APPENDICES

Appendix A - Kern River No. 1 Sediment Management Practices. Power Point presentation for stakeholders' meeting. 2009.

Appendix B - Kern River No.1 Hydroelectric Study, Smallmouth Bass Study Final Progress Report 7. 2007.

Appendix C - Kern River No. 3 Hydroelectric Project, Water Temperature Monitoring 2006 (without tables).

Appendix D - Kern River No. 3 Hydroelectric Project, Water Temperature Monitoring 2006 (tables only).

Appendix E – Annotated Bibliography of Hardhead References Relating to the Kern River. 2007.

Region. January 2009 Public Review Draft. Appendix A. California Environmental Protection Agency. 39 p.

Mills, T.J. 1972. Kern River Chemical Treatment – November 1972. California Department of Fish and Game, Region 4, Fresno, CA. Memo. 3 p.

Mills, T.J. 1973. Kern River, Section 2: Summary of Fish Sampling, December 1973. 1974. California Department of Fish and Game, Region 4, Fresno, CA. Memo. 2 p.

Mills, T.J. 1975. Kern River - Fish Sampling. 1975. California Department of Fish and Game, Region 4, Fresno, CA. Memo. 2 p.

Moyle, P. B. 2002. Inland Fishes of California, revised and expanded. University of California Press. Berkeley, CA. 502 p.

Moyle, P. B., J. E. Williams, and E. D. Wikramanayake. 1989. Fish Species of Special Concern. Univ. of Calif., Davis. Final report submitted to the Calif. Dept. of Fish and Game. Contract No. 7337. 222 p.

Myers, J. and L. Greiss. 2002. *An Analysis of a Heavy Precipitation Event over Interior South-Central California*. November 7-9, 2002. National Weather Service, Forecast Office. San Joaquin Valley/Hanford, CA.

Myric, C.A. and J.J. Cech, Jr. Swimming Mechanisms of Hardhead Minnows (*Mylopharodon conocephalus*): Preliminary Results. University of California, Davis. 8 p.

(SCE) Southern California Edison. 1991. Kern River No. 3 Water Power Project, Application for New License for Major Project, Existing Dam, Volume 2 of 2. Southern California Edison. Rosemead, CA.

(SCE) Southern California Edison. 2006. Kern River No. 3 Hydroelectric Project, Water Temperature Monitoring 2006. Southern California Edison. Rosemead, CA. Prepared by ECORP Consulting Inc.

(SCE) Southern California Edison. 2006. Borel Hydroelectric Project, Fish population monitoring Report 2006. Southern California Edison. San Dimas, CA. 21 p.

(SCE) Southern California Edison. 2007. Kern River No.1 Hydroelectric Study, Smallmouth Bass Study Final Progress Report 7. Southern California Edison. Rosemead, CA. Prepared by ENTRIX, INC.

Stephens, S.J., D. P. Christenson, M. Lechner, and H. Werner. 1995. Upper Kern Basin Fishery Management Plan. California Department of Fish and Game. Fresno, CA.

(Appendix E). The population in the lower Kern appears to be stable despite presence of small mouth bass and intermittent (no stocking when the water temperature exceeds 20 deg Celsius) trout stocking. The population data for hardhead in the upper Kern appears to be inconclusive. A downward trend at the monitoring sites in the upper Kern is likely a result of changes in flow regimes and habitat features over the monitoring period, during which there were several heavy sedimentation events affecting the Kern River. Fluctuation of the water temperature gradients in response to the increased flows, sedimentation and run-off may have resulted in corresponding shifts in location of hardhead. Major sediment flow events from the McNally Fire and other flood events during the period resulted in significant fish kill, both directly and due to predation by birds and mammals as the sediment filled pools and reduced cover and macroinvertebrate populations.

However, since stocking has remained a constant since the early 1930's, and prior to that native trout evolved concurrently with hardhead, there is no indication that stocking hatchery trout is associated with fluctuation in the population of hardhead. The years when the hardhead population was robust and extended well into the normally colder reaches of the upper Kern would seem to indicate that stocking hatchery trout is not associated with detrimental effects on hardhead.

5. Literature Cited

Brown, L. and P. B. Moyle, 1987. Survey of the Fishes of the Mid-Elevation Streams of the San Joaquin Valley, Draft Report for California Department of Fish and Game. University of California, Davis.

Calhoun,A. 1966. Inland Fisheries Management. California Department of Fish and Game. 546 p.

