DRAFT

North of the Delta
Offstream Storage Investigation

Progress Report

Appendix D: Fish Survey Summary

September 2000

Integrated
Storage
Investigations

CALFED
BAY-DELTA
PROGRAM

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Offstream Storage Investigation

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Appendix D: Fish Survey Summary

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September 2000

Integrated
Storage
Investigations

CALFED
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PROGRAM

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Fish Survey Summary

Introduction

In late 1997, the Department of Water Resources began a two-year reconnaissance level study of North of the Delta Offstream Storage authorized by Proposition 204—the Safe, Clean, Reliable Water Supply Act approved by voters in 1996. In early 1999, CALFED consolidated all storage investigations under a comprehensive program called Integrated Storage Investigations. The North of the Delta Offstream Storage Investigation was incorporated into one of seven ISI program elements.

The North of the Delta Offstream Storage Investigation continues engineering, economic, and environmental impact analyses to determine the feasibility of four north of the Delta storage projects. The four potential alternatives are Sites Reservoir, Colusa Project, Thomes-Newville Project, and Red Bank Project (Figure 1). Phase I, currently underway, includes preliminary field surveys of environmental resources and extensive field surveys of cultural resources, geological, seismic and foundation studies, and an engineering feasibility evaluation. Phase II will start when CALFED's Record of Decision and Certification for the Programmatic EIR/EIS is completed and if north of Delta offstream storage is consistent with CALFED's preferred program alternative. Phase II will include completion of necessary fish and wildlife surveys, evaluations of potential mitigation sites, preparation of project-specific environmental documentation, final project feasibility reports, and the acquisition of permits necessary for implementation.

Under Phase I, the Department of Fish and Game conducted studies of fish and wildlife resources in each project area. This appendix summarizes studies of fish in the tributaries that flow through each of the four proposed project areas. The information gathered will be used to describe impacts on fish resources during the planning process. Fishery studies conducted for the Sacramento River will be summarized in a separate report.

Contract with DFG

DFG initiated fish studies in 1997. Studies were conducted to develop data adequate to meet the needs of the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and DFG consultations as required by endangered species legislation. Past studies were also reviewed and evaluated as part of this effort.

Report Organization and Content

Results and discussions of findings in past fishery studies and recently conducted surveys of fishery resources in the four proposed project areas are included in this appendix. The general procedure for commonly used fish surveys are outlined, with specific sampling data and results discussed in respective sections for each proposed project area.

Methodology

At the proposed project sites, fish surveys were conducted by diving, seining, fyke netting, and/or electrofishing. These methods were used to collect data on occurrence and relative abundance of species of fish. This section discusses general procedures for these methods. Details of surveys and results for each site are discussed in the respective sections.

Diving

Fish were observed in deep pools by divers wearing faceplates. Fish species were identified and numbers of each species observed were recorded. Diving was used as a sampling technique when pools were too big or deep for other sampling methods.

Seining

A seine is used to collect fish for sampling data. Three different seines varying in size were used depending on the size of the pool. The largest seine was 60 feet long, 5 feet high, with a mesh size of one-quarter inch and a 7-foot-by -7-foot pocket. A medium sized seine was 29 feet long, 6 feet high, with a mesh size of one-quarter inch and a pocket size of 7 feet by 5 feet. The third seine, used only for small pools and ponds, was 12 feet long, 4 feet high, with a mesh size of one-quarter inch and a 7-foot-by-5-foot pocket. A seine was brought around from one edge of the pool to the other. To prevent fish from escaping, a barrier net was stretched across the creek upstream and downstream from the pool to be seined. Captured specimens were stored in a bucket of water until they could be examined. Specimens were identified and the first 20 of each species were measured for fork length to the nearest millimeter and then released downstream. The seine was pulled a total of three times at each site. Representative specimens were either preserved or photographed for positive identification.

