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Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE, Room 1-A
Washington, DC 20426

Subject: Fish Population Monitoring Report
Kern River No. 3 Hydroelectric Project (FERC P-2290)

Dear Ms. Bose:

The Southern California Edison (SCE) Company's Kern River No. 3 (KR3) Hydroelectric Project was issued a license by the Federal Energy Regulatory Commission (Commission) on December 24, 1996. Article 411 of the license requires fish population monitoring to be conducted once every five years for the term of the license. A study plan was developed in consultation with the California Department of Fish and Game, Sequoia National Forest, the U.S. Fish and Wildlife Service, and the National Park Service. The first post-license study was completed in 1998. The second study was delayed by adverse conditions in the river, which resulted in sedimentation in the study reach. SCE received concurrence from the above resource agencies that the river water had cleared sufficiently for the late October/early November 2006 study.

This filing submits the results of the October 9-16, 2011 fish population monitoring survey. The draft report was submitted to the above resource agencies on December 14, 2011 for review and comment; comments received are contained in the consultation section of the report. The results of the current study were compared with the results of the previous studies. The next fish population monitoring survey for the KR3 Project is currently scheduled for early October of 2016.

If the Commission has any questions regarding this filing, contact Candace Irelan at (909) 394-8714 or Candace.Irelan@sce.com.

Sincerely,

Walter D. Pagel

Enclosure

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Fish Population Monitoring Report 2011
Kern River No. 3 Hydroelectric Project

1.0 Introduction

This report describes fish population monitoring carried out in the North Fork Kern River (NFKR) during October 2011. The monitoring was required under the FERC license for Southern California Edison's (SCE) Kern River No. 3 (KR3) Hydroelectric Project (FERC Project No. 2290-006) issued on December 24, 1996. Article 411 of the license required that SCE develop a fish monitoring plan in consultation with the U.S. Forest Service (USFS), California Department of Fish and Game (DFG), the U.S. Fish and Wildlife Service (USFWS) and the U.S. National Parks Service (NPS). The article states that:

> *Within six months from the date of issuance of [the] license, the Licensee shall file with the Commission for approval a plan to monitor fish populations (Monitoring Plan). The Monitoring Plan shall include, but not be limited to, an implementation schedule, standard techniques for assessing fish populations, and sampling fish populations in 5 locations once every 5 years for the term of the license. The monitoring shall be 100 meter stations using techniques similar to those utilized in studies conducted for Exhibit E of the Licensee's application. A report shall be provided…within 120 days of the end of each reporting period.*
>
> *….The Licensee shall monitor fish populations in five locations along the Kern River. Two sites above the diversion, two sites between the diversion and Goldledge Campground and one site in the lower portion of the diverted reach.*

The Fish Monitoring Plan (Entrix1997) was filed with the FERC on June 23, 1997. The Plan describes the objective and proposed sampling approach of the fish monitoring program as follows:

> *The objective of this monitoring program is to monitor fish populations in the NFKR, specifically, fish populations in the vicinity of the Kern River No. 3 Project. Fish populations are to be monitored every five years. The monitoring program should identify changes in fish populations. In order to assess a population of fish, both the abundance of fish and the age structure of the population should be identified. In previous studies, two sampling techniques were used. Electrofishing was used to sample riffles, wadable runs and pocketwater habitat types. In pools and deeper runs, direct observation (direct counts of fish made during snorkeling) was used to estimate fish populations. This Plan proposes a similar approach using these standard techniques.*

The Plan proposes five sampling stations, two above Fairview dam and three below the dam, as specified by Article 411. The Plan further elaborates on the location and nature of the sampling stations as follows:

> *It was suggested that one of the sampling stations be located sufficiently downstream of Fairview Dam to facilitate the sampling of native minnows. One of the stations sampled in support of Exhibit E was located immediately downstream of Hospital Flat campground. This station was dominated by the presence of native fish species including minnows and suckers. This station is included among those proposed by this plan…. The upstream site [a short distance upstream of the Johnsondale Bridge] was suggested to facilitate sampling of the self-sustaining wild trout population in the special regulation section of the river…. The remaining three sampling stations will be selected on the basis of providing adequate sample of available habitats in each general area. Stations will include both shallow and deep habitats, which will be sampled by different methods. Each station will total about 100 m including both types of habitat. Only contiguous habitats of each type will be sampled…. The specific locations will be determined in the field based on sampling conditions and habitats present.*

The Plan proposes that the fish monitoring be conducted during early October to maintain consistency, with regard to flow and water temperature, with previous monitoring.

Fish population monitoring as required by the KR3 Monitoring Plan was first carried out during October 1998 (Entrix 1999). The next monitoring was scheduled for October 2003, but the 2002 McNally Fire, which burned 150,700 acres in and just upstream of the KR3 Project area and was followed by heavy rain, resulted in heavy sedimentation of the river. Following the fire, the agencies agreed that the likelihood of adverse impacts to fish resources from the sedimentation would confound interpretation of the results of the monitoring program, which is intended to document fish population responses to KR3 Project operations. Therefore, SCE postponed the next fish monitoring, with agency approval, until 2006, in the hope that sediments would have been flushed from the system by then, and fish populations would have recovered from the effects of the fire. The most recent monitoring was carried out during October and November 2006 (ECORPS 2007).

The following includes four sections and an appendix:

2.0 Methods
3.0 Results
4.0 Discussion
5.0 References Cited
Appendix A Agency Consultation

Seven figures and 17 tables are included in the text.

2.0 Methods

The methods used for the 2011 fish population monitoring survey were largely consistent with those proposed in the Monitoring Plan (Entrix 1997). However, in a few instances, modifications were made to maintain consistency with methods used in the 1998 (Entrix 1999) and 2006 (ECORPS 2007) surveys or because stream conditions necessitated a change. In all such instances, the changes are identified and discussed in the following descriptions of methods and reiterated in the Discussion section.

Monitoring Survey Stations and Sampling Sites

Monitoring stations were located within each of the five reaches of the river that were sampled in the 1998 and 2006 surveys: Hospital Flat, Goldledge, Roads End, Above Fairview Dam and Above Johnsondale Bridge (Figure 1). The specific locations for sampling sites were selected based on location information provided in the monitoring report for the 2006 survey (ECORPS 2007). In three instances, suitable conditions were not found at the reported sampling site location (see below), so new site locations were selected that matched the reported locations as closely as possible (Table 1). One electrofishing and one direct observation sampling site were located in close proximity of one another at each of the three survey stations downstream of Fairview Dam (Figure 1). The flow level upstream of the dam was too high (about 550 cfs) to permit electrofishing, so only direct observation sampling was conducted at the two stations upstream of the dam. The river channel upstream of the dam contained the river's entire flow, while flow downstream of the dam was much reduced because of KR3 hydropower diversions. Flow conditions also precluded electrofishing upstream of the dam during the 1998 and 2006 surveys (Entrix 1999, ECORPS 2007). Two sampling sites were selected for calibration sampling, both of which were located at the Roads End survey station; one upstream and the other downstream of the electrofishing and direct observation sampling sites (Figure 1). The calibration sites were deep enough for direct observation by divers, but also shallow enough for electrofishing. The two sampling sites upstream of Fairview Dam were near the Limestone Campground, which is about 1.7 miles from the dam, and above Johnsondale Bridge, which is about 2.7 miles from the dam.

Geographical coordinates of each of the sampling sites, as determined using a handheld GPS unit, are given in Table 1. These coordinates are the similar to those given in the report for the 2006 study (ECORPS 2007), except for the direct observation sites at Hospital Flat, Above Johnsondale Bridge and Above Fairview Dam. At the Hospital Flat and Above Johnsondale Bridge survey stations, the conditions found at the coordinates did not match sites photos included in the report for the 2006 study nor were they suitable for snorkeling. At the Above Fairview Dam site sampled in 2006, flow conditions were judged to be unsafe for snorkeling and the site was moved.

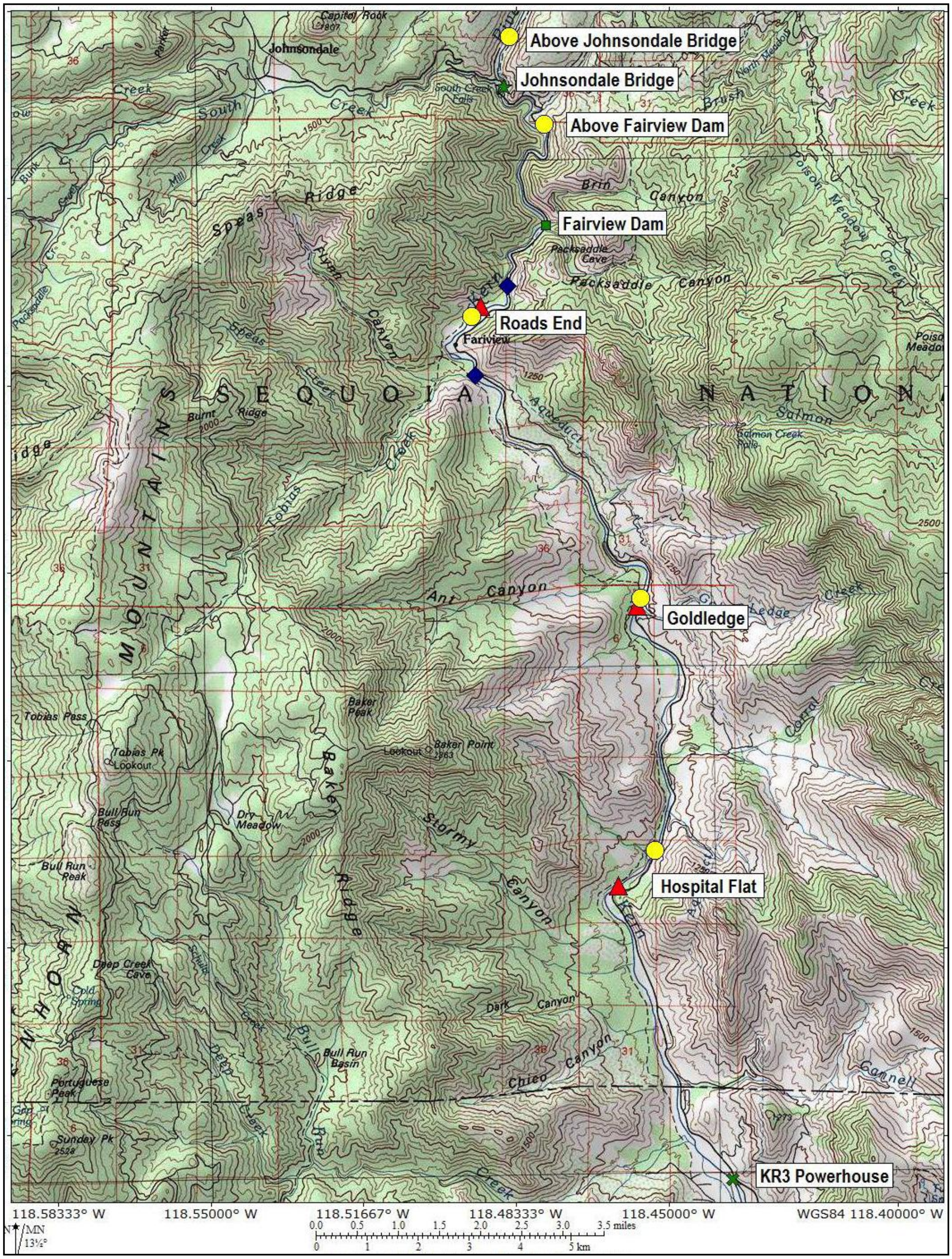

Figure 1. Locations of the 2011 KR3 Fish Monitoring Survey sampling sites (red triangles = electrofishing sites, yellow circles = direct observation sites, and blue diamonds = calibration sites) and other important features.

Table 1. Coordinates of upstream and downstream boundaries of Fish Monitoring Survey sampling sites in the NFKR, 2011.

Sampling Station/Site	Sampling Site Boundary Coordinates (degrees)			
	upstream, latitude	upstream, longitude	downstream, latitude	downstream, longitude
Hospital Flat				
Electrofishing	35.82792	118.46133	35.82749	118.46207
Direct observation*	35.83419	118.45364	35.83441	118.45338
Goldledge				
Electrofishing	35.87773	118.45720	35.87720	118.45757
Direct observation	35.87920	118.45651	35.87864	118.45674
Roads End				
Electrofishing	35.93100	118.48898	35.93066	118.49005
Direct observation	35.93065	118.49005	35.93050	118.49054
Upstream calibration	35.93510	118.48558	35.93452	118.48558
Downstream calibration	35.91918	118.49266	35.91885	118.49263
Above Fairview Dam				
Direct observation*	35.96250	118.47854	35.96245	118.47816
Above Johnsondale Bridge				
Direct observation*	35.97889	118.48446	35.97843	118.48471

** Sampling site location different from location in 2006*

The 2011 fish population monitoring was conducted during October 9 through 16. Electroshocking was conducted on October 10, 11 and 12, direct observation sampling (by mask and snorkel) was conducted on October 9, 15 and 16, and calibration sampling was conducted on October 13 and 14.

Physical Habitat Descriptions

Habitat and water quality measurements were made at each of the sampling sites. Surface areas of the sampling reaches were computed from reach lengths (measured using a hip chain) and channel widths (measured using a laser range finder). The channel widths were measured at 11 equidistant cross-sections at each sampling site, with the first and last cross-sections at the upper and lower boundaries of the site. Depths were measured using a survey stadia rod at ¼, ½, and ¾ distance across each of the width cross-sections. Maximum depth in each unit was also recorded. The high flows above Fairview Dam precluded stadia rod depth measurements at the upstream sites, so divers visually estimated the maximum depths.