(CDFG) California Department of Fish and Game, 1972. State Department of Fish and Game Re-stocks the Kern River. CDFG Region 4, Fresno, CA. News Release. 1 p.

(CDFG) California Department of Fish and Game, Inyo National Forest and U. S. Fish and Wildlife Service. 1999. Conservation Strategy for the Volcano Creek Golden Trout (*Oncorhynchus mykiss aguabonita*). California Department of Fish and Game. Fresno, CA. 17 p.

(CRWQCB) California Regional Water Quality Control Board. 1975. Water Quality Control Plan Report, Tulare basin. Central Valley Region.

(CRWQCB) California Regional Water Quality Control Board. 2009. Clean Water Act Section 305 (b) and 303 (d) Integrated Report for the Central Valley

Early electrofishing surveys were conducted by CDFG in Section 5 of the upper Kern River during the fall of 1971 at two locations: Site #1 was immediately above KR3 Powerhouse, and Site #2 was 2.5 miles below Fairview Dam. Sacramento pikeminnow and hardhead were present at both sites, but were counted together (CDFG, unpublished data). In CDFG electrofishing surveys conducted in September 1987 and 1988 above Fairview Dam, no hardhead were collected (CDFG, unpublished data).

Kern River Fish population monitoring has been completed as required for relicensing for the SCE Kern River No. 3 Powerhouse. The report and data for these studies are in Appendix C and D. Surveys completed by SCE since 1989 in the KR3 project reach have shown a decline in the hardhead population at the repeat sampling locations (SCE, 2006). Changes in minimum instream flows were developed during the period to make temperature conditions more favorable for trout. Under the old, lower flow regime, it's likely that temperatures favored hardhead in locations further upstream in the diverted reach. It is possible the new flow regime changed the transitional zone between rainbow trout and the hardhead/pikeminnow/sucker assemblage, moving it further downstream. If that is the case, fewer hardhead would be expected in the upper sampling sites. The extreme input of sediments after the 2002 McNalley Fire would have exacerbated the decline documented at the sampling sites(SCE, 2006).

4. Discussion

Although centrarchids, such as small mouth bass, have been indicated as predators of hardhead minnow, we have found no studies that indicate predation of hardhead by rainbow trout. Stocked rainbow trout are unlikely to be significant competitors, both by the nature of stocked trout and since they occupy biologically different niches in the stream. Optimal temperatures for rainbow trout are between 12-18 deg. Celsius; hardhead prefer water in excess of 20 deg. Celsius (Moyle 2002). The California Department of Fish and Game generally does not stock trout in streams or rivers that exceed 20 deg. Celsius. In riverine situations, hardhead tend to feed from the bottom third of the water column and prefer calmer waters, whereas rainbow trout tend to feed from riffles and the surface, in swifter waters. Peter Moyle described the niches and displays possible overlap in Inland Fishes of California. His conceptual model of feeding habits indicates both species utilize invertebrates (both aquatic and terrestrial) as a food source, and that "species in the assemblage show a high degree of segregation in their use of space and food." However, he does show a link of potential predation on juvenile hardhead by adult rainbow trout.

There is a substantial body of information on hardhead populations in both the upper and lower Kern River resulting from fish population monitoring studies by Southern California Edison as part of the re-licensing of their hydropower stations

In January 2009, the Central Valley Regional Water Quality Control Board proposed to identify the lower Kern River, Lake Isabella and the Upper Kern River as water quality impaired because they do not meet water quality standards for pH and dissolved oxygen. The impairment is stated as pH for the river segments and pH and dissolved oxygen for the lake (CRWQCB, 2009). Impacts to the fishery are unknown.

3. Fish Population Monitoring

Lower Kern River Fish Population Monitoring

The earliest fish population monitoring was done by CDFG between 1972 and 1974 in the lower Kern River from Isabella Reservoir to canal diversions in Oildale. This monitoring was in connection with a rotenone treatment by CDFG conducted in the entire reach to "control non-game fish" (CDFG, 1972). While hardhead and Sacramento pikeminnow were counted together, hardhead were indicated in the reports as present throughout the reach. After the rotenone treatment, dead fish were counted, and it was estimated that 3,353 lbs of hardhead and pikeminnow combined were killed (Mills, 1972). In the subsequent 1973 and 1975 fish population studies in the lower Kern River, the native fish populations apparently rebounded, and hardhead were documented as present in Sections 0 through 3 (Mills, 1973 and 1975).