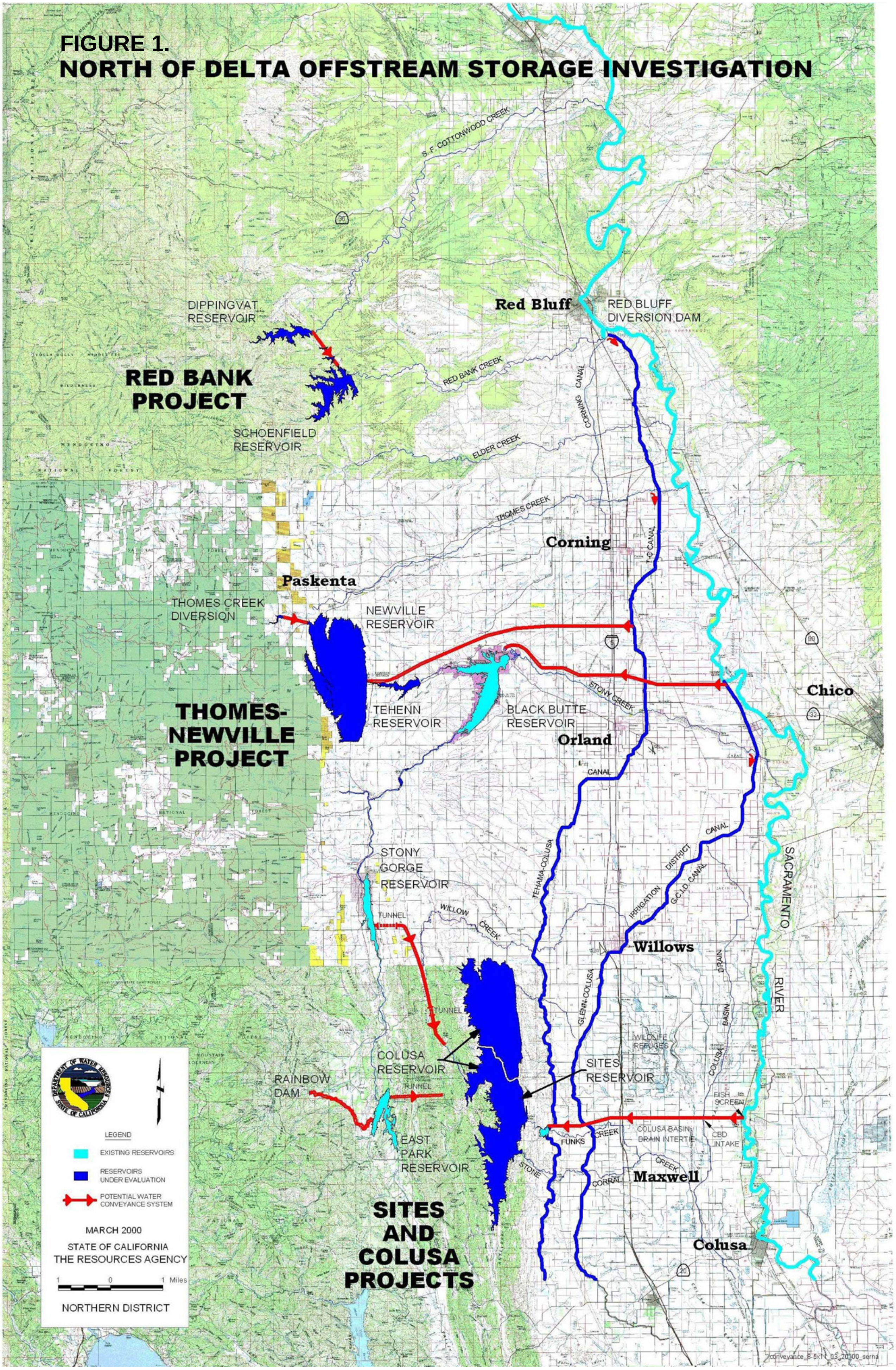

FIGURE 1.
NORTH OF DELTA OFFSTREAM STORAGE INVESTIGATION
S.F. COTTONWOOD CREEK
DIPPINGVAT RESERVOIR
Red Bluff
RED BLUFF DIVERSION DAM
RED BANK CREEK
RED BANK PROJECT
SCHOENFIELD RESERVOIR
ELDER CREEK
CORNING CANAL
THOMES CREEK
Corning
T.C. CANAL
Paskenta
THOMES CREEK DIVERSION
NEWVILLE RESERVOIR
STONY CREEK
Chico
TEHENN RESERVOIR
BLACK BUTTE RESERVOIR
THOMES-NEWVILLE PROJECT
Orland
CANAL
TEHAMA-COLUSA
IRRIGATION DISTRICT CANAL
G.C.I.D. CANAL
SACRAMENTO RIVER
STONY GORGE RESERVOIR
TUNNEL
WILLOW CREEK
Willows
GLENN-COLUSA
DRAIN
BASIN
COLUSA
WILDLIFE REFUGES
COLUSA RESERVOIR
SITES RESERVOIR
RAINBOW DAM
FISH SCREEN
COLUSA BASIN DRAIN INTERTIE
CBD INTAKE
FUNKS CREEK
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SITES AND COLUSA PROJECTS
Colusa

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Fyke Nets

