table 5). The rainbow trout biomass index was 1,180.2 gm/ac. Hardhead minnow biomass indices were calculated for both age class 0+ (115.6 gm/ac) and age class 1+ (125.0 gm/ac) fish. For the entire population, hardhead minnow biomass index was estimated to be 240.6 gm/ac.

Biomass indices for each of the three pools were calculated from the snorkel survey dataset for age class 0+ Cyprinidae species, and for age class 1+ hardhead (Table 6). The greatest biomass estimated for age class 0+ Cyprinidae was observed in Pool 1 (293.7 gm/ac), followed by 117.7 gm/ac in Pool 2. No cyprinids were observed in Pool 3.

Table 4. Snorkel Survey Observation Summary by Species and Pool No., Upstream of the EID Akin Powerhouse, October 14, 2004.

Pool No.	Date	Rainbow Trout	Hardhead Minnow (3.1"-6")	Cyprinidae (Unidentifiable Minnow) (0"-3")	Sacramento sucker	Riffle sculpin	Crayfish	Total No.
1	10/14/04	3	131	1,114	1	0	2	**1,251**
2	10/14/04	5	75	125	0	0	0	**205**
3	10/14/04	4	0	0	0	1	2	**7**
Total		**12**	**206**	**1,239**	**1**	**1**	**4**	**1,463**

Table 5. Biomass estimates for fish species collected during electrofishing survey in the vicinity of Akin survey in three pools upstream of Akin Powerhouse, SFAR, October 14, 2004.

Species	Actual Biomass (gm)	Mean Biomass (gm)	Population Estimate	Biomass Estimate (gm)	Site Area (m2)	Site Area (acres)	Biomass Estimate (gm/ac)
Brown trout	17.7	8.9	2	17.7	2780.3	0.687	25.8
Rainbow trout	417.7	24.6	33	810.8	2780.3	0.687	1180.2
Sacramento sucker	987.7	54.9	30	1646.2	2780.3	0.687	2396.2
Riffle sculpin	153	7.0	22	153.0	2780.3	0.687	222.7
Speckled dace	16.3	4.1	20	81.5	2780.3	0.687	118.6
Sacramento pikeminnow	43.7	2.7	80	218.5	2780.3	0.687	318.0
Hardhead minnow total [1]	227.5	1.9	80	153.9	2780.3	0.687	240.6
Hardhead Age 0+ [2]	*79.4*	*1.2*	*65*	*79.4*	*2780.3*	*0.687*	*115.6*
Hardhead Age 1+	*148.1*	*5.7*	*15*	*85.9*	*2780.3*	*0.687*	*125.0*

[1] The hardhead total population estimate is a summation of the Age 0+ actual catch and the Age 1+ population estimate.

[2] Age 0+ Population estimate not available, population estimate value indicates actual catch.

Table 6. Biomass estimates for Hardhead minnow and juvenile Cyprinidae species observed during snorkel survey in three pools upstream of Akin Powerhouse, SFAR, October 14, 2004.

Species	Mean Biomass (gm) [1]	Numbers Observed	Biomass Estimate (gm)	Estimated Site Area (m2)	Estimated Site Area (acres)	Biomass Estimate (gm/ac)
Pool 1						
Cyprinidae Age 0+	1.2	1,114	1,361	18750	4.6	293.7
Hardhead Age 1+	5.7	131	750	18750	4.6	161.9
Pool 2						
Cyprinidae Age 0+	1.2	125	153	5250	1.3	117.7
Hardhead Age 1+	5.7	75	429	5250	1.3	331.0
Pool 3						
Cyprinidae Age 0+	1.2	0	0	3000	0.7	0.0
Hardhead Age 1+	5.7	0	0	3000	0.7	0.0

[1] Biomass estimate from electrofishing survey data

The highest biomass estimated for age class 1+ hardhead was observed in Pool 2 (331.0 gm/ac), followed by 161.9 gm/ac in Pool 1.