Stream gradient (slope) over the length of each sampling site reach was measured using a hand-level and the stadia rod placed on the stream bottom. Visual estimates were made of the percentages, by surface area, of four stream habitat types (pool, run, riffle and pocketwater), four fish cover types (surface turbulence, instream object, undercut bank and overhanging vegetation within 48 inches of the water surface), and the following seven substrate types:

- organic debris or vegetation,
- fines (<2 mm),
- sand (2-8 mm),
- gravel (8-75 mm),
- rubble (75-305 mm),
- boulder (>305 mm), and
- bedrock.

Gravel deposits that were considered to be potentially suitable trout spawning habitat were identified and their surface areas were visually estimated. Water temperature, dissolved oxygen concentration, and specific conductivity were measured *in-situ* with a YSI® portable meter. Streamflow data for each day of sampling were obtained from SCE staff at the KR3 powerhouse.

In addition to the visual estimates of substrate composition described above, more quantitative estimates were made at the eight sampling sites downstream of Fairview Dam (Table 1). High streamflow precluded use of this procedure at the two sites upstream of Fairview Dam. The 2006 monitoring report recommended adoption of a more quantitative substrate characterization procedure than the previously used simple visual assessments to track potential effects on sedimentation of the 2002 McNally Fire and future fires or other events. The more quantitative procedure that was used in the current study consisted of measuring the widths along river cross-sections of homogenous substrate patches. These patches contained relatively uniform percentages of the substrate types listed above (e.g., 10% sand, 20% gravel, 40% rubble and 30% boulder, by surface area). However, the rubble and boulder categories were modified to make their size ranges consistent with those used in the two previous monitoring studies (rubble 75–600 mm and boulder > 600 mm) (Entrix 1999, ECORPS 2007). The first step of this procedure was to randomly select, at each sampling site, six of the 11 cross-sections that had been used for measuring the widths and depths of the site. GPS coordinates of the cross-section endpoints were recorded. A survey tape was then strung along each cross-section and the width of each homogenous substrate patch was measured along this transect from riverbank to riverbank. The percentages of particle types that characterized a patch were visually estimated. Finally, the mean substrate composition of the entire sampling site, expressed as the mean percentage of each substrate type found, was computed as the mean percentage per patch weighted by patch width:

$$P_s = \Sigma\Sigma\, W_i P_{si} / \Sigma\Sigma\, W_i$$

where P_s = the percentage of substrate type s at the sampling site,
P_{si} = the percentage of particle type s in patch i, and
W_i = the width along a transect of patch i.

The double summation indicates that the percentages and widths are summed over all the transects at a site.

Electrofishing

Fish abundances at shallow-water electrofishing sites (Table 1) were estimated using two-pass mark-recapture, as was done for both the 1998 and 2006 monitoring studies (Entrix 1999, ECORPS 2007). This procedure allows computation of confidence intervals for the abundance estimates, as described later. Before starting the electrofishing, a sampling site was isolated with 1/4-inch mesh (1/2-inch stretch mesh) block nets to prevent immigration or emigration of fish during sampling. The Monitoring Plan (Entrix 1997) calls for using 1/8-inch mesh block nets, without specifying if this refers to stretch mesh or bar (square) mesh. The report for the 1998 monitoring study indicated that 1/8 and 1/4 inch mesh were used, but again did not indicate whether this was stretch or bar mesh (Entrix 1999). And the report for the 2006 study indicated that 1/4-inch stretch mesh was used (ECORPS 2007). The Monitoring Plan includes agency comments addressing the risk that the use of 1/8-inch mesh block nets would result in clogging by leaf and other debris and collapse of the nets, but concludes that serious clogging could be avoided. Early October, the time of year proposed by the Plan, normally has little runoff, which reduces the risk of net clogging. However, during September 2011, heavy rain followed a fire in the NKFR watershed and additional rainfall fell during the first week of October. These events resulted in heavy runoff and high river flow, creating a risk of high loads of suspended material during the study period. Therefore, block nets with 1/2-inch stretch mesh were used for this year's study to reduce the risk of the nets collapsing from an accumulation of leaf and other debris. The biologists electrofishing the sites observed no movement of fish from the sites during sampling.

Electrofishing at the Hospital Flat and Goldledge sites was conducted using a streamside electrofishing unit operated from a ten-foot aluminum johnboat. The generator-powered electrofishing unit has a rated output of 2,500 watts and 8 amps and was used in a pulsed direct current mode to minimize damage to fish. Voltage, frequency, and pulse width were adjusted to provide adequate field strength to capture fish without causing mortality. The electrofishing unit was equipped with three anode pole leads. Three shocking teams (each team composed of one shocker and one netter) moved upstream in concert across a unified front during each sampling pass. As a crew safety consideration, one person remained on standby at the control box "kill" switch to cut the electrical output to all the anode poles in the event of an emergency (e.g., a crew member falls into the water). Because the river channel at the Roads End electrofishing site contained a large number of boulders and high gradient step-run habitat, three backpack shockers were used in place of the barge electrofishing unit at this site. All three backpack units were used in a pulsed direct current mode to minimize damage to fish. Voltage, frequency, and pulse width were adjusted to provide adequate field strength to capture fish without causing mortality.

All captured fish from the first electrofishing pass were removed to one of several available 5-gallon live buckets filled with river water and equipped with a small bait bucket aerator. Fish in the live buckets were periodically transferred to a 1/8-inch mesh netted live box located in the river outside of the study site and away from the electric field. Following their removal from the live box and live buckets and prior to handling, the fish were anesthetized in a weak CO_2 solution. All fish were identified to species, measured to the nearest millimeter in fork length, weighed to the nearest tenth of a gram, and inspected for any distinguishing marks (e.g., fin clips, tags) and evidence of injury or disease (e.g., hook scars, deformed fins, tumors, fungus). All rainbow trout were examined and characterized as to origin (wild versus hatchery). Scale samples were taken from most of the rainbow trout collected at each site for age determinations. The scales were taken from above the lateral line and along the length of the dorsal fin and were stored in labeled scale envelopes indicating sample site, date, species, and fork length. After processing, the fish were placed in an aerator–equipped bucket of cool river water, allowed to recover, and periodically transferred to the netted live box in the river. All fish were held in the live box until fully recovered from the shocking and handling.

As required for using mark-recapture to estimate population abundances, all fish captured during the first electrofishing pass were given a distinct mark during processing, except that fish ≤ 40 mm in length were not marked due to the risk of mortality in marking such small fish. This size was also used as a cutoff for marking fish in the 2006 survey (ECORPS 2007). Fish larger fish than 150mm were marked with a hole punched in their upper caudal fin, while smaller fish were marked using a small scissors to clip the upper corner of the upper caudal fin.

Following full recovery of the fish from the first electrofishing pass, they were randomly re-distributed throughout the sampling site and left undisturbed for a period of two hours before the second electrofishing pass through the reach was begun. An effort was made to use the same sampling effort for the second pass that was used for the first pass. The fish captured during the second pass were treated in the same way as those from the first pass, except that they were examined for the caudal fin clips (marks) given to the fish captured in the first pass and they were not marked. The recaptured fish (those with the marks) were re-measured, but were not re-weighed. Following recovery from handling, all fish were released back to the river.

Direct Observation Sampling

Abundances of fish in the deeper water sampling sites were estimated from visual counts made during direct observation sampling using mask and snorkel. The direct observation sampling was conducted at sampling sites located in all five monitoring stations (Figure 1, Table 1).

Prior to conducting any counts, all divers practiced their techniques by snorkeling through a non-survey pool to ensure that they were familiar with identifying, counting, and estimating the lengths of observed fish. To support size estimates, each diver used a "reference string" attached to a wrist data-slate-tablet. The strings were knotted at 76 mm, 152 mm, 305 mm and 406 mm, which corresponded to the various size categories of interest. Snorkelers used the knotted string to calibrate and validate their visual fish length estimates. As part of the training, the divers practiced estimating lengths of plastic fish silhouettes until their estimates were consistently accurate. This training procedure ensured that uniform standards and survey procedures were followed during the actual monitoring counts.

Before counts were begun within a sampling site, the site was sectioned into a number of observation lanes oriented parallel to the stream channel. The width of the lanes was determined based on measurements of underwater visibility to ensure that a diver in the middle of a lane was able to see fish at both lane margins. Divers counted only fish observed within their lane. Visibility was determined by measuring the distance that a snorkeler could identify the parr marks on a 2-inch floating rainbow trout lure. Visibilities in "full sun" and in shade were recorded for each site. The dive lanes were marked with weighted ropes deployed from the upstream to downstream end of the sample site by snorkelers. To minimize herding of fish toward the bottom or out of the site, lane lines were deployed one at a time. Floating pull lines were deployed at the two sites above Fairview Dam to assist divers in moving against the strong currents in this part of the river. A diver was stationed at the downstream end of each site to monitor fish movement from the site during lane line deployment.

After the last line was deployed, all divers carefully exited the water and waited a minimum of fifteen minutes before reentering the water to start their counts. The Fish Monitoring Plan calls for a two-hour waiting period between lane set up and fish counting to ensure that the fish will be naturally distributed during counting (Entrix 1997). However, the biologists conducting this study judged that such a long waiting period would unnecessarily reduce the time available for sampling. These biologists have conducted snorkel surveys over many years and within hundreds of sampling sites in multiple streams (including the Kern River, the upper Sacramento River, San Luis Obispo Creek, the Ventura River, and Matilija Creek) and have found that 15 minutes is a fully adequate waiting period.

The counts began with a group of divers carefully entering the water and crawling across the lower site boundary to their assigned diving lanes. Once all divers were in position, the crew leader gave a hand signal and all divers moved upstream in their respective lanes, being careful to stay aligned along a single parallel front. At most sites, one person not diving followed along the bank and communicated with the divers to make sure that they moved at the same pace and maintained a parallel orientation as they moved upstream. This precaution minimized the chance that fish could swim downstream through the divers undetected. As they moved, the divers noted and recorded the species and size classes of the fish observed in their lanes on wrist tablets. Each diver carried their knotted wrist string for estimating fish fork lengths, as described above. Locations with cover were inspected closely for concealed fish. An additional diver monitored the upstream boundary of each sampling site boundary and recorded data on any fish moving upstream out of the sampling reach. After reaching the upstream end of the site, counts were tallied and recorded on data sheets

Because the counts made in the observation lanes required divers to focus their efforts on habitat within the main channel, separate counts along the bank margin habitat, where smaller fish tend to reside, were conducted immediately after the main channel counts. For these counts, a diver swam upstream along each bank and counted fish within a six-foot wide margin along each bank.

Calibration

It is generally assumed that during direct observation surveys, divers will not observe and count all of the fish present. To estimate the difference between the numbers observed and counted and numbers actually present, a calibration site may be sampled using both the direct observation procedure and a second sampling method that is believed to yield a more accurate estimate of the number of fish present. The Fish Monitoring Plan specifies that an electrofishing technique be used to calibrate the results of the direct observations (Entrix 1997). The calibration site needs to be deep enough for direct observation by divers, but also shallow enough for electrofishing.

In 2011, calibration of direct observation results was conducted by sampling fish populations with both direct observation and electrofishing at two sites within the Roads End survey station (Table 1, Figure 1). Calibration sites were also located within this survey station for the 1998 and 2006 surveys (Entrix 1999, ECORPS 2007). Both of these surveys based their electrofishing abundance estimates on the total numbers of fish caught during a single electrofishing pass. However, there is no evidence that one-pass electrofishing provides an abundance estimate that is any more accurate than that obtained from direct observation sampling. Therefore, in 2011, the two-pass mark-recapture procedure was used for the calibration electrofishing. This procedure provides more accurate estimates of absolute abundance than one-pass electrofishing and allows determination of confidence intervals (Hartley1980, Lockwood and Schneider 2000). Also, this is the procedure that was used to estimate abundances at the shallow-water sites in the current and the two previous monitoring surveys.

At each calibration site, block nets were installed prior to any sampling. This ensured that the two sampling techniques sampled from an identical population of fish. Once the block nets were in place, a direct observation count was conducted followed by an electrofishing survey. Sampling protocols and equipment for both sampling procedures were the same as those previously described. A comparison of the direct counts to the electrofishing abundance estimates was used to estimate the proportion of fish present but not counted during direct observation sampling.

Data Analysis

The mark-recapture abundance estimates using the electrofishing data were computed from an adjusted Petersen estimate as described by Lockwood and Schneider (2000) and using Chapman’s correction:

$$N = ((M+1)*(C+1))/(R+1) - 1$$

where N = population estimate (total number of fish present), M = number of marked fish, C = total number of fish caught on second pass and R = number of marked fish caught (i.e., recaptured) on second pass. The 95 percent confidence limits for the abundance estimates were calculated using Ricker’s method with a Poisson distribution (Lockwood and Schneider 2000). These abundance estimation procedures are the same as those used for the 1998 and 2006 surveys (Entrix 1999; ECORP 2007). Because fish less than 40 mm in length were not marked, the mark-recapture abundance estimates do not include these fish. The abundance estimates were used with fish mean weight data to generate standardized (by surface area) biomass estimates.

The scales collected from rainbow trout for age information were mounted on slides and then examined and aged independently by two biologists. Results that disagreed on age estimation were reviewed by a third biologist, who determined a final age estimate.

3.0 Results

Habitat Descriptions

The physical dimensions (length, average width, surface area, mean and maximum depths, and gradient), water quality (water temperature, dissolved oxygen concentration, specific conductivity), and habitat characteristics (habitat types, fish cover, and substrate) of the monitoring sites are given in Table 2. Results for both the visual and cross-section measurement estimates of substrate composition are provided. There were no obvious differences among sampling sites in any of the water quality or habitat characteristics measured, except that specific conductivity appears to increase from upstream to downstream sites (Table 2). Run was the most prevalent habitat type at most sites, and instream objects, which primarily consisted of boulders, was the dominant fish cover type.

The two procedures for estimating substrate composition gave similar results for most sites, although the visual estimation method indicated that boulder was the dominant substrate type at most sites, while the cross-sections method indicated that rubble and boulders were co-dominant. Note, however, that the boulder size category used for the visual estimation procedure (>305 mm) was considerably broader than that used for the cross-sections method (>612 mm) and, therefore, would be expected to cover a greater percentage of the site. The difference in the fine particle category estimates using these two methods was less than 4% for both the fine (2.3 %) and the sand (3.4%) substrate categories.