Fish captured in fyke nets were measured for fork length to the nearest millimeter and weighed by water displacement to the nearest gram. No estimates of abundance were done for fish caught in fyke nets. Therefore, these fish were not included in the relative abundance tables.

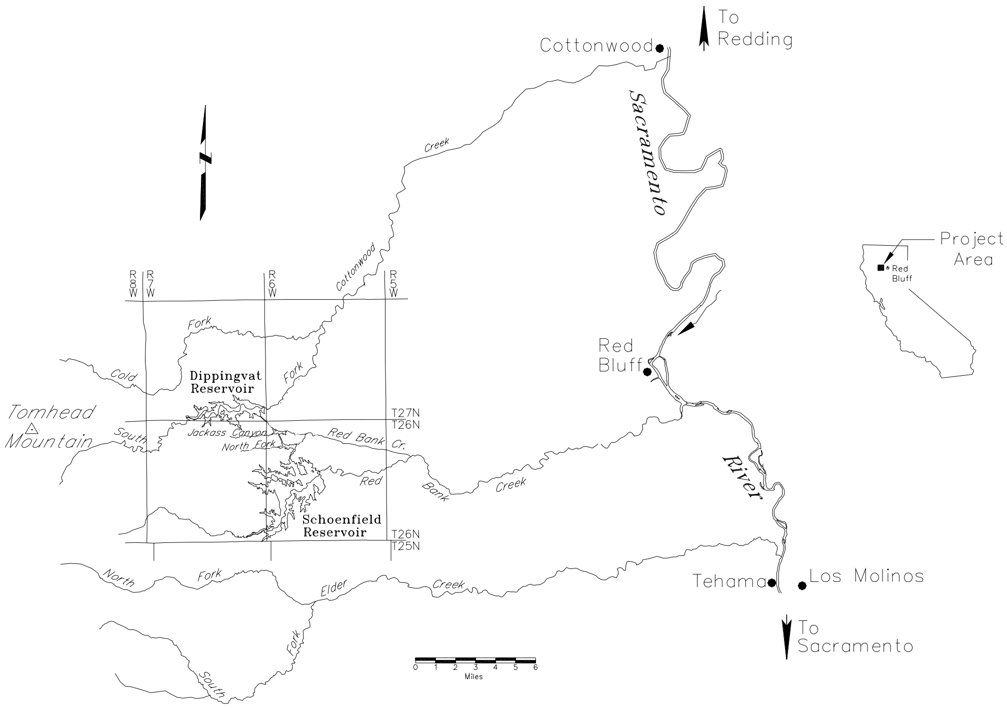
Electrofishing

Electrofishing was done with a Smith-Root Type VII electroshocker. Sections of creek varying from 33 to 138 feet were netted off, upstream and downstream. With a backpack electroshocker, DFG biologists waded into the stream starting from the upstream net and moved downstream. The anode of the electrofisher was inserted into likely fish habitat. The stunned fish were then collected into buckets, measured for fork length to the nearest millimeter for the first 20 of each species, and then a plus count was taken. Fish were weighed using water displacement to the nearest gram. The surface area of each station was calculated in square feet and then converted to square millimeters for fish density analysis. The resulting relative abundance was converted to and reported in fish per square yard.