4.0 SUMMARY

Based on the results of the electrofishing and snorkeling surveys conducted in October 2004, the number of fish species captured (seven) indicates that a relatively diverse assemblage of fish is present in the SFAR in the vicinity of Akin Powerhouse. Hardhead minnow were the most abundant species observed in both shallow and deep-water habitats. All fish appeared to be in good condition. Based on the length-frequency histograms (Appendix B), it appears that at least two age classes of hardhead were present during the October 2004 sampling event, indicating a relatively healthy population structure.

Hardhead minnow biomass indices were calculated for the electrofishing (shallow habitat) and snorkel (deepwater habitat) surveys. The shallow habitat biomass index (240.6 gm/ac) were within the range of the deepwater biomass indices (161.9 to 331.0 gm/ac).

Although no sampling was conducted in Slab Reservoir, it is likely that hardhead minnow are abundant in Slab Reservoir. Individual spawners (age class 1+ and older) migrate upstream from Slab Reservoir to spawn in low-velocity flows present in the major pools of the SFAR. It also appears that hardhead in 2003 migrated upstream to spawn at least as far as the second major pool upstream from the Akin Powerhouse. Each pool had a drop in elevation at the base of the pool, making upstream migration difficult for spawning hardhead. A moderate barrier (during moderate flows) to upstream passage for hardhead occurs at the top of the second pool, and a major barrier at the top of Pool 3, making it unlikely that hardhead are present upstream, especially given their absence in Pool 3.

5.0 LITERATURE CITED

Van Deventer, J. S. and W. S. Platts. 1986. Microfish Interactive Program. Microsoft Corporation.

LIST OF APPENDICES

APPENDIX A

Flow Measurement During Electrofishing Survey.

South Fork American River (SFAR) - Akin Powerhouse - (10/14/04)						
Station	**Distance (ft)**	**Width (ft)**	**Depth (ft)**	**Velocity (ft/s)**	**Discharge (cfs)**	***Notes**
1 - (LWE)	72.0	1.50	0.20	-0.02	-0.006	
2	69.0	3.00	1.10	0.08	0.264	*eddy*
3	66.0	3.00	1.60	0.40	1.920	
4	63.0	3.00	2.30	1.06	7.314	
5	60.0	3.00	2.00	1.60	9.600	*on top of boulder*
6	57.0	3.00	2.60	0.90	7.020	
7	54.0	3.00	0.40	1.72	2.064	*on top of boulder*
8	51.0	3.00	1.60	0.88	4.224	*behind boulder*
9	48.0	3.00	1.00	1.67	5.010	
10	45.0	3.00	0.60	1.89	3.402	*on top of boulder*
11	42.0	3.00	1.00	1.70	5.100	*on top of boulder*
12	39.0	3.00	1.50	0.20	0.900	*behind boulder*
13	36.0	3.00	0.60	1.56	2.808	
14	33.0	3.00	1.65	1.60	7.920	
15	30.0	3.00	2.00	1.65	9.900	
16	27.0	3.00	1.55	0.86	3.999	*behind boulder*
17	24.0	3.00	1.40	0.10	0.420	*behind boulder*
18	21.0	3.00	1.00	0.14	0.420	*behind boulder*
19	18.0	3.00	0.80	0.23	0.552	
20	15.0	3.00	1.75	0.68	3.570	
21	12.0	3.00	1.00	0.12	0.360	
22 - (RWE)	9.0	1.50	0.00	0.00	0.000	
				Flow =	**76.761**	**cfs**

Date: **10/14/04**

Time: **1620**

APPENDIX B

Length Frequency Histograms for Fish Collected During Electrofishing Survey.

