State of California
The Resources Agency
Department of Water Resources

STURGEON DISTRIBUTION AND HABITAT USE: ADDENDUM INCLUDING OTHER FISHES IN THE LOWER FEATHER RIVER SP-F3.2 TASK 3A

Oroville Facilities Relicensing
FERC Project No. 2100

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REPORT SUMMARY

The goal of SP-F3.2 Task 3A was to determine the distribution, spawning locations and timing, habitat usage, residence time, and emigration patterns of sturgeon in the lower Feather River. Sampling by angling and fyke trapping was unsuccessful at capturing any sturgeon for the planned radio telemetry study. However, several sturgeon were seen breaching downstream of Shanghai Bend from June 1-10, 2004. Flows at this time ranged from 3,691-5,577 cfs. While flows above 5,100 cfs seemed unlikely to have prevented passage, more information is needed on sturgeon swimming ability before this issue can be determined. Based on the size of the individuals seen and the leaping behaviors observed, it is possible that spawning may have occurred downstream of Shanghai Bend. This area was comparable with other known sturgeon spawning habitats given that it consisted of deep, high velocity waters. However, water temperatures, averaging between 66.6°F (19.2°C) and 71.4°F (21.9˚C), were warmer than preferred temperatures indicated by the literature for spawning sturgeon.

The fyke trap used in the 2004 study season and the egg and larval survey during the 2003 season did not capture any sturgeon, but other fishes were captured and general distribution for these species (striped bass, shad, salmonids, minnows, sculpin, bass, etc.) is presented in this report.

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1.0 INTRODUCTION

The Oroville Dam and its associated facilities prevent sturgeon migration to the upper Feather River and so it is important to evaluate the suitability of spawning and holding areas downstream of the Oroville Dam facilities. As a result, this study was initiated to help identify how operation of the Oroville Facilities may impact sturgeon in the lower Feather River through its effects on flow, temperature and habitat. This report covers the extension of the radio tagging and tracking component for sturgeon into the 2004 field season. The objectives of this study are to 1) define sturgeon spawning and rearing distribution and timing; 2) relate habitat usage to environmental variables and 3) provide data to evaluate management decisions concerning future monitoring programs, operational changes of the dam and/or habitat enhancement within the lower Feather River. In addition, data gathered on other fishes in the course of this study will be provided.

1.1 BACKGROUND INFORMATION

Green sturgeon are anadromous fish that spawn in rivers on the west coast, but spend most of their life in estuarine and marine environments, ranging geographically from southern Alaska to Mexico (Beamesderfer and Webb 2002). Most of the adult lifestage is spent in the ocean, and adults may undergo long migrations (Beamesderfer and Webb 2002). Adult green sturgeon females are generally mature by age 20-25 years (6-7 feet in length), while males mature at approximately 15-17 years (5-6 feet in length) (Beamesderfer and Webb 2002). Although little information on green sturgeon life history and habitat requirements exists, adult green sturgeon appear to migrate upstream into freshwater beginning in the latter part of February and, in the Sacramento River, may continue migrating as far as 200 miles upstream before spawning (Beamesderfer and Webb 2002). Adult white sturgeon migrate into the Sacramento River beginning in October (USFWS 1995). On the Rogue River in Oregon, green sturgeon holding sites were typically deeper than 5 meters, with in-river residence time ranging upwards of 6 months (Grimaldo and Zeug 2001; Erickson et al. 2002). Green sturgeon prefer spawning temperatures between 50-63°F (10-17.2°C) (pers. comm., Doroshov 2001) and white sturgeon between 46.4-66.2°F (8-19°C) (Moyle 2002).

In areas outside of the Central Valley, sturgeon spawn over rocks, compact clay substrates, or large gravels at depths of approximately 30 feet with water velocities ranging from 5-10 feet per second (fps), while Central Valley sturgeon have been observed using gravel, rubble or soft-bottom stream reaches for spawning (USFWS 1995). Although most white sturgeon spawning occurs in March and April, spawning may begin as early as February and may continue into June (USFWS 1995). Spawning can be indicated by breaching/leaping behavior (Moyle 2002). Sexual maturity is reached at around 29.5-41.3 in (75-105 cm) in male white sturgeon and 37.4-53.1 in (95-135 cm) in female white sturgeon, whereas green sturgeon mature around 51.1-59.1 in (130-150 cm) (Moyle 2002). Sturgeon eggs have been found in the Sacramento

River from mid-February through late May (Kohlhorst 1976). Juveniles may spend 1 to 4 years in freshwater and estuarine environments before entering saltwater habitats (Beamesderfer and Webb 2002).