The estimated streamflow, obtained daily from SCE staff at the KR3 powerhouse, ranged from 90 to 95 cfs at the downstream sites and from 530 to 550 cfs at the upstream sites. Visibility ranged from 3 to 6 feet in the shade and 4 to 8 feet in the sun.

Table 2. Habitat and water quality measurements at ten monitoring sites in the NFKR, 2011

Survey Station	Hospital Flat		Goldledge		Roads End				Above Fairview Dam	Above Johnsondale Bridge
Sampling Site Method	Electrofish	Snorkel	Electrofish	Snorkel	Electrofish	Snorkel	Lower Calibration	Upper Calibration	Snorkel	Snorkel
Date Sampled	10-Oct-11	9-Oct-11	11-Oct-11	15-Oct-11	12-Oct-11	15-Oct-11	13-Oct-11	14-Oct-11	16-Oct-11	15-Oct-11
Site Dimensions										
Site (reach) Length (m)	89.6	32.3	65.8	68	105.2	49.4	35.7	66.4	41.4	51.2
Mean Width (m)	29.2	21.0	28.1	20.9	18.4	21.9	23.5	12.2	30.3	26.4
Surface Area (m2)	2,617	679	1,848	1,424	1,935	1,082	837	810	1,247	1,349
Mean Depth (m)	0.6	0.8	0.5	0.7	0.7	0.7	0.6	0.7	not measured	not measured
Maximum Depth (m)	1.4	1.4	1.0	1.6	1.3	1.2	1.6	1.2	~2.5	~2
Gradient (%)	0.07	0.19	1.20	0.22	0.88	0.31	0.43	0.69	0.52	0.12
Water Quality										
Time	10:33	15:30	12:02	9:35	11:50	11:33	12:03	10:50	9:52	15:43
Water temp (C)	11.5	14.6	12.9	12.2	12.0	11.7	13.0	11.5	10.7	12.5
Specific Conductivity (µS/cm)	127.5	126.1	121.5	116.3	87.0	84.6	112.1	81.8	86.3	84.9
Dissolved Oxygen (mg/L)	9.8	8.8	8.4	9.7	10.8	9.5	10.5	9.5	10.0	9.2
Habitat Type (% of site)										
Pool	5	35	15	20	5	5	20	0	5	30
Run	80	10	25	65	40	55	70	95	85	60
Riffle	5	5	55	0	30	5	10	5	5	5
Pocketwater	10	50	5	15	25	35	0	0	5	5
Fish Cover (% of site)										
Surface turbulence	5	5	20	5	35	5	5	5	10	5
Instream object	10	40	45	45	55	65	15	10	40	40
Undercut bank	15	5	10	5	5	0	5	0	0	0
Overhanging vegetation	10	10	10	5	10	5	5	5	5	5
Substrate (% of site - visual estimates)										
Organic debris/Vegetation	0	0	0	0	0	0	0	0	0	0
Fines	5	5	5	5	5	5	5	5	5	5
Sand	30	25	20	30	5	15	20	20	20	20
Gravel	10	5	15	5	10	10	15	20	5	5
Rubble	25	20	30	25	30	20	30	25	25	20
Boulder	30	45	30	35	50	50	15	30	30	40
Bedrock	0	0	0	0	0	0	15	0	15	10
Trout spawning area (m2)	0.0	2.8	10.7	2.9	2.6	8.7	41.6	16.7	0.0	0.0
Substrate (% of site - cross-sections)										
Organic debriss/Vegetation	0	0	4	0	2	0	1	0	--	--
Fines	3	1	3	1	1	2	1	3	--	--
Sand	19	22	14	21	9	14	24	15	--	--
Gravel	18	7	13	9	5	11	21	28	--	--
Rubble	33	25	34	29	28	32	34	45	--	--
Boulder	25	45	31	40	54	42	14	10	--	--
Bedrock	0	0	1	0	0	0	5	0	--	--

Fish Species Composition

Table 3 shows the total number fish captured by electrofishing or counted during direct observation sampling for each species at each of the sampling sites. It should be remembered that electrofishing and direct observation were conducted at the same locations at the two Roads End calibration sites. Sacramento suckers (SKR) dominated the electrofishing catches and direct observation counts at all sites, except the lower Roads End calibration site, where rainbow trout was the dominant species. A total of 1,146 fish were sampled during the survey and 848 of these (74 percent) were Sacramento suckers. The majority of the remaining fish sampled were rainbow trout (RBT: 243 individuals and 21 percent). The other species sampled were Sacramento pikeminnow (PKM: 51 individuals and 4 percent) and brown trout (BRN: 4 individuals and < 1 percent). One 309 mm fork length (FL) rainbow trout captured at Hospital Flat was identified as a hatchery fish and all the rest were identified as wild. All but one of the native minnows observed during snorkeling were less than 152 mm FL. Because of their small size, these fish could not be identified to species without handling. However, all minnows collected during electrofishing and the one large minnow observed during snorkeling were identified as Sacramento pikeminnow, so it was assumed that the small minnows observed during snorkeling were also Sacramento pikeminnow, although the possibility that some of these were hardhead could not be ruled out.

Table 3. Numbers by species of fish sampled by electrofishing and direct observation at seven sites on the NFKR, 2011.

Survey Station - Sampling Site	Electrofishing				Direct Observation			
	RBT	**BRN**	**PKM**	**SKR**	**RBT**	**BRN**	**PKM***	**SKR**
Hospital Flat	10	1	23	143	10	0	17	29
Goldledge	41	0	0	136	22	0	11	103
Roads End	27	1	0	166	24	0	0	69
Lower Roads End Calibration	33	0	0	13	23	0	0	9
Upper Roads End Calibration	14	1	0	63	26	1	0	46
Above Fairview Dam	--	--	--	--	2	0	0	58
Above Johnsondale Bridge	--	--	--	--	11	0	0	13
SPECIES TOTALS	125	3	23	521	118	1	28	327

** Includes minnows too small to identify, but were assumed to be Sacramento pikeminnow because all other minnows sampled that could be identified were pikeminnows.*

Electrofishing

Population Abundance and Biomass

The electrofishing mark-recapture estimates of numerical abundance and biomass of the fish populations at the three electrofishing sites downstream of Fairview Dam are given in Tables 4 and 5. Mark-recapture population estimates were not computed for brown trout or Sacramento pikeminnow because fewer than three individuals of these species were recaptured on the second electrofishing pass at these sites. A minimum of three recaptures is considered necessary for reliable mark-recapture estimates (Lockwood and Schneider 2000). Where mark-recapture estimates were not computed, the total number of fish captured in the two electrofishing passes (not including recaptures) was used for abundance and biomass estimates, which likely underestimates the actual values. Confidence intervals could not be computed for the population estimates based on total numbers captured.

Table 4. Mark-recapture numerical abundance estimates for fish species at three electrofishing sites in the NFKR, 2011.

Species	Hospital Flat	Goldledge	Roads End
Rainbow trout			
Abundance (fish/km)	145	794	406
95% CI	112* - 379	759* - 1,446	257* - 900
Brown trout			
Abundance (fish/km)	11**	0	10**
95% CI			
Sacramento pikeminnow			
Abundance (fish/km)	257**	0	0
95% CI			
Sacramento sucker†			
Abundance (fish/km)	3,437	2,177	3,121
95% CI	2,100 - 5,934	1,716* - 3,071	2,143 - 4,722

** Lower CI based on total number captured (number marked in first pass plus unmarked number in second pass) because computed lower CI was below number captured.*

*** No mark-recapture estimate computed because fewer than 3 fish recaptured. Abundance estimate based on total number captured (number marked in first pass plus unmarked number in second pass).*

† *Abundance estimates for sucker do not include fish <40 mm*

Table 5. Mark-recapture biomass estimates for fish species at three electrofishing sites in the NFKR, 2011.

Species	Hospital Flat	Goldledge	Roads End
Rainbow trout			
Biomass (kg/ha)	3.3	9.1	6.2
95% CI	2.5 - 8.6	8.8 - 16.7	3.9 - 13.7
Brown trout			
Biomass (kg/ha)	0.1	0	0.1
95% CI	---	---	---
Sacramento pikeminnow			
Biomass (kg/ha)	1.3	0	0
95% CI	---	---	---
Sacramento sucker			
Biomass (kg/ha)	35.2	199.7	403.5
95% CI	21.5 - 60.8	157.8 - 282.3	277.4 - 611.1

Sacramento sucker was the dominant species at all three sites (Tables 4 and 5). This conclusion carries a high level of confidence because none of the 95 percent confidence intervals for the sucker and rainbow trout population estimates overlap. The Sacramento sucker population estimates are for fish greater than 40 mm in length only because, as described in the Methods section, fish less than or equal to 40 mm were not marked and were therefore no included in the mark-recapture analyses. All rainbow trout captured were greater than 40 mm in length (see below).

Abundance and biomass of brown trout and Sacramento pikeminnow were generally much lower than those of Sacramento sucker and rainbow trout (Tables 4 and 5). The only exception was for Sacramento pikeminnow at the Hospital Flat site. The pikeminnow had a relatively high numerical abundance at Hospital Flat, but their biomass was low because 74 percent of these fish weighed half a gram or less. No pikeminnow were found by electrofishing at any other site.

The mark-recapture estimates of numerical abundance and biomass for both rainbow trout and Sacramento sucker varied substantially among sites (Tables 4 and 5). Abundance of rainbow trout ranged from 145 fish per kilometer at the Hospital Flat site to 794 fish per kilometer at the Goldledge site, and biomass ranged from 3.3 to 9.1 kilograms per hectare at the same two sites. Abundance of Sacramento sucker ranged from 2,177 fish per kilometer at the Goldledge site to 3,437 fish per kilometer at the Hospital Flat site. However, despite the high numerical abundance of suckers at Hospital Flat, this site had the lowest biomass because the suckers at Hospital Flat were much smaller on average than those at the other sites. The mean weight of suckers at Hospital Flat was 26 grams, while the means at Goldledge and Roads End were 224 grams and 230 grams, respectively. Total sucker biomass ranged from 35.2 kilograms per hectare at the Hospital Flat site to 403.5 kilograms per hectare at the Roads End electrofishing site.

Age Structure and Length Distribution

Table 6 provides age classification results for wild rainbow trout based on scale analysis of 74 samples collected during electrofishing sampling at the three electrofishing sites and the two calibration sites. Three age classes of trout were identified: Age 0+, which were hatched during the previous spring, Age 1+ and Age 2+. There was no overlap of lengths among the three age classes except for one Age 1+ trout sampled at the Lower Roads End Calibration site that was 115 mm FL. The next smallest Age 1+ trout was 166 mm FL and was from the same site. The length ranges from Table 6 for all of the sites combined were used to age trout collected and measured during electrofishing sampling whose scales were not processed. However, 166 mm FL was used as the lower bound for Age 1+ trout (except for the one 115 mm FL trout whose scales indicated that it was an Age 1+ fish). These results were used with length and weight data for the fish to determine the length ranges; mean lengths, weights, and condition factor; and percentages of numerical abundance and biomass for the three age classes of the rainbow trout populations at the three electrofishing stations (Table 7). Results for the two calibration sites are not included in Table 7 because the habitats at these sites were different from those at the electrofishing sites. Length-frequency histograms of rainbow trout from the calibration sites are provided later in this report.

Table 6. Age determination results from scales of wild rainbow trout at the three electrofishing and two calibration sites on the NFKR, 2011.

Site / Age Class	n	Length Range (mm)	Mean Length (mm)
Hospital Flat			
Age 0+	7	79 - 132	106
Age 1+	2	221 - 228	225
Age 2+	0	---	---
Goldledge			
Age 0+	15	94 - 139	115
Age 1+	8	170 - 212	192
Age 2+	1	259	259
Roads End			
Age 0+	9	90 - 138	113
Age 1+	2	182 - 192	187
Age 2+	0	---	---
Lower Roads End Calibration			
Age 0+	9	79 - 122	104
Age 1+	7	115* - 232	185
Age 2+	4	233 - 349	270
Upper Roads End Calibration			
Age 0+	8	72 - 120	100
Age 1+	2	195 - 221	208
Age 2+	0	---	---
All Sites Combined			
Age 0+	48	72 - 139	109
Age 1+	21	115* - 232	194
Age 2+	5	233 - 349	268

All other Age 1+ trout collected at Lower Calibration site ≥ 166 mm FL.

The distributions of the trout age classes were similar at the three electrofishing sites, although percentages for abundance and biomass of Age 0+ were somewhat higher and of Age 1+ were somewhat lower at the Roads End site (Table 7). At all three sites, Age 0+ were most abundant and Age 1+ had the greatest biomass. Abundance of Age 2+ trout was low at all three sites. The mean condition factor ranged from 1.01 for Age 1+ trout at the Goldledge site to 1.20 for Age 0+ trout at the Hospital Flat and Roads End sites (Table 7). These values lie within the normal range for wild rainbow trout and indicate a population in good condition (Hanson Environmental 2005). The Goldledge site had the lowest mean condition factor for all three age classes.

Table 7. Length, weight, condition factor, and percent abundance and biomass of wild rainbow trout age classes at three electrofishing sites in NFKR, 2011.