Red Bank Project Fish Studies

This section describes the results of current and past fish studies conducted on Red Bank, South Fork Cottonwood, and Cottonwood Creeks, the major tributaries of the Red Bank Project area (Figure 2). Past studies date to 1969 and contain the reconnaissance-level fish and wildlife evaluation of Sacramento Valley alternative west side conveyance routes prepared by DFG (Smith and Van Woert 1969). Other studies reviewed include reports prepared by DFG and DWR in 1972, 1975, 1985, and 1987 (Haley and Van Woert 1972, Bill et al. 1975, Brown et al. 1985, Smith 1987).

Figure 2. Cottonwood Creek System and the Red Bank Project



Red Bank Creek Fish Resources

DFG Biologists sampled fish in Red Bank Creek within the footprint of the Schoenfield Reservoir in 1998. Data were collected at 28 stations. In summer 1998, seining was done at 16 stations dispersed on Red Bank Creek and its tributaries, Dry and Grizzly Creeks. Twelve stations were sampled on Red Bank Creek by electrofishing in October and November 1998.

Nongame Fish

Four species of nongame fish were observed (Table 1). The most common species of nongame fish found were California roach (0.588 fish/yd^2) and Sacramento pike minnow (0.158 fish/yd^2) (Table 2).

Resident Game Fish

In 1998, DFG biologists observed four species of resident game fish in Red Bank Creek (Table 3). The most common resident game fish were largemouth bass (0.009 fish/yd^2) and bluegill (0.001 fish/yd^2) (Table 4).

Steelhead

Also in 1998, DFG biologists found juvenile steelhead in the footprint of the proposed Schoenfield Reservoir in Red Bank by electrofishing and estimated density to be 0.002 fish/yd^2. Steelhead were found in two of 28 stations sampled.

Table 1. Nongame Fish Observed in the Red Bank and Cottonwood Creeks

Common Name	Scientific Name	Cottonwood Creek (1976)	Red Bank Creek (1998)
California roach	*Hesperoleucus symmetricus*	X	X
Carp	*Cyprinus carpio*	X	
Golden shiner	*Notemigonus crysoleucas*	X	
Hardhead	*Mylopharodon conocephalus*	X	
Hitch	*Lavinia exilicauda*	X	
Mosquitofish	*Gambusia affinis*	X	
Pacific lamprey	*Lampetra tridentata*	X	X
Prickly sculpin	*Cottus asper*	X	
Sacramento pike minnow	*Ptychocheilus grandis*	X	X
Sacramento sucker	*Catostomus occidentalis*	X	X
Speckled dace	*Rhinichthys osculus*	X	
Threespine stickleback	*Gasterosteus aculeatus*	X	
Tule perch	*Hysterocarpus traski*	X	

Table 2. Relative Abundance of Nongame Fish (Fish/Yd^2) Caught in Lower Cottonwood Creek, 1976, and in Red Bank Creek, 1998

Species	Cottonwood Creek (1976)	Red Bank Creek (1998)
California roach	0.003	0.588
Carp	0.003	
Hardhead	0.022	
Sacramento pike minnow	0.015	0.158
Sacramento sucker	0.006	0.091

Table 3. Game Fish Observed in Cottonwood Creek, 1976, and in Red Bank Creek, 1998