To develop restoration recommendations for sturgeon, USFWS (1995) collected the following information about the Feather River drainage system. Sturgeon are known to migrate into the Feather River, but detailed information regarding their migratory behavior and reproduction is limited. In the mid-70s to early 80s, adult green sturgeon were angled in the lower Feather River each year, with the majority of catches occurring from March to May and a few additional catches occurring in July and August. In 1993, adult green sturgeon were angled at the Thermalito Afterbay Outlet. Angling data indicate that most green and white sturgeon spawning in the Feather River occurs from March through May. Spawning locations for green sturgeon in the Feather River are unknown, but it has been suggested that spawning may be limited to areas just downstream of the Thermalito Afterbay Outlet. Based on angler catch rates, spawning has been suggested to occur downstream of the Thermalito Afterbay Outlet at River Mile 59 and Gridley Bridge at River Mile 50.75.

1.1.1 Statutory/Regulatory Requirements

Section 4.51(f)(3) of 18 CFR requires reporting of certain types of information in the FERC Application for License for major hydropower projects, including a discussion of the fish, wildlife and botanical resources in the vicinity of the project. The discussion needs to identify the potential impacts of the project on these resources, including a description of any anticipated continuing impact for on-going and future operation of the project. In addition to helping fulfill these requirements, information developed in this study plan also may be used in determining appropriate protection, mitigation and enhancement (PM&E) measures.

1.1.2 Study Area

1.1.2.1 Description

Field activities for the sturgeon radio telemetry study occurred from the Fish Barrier Dam downstream to the confluence of the Sacramento and Feather rivers at Verona (Figure 1.1.2.1-1). Angling for sturgeon occurred from Verona upstream to Star Bend, at Shanghai Bend upstream to the mouth of the Yuba River, and at Sunset Pumps. A fyke trap was deployed at two different locations: 1) four miles downstream of the Star Bend Boat Ramp (RM 13.8) from January 6-June 9, 2004 and 2) a half mile below Sunset Pumps (RM 38) from June 12-August 9, 2004. The egg and larval surveys took place in 2003 at Eye Pool (RM 60), Big Hole Islands (57.8), and Shanghai Bend (24.3).