Site Age Class	Length Range (mm)	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor	Abundance Percentage	Biomass Percentage
Hospital Flat						
Age 0+	79-132	106	15	1.20	78%	30%
Age 1+	221-228	225	124	1.09	22%	70%
Age 2+	---	---	---	---	0%	0%
Goldledge						
Age 0+	93-139	111	15	1.05	76%	35%
Age 1+	170-226	195	77	1.01	22%	52%
Age 2+	259	259	179	1.03	2%	13%
Roads End						
Age 0+	76-138	104	14	1.20	85%	44%
Age 1+	182-192	189	78	1.16	11%	31%
Age 2+	255	255	192	1.16	4%	25%
All Sites						
Age 0+	76-139	107	15	1.15	80%	35%
Age 1+	170-228	203	93	1.09	18%	50%
Age 2+	255-259	257	185	1.09	2%	14%

The length frequency distributions of wild rainbow trout and other species captured at the three electrofishing sites reveal further information about the age structure of the populations (Figures 2 through 4). The length frequencies of the trout were largely similar at the three sites and, therefore, are presented together on one graph (Figure 2). The results show a well-differentiated size cohort ranging from 75 to 135 mm FL and another size cohort ranging from 175 to 225 mm FL (Figure 2). One trout greater than 250 mm FL was captured at both the Goldledge and Roads End sites. The scale reading results indicate that the first cohort is Age 0+, the second cohort is Age 1+, and the two trout greater than 250 mm FL are Age 2+.

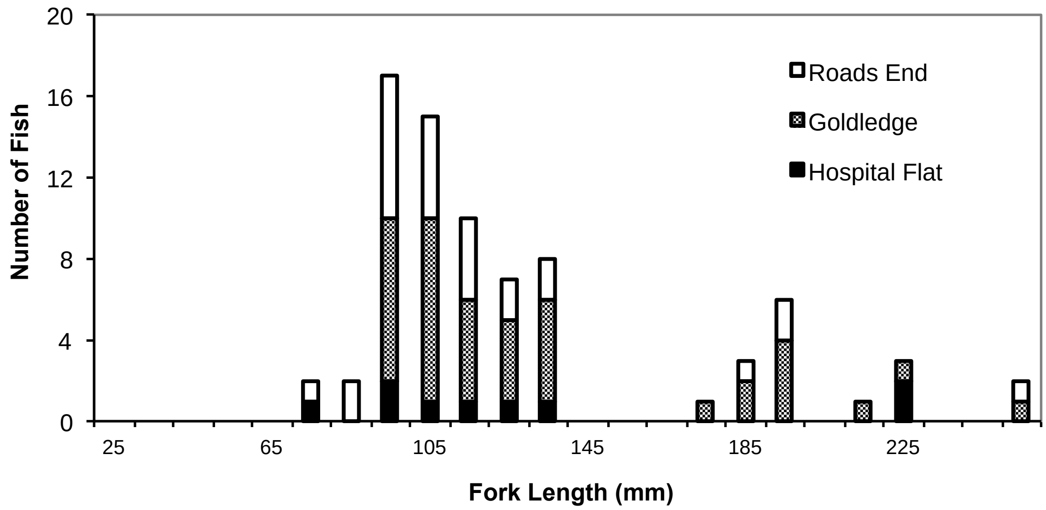

Figure 2. Length-frequency distributions of wild rainbow trout captured at three electrofishing sites in the NFKR, 2011.

The length frequency distributions of Sacramento suckers, in contrast to those of rainbow trout, varied substantially among the sites and, therefore, are graphed separately for each site (Figure 3). The results for suckers at the Hospital Flat site show three size cohorts of fish; a well-differentiated cohort 65 mm FL and below and two less distinct groups, ranging from 85 to 125 mm FL and from 145 to 175 mm FL (Figure 3). The smallest size group is considered to be Age 0+, the next in size is considered to be Age 1+, and the largest is considered to be Age 2+. These size-at-age ranges are consistent with those from other sources (Moyle 2002) and the results from the two previous fish monitoring studies (Entrix 1999, ECORPS 2007). Few larger fish were collected at Hospital Flat (Figure 3).

The length-frequency results for Sacramento sucker at the other two electrofishing sites are very different from those at Hospital Flat (Figure 3). The Age 0+, Age 1+, and Age 2+ cohorts were present at the Goldledge site, but they were less abundant than at the Hospital Flat site. The first two age classes were even less abundant at the Roads End site. However, large suckers were much more abundant at both the Goldledge and Roads End sites than at the Hospital Flat site. The graphs show no distinct size cohorts for the large suckers, but on the basis of their size range (about 195 mm to 385 mm FL) they likely represent a mixture of ages ranging from three to seven years, or older (Moyle 2002). The abundance of these older fish suggests that growth and survival conditions in the NFKR have been good for suckers in recent years.

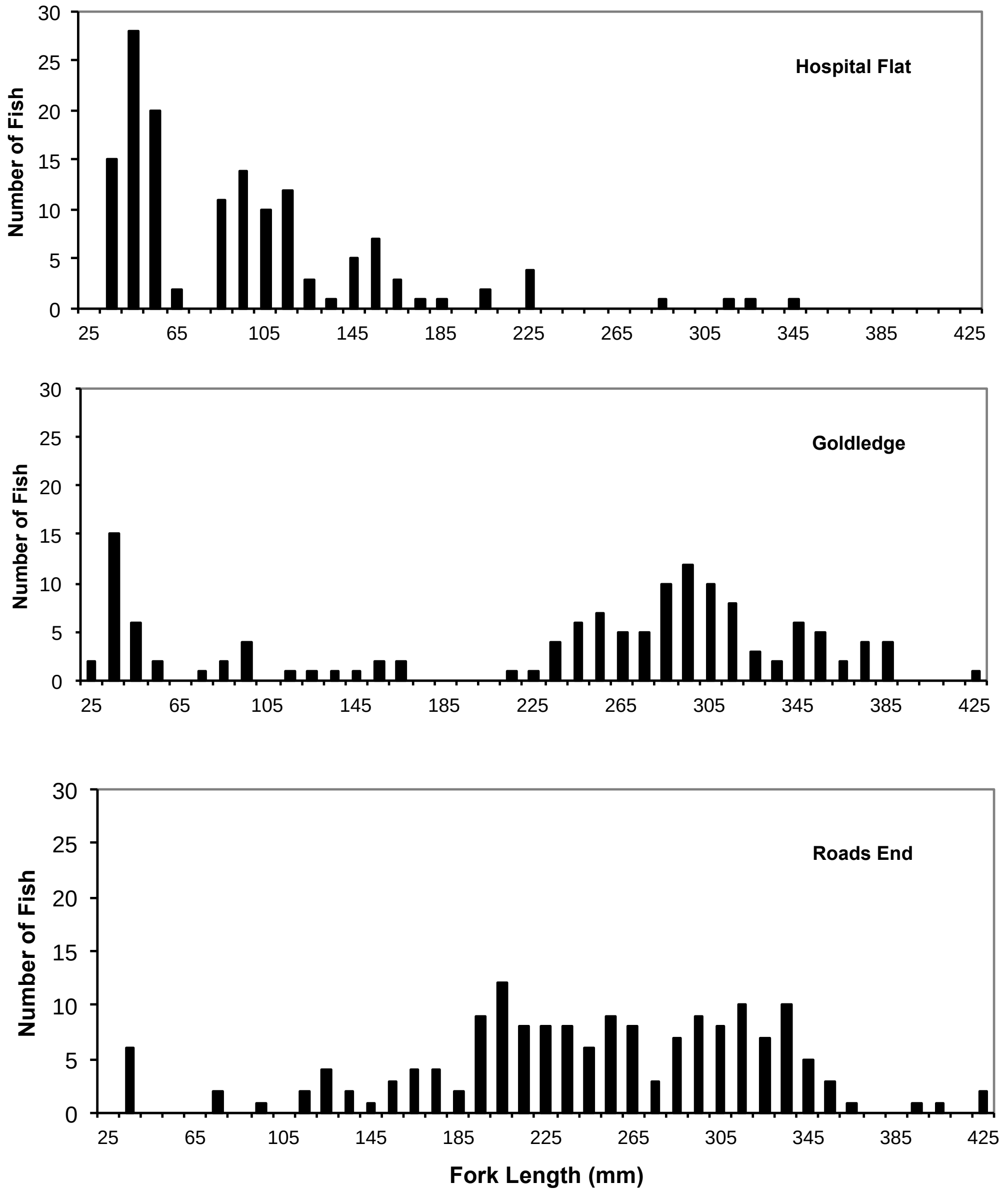

Figure 3. Length-frequency distributions of Sacramento sucker captured at three electrofishing sites in the NFKR, 2011.

All Sacramento pikeminnow captured were from the Hospital Flat site. Most of these fish were less than 40 mm FL and likely hatched during the previous spring (Age 0+) (Figure 4). The larger pikeminnow are believed to range from three to four years old.

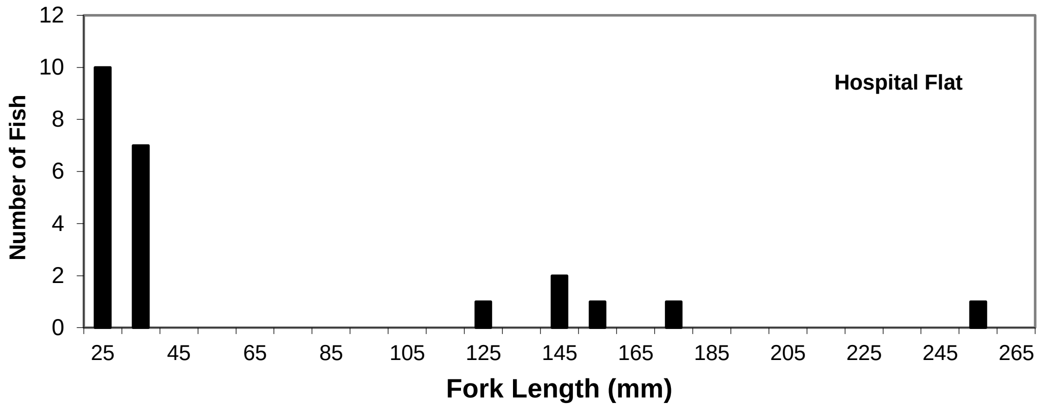

Figure 4. Length-frequency distributions of Sacramento pikeminnow captured at the Hospital Flat electrofishing site in the NFKR, 2011.

Two brown trout, 128 mm FL and 111 mm FL, were captured at the Hospital Flat and Roads End sites, respectively.

Direct Observation

Results of the direct observations (i.e., snorkeling) counts for the five direct observation sites are given in Table 8. No brown trout were observed at any of these sites. Sacramento sucker was the most abundant species at all of the sites, although the abundance estimate for rainbow trout at the Above Johnsondale Bridge site was only a little below that for suckers. Suckers were much less abundant at this site than at any of the other four sites. The length frequency distributions of rainbow trout were fairly consistent among sites, with most trout at all sites between 76 and 305 mm FL. For Sacramento sucker, however, length distributions varied greatly among sites. Suckers less than 76 mm FL were predominant at the two downstream-most sites, Hospital Flat and Goldledge, suckers between 152 and 406 mm FL were predominant at the Roads End and Above Fairview Dam, and suckers greater than 305 mm FL were predominant at the upstream-most site, Above Johnsondale Bridge. All Sacramento pikeminnow observed during the snorkeling counts were located at Hospital Flat and Goldledge, and almost all of them were less than 152 mm FL. As previously indicated, it was assumed based on electrofishing results that all small minnows observed during snorkeling were Sacramento pikeminnow, but the possibility that some of these were hardhead cannot be ruled out.

Table 8. Numbers counted by direct observation in five size classes of four fish species at five sampling sites on the North Fork Kern River, 2011.

Species / Site	Number of Fish per Kilometer by Size Class (mm, FL)					
	<76	76-152	152-305	305-406	>406	Total
Rainbow trout						
Hospital Flat	62	93	124	31	0	310
Goldledge	0	221	88	0	15	324
Roads End	20	283	142	40	0	486
Above Fairview Dam	0	0	48	0	0	48
Above Johnsondale Bridge	0	59	156	0	0	215
Sacramento pikeminnow						
Hospital Flat	526*		0	0	0	526
Goldledge	147*		0	0	15	162
Roads End	0	0	0	0	0	0
Above Fairview Dam	0	0	0	0	0	0
Above Johnsondale Bridge	0	0	0	0	0	0
Sacramento sucker						
Hospital Flat	619	93	186	0	0	898
Goldledge	1,132	147	147	88	0	1,515
Roads End	121	61	850	364	0	1,397
Above Fairview Dam	48	0	676	556	121	1,401
Above Johnsondale Bridge	20	0	39	117	78	254

* *These minnows were too small to identify, but were assumed to be Sacramento pikeminnow because all other minnows sampled that could be identified were pikeminnows. The small minnows were grouped into the first two size classes.*

Calibration

Two sites at the Roads End survey station, one upstream and the other downstream of the Roads End electrofishing and direct observation sites were sampled by both methods to compare the efficiency of the two sampling methods (Figure 1). As indicated in the Methods section, it is assumed that part of the fish populations sampled by direct observation are not detected and, therefore, are not counted, and that sampling by electrofishing with mark-recapture provides a more reliable estimate of the numbers of fish actually present. By using both methods to sample the same population of fish and then comparing the results, the proportion of the fish population missed by direct observation sampling can be estimated. This proportion can then be used to obtain a "corrected" estimate of the direct observation fish counts.

As expected, the electrofishing sampling using mark-recapture provided higher estimates of fish abundance than the direct observation sampling (Table 9). The direct observation estimates of abundance are consistently lower than the lower confidence level of the mark-recapture estimates, which indicates that the differences in the estimates are statistically significant. No mark-recapture estimate of abundance was determined for rainbow trout at the upper calibration site because only two trout were recaptured on the second electrofishing pass at this site. As described previously, a minimum of three recaptures is considered necessary to obtain a reliable population estimate. The abundance estimate given in Table 9 for rainbow trout is extrapolated from the total number of rainbow trout captured by electrofishing (not including recaptures). This is a minimum estimate of abundance and most likely underestimates the number of rainbow trout that were actually present. A mark-recapture estimate of abundance at the upper calibration site could not be determined for brown trout either because only one brown trout was captured by electrofishing.