Lower Kern River Fish population monitoring has been completed as required for relicensing for the PG&E Kern Canyon Powerhouse, SCE Kern River No. 1 Powerhouse (KR1) and SCE Borel Powerhouse. The report and summarized data for the KR1 studies conducted in 1999, 2000, 2001, 2002, 2003, 2004 and 2006 are in Appendix B. The surveys in the lower Kern do not show much change in the hardhead population over the period of the surveys. The sampling methodologies employed in the surveys are limited in their reflection of the true composition of the fish fauna, as highlighted by the absence of hitch in any of the sampling results. Hitch is known to be present, and is one of the popular fly fishing targets in the lower Kern River below Isabella Dam.

Isabella Reservoir

Hardhead have also been documented in Isabella Reservoir in small numbers during gill net sampling and shore seining in 1999 and 2000. They represented 1% of the total catch and ranged in size from 106-459 mm TL. Weight ranged from 11-1200 g (USFS unpublished data).

Upper Kern River Fish Population Monitoring

In studies by SCE conducted in 2006, four years after the McNalley Fire, fine sediment, primarily sand, was still prevalent throughout the study area. The Roads End electrofishing site, for example, in 1998 was composed of 60% boulder and 25% rubble. In 2006, the substrates at that site were 60% boulder and 20% sand. Hospital Flat showed an increase from zero to 2% silt and 15 to 48% sand in comparing the measurements between 2002 and 2006 (SCE 2006).

In the lower Kern River, another catastrophic event occurred in 2001, when Southern California Edison (SCE), in the course of maintenance operations at Democrat Dam, released roughly 272,000 cubic yards of sediment into the Kern River below the dam. Impacts to the fishery were devastating. In the aftermath, SCE was required to produce yearly sediment monitoring in the project reach. A sediment management plan was also developed to prevent future occurrences of this magnitude. A PowerPoint presentation summarizing the sediment monitoring to date and sediment management plan operations is in Appendix A.

The high sediment loads resulting from the McNalley Fire runoff and the Democrat Dam pond drain reduced habitat for both fish and the bottom-dwelling invertebrates upon which they feed. During and subsequent to those events, the interstitial spaces between larger substrates of cobble, boulder and bedrock became filled with fine sediment for a period of approximately 5-6 years before being flushed from the system in both the upper and lower river. The filling of riffle habitat likely impacted spawning and rearing success for all species of fish. Pools, runs and riffles were filled so deeply with fine sediment that cover for all species of fish was reduced to nearly nothing, and predation by birds and mammals effectively cleaned out the fish in the impacted reaches as the sediment moved downstream. High turbidity during the heavy runoff events also likely interfered with fish feeding success due to lack of water clarity.

Water Quality

While the impacts of sedimentation to fish populations in the Kern River have been well-documented, other possible stressors to the native fish populations are becoming apparent in 2009.

Water quality in the Kern River has been generally good historically. The river has usually been cold, low in turbidity and dissolved solids, and slightly alkaline. Water quality standards for the Kern River watershed are set by the State Water Resources Control Board. Water temperature should be no more than 5^{o} F above natural temperature of water. The level of dissolved oxygen in the water (cold water designation) should be 8 milligrams per liter or higher (CRWQCB, 1975). State standards for water quality parameters have been rarely exceeded during the spring runoff period. During the summer months, for the Kern River upstream of Isabella Reservoir, water temperature standards may be exceeded during low flow periods (Stephens et al. 1995).

Isabella Reservoir in 1985. That survey showed hardhead to be present in apparently stable numbers (Brown and Moyle, 1987).

There was only limited information about the distribution and habits of hardhead in the Kern River until fish population studies were completed as required for hydroelectric power plant relicensing over the past two decades. Statewide, the Department of Fish and Game considers the hardhead a "Species of Special Concern." Moyle, et al. (1989) places the hardhead in Class 3, which means "These are uncommon taxa occupying much of their natural range, formerly more abundant, but still with pockets of abundance within their range." Hardhead is also a USDA-Forest Service “sensitive” species.

2. Habitat Alterations in the Kern Watershed

Natural flow regimes in the Kern River through most of the stocked sections have been altered significantly since the early 20th century by hydroelectric impoundments and diversions, and the construction of Isabella Dam for flood control which impounded the Kern River in the early 1950s. Several catastrophic events have occurred within the last decade resulting in heavy sediment deposition into the Kern River both above and below Isabella Reservoir which have negatively impacted all of the biotic components of the river over an extended period.