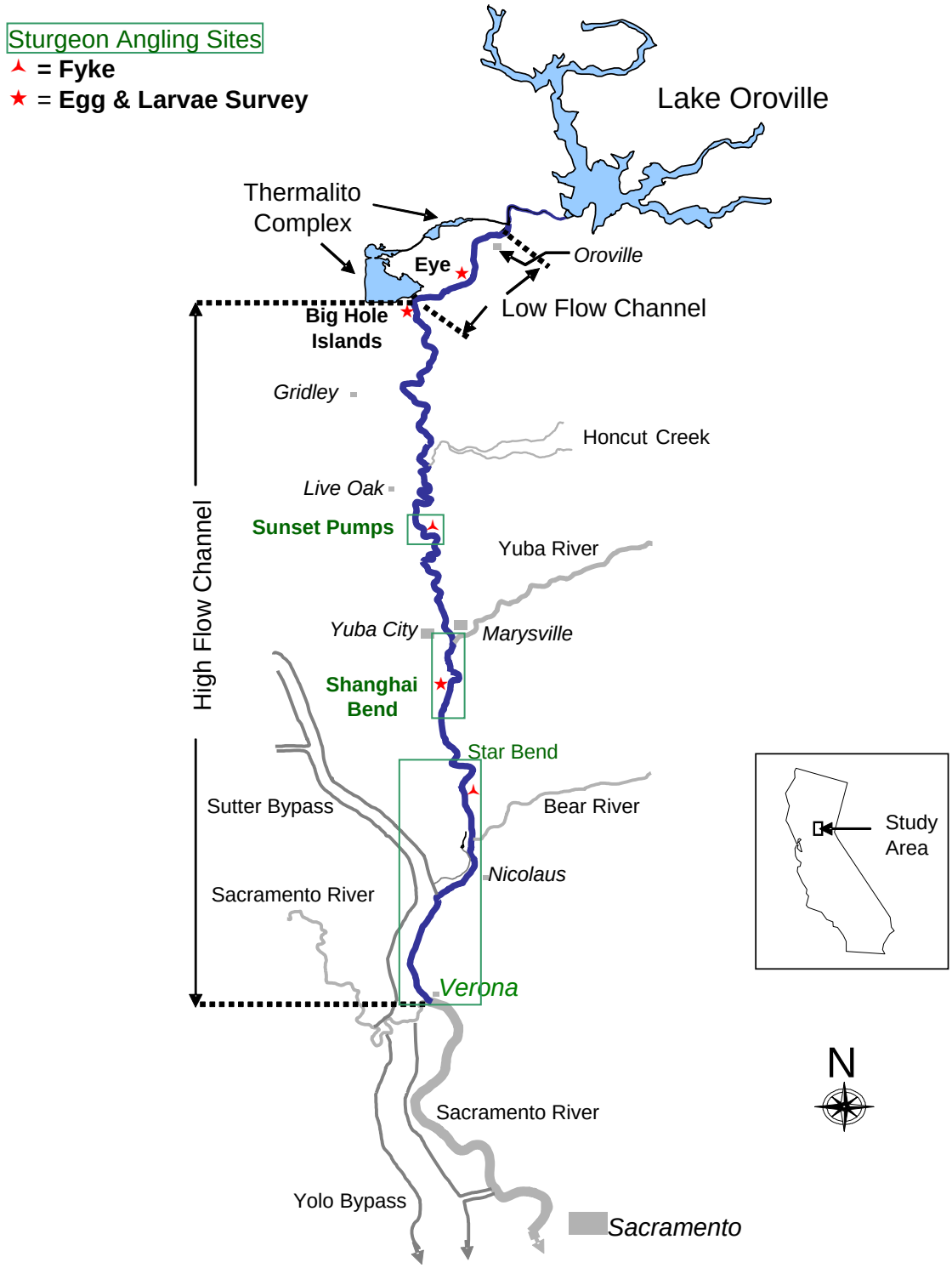

Figure 1.1.2.1-1. Sturgeon angling, fyke trap, and egg and larval sites.

1.1.2.2 History

No studies of adult sturgeon have been conducted in the Feather River. In 1973, efforts to sample larval sturgeon at the mouth of the river were unsuccessful (USFWS 1995). In 2000 and 2001, the Department of Fish and Game sampled for sturgeon eggs and larvae near Shanghai Bend, the Thermalito Afterbay Outlet (Outlet), and near boat ramps at Gridley Bridge, Live Oak and Boyd's Landing (Schaffter and Kolhorst 2001). A small white sturgeon was observed. The researchers concluded that while the methods used were successful in sampling white sturgeon in the Sacramento River, they were likely ineffective for green sturgeon. Since green sturgeon eggs exhibit poor adhesion (Van Eenennaam et al. 2001), the probability of capture using an artificial substrate composed of latex-coated animal hair (McCabe and Beckman 1990; Schaffter 1997) is likely poor. Larval nets have also proven ineffective, apparently due to lack of swim-up behavior and the limited activity typical of green sturgeon larvae (Van Eenennaam et al. 2001).

1.2 DESCRIPTION OF FACILITIES

The Oroville Facilities were developed as part of the State Water Project (SWP), a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. The Oroville Facilities are also operated for flood management, power generation, to improve water quality in the Delta, provide recreation, and enhance fish and wildlife.

FERC Project No. 2100 encompasses 41,100 acres and includes Oroville Dam and Reservoir, three power plants (Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Oroville Wildlife Area (OWA), Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, and transmission lines, as well as a number of recreational facilities. An overview of these facilities is provided on Figure 1.2-1. The Oroville Dam, along with two small saddle dams, impounds Lake Oroville, a 3.5-million-acre-feet (maf) capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level.

The hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts (MW). The Hyatt Pumping-Generating Plant is the largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream of Oroville Dam. The plant has a generating and pumping flow capacity of 16,950 cfs and

5,610 cfs, respectively. Other generation facilities include the 3-MW Thermalito Diversion Dam Power Plant and the 114-MW Thermalito Pumping-Generating Plant.

Thermalito Diversion Dam, four miles downstream of the Oroville Dam creates a tail water pool for the Hyatt Pumping-Generating Plant and is used to divert water to the Thermalito Power Canal. The Thermalito Diversion Dam Power Plant is a 3-MW power plant located on the left abutment of the Diversion Dam. The power plant releases a maximum of 615 cubic feet per second (cfs) of water into the river.

The Power Canal is a 10,000-foot-long channel designed to convey generating flows of 16,900 cfs to the Thermalito Forebay and pump-back flows to the Hyatt Pumping-Generating Plant. The Thermalito Forebay is an off-stream regulating reservoir for the 114-MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant is designed to operate in tandem with the Hyatt Pumping-Generating Plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into the Thermalito Afterbay, which is contained by a 42,000-foot-long earth-fill dam. The Afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. Several local irrigation districts receive water from the Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the Afterbay outlet, and provides attraction flow for the hatchery. The hatchery was intended to compensate for spawning grounds lost to returning salmon and steelhead trout from the construction of Oroville Dam. The hatchery can accommodate 15,000 to 20,000 adult fish annually.

The Oroville Facilities support a wide variety of recreational opportunities. They include: boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating sites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment. There are major recreation facilities at Loafer Creek, Bidwell Canyon, the Spillway, North and South Thermalito Forebay, and Lime Saddle. Lake Oroville has two full-service marinas, five car-top boat launch ramps, ten floating campsites, and seven dispersed floating toilets. There are also recreation facilities at the Visitor Center and the OWA.