Mark-recapture abundance estimates were obtained for rainbow trout at the lower calibration site and for Sacramento sucker at both sites (Table 9). For rainbow trout, the ratio of the mark-recapture estimate to the direct observation estimate was 2.2. This ratio suggests that the numbers of rainbow trout counted at the other direct observation sites and reported in Table 8 constitute only about 45 percent of the trout actually present. "Corrected" estimates of the rainbow trout present at those sites could be obtained by multiplying the counts in Table 8 by a factor of 2.2. For Sacramento sucker the ratios of the mark-recapture to direct observation estimates were 1.8 at the lower calibration site and 1.7 at the upper site. The average, 1.75, could be used as a factor to "correct" the counts for suckers reported in Table 8.

Table 9. Comparisons of electrofishing and direct observation estimates of fish abundances at two calibration sites in the NFKR, 2011.

Species	Lower Calibration Site			Upper Calibration Site		
	EF	DO	Ratio EF:DO	EF	DO	Ratio EF:DO
Rainbow trout						
Abundance (fish/km)	51	23	2.2	14**	26	0.5††
95% CI	33* - 113	---		---	---	
Brown trout						
Abundance (fish/km)	0	0	---	1**	1	1.0††
95% CI	---	---		---	---	
Sacramento pikeminnow						
Abundance (fish/km)	0	0	---	0	0	---
95% CI	---	---		---	---	
Sacramento sucker†						
Abundance (fish/km)	16	9	1.8	79	46	1.7
95% CI	12* - 40	---	---	55* - 136	---	

** Lower CI based on total number captured (number marked in first pass plus unmarked number in second pass) because computed lower CI lower than number captured.*

*** No mark-recapture estimate computed because fewer than 3 fish recaptured. Abundance estimate based on total number captured (number marked in first pass plus unmarked number in second pass).*

† *Abundance estimates for sucker do not include fish <40 mm.*

†† *These ratios should not used to calibrate direct observation counts because they are based on unreliable electrofishing abundance estimates.*

The size distributions of rainbow trout and Sacramento suckers collected by electrofishing at the calibration sites did not differ substantially from those observed by snorkeling (Figure 5). The one apparent exception was for suckers at the lower calibration site, where the smallest size class (<76 mm FL) dominated the size distribution of suckers observed during snorkeling and a larger size class (153 – 305 mm

FL) dominated the size distribution of the electrofishing catch, but the total number of suckers sampled at this site was much lower than the total number sampled at the upper calibration site (Table 2) and, therefore, the results are considered less reliable.

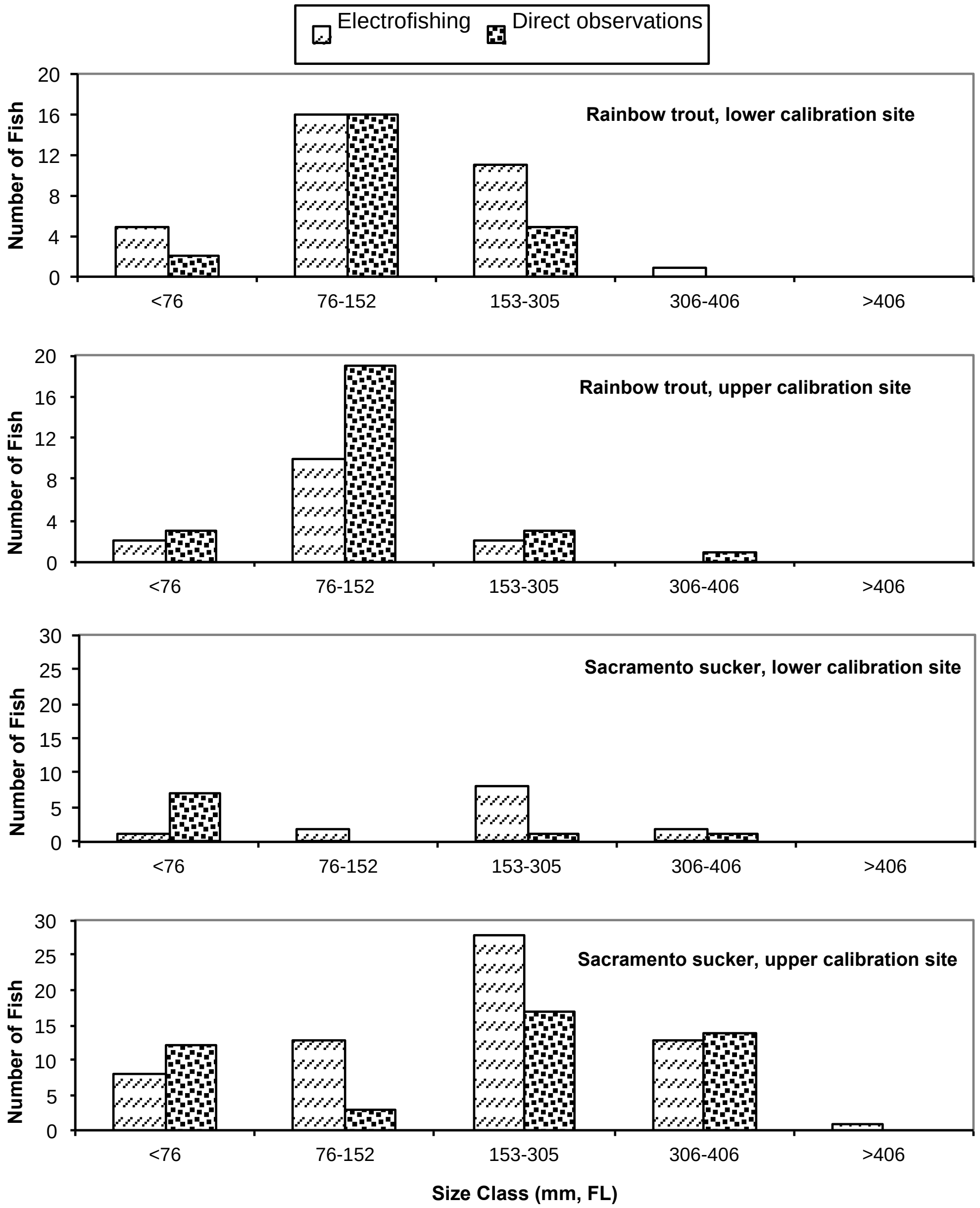

Figure 5. Comparisons of lengths of rainbow trout and Sacramento sucker sampled by electrofishing and direct observation at two calibration sites in the NFKR, 2011.

4.0 Discussion

Differences in Study Methods among Survey Years

The 2011 KR3 Project Fish Population Monitoring study was completed successfully using procedures largely consistent with those recommended in the Fish Monitoring Plan (Entrix 1997) or used in the two previous monitoring studies (Entrix 1999, ECORPS 2007). The most important differences were the addition of a new procedure for estimating substrate composition, use of different mesh-sized block nets for electrofishing, a reduction in the waiting period for direct observation sampling, changes in the location of three of the direct observation sampling sites, and differences in the estimation procedure used with electrofishing data to estimate population abundance for calibration of direct observation fish counts.

The new procedure for estimating substrate composition was added in response to a recommendation included in the 2006 study report (ECORPS 2007). The new procedure, which is described in the Methods section, provides a more systematic method for characterizing substrate composition. However, the new procedure, which is more complex and labor-intensive than the original procedure, produced results that were not substantially different from the results of the original (Table 2), so it may not be worthwhile to continue using the new procedure in the future.

As discussed in the Methods section, a larger mesh size than that recommended in the Fish Monitoring Plan was used for the electrofishing block nets because a fire and rainfall events during September and early October 2011 created a risk of net clogging and collapse. Nevertheless, the 1/2-inch mesh that was used for the current year's sampling is smaller than that normally and successfully used by the highly experienced team of biologists that conducted the electrofishing for the 2011 survey. No movement of fish from the sites was observed during electrofishing.

The Monitoring Plan calls for a two-hour waiting period between lane set up for direct observation sampling and fish counting (Entrix 1997), but a 15-minute waiting period was used for the 2011 study. The biologists conducting this study judged that a two-hour waiting period would unnecessarily reduce the time available for sampling. These biologists have determined, based on experience conducting snorkel surveys over many years and within hundreds of sampling sites in multiple streams, that 15 minutes is a fully adequate waiting period.

Locations of three of the direct observation sites sampled in 2011 were changed from the locations given in the report of the 2006 study (ECORPS 2007). As noted in the Methods section, the locations were changed at the Hospital Flat and Above Johnsondale Bridge survey stations because the river at the GPS coordinates reported for the 2006 study did not match the site photos included in the report and did not have habitat suitable for snorkeling. New locations with suitable habitat were located as close to the reported GPS coordinates as possible. The location of the Above Fairview Dam site was changed because high flows created hazardous conditions for snorkeling. Flow above the dam during the survey period in 2011 was higher (~550 cfs) than that in 2006 (~280 cfs) or 1998 (~470 cfs). The changes in site locations may have contributed to some differences in the results of the different studies, as discussed later. A detailed photographic record was made of each of the sampling sites during the current survey, which, together with the GPS coordinates (Table 1), should help to ensure that the same locations are used for sampling in future surveys. However, future changes in sampling site locations may be required if high flow events alter habitats in the river.

The 1998 and 2006 studies used the catch results from a single electrofishing pass to calibrate the fish counts from the direct observation sampling. The 2011 study used two-pass electrofishing with mark-recapture. The mark-recapture method allows estimation of absolute fish abundance, which is needed for calibrating the direct observation counts. A further advantage of the mark-recapture procedure is that it allows computation of confidence intervals that can be used to determine the precision of the abundance estimates.

Comparisons among Survey Years in Physical Habitat

Tables 10 through 12 compare physical habitat conditions found during the 2011 monitoring survey with those from the two previous post-license surveys (Entrix 1999, ECORPS 2007). Table 10 gives results from the three electrofishing sampling sites and Table 11 gives results from the five direct observation sampling sites. Table 12 gives results from the two Roads End calibration sites and is included because no physical habitat results are provided for the Roads End direct observation site in the report of the 1998 survey (Entrix 1999). The calibration site results are the only results available for comparing relatively deep-water habitat at the Roads End survey station in all three surveys.

Table 10. Physical habitat conditions at three electrofishing sites in the NFKR during the 1998, 2006 and 2011 fish monitoring surveys.

Survey Station	Roads End			Goldledge			Hospital Flat		
Year Sampled	1998	2006	2011	1998	2006	2011	1998	2006	2011
Date	10/13	10/28	10/10	10/13	10/28	10/10	10/13	10/28	10/10
Time	10:15	14:45	11:50	13:00	9:00	12:02	13:09	9:00	10:33
Site Dimensions									
Site (reach) Length (m)	70	100	105	75	60	66	82	90	90
Mean Width (m)	14.4	17.6	18.4	27.0	27.8	28.1	30.9	29.1	29.2
Surface Area (m2)	1,014	1,760	1,935	2,040	1,666	1,848	2,543	2,619	2,617
Mean Depth (m)	0.9	0.5	0.7	0.6	0.4	0.5	0.5	0.5	0.6
Maximum Depth (m)	1.3	0.9	1.3	1.1	1.0	1.0	1.3	1.7	1.4
Water Quality									
Water temp (C)	8.0	8.3	12.0	12.0	7.4	12.9	12.0	7.7	11.5
Specific Conductivity (μS/cm)	70	71	87	100	85	122	100	85	128
Dissolved Oxygen (mg/L)	9.8	10.3	10.8	9.4	11.4	8.4	9.0	11.1	9.8
Habitat Type (% of site)									
Pool	0	0	5	0	25	15	0	25	5
Run	100	65	40	40	35	25	25	75	80
Riffle	0	35	30	40	40	55	75	0	5
Pocketwater	0	0	25	20	0	5	0	0	10
Substrate (% of site)									
Fines	0	0	5	2	3	5	0	2	5
Sand	10	20	5	15	17	20	15	48	30
Gravel	5	5	10	13	15	15	30	5	10
Rubble	25	15	30	29	30	30	40	35	25
Boulder	60	60	50	50	35	30	15	10	30
Bedrock	0	0	0	0	0	0	0	0	0

Dimensions of the electrofishing site were similar for the 2006 and 2011 surveys, as expected because the 2011 survey used the GPS coordinates from the 2006 survey to locate these sites (Table 10). No GPS coordinates were available for the 1998 study site locations. Dimensions of the direct observation sites downstream of Fairview Dam were largely similar for all three surveys (Table 11), despite the fact that the GPS coordinates of the Hospital Flat site in the 2011 survey were different from those reported for the 2006 survey. However, the dimensions given for the Goldledge site in the 1998 survey were quite different from the dimensions given for this site in the 2006 and 2011 surveys. The dimensions of the two sites upstream of the Fairview Dam varied among three surveys more than those of the three downstream sites. The dimensions of the two Roads End calibration sites were also quite variable among the surveys (Table 12).

Differences in water quality conditions among the survey years were likely related to differences in the time of year that the surveys were conducted and, perhaps, to effects of the fire and runoff in 2011. Water temperature was several degrees higher at all sites in 2011 than 2006 (Tables 10 through 12), which likely resulted from warmer air temperatures in 2011. The 2006 survey was conducted in late October and the 2011 survey was conducted in early October. Specific conductivity was also consistently higher in 2011 than in 2006 or 1998, which may have been a result of the fire and runoff during September 2011 (Tables 10 through 12). Conductivity increased downstream in 2011, perhaps as a result of increased sedimentation of runoff downstream.

Table 11. Physical habitat conditions at five direct observation sites in the NFKR during the 1998, 2006 and 2011 fish monitoring surveys.