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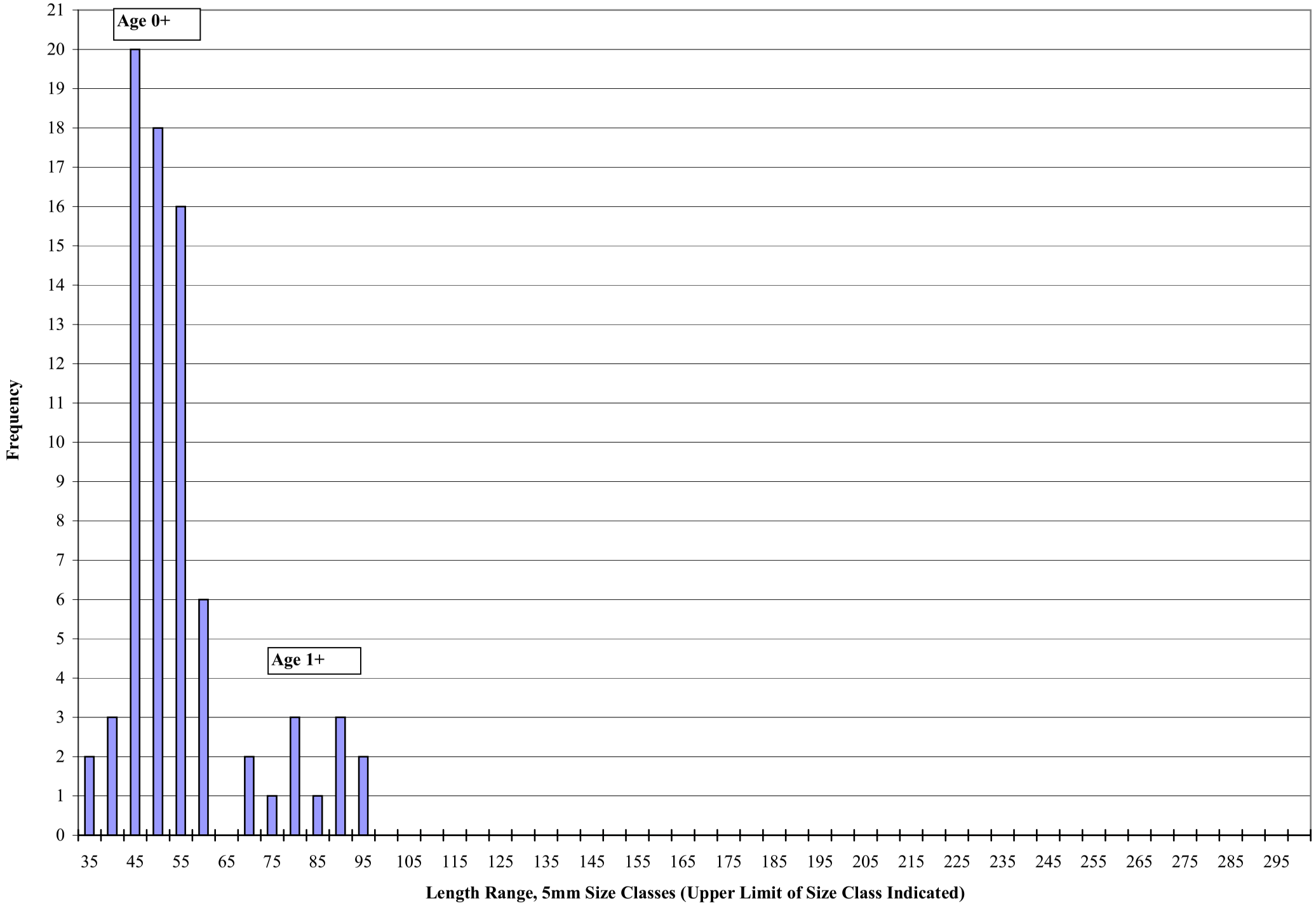