The OWA comprises approximately 11,000-acres west of Oroville that is managed for wildlife habitat and recreational activities. It includes the Thermalito Afterbay and surrounding lands (approximately 6,000 acres) along with 5,000 acres adjoining the

Feather River. The 5,000 acre area straddles 12 miles of the Feather River, which includes willow and cottonwood lined ponds, islands, and channels. Recreation areas include dispersed recreation (hunting, fishing, and bird watching), plus recreation at developed sites, including Monument Hill day use area, model airplane grounds, three boat launches on the Afterbay and two on the river, and two primitive camping areas. California Department of Fish and Game's (DFG) habitat enhancement program includes a wood duck nest-box program and dry land farming for nesting cover and improved wildlife forage. Limited gravel extraction also occurs in a number of locations.

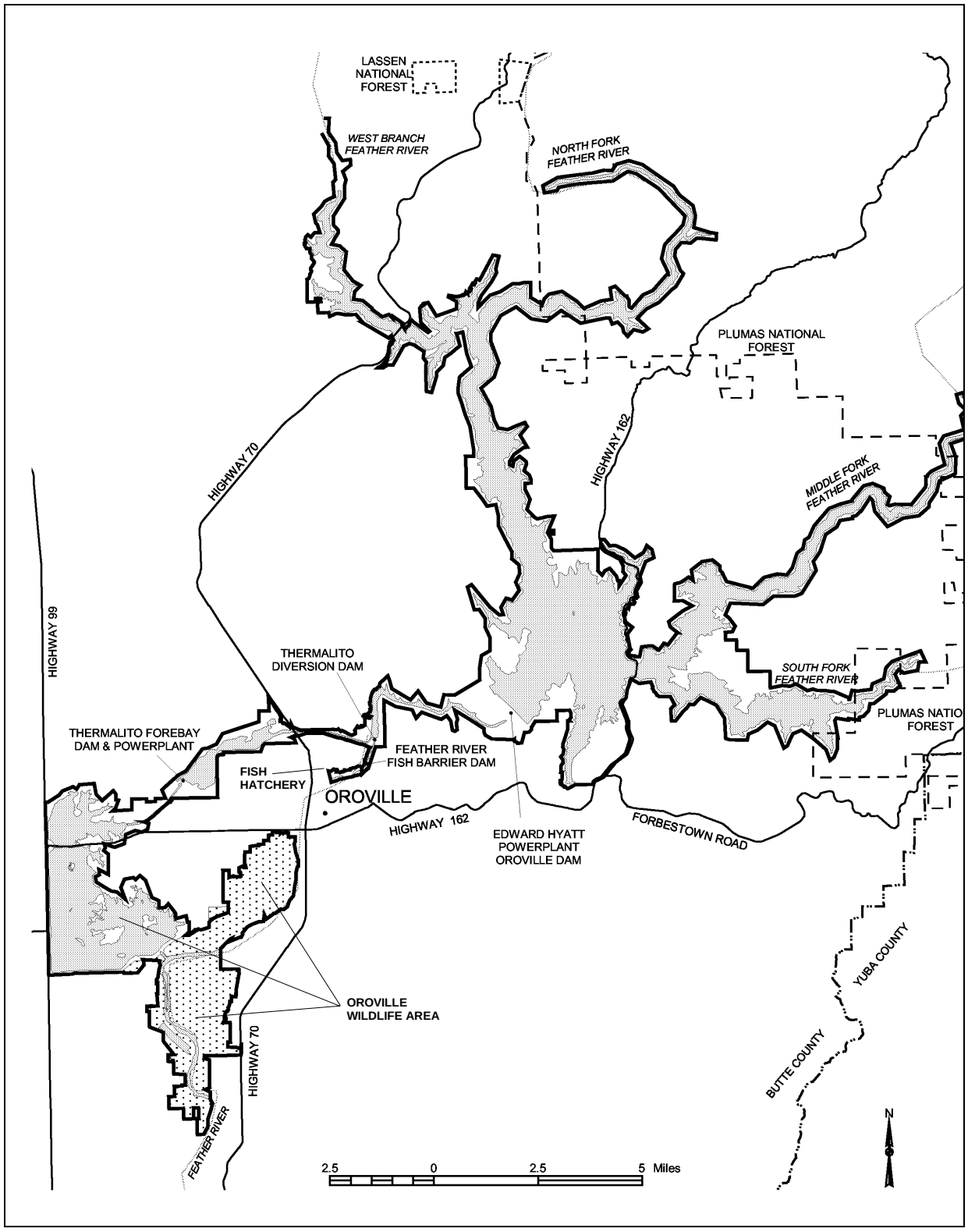

Figure 1.2-1. Oroville Facilities FERC Project Boundary

1.3 CURRENT OPERATIONAL CONSTRAINTS

Operation of the Oroville Facilities varies seasonally, weekly and hourly, depending on hydrology and the objectives DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversion and water quality. Lake Oroville stores winter and spring runoff for release to the Feather River as necessary for project purposes. Meeting the water supply objectives of the SWP has always been the primary consideration for determining Oroville Facilities operation (within the regulatory constraints specified for flood control, in-stream fisheries, and downstream uses). Power production is scheduled within the boundaries specified by the water operations criteria noted above. Annual operations planning is conducted for multi-year carry over. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. Currently, that level has been established at 1,000,000 acre-feet (af); however, this does not limit draw down of the reservoir below that level. If hydrology is drier than expected or requirements greater than expected, additional water would be released from Lake Oroville. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet above mean sea level (msl) in June and then can be lowered as necessary to meet downstream requirements, to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired levels the following spring. Project operations are directly constrained by downstream operational constraints and flood management criteria as described below.