Survey Station	**Roads End**			**Goldledge**			**Hospital Flat***			**Above Fairview Dam***			**Above Johnsondale Bridge***		
Year Sampled	1998*	2006	2011	1998	2006	2011	1998	2006	2011	1998	2006	2011	1998	2006	2011
Date	---	10/31	10/15	10/15	10/26	10/15	10/14	10/26	10/9	10/18	10/26	10/16	10/17	11/1	10/15
Time	---	9:30	11:33	11:45	15:30	9:35	11:45	13:00	15:30	10:15	10:30	9:52	12:20	10:30	15:43
Site Dimensions	---														
Site (reach) Length (m)	---	40	49	50	50	68	30	30	32	50	50	41	50	30	51
Mean Width (m)	---	18.7	21.9	18.0	30.0	20.9	25.0	25.0	21.0	15.0	30.0	30.3	20.0	25.0	26.4
Surface Area (m2)	---	748	1,082	900	1,500	1,424	750	750	679	750	1,500	1,247	1,000	750	1,349
Mean Depth (m)	---	0.5	0.7	1.8	0.4	0.7	1.4	1.0	0.8	1.5	1.0	---	2.0	1.5	---
Maximum Depth (m)	---	1.0	1.2	3.7	1.2	1.6	2.0	2.0	1.4	3.0	2.0	~2.5	2.5	2.5	~2
Water Quality	---														
Water temp (C)	---	5.8	11.7	---	10.7	12.2	---	11.3	14.6	---	7.6	10.7	---	6.5	12.5
Specific Conductivity (µS/cm)	---	67	85	---	81	116	---	80	126	---	75	86	---	93	85
Dissolved Oxygen (mg/L)	---	12.0	9.5	---	10.4	9.7	---	10.1	8.8	---	11.2	10.0	---	11.4	9.2
Habitat Type (% of site)	---														
Pool	---	5	5	100	5	20	0	5	35	0	0	5	0	20	30
Run	---	70	55	0	90	65	0	90	10	100	100	85	100	65	60
Riffle	---	25	5	0	5	0	0	5	5	0	0	5	0	15	5
Pocketwater	---	0	35	0	0	15	100	0	50	0	0	5	0	0	5
Substrate (% of site)	---														
Fines	---	2	5	0	3	5	0	1	5	0	2	5	0	2	5
Sand	---	20	15	30	20	30	5	1	25	20	8	20	30	18	20
Gravel	---	8	10	0	2	5	5	8	5	10	12	5	10	10	5
Rubble	---	40	20	0	50	25	30	25	20	50	8	25	20	35	20
Boulder	---	30	50	10	25	35	60	65	45	10	60	30	40	30	40
Bedrock	---	0	0	60	0	0	0	0	0	10	10	15	0	5	10

Table 12. Physical habitat conditions at the two Roads End calibration sites in the NFKR during 1998, 2006 and 2011 fish monitoring surveys.

Survey Station	Roads End					
Sampling Site	Lower Calibration Site			Upper Calibration Site		
Year Sampled	1998*	2006	2011	1998	2006	2011
Date	10/16	10/27	10/13	10/1	10/27	10/14
Time	10:15	14:45	12:03	10:45	11:45	10:50
Site Dimensions						
Site (reach) Length (m)	30	33	36	30	61	66
Mean Width (m)	14.0	17.0	23.5	14.0	10.5	12.2
Surface Area (m2)	450	561	837	450	640	810
Mean Depth (m)	0.6	0.7	0.6	0.8	0.4	0.7
Maximum Depth (m)	1.1	1.6	1.6	1.2	0.7	1.2
Water Quality						
Water temp (C)	---	7.1	13.0	---	6.7	11.5
Specific Conductivity (µS/cm)	---	87	112	---	66	82
Dissolved Oxygen (mg/L)	---	10.9	10.5	---	10.9	9.5
Habitat Type (% of site)						
Pool	0	8	20	0	0	0
Run	100	87	70	100	100	95
Riffle	0	5	10	0	0	5
Pocketwater	0	0	0	0	0	0
Substrate (% of site)						
Fines	0	5	5	0	1	5
Sand	20	35	20	10	15	20
Gravel	0	5	15	0	4	20
Rubble	50	30	30	50	60	25
Boulder	30	15	15	40	20	30
Bedrock	0	10	15	0	0	0

The frequencies of habitat types were largely similar between the 2006 and 2011 surveys at the three electrofishing sites, but were less similar for the 1998 survey (Table 10). The differences with the 1998 survey likely result from differences in the locations of the sites used in 1998, but changes in habitat cannot be ruled out because very high river flow occurred during the 2005 water year, which could have altered habitats in the river channel. The habitat type frequencies were also similar among survey years for the Roads End calibration sites (Table 12), but were less similar among the survey years for the direct observations sites (Table 11). It is uncertain, however, to what the degree the differences are the result of differences in habitat types, differences in site locations, or differences in methodology. Differences in methodology, for instance, include some inconsistencies in the habitat types used for the three surveys.

The substrate composition results are especially important because of concerns raised in the report of the 2006 monitoring results regarding the effects of the 2002 McNally Fire, as well as future fires, on sediment deposition in the NFKR (ECORPS 2007). According to that report, effects of the McNally Fire were evident in increased sand at the Hospital Flat and Roads End electrofishing sites since the 1998 survey (Table 10). The report did not mention, however, that sand was more prevalent in 1998 than in 2006 at all of the direct observation sites (Tables 11). The fire and rain event in September 2011 produced extreme turbidity in the KR3 reach of the NFKR for a period of a week or two about a month before the 2011 monitoring survey began. The higher percentage of fines found at all of the sites in 2011 (Tables 10 through 12) may have been the result of this turbidity event. There is no clear evidence of a consistent difference in other substrate constituents among the three survey years (Tables 10 through 12). The most striking difference is a high percentage (60 percent) of bedrock at the Goldledge direct observation site in 1998 and no bedrock at the site in 2006 or 2011 (Table 11), which presumably indicates that the location used for this site in 1998 was different. Other differences (e.g. Hospital Flat and Above Fairview Dam direct observation sites) likely also result from differences in site locations.

Fish Species Composition and Abundance

Fish species composition in the KR3 Project area has changed substantially over the past two decades. Abundance of hardhead, a California Species of Special Concern (Moyle et al. 1995) and a U.S. Forest Service Sensitive Species (http://www.fs.fed.us/r5/snfpa/final-seis/vol1/appendix-c/assessments/sensitive-species/index.html), has steadily declined since the first KR3 relicensing survey, conducted in 1989 (Table 13, Figure 6). Hardhead were found in low abundance at the Hospital Flat site during the 1998 survey and no hardhead were found at any site in either the 2006 or 2011 surveys. Two other species, Sacramento pikeminnow and common carp, have also declined or disappeared entirely since 1989 (Table 13, Figure 6). Only one hatchery rainbow trout was identified during the 2011 survey and relatively few trout were found during the 2006 survey. Abundance of brown trout has been consistently low (Table 13). Wild rainbow trout and Sacramento sucker, the most abundant species during the two previous post-license monitoring surveys, were also the most abundant species during 2011 (Table 13, Figure 6). The 2011 numerical abundances of wild rainbow trout at the three electrofishing sites were above or close to the mean site abundances for all previous survey years (Table 13), but rainbow trout biomasses were consistently well below the mean biomasses (Table 14). The reduced biomasses resulted from the relatively small sizes of the 2011 trout (Table 15). Sacramento suckers at the electrofishing sites in the 2011 survey were also similar in abundance to but lower in biomass than the means (Tables 13 and 14, Figures 6 and 7). Their biomass was especially low at the Hospital Flat site, where, as previously indicated, the population was dominated by Age 0+ and Age 1+ fish (Figure 3). Suckers also had a high abundance and low biomass at this site in 2006 (Tables 13 and 14, Figures 6 and 7).

The reductions in the abundance of hardhead, Sacramento pikeminnow and common carp noted above could be the result of seasonal migrations out of the sampling area rather than declines in the populations of these species. Common carp is a warmwater species and hardhead and Sacramento pikeminnow have higher water temperature preferences than trout or Sacramento suckers (Bettelheim 2001, Moyle 2002). The preferred temperature range for hardhead is about 24 to 28°C (Moyle 2002), while the optimal water temperature for Sacramento pikeminnow is about 15^{o}C (Bettelheim 2001). The three relicensing monitoring surveys (1989, 1990 and 1991) were conducted during September, when water temperatures are generally high, while the three post-license surveys (1998, 2006 and 2011) were conducted in October, when water temperatures are lower. The change in the sampling schedule was made because the new project license mandated an increase from 70 cfs to 100 cfs in September minimum flow releases, raising concerns that the efficiency of fish sampling would be affected (Entrix 1997). The Fish Monitoring Plan recommended that the post-license surveys be conducted in October, when the required minimum flow is 80 cfs. The Plan further recommended that the sampling be conducted early in the month to minimize effects of water temperature reductions during October. However, during all three post-license surveys, water temperature was below 15^{o}C at all sampling sites (Tables 10 through 12). It is therefore possible that during early October of the survey years, carp, hardhead and pikeminnow migrated downstream and out of the KR3 project area as the water temperature dropped and, therefore, were less available to sampling than they would have been during September.

Another important factor potentially affecting the abundance of hardhead, Sacramento pikeminnow and common carp is the annual discharge. All three water years (October through September) during which the relicensing monitoring surveys were conducted (1989, 1990, and 1991) were critically dry years in the San Joaquin Basin, which lies immediately north of the Kern River Basin. In contrast, the three water years affecting the post-license surveys (1998, 2006 and 2011) were wet years. The April 1, 2011 snowpack was about 162 percent of average. It is reasonable to presume that the differences in hydrologic conditions affected the fish abundances.

Table 13. Estimates of fish numerical abundance at three electrofishing sites in the NFKR during 1989 – 1991, 1998, 2006 and 2011 surveys, and 1989 – 2006 mean.

	Numerical Abundance (fish/km)						
	1989	1990	1991	1998	2006	2011	Mean
Roads End							
Wild rainbow trout	320	186	113	405	215	406	248
Hatchery rainbow trout	52	144	41	14	40	0	58
Brown trout	10	0	10	0	20	10	8
Sacramento pikeminnow	1,351	1,423	773	14	0	0	712
Sacramento sucker	5,732	2,691	3,062	4,286	774	3,121	3,309
Hardhead	10	10	0	0	0	0	4
Common carp	0	0	0	0	0	0	0
Total for station	7,475	4,454	3,999	4,719	1,049	3,537	4,339
Goldledge							
Wild rainbow trout	269	86	258	1,496	396	794	501
Hatchery rainbow trout	75	65	108	93	0	0	68
Brown trout	0	0	0	13	0	0	3
Sacramento pikeminnow	2,634	3,935	1,839	339	17	0	1,753
Sacramento sucker	3,710	4,065	3,774	5,159	3,464	2,177	4,034
Hardhead	441	398	118	0	0	0	191
Common carp	0	0	0	0	0	0	0
Total for station	7,129	8,549	6,097	7,100	3,877	2,971	6,550
Hospital Flat							
Wild rainbow trout	10	0	0	1,028	0	134	208
Hatchery rainbow trout	0	0	0	85	0	11	17
Brown trout	0	0	0	0	0	11	0
Sacramento pikeminnow	2,699	6,117	3,495	170	489	257	2,594
Sacramento sucker	1,748	1,476	2,825	4,700	5,822	3,437	3,314
Hardhead	2,194	1,126	73	12	0	0	681
Common carp	68	155	19	0	0	0	48
Total for station	6,719	8,874	6,412	5,995	6,311	3,850	6,862

Table 14. Estimates of fish biomass at three electrofishing sites in the NFKR River during 1989 – 1991, 1998, 2006 and 2011 surveys, and 1989 – 2006 mean.

	Fish Biomass (kg/km)						
	1989	1990	1991	1998	2006	2011	Mean
Roads End							
Wild rainbow trout	22.1	9.7	1.8	19.3	13.0	6.2	13.2
Hatchery rainbow trout	8.2	28.1	5.4	2.3	92.9	0.0	27.4
Brown trout	0.9	0.0	0.1	0.0	1.9	0.1	0.6
Sacramento pikeminnow	20.8	145.0	91.6	1.1	0.0	0.0	51.7
Sacramento sucker	708.5	549.2	404.7	712.4	229.5	403.9	520.9
Hardhead	0.1	0.6	0.0	0.0	0.0	0.0	0.1
Common carp	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total for station	760.6	732.6	503.6	735.1	337.3	410.2	613.8
Goldledge							
Wild rainbow trout	10.7	5.7	9.5	51.2	25.1	9.2	20.4
Hatchery rainbow trout	9.0	9.8	23.6	31.5	0.0	0.0	14.8
Brown trout	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Sacramento pikeminnow	35.1	44.1	17.9	1.6	<0.1	0.0	24.7
Sacramento sucker	657.4	662.9	522.8	623.8	671.0	200.2	627.6
Hardhead	9.6	16.1	6.6	0.0	0.0	0.0	6.5
Common carp	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total for station	721.8	738.6	580.4	708.2	696.1	209.4	689.0
Hospital Flat							
Wild rainbow trout	0.1	0.0	0.0	43.9	0.0	1.8	8.8
Hatchery rainbow trout	0.0	0.0	0.0	23.4	0.0	1.5	4.7
Brown trout	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Sacramento pikeminnow	131.5	262.4	30.8	1.0	15.9	1.3	88.3
Sacramento sucker	506.8	433.9	451.1	287.0	43.9	35.2	344.5
Hardhead	48.3	34.5	8.2	0.0	0.0	0.0	18.2
Common carp	92.7	172.7	33.2	0.0	0.0	0.0	59.7
Total for station	779.4	903.5	523.3	355.3	59.8	39.9	524.3