Common Name	Scientific Name	Cottonwood Creek (1976)	Red Bank Creek (1998)
Black bullhead	*Ictalurus melas*	X	
Bluegill	*Lepomis macrochirus*	X	X
Brown bullhead	*Ictalurus nebulosus*	X	
Brown trout	*Salmo trutta*	X	
Chinook salmon	*Onchorhynchus tshawytscha*	X	
Green sunfish	*Lepomis cyanellus*	X	X
Largemouth bass	*Micropterus salmoides*	X	X
Smallmouth bass	*Micropterus dolomieui*	X	
Steelhead	*Onchorhynchys mykiss*	X	X
White catfish	*Ictalurus catus*	X	

Table 4. Relative Abundance of Resident Game Fish (Fish/ Yd^2) Caught in Lower Cottonwood Creek and in Red Bank Creek

Species	Cottonwood Creek (1976)	Red Bank Creek (1998)
Bluegill	0.022	0.001
Brown bullhead	0.006	
Green sunfish	0.015	0.001
Largemouth bass	0.003	0.009
Smallmouth bass	0.003	

Cottonwood Creek Fish Resources

DFG biologists surveyed Cottonwood Creek from the confluence of the north fork to the mouth of Cottonwood Creek in 1976 (Richardson et al. 1978). Observations were made by diving, seining, fyke netting, and electrofishing. Abundance estimates were made for fish caught by electrofishing. Fish caught in fyke nets or observed by divers were not included in the relative abundance tables, because no estimates of abundance were done for these fish.

Nongame Fish

Thirteen species of nongame fish were observed (Table 1). The most common species of resident nongame fish found were hardhead (0.022 fish/yd^2) and Sacramento pike minnows (0.015 fish/yd^2) (Table 2). Some Sacramento pike minnows and Sacramento suckers also migrate to the Sacramento-San Joaquin estuary to rear and return to Cottonwood Creek as adults to spawn (Richardson et al. 1978). Life history information is valuable in planning instream flow studies, HEP evaluations, and determining project impacts.

Resident Game Fish

Ten species of resident game fish were observed in the Cottonwood Creek system in 1976 (Richardson et al. 1978) (Table 3). The most common resident game fish were bluegill (0.022 fish/yd^2) and green sunfish (0.015 fish/yd^2) (Table 4). Green sunfish and bluegill were common in the lower reaches surveyed (Richardson et al. 1978).

Steelhead

DFG biologists found juvenile steelhead in South Fork Cottonwood Creek in the Yolla Bolly Wilderness in the summer of 1976. No estimates of numbers of juvenile steelhead were made. The Yolla Bolly Wilderness is well above the site of the proposed Dippingvat Dam. Adult steelhead were seined from the mouth of Cottonwood Creek in November 1976 (Brown, et al., 1985). DFG estimates that Cottonwood Creek supports an average annual migration of 1,000 steelhead based on the best estimates of biologists who were most familiar with Cottonwood Creek (DFG 1966).

Chinook Salmon

Fall Run. Fall-run chinook salmon ascend Cottonwood Creek and spawn in late October through November (Richardson et al. 1978). They spawn in

Cottonwood Creek from the mouth to the confluence of North Fork Cottonwood Creek. About 53 percent of fall-run chinook salmon spawn from the mouth of Cottonwood Creek to the Interstate-5 highway bridge, 23 percent spawn from the Interstate-5 highway bridge to the confluence of Cottonwood Creek and South Fork Cottonwood Creek, and 24 percent spawn in Cottonwood Creek between the confluence of the south and north forks. Their young begin migrating after they incubate in January (Richardson 1978). They migrate downstream from January through May. DFG estimates that an average of 3,600 fall-run chinook salmon spawn in Cottonwood Creek (Table 5) (Elwell 1962; Fry 1961; Fry and Petrovich 1970; Hoopaugh 1978; Hoopaugh and Knudson 1979; Kano et al. 1996; Kano 1998a, 1998b; Knutson 1980; Mahoney 1962; Menchen 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970; Puckett et al. 1979; Reavis 1983, 1984, 1986).