Sedimentation and Turbidity

From July through September 2002, the McNalley Fire burned roughly 150,000 acres in the upper Kern River watershed from Roads End to well into the Golden Trout Wilderness. Prior to the McNalley Fire runoff, the upper Kern River was considered to be a large enough system that it was capable of carrying more sediment than was being delivered (SCE, 1991).

On November 8, 2002, a heavy rain event in the burned area delivered debris, ash, and mud into the Kern River on an unprecedented scale. The Johnsondale Weather Station recorded 16.4 inches of rain falling within a 3-day period in November 2002 (Myers and Greiss, 2002). Peak flows were measured at greater than 26,000cfs. A tremendous volume of sediment from ORV sites, roads, hiking trails and burned slopes in the burned area was washed into the river. The sediment buildup in the river was so severe that the Kern River Planting Base was taken offline for an extended period of nearly a year. The two generators at SCE’s KR3 Powerhouse remained online and sustained extensive damage during the period of high sediment flows and turbidity. One of the two generators was offline for a year and a half ending in February, 2009 as a result. The second is scheduled for a similar extensive rebuild in the fall of 2009 (Derek Tito, SCE hydrologist, personal communication, 2009).

Hardhead

Hardhead are native to the Sacramento and San Joaquin River systems, and evolved there in association with native rainbow trout. The species represent two different assemblages, and their association represents a transitional zone. The transitional zone may vary depending on water temperature, but there would be expected to be a portion of overlap for the two assemblages. They are a member of the minnow family (Cyprinidae), which can grow up to two feet in length. The genus exists in the fossil record since at least the Miocene period (Moyle, 2002). They are typically found in the more undisturbed sections of large streams at middle elevations, and are most abundant in warm, clear streams and rivers with large, deep pools with sandy bottoms (Moyle, 2002). They are classified as bottom browsers, feeding on small invertebrates and aquatic plants in quiet waters. Juvenile hardhead are primarily insectivorous and provide some forage for predatory species (Calhoun, 1966).

Hardhead have successfully co-existed with trout and other native fish species in the upper and lower Kern River both prior to and after the initiation of non-native hatchery-reared rainbow trout stocking. They have different habitat preferences than rainbow trout, occupying different locations within the stream. Adult hardhead are usually found in deeper pools and runs with slow velocities of 20-40 cm/sec. and sand, gravel or rock substrates. They tend to occupy the lower half of the water column, whereas trout prefer surface waters in swifter-flowing sections of the stream (Moyle, 2002). Their summer temperature preference range is 19-22°C, while trout prefer cooler water and avoid temperatures above 20°C. Hardhead are poor swimmers at low temperatures and so are unlikely to move upstream above barriers like rainbow trout (Moyle, 2002). In kinematic studies Myric documented that hardhead were found to prefer lower velocities than rainbow trout or Sacramento sucker (*Catostomus occidentalis*), and velocities greater than or equal to that preferred by Sacramento pikeminnow (*Ptychocheilus grandis*) (Myric). Although the early life history of hardhead is poorly known, in the Kern, juvenile hardhead have been observed congregating at the edges of streams among large cobble and boulders (Moyle, 2002). Along with trout, hardhead are good indicators of relatively undisturbed habitat, and are intolerant of low dissolved oxygen and turbidity. Both require complex habitat structure and good streambank vegetation.

While both Sacramento suckers and Sacramento pikeminnows extend upstream into the upper Kern River beyond Section 6, hardhead have not been observed above Johnsondale Bridge. Hardhead were found during 1989 and 1990 surveys of the Kern River from Southern California Edison Company (SCE) KR3 upstream to Goldledge Campground (SCE, 1991). While surveys conducted by Brown and Moyle in 1970 and 1985 showed that over its entire range the hardhead appears to have declined to a significant extent, the only survey they conducted in the Kern during that study was at 5 sites in the lower Kern below

retreat of the glaciers 10,000 years ago (Stephens et al, 1995). The main stem throughout most of the stocked sections and upstream to near the headwaters in Sequoia National Park was historically inhabited by the Kern River rainbow trout (*Oncorhynchus mykiss gilberti*). In its lower reaches, the Kern River continues to support the southernmost native populations in California of non-game fishes in the pikeminnow-hardhead-sucker assemblage, which extends at least throughout Sections 0 – 6 of the river. Other native species present include hitch (*lavinia exilicauda*), and possibly others.