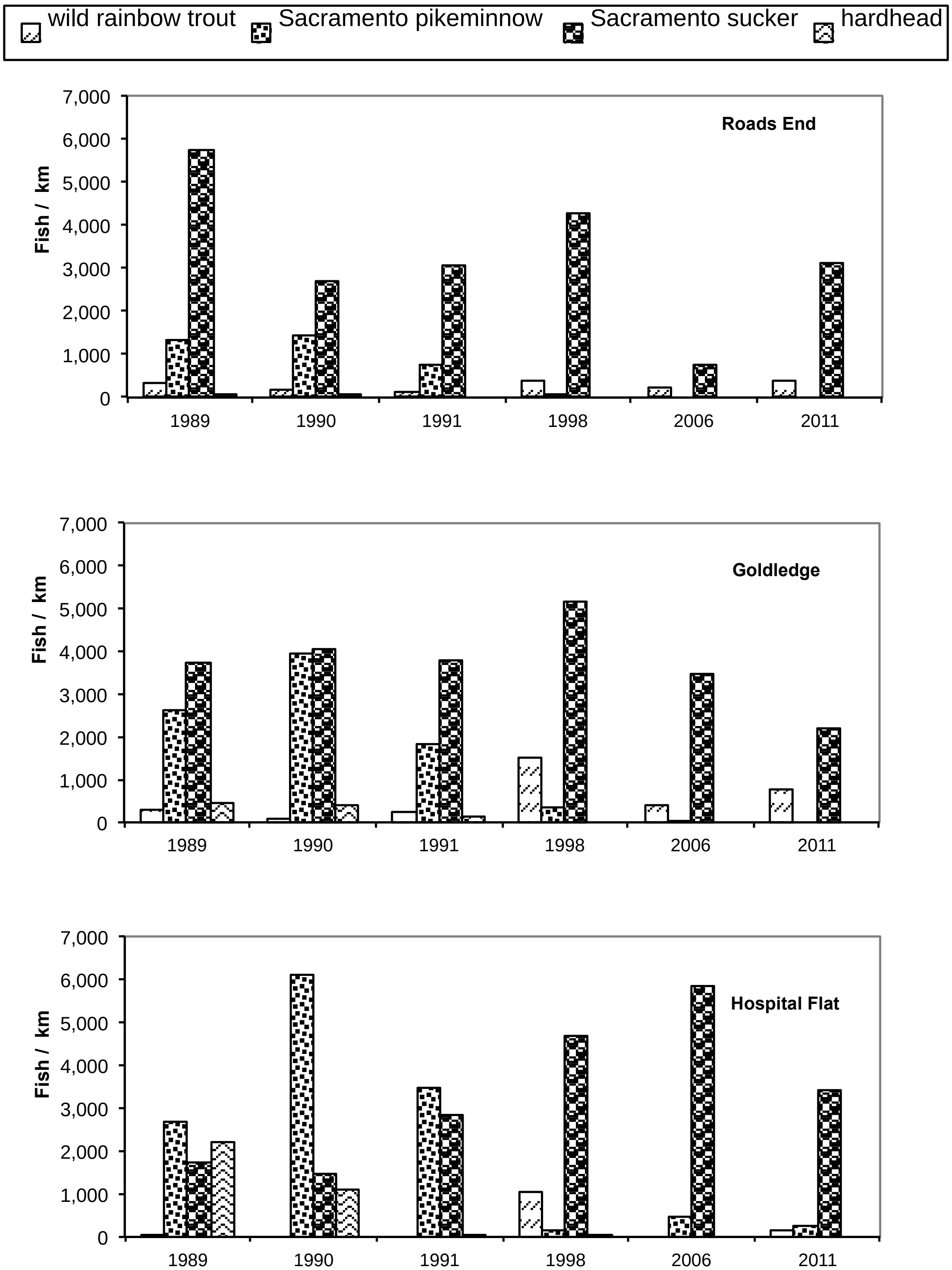

Figure 6. Estimates of numerical abundance of four most abundant fish species at three electrofishing sites in the NFKR during 1989 – 1991, 1998, 2006 and 2011 surveys.

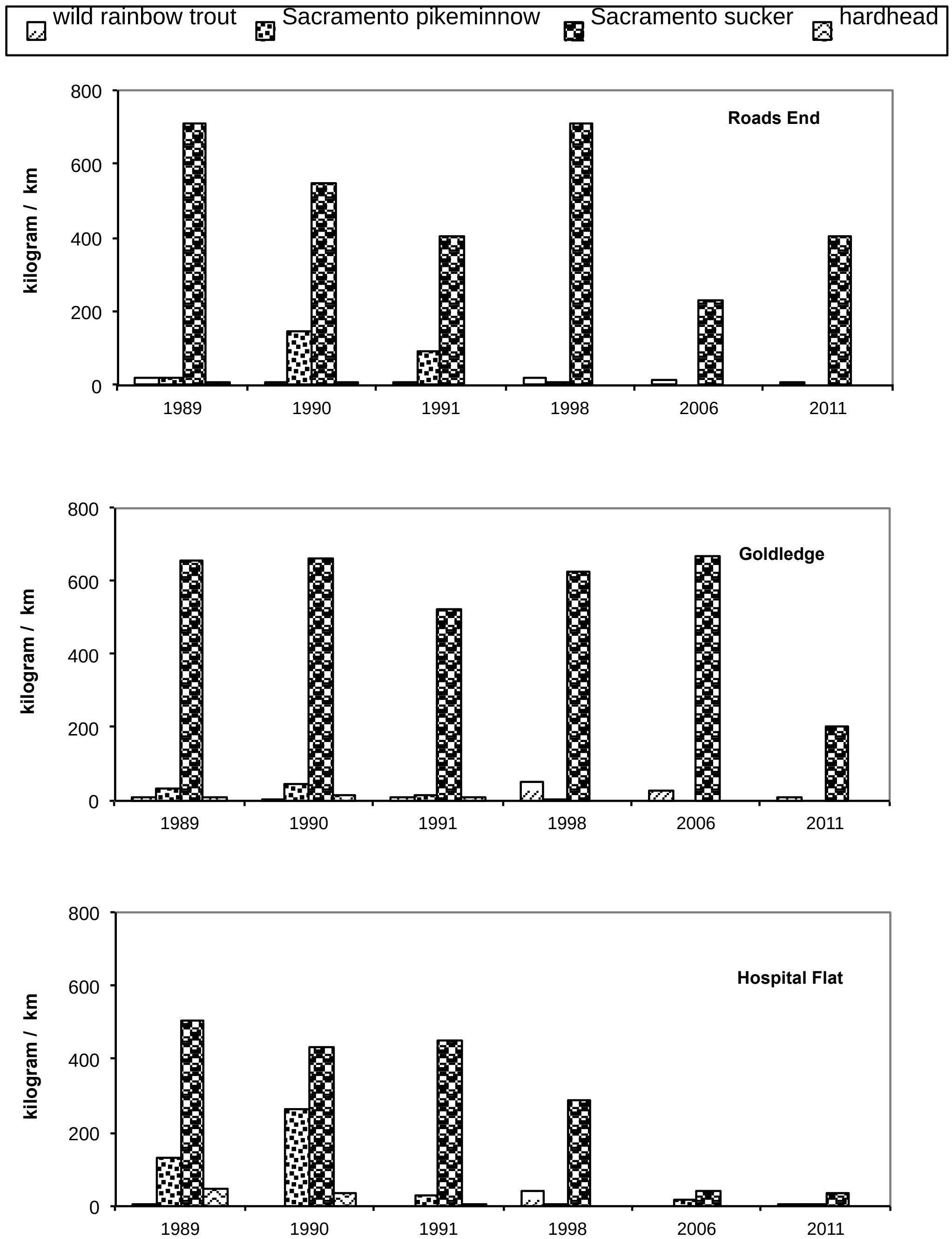

Figure 7. Estimates of biomass of four most abundant fish species at three electrofishing sites in the NFKR during 1989 – 1991, 1998, 2006 and 2011 surveys.

Rainbow trout and Sacramento sucker were the only species sufficiently abundant during the 2011 monitoring survey to allow their spatial patterns of abundance to be determined. The electrofishing results indicated that rainbow trout were most abundant, both in terms of numbers and biomass, at the Goldledge site (Tables 13 and 14, Figure 6), while the direct observation sampling results indicated that the trout were most abundant at the Roads End site (Table 15). Abundance of trout was substantially lower at the direct observation sites upstream of Fairview Dam than those in the diverted reach (Table 15), although the much higher flow upstream of the dam may have contributed to this apparent difference by creating more difficult sampling conditions. The size distribution of the trout was similar among the three electrofishing and five direct observation sites (Figure 2 and Table 15).

Table 15. Estimates of rainbow trout abundance by size class at five direct observation sites in the NFKR during monitoring surveys in 1998, 2006 and 2011.

	Size Class (mm FL)					
	<75	**76-175**	**176-305**	**306-405**	**>406**	Total
1998						
Above Johnsondale Bridge	0	80	340	0	0	420
Above Fairview Dam	0	80	60	0	0	140
Roads End	0	33	0	0	0	33
Goldledge	0	80	180	80	0	340
Hospital Flat	33	433	100	0	0	566
2006						
Above Johnsondale Bridge	0	0	33	133	67	233
Above Fairview Dam	20	0	20	100	0	140
Roads End	0	8	8	52	8	76
Goldledge	220	0	0	0	0	220
Hospital Flat	0	0	0	33	0	33
2011		(76-152)*	(153-305)*			
Above Johnsondale Bridge**	0	59	156	0	0	215
Above Fairview Dam**	0	0	48	0	0	48
Roads End	20	283	142	40	0	486
Goldledge	0	221	88	0	15	324
Hospital Flat**	62	93	124	31	0	310

** These size classes were slightly different from those used for the previous two surveys.*
*** Locations of these three sites were different from their locations in the 2006 survey. See text for explanation.*

Rainbow trout were also most abundant at the Goldledge electrofishing site in the 1991, 1998 and 2006 surveys (Tables 13 and 14, Figures 6 and 7). Numbers were especially high at this site in 1998, and the report for this survey offered speculation that their abundance here was due to good spawning habitat in Ant Creek Canyon, which drains into the NKFR upstream of the Goldledge site (Entrix 1999). In the 1989 and 1990 surveys, rainbow trout were most abundant at the Roads End electrofishing site (Tables 13 and 14). The distribution of trout abundance among the five direct observation sites has been much more variable, with abundance peaking at the Hospital Flat site in 1998, the Above Johnsondale Bridge site in 2006, and the Roads End site in 2011 (Table 15).

Sacramento suckers were the dominant species, both in terms of numbers and biomass, at all three electrofishing sites in 2011 (Tables 13 and 14, Figures 6 and 7). The Hospital Flat site had the highest numerical abundance but the lowest biomass because small fish dominated the sucker population at this site, while most of the suckers at the other two sites were relatively large (Figure 3). Suckers were also the most abundant species at all the direct observation sites and their sizes increased from downstream to upstream, except that the sucker population at the Goldledge site had a similar size distribution to that at the Hospital Flat site (Table 16).

Table 16. Estimates of Sacramento sucker abundance by size class at five direct observation sites in the NFKR during monitoring surveys in 1998, 2006 and 2011.

	Size Class (mm FL)					
	<75	**76-175**	**176-305**	**306-405**	**>406**	Total
<u>1998</u>						
Above Johnsondale Bridge	0	0	40	160	40	240
Above Fairview Dam	0	20	160	140	0	320
Roads End	67	0	0	0	0	67
Goldledge	580	80	260	460	100	1,480
Hospital Flat	1,633	200	0	67	0	1,900
<u>2006</u>						
Above Johnsondale Bridge	0	0	0	167	67	234
Above Fairview Dam	0	0	0	60	0	60
Roads End	142	8	0	15	8	173
Goldledge	1,000	60	100	100	0	1,260
Hospital Flat	133	0	767	67	0	967
<u>2011*</u>		(76-152)*	(153-305)*			
Above Johnsondale Bridge**	20	0	39	117	78	254
Above Fairview Dam**	48	0	676	556	121	1,401
Roads End	121	61	850	364	0	1,397
Goldledge	1,132	147	147	88	0	1,515
Hospital Flat**	619	93	186	0	0	898

** These size classes were slightly different from those used for the previous two surveys.*
*** Locations of these three sites were different from their locations in the 2006 survey. See text for explanation.*

Sacramento sucker was the dominant species at all three electrofishing sites during the past three surveys, but Sacramento pikeminnow was dominant in terms of numbers, although not biomass, at the Hospital Flat site during the 1989, 1990 and 1991 surveys (Tables 13 and 14). Suckers were relatively low in abundance at the Roads End, Above Fairview Dam, and Above Johnsondale Bridge direct observation sites in 1998 and 2006, but were much more abundant at the Roads End and Above Fairview Dam sites in 2011 (Table 16). The size distribution of suckers was skewed towards higher size classes at the upstream sites in all three surveys (Table 16). At Roads End, the size distribution in

2011 was more like that at the sites upstream of the dam, while in the two previous surveys it was more like at the two downstream-most sites.

Rainbow Trout Age Structure

The age structure of wild rainbow trout has differed greatly among the three post-license monitoring surveys (Table 17). In 1998, Age 1+ and Age 2+ trout dominated the populations at all three electrofishing sites. In 2006, Age 1+ dominated and the number of Age 0+ was especially low, which, as noted in the report for the 2006 survey (ECORP 2007), indicates poor recruitment during spring 2006. In 2011, Age 0+ trout dominated the age structure, with Age 1+ second most abundant, and few Age 2+ present. Domination by the Age 0+ class indicates that the trout population had good recruitment in 2011. The very low number of Age 2+ and older trout suggest that recruitment and survival was less good in other recent years.

The average size and weights of the trout age classes were generally more similar between 2006 and 2011 than between either of these years and 1998 (Table 17). Also, Age 3+ trout were found at all three sites in 1998, while no Age 3+ trout were found in 2006 or 2011.

Table 17. Length, weight, condition factor, and percent abundance of wild rainbow trout age classes at three electrofishing sites in the NFKR during monitoring surveys in 1998, 2006 and 2011.