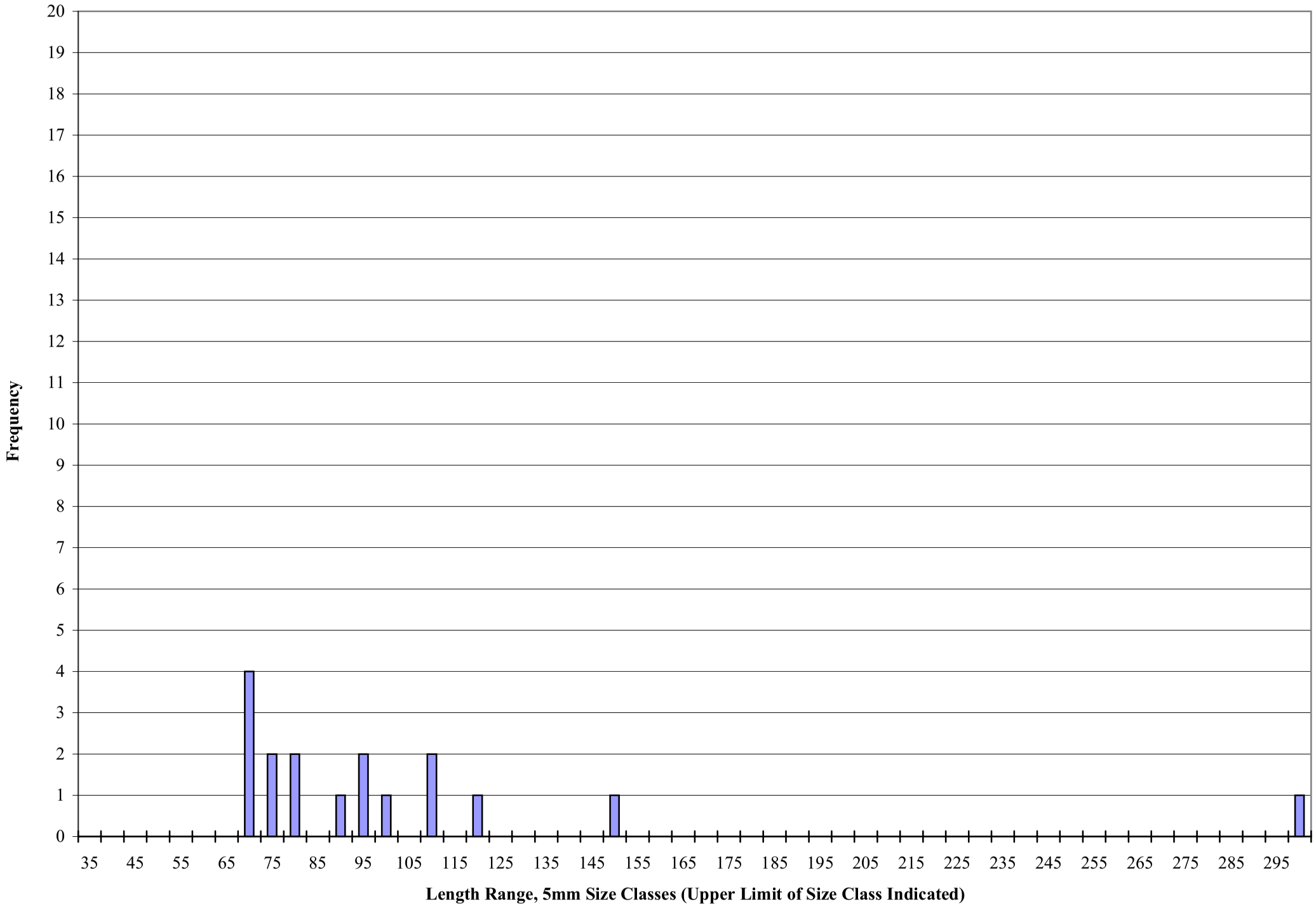
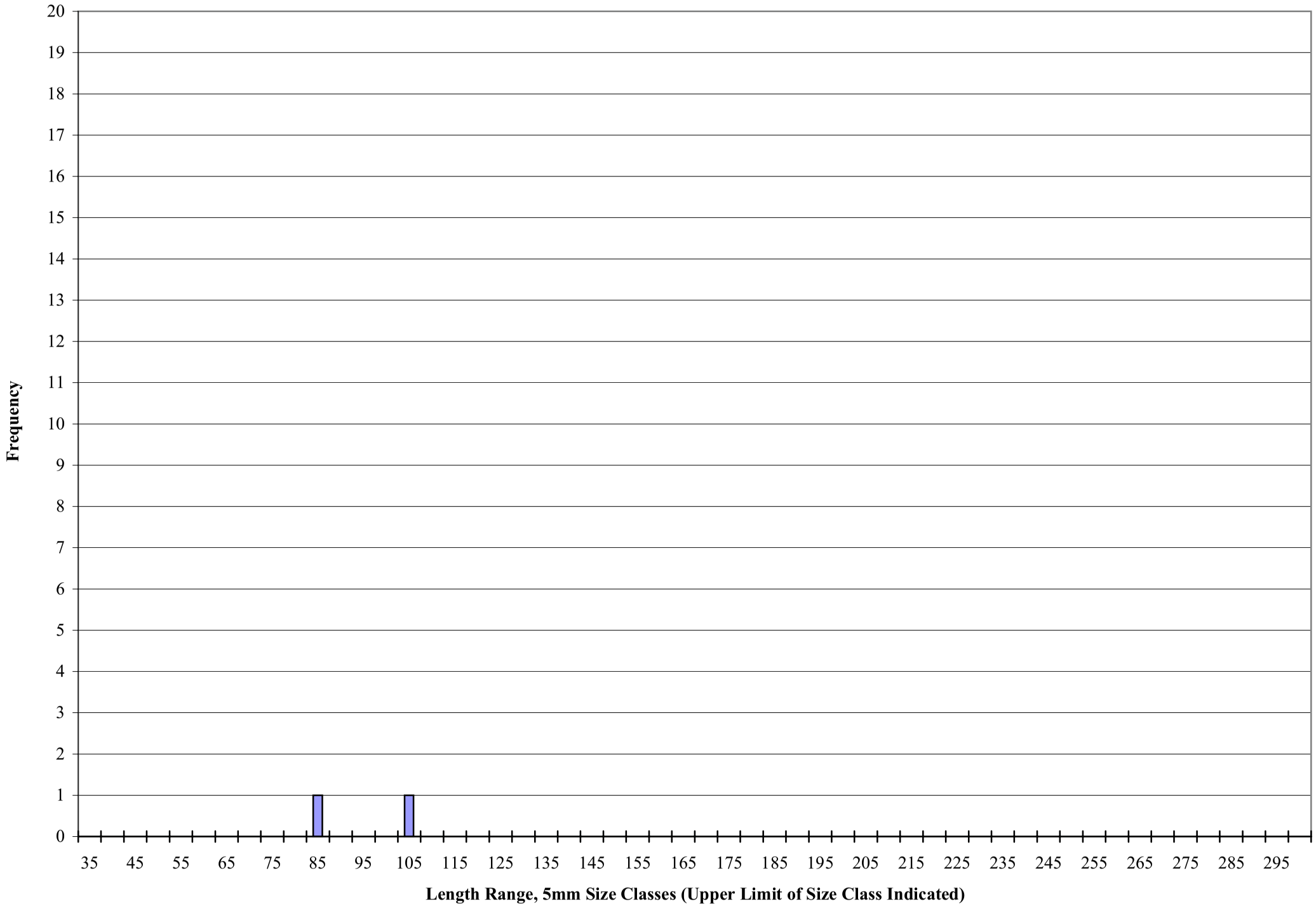
Hardhead Minnow Length Frequency - SFAR - Akin Powerhouse Electroshocking - October 14, 2004.