1.3.1 Downstream Operation

An August 1983 agreement between DWR and DFG entitled, “Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife,” sets criteria and objectives for flow and temperatures in the low flow channel and the reach of the Feather River between Thermalito Afterbay and Verona. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona which vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.; (3) requires flow stability during the peak of the fall-run Chinook spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass.

1.3.1.1 Instream Flow Requirements

The Oroville Facilities are operated to meet minimum flows in the Lower Feather River as established by the 1983 agreement (see above). The agreement specifies that Oroville Facilities release a minimum of 600 cfs into the Feather River from the

Thermalito Diversion Dam for fisheries purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline.

Generally, the instream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. However, if runoff for the previous April through July period is less than 1,942,000 af (i.e., the 1911-1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs from October to February, and 1,000 cfs for March. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become de-watered.

1.3.1.2 Temperature Requirements

The Diversion Pool provides the water supply for the Feather River Fish Hatchery. The hatchery objectives are 52°F for September, 51°F for October and November, 55°F for December through March, 51°F for April through May 15, 55°F for last half of May, 56°F for June 1-15, 60°F for June 16 through August 15, and 58°F for August 16-31. A temperature range of plus or minus 4°F is allowed for objectives, April through November.

There are several temperature objectives for the Feather River downstream of the Afterbay Outlet. During the fall months, after September 15, the temperatures must be suitable for fall-run Chinook. From May through August, they must be suitable for shad, striped bass, and other warmwater fish.

The National Marine Fisheries Service has also established an explicit criterion for steelhead trout and spring-run Chinook salmon. Memorialized in a biological opinion on the effects of the Central Valley Project and SWP on Central Valley spring-run Chinook and steelhead as a reasonable and prudent measure; DWR is required to control water temperature at Feather River mile 61.6 (Robinson's Riffle in the low-flow channel) from June 1 through September 30. This measure requires water temperatures less than or equal to 65°F on a daily average. The requirement is not intended to preclude pump-back operations at the Oroville Facilities needed to assist the State of California with supplying energy during periods when the California ISO anticipates a Stage 2 or higher alert.

The hatchery and river water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Under existing agreements, DWR provides water for the Feather River Service Area (FRSA) contractors. The contractors claim a need for warmer water during spring and summer for rice germination and growth (i.e., 65°F from approximately April through mid May, and 59°F during the remainder of the growing season). There is no obligation for DWR to meet the rice

water temperature goals. However, to the extent practical, DWR does use its operational flexibility to accommodate the FRSA contractor's temperature goals.

1.3.1.3 Water Diversions

Monthly irrigation diversions of up to 190,000 (July 2002) af are made from the Thermalito Complex during the May through August irrigation season. Total annual entitlement of the Butte and Sutter County agricultural users is approximately 1 maf. After meeting these local demands, flows into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. In the northwestern portion of the Delta, water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct.

1.3.1.4 Water Quality

Flows through the Delta are maintained to meet Bay-Delta water quality standards arising from DWR's water rights permits. These standards are designed to meet several water quality objectives such as salinity, Delta outflow, river flows, and export limits. The purpose of these objectives is to attain the highest water quality, which is reasonable, considering all demands being made on the Bay-Delta waters. In particular, they protect a wide range of fish and wildlife including Chinook salmon, Delta smelt, striped bass, and the habitat of estuarine-dependent species.

1.3.2 Flood Management

The Oroville Facilities are an integral component of the flood management system for the Sacramento Valley. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers (USACE). Under these requirements, Lake Oroville is operated to maintain up to 750,000 af of storage space to allow for the capture of significant inflows. Flood control releases are based on the release schedule in the flood control diagram or the emergency spillway release diagram prepared by the USACE, whichever requires the greater release. Decisions regarding such releases are made in consultation with the USACE.

The flood control requirements are designed for multiple use of reservoir space. During times when flood management space is not required to accomplish flood management objectives, the reservoir space can be used for storing water. From October through March, the maximum allowable storage limit (point at which specific flood release would have to be made) varies from about 2.8 to 3.2 maf to ensure adequate space in Lake Oroville to handle flood flows. The actual encroachment demarcation is based on a wetness index, computed from accumulated basin precipitation. This allows higher levels in the reservoir when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high in the basin (i.e., wetness in the

watershed above Lake Oroville), the flood management space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the flooding potential decreases, which allows capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season. During flood events, actual storage may encroach into the flood reservation zone to prevent or minimize downstream flooding along the Feather River.