Historical Distribution of Kern River Rainbow Trout

Prior to the initiation of hatchery-reared rainbow trout stocking, about 70 years ago, it is believed that the range of the native Kern River rainbow normally extended downstream at least into the lower reaches of Section 3. Ardis Walker, a Kern River Valley native, recalled that around 1900, Kern River rainbow trout occurred in the Kern River to well below the present site of Isabella Dam (Stephens et al, 1995). In another anecdotal reference, local rancher Frank Liebel stated that he was told by his mother that Kern River trout had been transplanted into upper Erskine Creek around 1900 from the Kern River near the mouth of Erskine Creek (Frank Liebel, personal communication).

In examinations of an archaeological site at the mouth of the Kern Canyon, no evidence was found of salmonid bones in any of the Native American kitchen middens, although other native fish bones were found (Dr. Ken Gobalet, California State University, Bakersfield, personal communication), indicating that salmonids were not present in that portion of the river for thousands of years. It is know that in the Kern River Valley in the area of present-day Lake Isabella, local Native Americans utilized all the species of fish present as a food source, including rainbow trout.

In 1927, a fish hatchery was established near Kernville, and nonnative rainbow trout were reared to plant in nearby waters to supplement natural populations to meet the needs of an increasing recreational fishing public. Hatchery-reared rainbow trout hybridized with and eventually completely displaced the native Kern River rainbow in the stocked sections of the river.

Currently, genetic studies are underway at the University of California at Davis to try to identify extant populations of native Kern River rainbow trout in the basin. Upon expected completion of the study in 2009, the hatchery at Kernville will begin the process of establishing a Kern River rainbow trout broodstock in order to eventually rear and stock a trout strain that is as close to native to the Kern River basin as possible.

Introduction

In a November 24, 2008 court order, the California Department of Fish and Game (CDFG) was temporarily ordered to stop stocking non-native hatchery-reared trout in many rivers and lakes in California. This action was the result of a lawsuit brought by the Center for Biological Diversity (CBD) and the Pacific Rivers Council (PRC) against the DFG alleging that the stocking of hatchery trout has a "significant environmental impact on native species." The CDFG had been ordered to conduct an Environmental Impact Report (EIR) under the California Environmental Quality Act (CEQA) by the end of 2008. Because the CDFG told the court that the EIR would not be completed until January 2010, the court ordered the CDFG to work with CBD and PRC to negotiate an agreement by November, 24, 2008 where stocking would be allowed to take place until completion of the EIR.

The plaintiffs had a list of 25 species which, if present, they would not agree to the stocking of trout. The main stem Kern River above and below Isabella Reservoir (sections 0-6, Table 1) was included in the list of waters where stocking would not be allowed because it contains one of the native species on the list, hardhead minnow (*Mylopharodon conocephalus*). Although it also contains hardhead, stocking will still be allowed in Isabella Reservoir, because reservoirs over 1000 acres were exempted from the ban.

Section	Description	Stocked*
0	Below Kern River No. 1 Powerhouse (KR1)	no
1	KR1 to Democrat Dam	yes
2	Democrat Dam to Borel Powerhouse (Sandy Flat)	yes
3	Borel Powerhouse (Keyesville Bridge) to Main Dam	no
4	Lake Isabella (Riverside Park, Kernville) to Kern River No.3 Powerhouse (KR3)	yes
5	KR3 to Fairview Dam	yes
6	Fairview Dam to Johnsondale Bridge	yes
7	Above Johnsondale Bridge	no

* Sections stocked prior to the Nov. 24 court order.

Table 1. Kern River Planting Sections

1. Hardhead and Rainbow Trout in the Kern River

The Kern River is unique in that it is the southernmost river in the Sierra Nevada Mountains, and its native trout species have been isolated from anadromous stocks for thousands of years. Natural barriers and uninhabitable conditions, particularly warm water and limited oxygen, in the lowermost reaches prevented salmonids from entering or exiting the river in the drying period following the

Hardhead and Trout in the Kern River

February 27, 2009

by

Christine L. McGuire
Associate Biologist
California Department of Fish and Game
P.O. Box 1908, Kernville, CA 93238
cmcguire@dfg.ca.gov