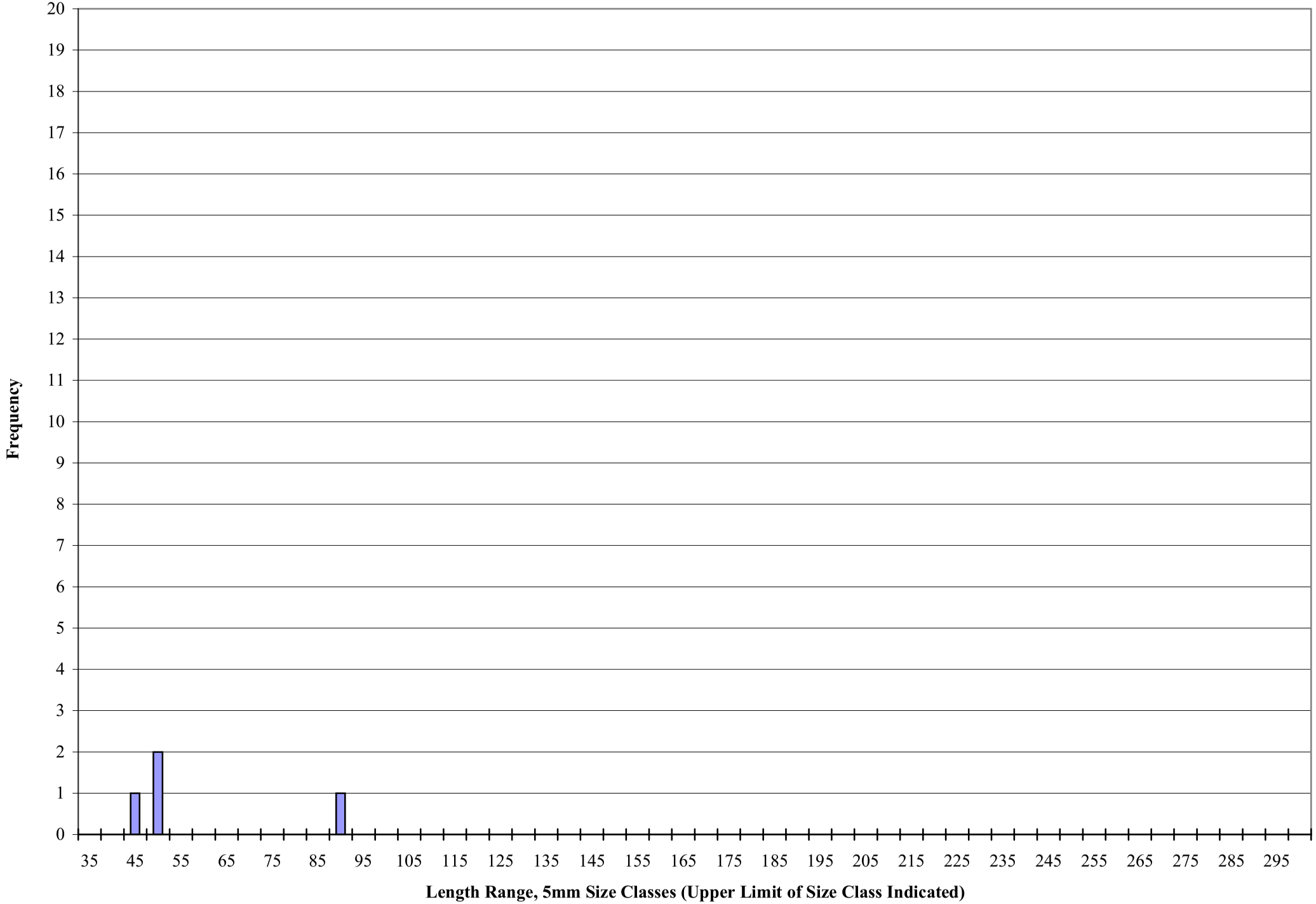


Rainbow Trout Length Frequency - SFAR - Akin Powerhouse Electroshocking - October 14, 2004.