2.0 NEED FOR STUDY

This study is needed because project operations influence flow rates, river stage, habitat availability, water temperature and other factors contributing to the success of sturgeon populations within the study area. Changes in river stage can change the availability of habitat for spawning and rearing, therefore affecting spawning and rearing success and subsequent year-class strength. Project operations may affect the distribution of Feather River sturgeon, change the availability and quality of habitat, and change the magnitude, frequency and timing of flow and water temperatures in the Feather River, thus potentially influencing migration and emigration timing as well as egg and juvenile development. Therefore, this study is necessary to evaluate potential project impacts on sturgeon and their habitat in the Feather River downstream of the Fish Barrier Dam.

3.0 STUDY OBJECTIVE(S)

Little information exists regarding either green or white sturgeon in the Feather River (USFWS 1995) and therefore specific field studies designed to provide additional information on green sturgeon distribution and habitat characteristics were proposed in Task 3A. The study objective was to gather baseline information about sturgeon life history, distribution and habitat use in the lower Feather River and to evaluate potential project effects on sturgeon habitat within the study area. Since previous efforts were not successful at obtaining sturgeon, an additional year of the telemetry component of the study was conducted.

4.0 METHODOLOGY

4.1 STUDY DESIGN

Radio telemetry was to be used in the lower Feather River to determine sturgeon pre-spawning habitat use, spawning locations and timing, the upstream extent of green sturgeon migration, post-spawning habitat use, residence time, and emigration patterns.

4.2 METHODS

4.2.1 Angling

Angling efforts to catch sturgeon for radio telemetry began in February and were guided by Craig Smith of Craig Smith Fishing Guide Service. Two anglers fished from Verona upstream to Sunset Pumps for a total of 207 angler hours during the 2004 study season (Table 4.2.1-1). Salmon roe, pile worms, ghost shrimp, eel, sardine and crawdads were used as bait. Angling effort was increased during June when sturgeon were spotted breaching.

Table 4.2.1-1. Location and effort of 2004 sturgeon angling.

Month	Angler Hours	General Location
February	24	Star Bend (RM 18.8)
March	12	Mouth of Bear River (RM 11.8)
	13	Verona (RM 0)
	14	Sunset Pumps (RM 38)
June	108	Shanghai Bend (RM 25)
July	12	Shanghai Bend
	24	Sunset Pumps
Total	207	

4.2.2 Fyke Trap

A 3-m diameter fyke trap was deployed approximately four miles downstream of Star Bend Boat Ramp (13.8) from January 6 - June 9 and approximately two miles downstream of Sunset Pumps (RM 36.7) from June 12 - August 9. The fyke was checked every 1-3 days depending on the amount of fish captured. All fish species were identified and measured to the nearest centimeter. In conjunction with SP-F10 Task 1E, any Chinook salmon captured were radio-tagged.

4.2.3 Larval Drift Nets (Update to Study Conducted in 2003)

Larval sampling was conducted three times a week at night from February 24 through August 21, 2003 using both a surface and a benthic conical drift net. Collections took place once every week at each of the following locations: 1) in the Low Flow Channel (LFC) at Eye Pool; 2) in the High Flow Channel (HFC) at Big Hole Islands approximately one mile below the Thermalito Afterbay Outlet and; 3) in the HFC downstream of Shanghai Bend.

Each site had a plume of water that flowed into a pool of water. The nets were deployed on the fringe of the plume in a high flow area that would not cause backwash in the nets. One to two sets were made each night with both nets fished simultaneously between the two hours before sunrise. Each set was deployed from a boat and held stationary for approximately 20-40 minutes depending on debris build-up.

The surface net, constructed of 505 µm mesh with a round-mouthed opening of 0.5 m^2, was attached to a 3-m pole that held the mouth opening below the surface of the water off the side of the boat. The benthic net, constructed of 1200 µm square polyester mesh with a square-mouthed opening of 1.5 m^2, was fished off the back of the boat. The net was attached to a weighted, galvanized iron frame that placed the bottom of the mouth opening approximately 5 cm above the substrate. A YSI 85 multi-parameter instrument was used to measure surface and bottom temperature, dissolved oxygen and conductivity. Samples were preserved in 10% formalin containing Rose Bengal and sorted in the lab.