Site / Year / Age Class	Length Range (mm)	Average Length (mm)	Average Weight (g)	Average Condition Factor	Abundance Percentage
Roads End					
1998					
Age 0+	91-95	94	9	1.11	23%
Age 1+	103-136	119	21	1.23	35%
Age 2+	156-201	183	72	1.16	23%
Age 3+	211-229	217	113	1.10	19%
2006					
Age 0+	102	102	12	1.17	2%
Age 1+	92-215	146	42	1.14	79%
Age 2+	186-220	210	114	1.24	19%
2011					
Age 0+	76-138	104	14	1.20	85%
Age 1+	182-192	189	78	1.16	11%
Age 2+	255	255	192	1.16	4%
Goldledge					
1998					
Age 0+	81-101	92	9	1.16	28%
Age 1+	1001-135	115	18	1.16	44%
Age 2+	156-232	192	81	1.11	25%
Age 3+	189-252	221	123	1.10	3%
2006					
Age 0+	89	89	7	1.02	7%
Age 1+	113-178	141	36	1.18	80%
Age 2+	237-252	246	183	1.23	13%
2011					
Age 0+	93-139	111	15	1.05	76%
Age 1+	170-226	195	77	1.01	22%
Age 2+	259	259	179	1.03	2%
Hospital Flat					
1998					
Age 0+	77-98	87	8	1.20	11%
Age 1+	98-147	117	19	1.19	53%
Age 2+	162-222	195	78	1.05	29%
Age 3+	200-244	215	117.5	1.07	8%
2006	*No trout captured at this site in 2006*				
2011					
Age 0+	79-132	106	15	1.20	78%
Age 1+	221-228	225	124	1.09	22%
Age 2+	---	---	---	---	0%

Conclusion

As previously indicated, the principal objective of the Fish Monitoring Plan is to provide information on the abundance of fish near the KR3 project area over time (Entrix 1997). The results of the 2011 survey show a continuation in the decline of the native minnow species, hardhead and Sacramento pikeminnow, that was noted in the previous two post-license monitoring surveys, but the interpretation of these results uncertain. There is no evidence that the reduction is related to effects of the KR3 project and, as previously discussed, it is possible that the reduction is at least partly attributable to the change in sampling schedule from September (1989 - 1991 surveys) to October (1998, 2006, and 2011 surveys) and natural variations in hydrologic conditions. The numerical abundances of wild rainbow trout and Sacramento sucker in 2011 were generally close to the means for the previous surveys at all three electrofishing sites, but the biomasses were low. For Sacramento sucker, biomass was particularly low at the Hospital Flat site because of relatively high numbers of young suckers and low numbers of older suckers. This pattern, which was also true in 2006, suggests that recruitment of suckers is good at the Hospital Flat site, but survival is poor or older suckers migrate to other locations. The relatively low biomass of trout at all sites in 2011 reflects a population dominated by Age 0+ fish, indicating good recruitment in 2011 and poorer recruitment and survival in other recent years. Year-to-year variations in recruitment and survival in the KR3 project area, as in any stream environment, are expected and are likely attributable to natural variations in environmental conditions.

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APPENDIX A

Agency Consultation

This appendix includes two sections. Section A provides the responses from the agencies to SCE's request for comments on the public draft of this report. Section B provides a copy of the cover letter from SCE to the resource agencies circulated with the draft report, as well as emails sent by SCE to remind agency staff of the request for comments. Responses to SCE's request for comments were received from the Sequoia National Forest (SQF), U.S. Fish and Wildlife Service (USFWS), and National Park Service (NPS). The SQF submitted comments, while the NPS and USFWS indicated that they had no comment on the report. The California Department of Fish and Game (CDFG) indicated that would prepare a response, but no response was received by the time that the report was filed with the FERC. The comments received from the SQF and SCE's responses are provided below. The contents of emails received from the agencies with no comments on the report are also provided.

A. Agency Comments and SCE Responses

Comments from the SQF in response to the December 14, 2011 public draft of the 2011 KR3 Fish Population Monitoring report are provided in the following, together with SCE's responses. Text of emails from the NPS and the USFWS are included as well.

1. **SQF Comments** (February9, 2012 email from Steve Anderson, Kern River RD, USGS – Kernville, CA).

Comment #1: It would probably be good to note other actions that would have a bearing on fish population or age structure. I didn't notice anything in the report regarding the hydrologic year or comparison of hydrologic years for fish sampling years. I know 2011 had a very high water yield and even though the water flow was ~100 CFS each year during sampling, the overall water year would likely have a significant role in explanations of changes in abundance, species composition etc. on a year to year basis. I don't see adding something like that to this report, but I do think there should be a sentence somewhere putting the water year into perspective compared to other years. Such as: "2011 was a wet year with ~162 percent of average April 1 snowpack" as a reference for future comparisons between sample years.

Comment #2: The conclusion section notes a "decline" in the hardhead population and then goes on to explain why this may not represent an actual decline in the population. Since it is a draft, I suggest changing the statement to a "decline in detection of hardhead" rather than a decline in the population of hardhead. These things tend to get cited out of context.

Comment #3: I think it might be better to shift the sampling date back to September? The report notes that the FERC relicense required a higher minimum flow in September and the September pre license sampling date was shifted to October post license to reflect similar flows compared to pre-licensing sampling. But the surveys show a huge difference in species and total biomass from pre-licensing to post licensing. The absence of hard head is explained as probably due to a change in water temperature between the September pre-licensing surveys and the October post licensing surveys. Biomass may reflect the same or a lower biomass of hatchery fish due to cessation of stocking about the same period. So it would seem that water temperature and/or time of year may be more important than flow as a variable to determine if the changes to the license were of value to fisheries or water quality. I would expect that the increased flows under the new permit would result in better conditions for fisheries and water quality. Seems like the monitoring should be designed to show or at least attempt to show the difference in same time of year fisheries biomass, species composition and water quality with the higher flow. If the new flow requirement wasn't effective, then it should be revisited in the next license or retained if it was effective. But the changed monitoring doesn't tell me anything one way or the other.

SCE Responses

Response to Comment #1: A paragraph concerning hydrologic conditions during the six survey years has been added to the Discussion section on page 30 of the report.

Response to Comment #2: The second sentence of the Conclusion section has been revised to indicate that interpretation of study results showing a decline in abundance is uncertain.

Response to Comment #3: SCE acknowledges SQF's concerns regarding the change in the time of year from the relicensing to post-license monitoring surveys and will continue discussions with the SQF on this matter. The Fish Monitoring Plan calls for a change in the time of sampling from September to early October because the new FERC license required an increase in September minimum flows from 70 cfs to 100 cfs. The October minimum required flow is 80 cfs, so by shifting the surveys to October, greater consistency in flow conditions between the pre- and post-license conditions would be achieved, and sampling effectiveness, which is generally lower at higher flows, would be improved. The Plan addresses the possible changes in water temperature that would result from the change in timing and their potential effects, but concludes that changes in flow are a greater concern. Note the 2011 KR3 Fish Population Monitoring report does not assert, as indicated in the comment, that the "absence of hardhead is … *probably* [italics added] due to a change in water temperature…." Rather, the report states: "It is therefore possible that … carp, hardhead and pikeminnow migrated downstream and out of the KR3 project area as the water temperature dropped and, therefore, were less available to sampling…."

2. NPS Comment (February 14, 2012 email from Christine Smith with comment from Koren Nydick, Science Coordinator/Ecologist, Sequoia and Kings Canyon National Parks, Three Rivers, CA).

Candace,

Please see response below.

Christine Smith
Management Assistant

Sequoia and Kings Canyon National Parks
47050 Generals Highway
Three Rivers, CA 93271

phone 559 565-3105
fax 559 565- 4202

You asked me to preview and prepare a response by 1/31 if SEKI had one to the report titled, "Fish Population Monitoring 2011, Kern River No. 3 Hydroelectric Project". This monitoring is required every 5 years.

I have read the report but do not think it is necessary for SEKI to prepare a response.

1) This report is for the Kern River many miles downstream of SEKI. Thus, the parks are very unlikely to be impacted by the hydroelectric project. Danny Boiano was consulted and he agreed. Danny was not aware of SEKI submitting comments on previous surveys for this project.

2) The monitoring methods were fairly standard. There is some uncertainty in the interpretation of the results due to changes in methodology over time, but the changes in methodology were well described and in most case unavoidable due to changes in physical environmental conditions and the need to keep field technicians safe.

3) The conclusion was that there is a continuation of the decline in native minnow, species, hardhead and Sacramento pikeminnow that was noted in previous surveys. There is no evidence that the reduction is related to the effects of the hydroelectric project. It could be related to changes in the timing of sampling alluded to in #2 above.

additionally.....

I read the comments of the USFS you provided below. I agree with all the comments. It might be better to conduct the sampling in September instead of October. The goal is to do the sampling during as similar conditions as those that occurred during the sampling conducted in the pre-licensing period. Before licensing, the sampling occurred in

September. But due to the human manipulation of flow, flow in September is now elevated and that is why they pushed sampling to October. October is colder, however, and those lower temperatures may be the cause of declines in fish detection (i.e., results may be caused by a change in method rather than a change in the populations). So it appears that either flow or temperature will be different pre- and post-licence sampling no matter what is done - so it's a trade off.

I agree that the monitoring program would benefit from a more thorough review to address this issue now that several sampling events have occurred. Because of #1 noted above, I did not think that it was SEKI who should instigate it. USFS is more appropriate to instigate it, and they have.

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Koren R. Nydick, PhD
Science Coordinator/Ecologist
Sequoia & Kings Canyon National Parks
Phone: 559-565-4292
FAX: 559-565-4207

3. USFWS Comment (January 30, 2012 email from Deborah Giglio, Supervisory Fish and Wildlife Biologist Conservation, Restoration and Contaminants Program, Sacramento, CA).

From: Deborah_Giglio@fws.gov To: Candace.Irelan@sce.com Date: 01/30/2012 08:22 AM Subject: Re: Fw: 2nd request for comments

We have no comment. Thank you.

Deborah A. Giglio-Willoughby
Supervisory Fish and Wildlife Biologist
Conservation, Restoration and Contaminants Program
U.S. Fish and Wildlife Service
2800 Cottage Way, Suite W-2605
Sacramento, CA 95825
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fax (916) 414-6712
e-mail deborah_giglio@fws.gov

B. SCE Communications to the Resource Agencies during Circulation of Public Draft

The following letter was emailed to the SQF, USFWS, NPS, and CDFG with the release of the December 14, 2011 public draft of the 2011 KR3 Fish Population Monitoring report. Follow-up emails asking for responses were sent January 27, 2012 and February 9, 2012. These emails are reprinted below the December 14 letter.

SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL Company

Walter D. Pagel
Manager
Eastern Hydro Division

December 14, 2011

Mr. Kevin Elliott, Forest Supervisor
U.S. Forest Service
Sequoia National Forest
1839 South Newcomb Street
Porterville, CA 93257

Ms. Susan Moore, Field Supervisor
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, CA 95825

Mr. Jeff Single, Regional Manager
California Department of Fish and Game
1234 East Shaw Avenue
Fresno, CA 93710

Ms. Karen Taylor-Goodrich, Superintendent
National Park Service
Sequoia National Park
47050 Generals Highway
Three Rivers, CA 93271-9700

Subject: Fish Population Monitoring, 2011
Kern River No. 3 Hydroelectric Project (FERC No. 2290)

Dear Agency Representatives:

The license for the Kern River No. 3 Project (KR3) was issued by the Federal Energy Regulatory Commission (Commission) on December 24, 1996 to Southern California Edison Company (SCE). Under Article 411 of the license, SCE has completed the most recent of its required once-every-5-years fish population monitoring surveys for the KR3 Project.

The attached draft report contains the results of the monitoring survey, and is being provided to you for a 30-day review and comment period. SCE would appreciate receiving your comments by January 31, 2012 in order to meet the Commission's filing deadline.

Please contact Candace Irelan at (909) 394-8714 or Candace.Irelan@SCE.com if you have any questions regarding this request.

Sincerely,

Walter D. Pagel

Enclosure

cc: A. Willy, USFWS
D. Giglio, USFWS
B. Beal, CDFG
J. Means, CDFG
T. Purpuro, CDFG
R. Porter, USFS
S. Anderson, USFS

300 North Lone Hill Avenue
San Dimas, CA 91773-1741
909.394.8720

From: <Candace.Irelan@sce.com>
Date: Fri, 27 Jan 2012 15:11:26 -0800
To: "deborah_giglio@fws.gov" <deborah_giglio@fws.gov>, <allison_willy@fws.gov>, Brian Beal <Brian_Beal@dfg.ca.gov>, Julie Means <jmeans@dfg.ca.gov>, Tracy Purpuro <TPURPURO@dfg.ca.gov>, Roger W Porter <rwporter@fs.fed.us>, Steve W Anderson <swanderson@fs.fed.us>
Cc: Sophie Unger <sophia.unger@sbcglobal.net>, <Lisa.Smith@SCE.com>, Danielle Chupa <danielle.chupa@sce.com>
Subject: 2nd request for comments

Agency representatives:
On December 14th, 2010 (see attached cover letter) we asked that you review and make comments on the Kern River No. 3 fish population monitoring study draft report. We asked that you provide comments by the end of January.
Would you please send (e-mail is fine) me your comments as soon as possible so that I can get this report filed with the FERC on time. If you have no comments to make, please e-mail that statement to me as well.
Your attention to this item is much appreciated as I know you're all busy.
Thanks.

From: <Candace.Irelan@sce.com>
Date: Thu, 9 Feb 2012 11:40:55 -0800
To: <Brian_Beal@dfg.ca.gov>, Julie Means <jmeans@dfg.ca.gov>, Tracy Purpuro <TPURPURO@dfg.ca.gov>, Roger W Porter <rwporter@fs.fed.us>, Steve W Anderson <swanderson@fs.fed.us>
Cc: Sophie Unger <sophia.unger@sbcglobal.net>, <Lisa.Smith@SCE.com>, Danielle Chupa <danielle.chupa@sce.com>
Subject: 3rd request for comments

Agency Representatives:
I have received a comment from Fish and Wildlife Service but no others. I'm running out of time with the FERC filing deadline, which is Monday, 2/13. I would appreciate receiving your comments by tomorrow so that they can be included with the KR3 fish monitoring report filing.
Thanks.

Document Content(s)