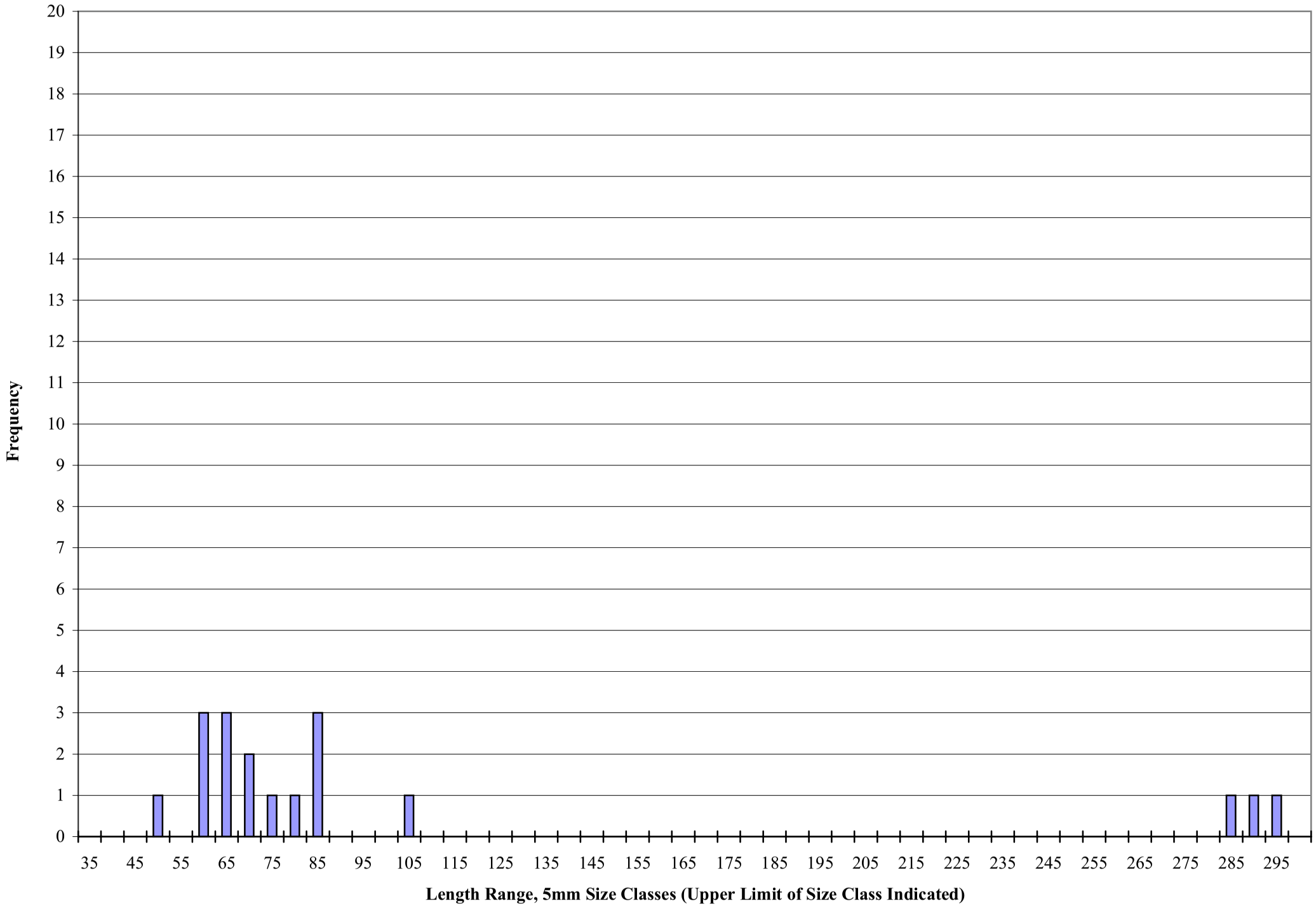


Brown Trout Length Frequency - SFAR - Akin Powerhouse Electroshocking - October 14, 2004.