5.0 STUDY RESULTS AND DISCUSSION

5.1 ANGLING

No adult sturgeon were caught during the 207 hours of fishing effort. However, during our angling attempts, sturgeon were spotted breaching below Shanghai Bend from June 1 through June 10. During this period of time, average daily flows ranged from 3,691-5,577 cfs. It is uncertain if the sturgeon seen at Shanghai Bend preferred this site or were unable to pass. Flows at ~5,100 cfs (assessed by B. Cavallo [DWR] and A. Seesholtz [DWR] on June 10, 2004) seemed to alleviate the majority of obstacles found in this area since the side channel was fairly inundated and the falls in the main channel ranged from less than 1.0 ft (0.3 m) high on river right to complete submersion on river left in the area with the high-velocity chute described in DWR (2003a). However, more information is needed on sturgeon swimming ability before passage issues can be determined.

During the observations of breaching sturgeon, one individual was identified as a green sturgeon while all the others that could be seen well enough were identified as white sturgeon. The identification differences of the green and white sturgeon were based on gross morphological differences between that two species which included rostrum shape, scute size and shape, and body coloration. One white sturgeon leapt completely out of the water and was estimated to be approximately eight feet long. A sturgeon carcass found at Boyd's Landing Boat Ramp (RM 23) was genetically identified as a white sturgeon (Beamesderfer et al. 2004).

While unconfirmed, it is possible that spawning may have occurred downstream of Shanghai Bend based upon the sizes of the individuals seen and the breaching behavior displayed by the sturgeon. This area was comparable with other documented sturgeon spawning habitat in that it consisted of deep, high velocity waters. Depth ranged from 6-22 feet. Mixed substrates of compact clay, sand, gravel and small rocks (2-6 inches) were observed. However, during the time the breaching behavior was observed, average daily temperatures of 66.6-71.4°F (19.2-21.9˚C) were recorded which are warmer than preferred spawning temperatures indicated by the literature.

5.2 FYKE TRAP

No sturgeon were captured in the fyke trap at the Star Bend or Sunset Pumps sites. Striped bass *Morone saxatilis*, channel catfish *Ictalurus punctatus*, common carp *Cyprinus carpio*, American shad *Alosa sapidissima*, and smallmouth bass *Micropterus dolomieu* were found at both fyke locations, although they were more abundant at Star Bend with the exception of smallmouth bass (Table 5.2-1). Over half of the striped bass sampled (N=75) were caught April 8 below Star Bend. Sacramento sucker *Catostomus occidentalis*, Sacramento pikeminnow *Ptychocheilus grandis*, hitch *Lavinia exilicauda*,

largemouth bass *Micropterus salmoides* and steelhead *Oncorhynchus mykiss* were captured only at Star Bend, while Chinook salmon *O. tshawytscha* were only captured at the Sunset Pumps (Table 5.2-1).

Table 5.2-1. Summary of species caught by location during January-August, 2004 in the fyke trap survey. Bold font indicates a native species.

Common Name	*Scientific Name*	Star Bend, RM 13.8 (Size range in cm)	Sunset Pumps, RM 36.7 (Size range in cm)	Total
Striped bass	*Morone saxatilis*	140 (30-100)	8 (42-69)	148
Channel catfish	*Ictularus punctatus*	17 (33.5-63)	3 (47-63)	20
Common carp	*Cyprinus carpio*	14 (26-70.5)	1 (66)	15
Sacramento sucker	***Catostomus occidentalis***	13 (44-65)	*	13
American shad	*Alosa sapidissima*	6 (36-44)	1 (31)	7
Smallmouth bass	*Micropterus dolomieu*	2 (35-41)	4 (36-43)	6
Chinook salmon	***Oncorhynchus tshawytscha***	*	6 (66-104)	6
Sacramento pikeminnow	***Ptychocheilus grandis***	2 (59-65)	*	2
Hitch	***Lavinia exilicauda***	1 (38)	*	1
Largemouth bass	*Micropterus salmoides*	1 (35.5)	*	1
Steelhead (clipped)	***Oncorhynchus mykiss***	1 (45)	*	1
	Total	177	23	220

5.3 EGG AND LARVAL SURVEYS (UPDATE TO STUDY CONDUCTED IN 2003)

No sturgeon eggs or larvae were identified in the 288 drift samples taken during the 2003 sampling season [see Methods and Results in DWR (2003b)]. Nonetheless, as stated in DWR (2003b), specimens sampled during the larval study needed to be identified to family and if possible species and would be reported at a latter date. This data, summarized in Table 5.3-1, indicates that sculpin *Cottus spp.*, Sacramento suckers and wakasagi *Hypomesus transpacificus* were the most abundant larval fish species. The majority of cyprinids, such as Sacramento pikeminnow, hardhead *Mylopharodon conocephalus*, California roach *Lavinia symmetricus* and common carp, were found in the LFC except for splittail *Pogonichthys macrolepidotus*. Splittail larvae (~8 mm) were sampled on April 14 and again on April 28 which indicates at least one if not two spawning events occurred upstream of the Shanghai Bend sampling site. American shad eggs and larvae were found in both the LFC and HFC, but abundance was the highest at the most downstream site.