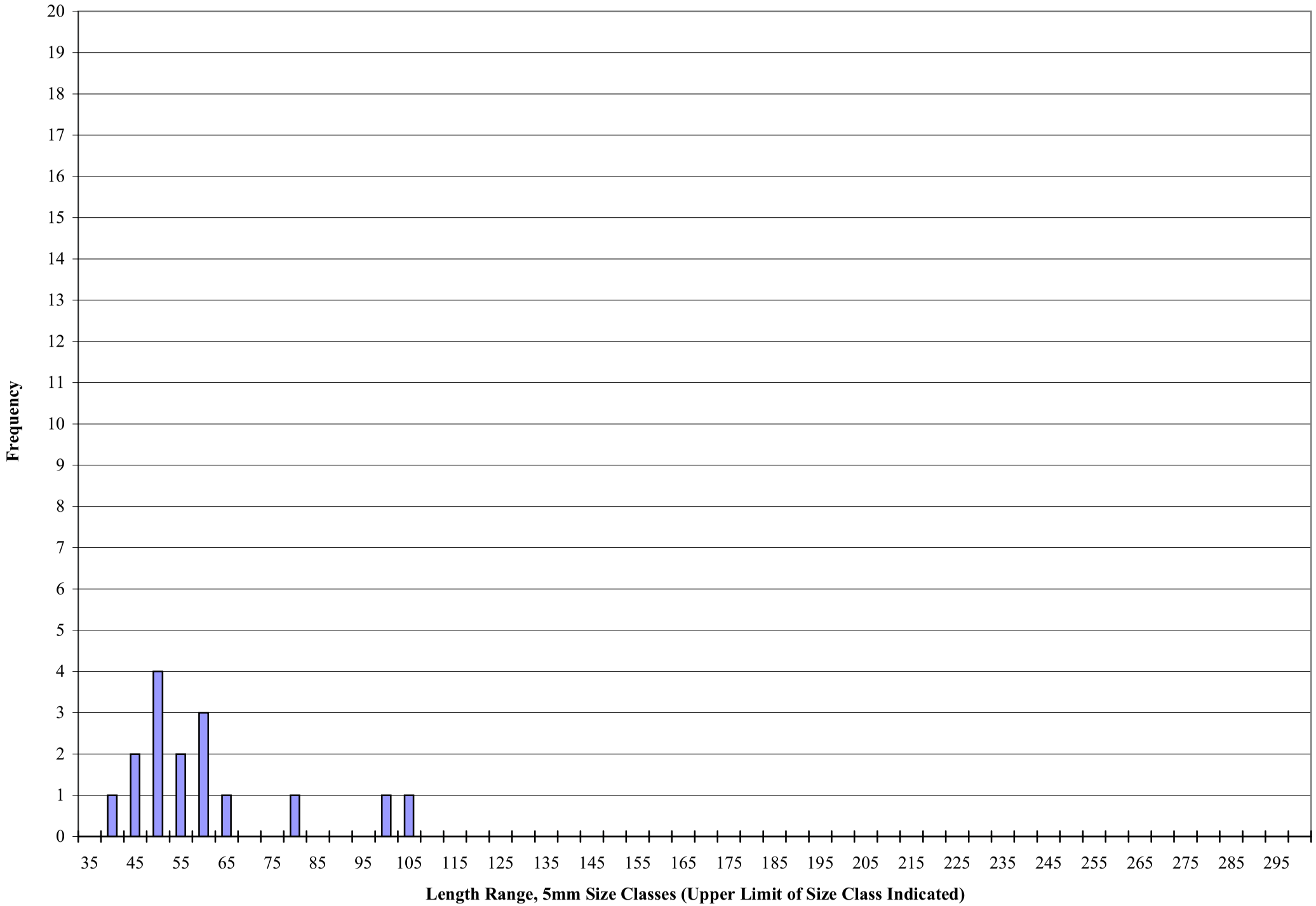



Speckled Dace Length Frequency - SFAR - Akin Powerhouse Electroshocking - October 14, 2004.
Frequency
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
205
215
225
235
245
255
265
275
285
295
Length Range, 5mm Size Classes (Upper Limit of Size Class Indicated)

Sacramento Sucker Length Frequency - SFAR - Akin Powerhouse Electroshocking - October 14, 2004.



Sacramento Pikeminnow Length Frequency - SFAR - Akin Powerhouse Electroshocking - October 14, 2004.



Riffle Sculpin Length Frequency - SFAR - Akin Powerhouse Electroshocking - October 14, 2004.