Table 5.3-1. Summary of species caught by location in drift nets during the February-August, 2003 egg and larval survey. Bold font indicates a native species.

Common name	*Scientific name*	Eye Riffle (RM 60)	Big Hole Islands (RM 57.8)	Shanghai Bend (RM 24.3)	Total
Sculpin spp.	***Cottus spp.***	172	914	1	1087
Sacramento sucker	***Catostomus occidentalis***	211	297	378	886
American shad eggs		7	272	586	865
Wakasagi	*Hypomesus nipponensis*	12	791	3	806
Unidentified egg		50	36	360	446
Chinook salmon	***Oncorhynchus tshawytscha***	5	27	8	40
Sacramento pikeminnow	***Ptychocheilus grandis***	28	6	2	36
American shad	*Alosa sapidissima*	*	1	18	19
Sculpin eggs		*	5	*	5
California roach	***Lavinia symmetricus***	3	*	*	3
Splittail	***Pogonichthys macrolepidotus***	*	*	3	3
Common carp	*Cyprinus carpio*	2	*	*	2
Hardhead	***Mylopharodon conocephalus***	2	*	*	2
Largemouth bass	*Micropterus salmoides*	*	*	2	2
Threadfin shad	*Dorosoma petenense*	1	1	*	2
Pacific lamprey	***Lampetra tridentata***	*	1	*	1
Steelhead	***Oncorhynchus mykiss***	1	*	*	1
Tule perch	***Hysterocarpus traski***	*	1	*	1
	Total	494	2352	1361	4207

6.0 CONCLUSION

Despite extensive sampling effort, we were unable to collect sufficient data that would allow us to evaluate project effects on adult sturgeon. However, the breaching/leaping behaviors exhibited and the sizes of the individuals seen below Shanghai Bend suggest that sturgeon may potentially use the lower Feather River for spawning. It is uncertain if the sturgeon seen at Shanghai Bend preferred this site or were unable to pass due to low flows. More information is needed on sturgeon swimming ability before passage issues can be determined.

7.0 REFERENCES

Beamesderfer, R. C. P. and M. A. H. Webb. 2002. Green Sturgeon Status Review Information.

Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on green sturgeon occurrence in the Sacramento and San Joaquin Rivers and tributaries. Report by S. P. Cramer & Associates to State Water Contractors, Sacramento, CA.

Doroshov, S. I. Professor. University of California at Davis. Speaker at the IEP Resident Fish Project Work Team Hosted Meeting on Green Sturgeon; August 30, 2001.

DWR. 2003a. Final assessment of potential sturgeon passage impediments, SP-F3.2 Task 3A. Prepared for DWR under the direction of SWRI. Sacramento, California. September 2003.

DWR. 2003b. Final assessment of sturgeon distribution and habitat use, SP-F3.2 Task 3A. Oroville Facilities Relicensing FERC Project No. 2100. Sacramento, California. December 15, 2003.

Erickson, D. L., J. A. North, J. E. Hightower, J. Weber and L. Lauck. 2002. Movement and habitat use of green sturgeon *Acipenser medirostris* in the Rogue River, Oregon, USA. Journal of Applied Ichthyology 18: 565-569.

Grimaldo, L. and S. Zeug. 2001. IEP Resident Fish Project Work Team Hosts Meeting on Green Sturgeon. Interagency Ecological Program (IEP) for the San Francisco Estuary Newsletter 14: (4) 19-23. Available at: http://iep.water.ca.gov/report/newsletter/2001fall/IEPNewsletterFall2001.pdf

Kohlhorst, D. W. 1976. Sturgeon spawning in the Sacramento River in 1973, as determined by distribution of larvae. California Fish and Game 62: 32-40.

McCabe, G. T. and L. G. Beckman. 1990. Use of an artificial substrate sampler to collect white sturgeon eggs. California Fish and Game 76: 248-250.

Moyle, P. B. 2002. Inland Fishes of California, 2nd Edition. University of California Press, Berkeley, California.

Schaffter, R. G. 1997. White sturgeon spawning migrations and location of spawning habitat in the Sacramento River, California. California Fish and Game 83: 1-20.

Schaffter, R. G. and D. W. Kohlhorst. 2001. Final report for phase 2, Task 5: determination of green sturgeon spawning habitats and their environmental conditions. Final report submitted to CALFED, Sacramento, California.

USFWS. 1995. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volume 3. May 5, 1995. Prepared for USFWS under the direction of the Anadromous Fish Restoration Program Core Group. Stockton, California.

Van Eenennaam, J.P., M. A. H. Webb, X. Deng, S. I. Doroshov, R. B. Mayfield, J. J. Cech, Jr., D. C. Hillemeier and T. E. Willson. 2001. Artificial spawning and larval rearing of Klamath River green sturgeon. Transactions of the American Fisheries Society 130:159-165.