Table 5. Estimates of Chinook Salmon Spawning in the Cottonwood Creek System, 1952-98 (DFG Spawning Stock Reports)

Year	Fall Run	Spring Run		
		Beegum Gulch	North Fork	South Fork
1952	-	-	-	-
1953	3,000	-	-	-
1954	1,000	-	-	-
1955	800	-	-	-
1956	660	-	-	-
1957	358	-	-	-
1958	600	-	-	-
1959	3,300	-	-	-
1960	350	-	-	-
1961	1,500	-	-	-
1962	6,000	-	-	0
1963	3,500	-	-	-
1964	3,450	-	-	-
1965	900	-	-	-
1966	2,900	-	-	-
1967	600	-	-	-
1968	8,540	-	-	-
1969	4,967	-	-	-
1970	-	-	-	-
1971	-	-	-	-
1972	-	-	-	0
1973	-	0	-	-
1974	-	3	-	-
1975	-	3	-	1
1976	2,427	-	-	-
1977	1,512	-	-	-
1978	1,120	-	-	0
1979	-	-	-	-
1980	-	-	-	-
1981	3,356	-	-	-
1982	700	0	-	-
1983	1,000	-	-	-
1984	500	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	0	-	-
1990	-	-	-	-

Table 5. Estimates of Chinook Salmon Spawning in the Cottonwood Creek System, 1952-98 (DFG Spawning Stock Reports) continued

Year	Fall Run	Spring Run		
		Beegum Gulch	North Fork	South Fork
1991	676	-	-	-
1992	1,585	-	-	-
1993	-	1	-	-
1994	-	-	-	-
1995	-	8	-	-
1996	-	6	-	-
1997	-	-	-	-
1998	-	477	-	0

Late Fall-Run. Late fall-run chinook salmon migrate up Cottonwood Creek and spawn in January. DFG Biologists observed them spawning at the mouth of North Fork Cottonwood Creek in January 1976 (Richardson et al. 1978). Their young migrate downstream in May and June as much smaller fry than fall-run at that time of year. Young late fall-run chinook salmon were caught in fyke nets near the mouth of Cottonwood Creek in May and June 1976 (Richardson 1978). DFG estimates that an average of 300 late fall-run chinook salmon migrate up Cottonwood Creek (Smith and Van Woert 1969). DFG biologists surveying Cottonwood Creek in 1977 observed late fall-run chinook salmon spawning, but no estimates of run size were made.

Spring-Run. Spring-run chinook salmon migrate up Cottonwood Creek in April and spend the summer in deep pools in South Fork Cottonwood Creek, Beegum Gulch, and North Fork Cottonwood Creek. Most are found in Beegum Gulch. Young spring-run chinook salmon migrate downstream from January through May. DFG estimates that an average of 500 spring-run chinook salmon migrate up Cottonwood Creek (DFG 1966). DFG biologists surveyed Beegum Gulch in 1998 and found about 500 spring-run chinook salmon. Some young spring-run salmon from the Sacramento River use the lower reach of Cottonwood Creek from Interstate-5 to the mouth for rearing during the summer and fall (Richardson et al. 1978).

Spawning Habitat. DFG biologists took gravel samples in summer 1977 to measure quantity and quality of salmon spawning habitat in Cottonwood Creek. Approximately 392,000 square feet of gravel suitable for chinook salmon spawning was identified in the Cottonwood Creek system (Richardson and Brown 1978). About 40,000 square feet of that total was in south fork. Other investigations have produced estimates ranging from 285,000 square feet (Hansen et al. 1940) to 2,000,000 square feet (Leach and Van Woert 1968) of gravel in the system. A female chinook salmon requires about 100 square feet of gravel for spawning (Leach and Van Woert 1968). Most of the gravel was found in Cottonwood Creek below its confluence with North Fork Cottonwood Creek. Little suitable gravel was found in North Fork Cottonwood Creek.

Instream Flow. An instream flow study was conducted in 1976 and 1977 to measure the amount of chinook salmon spawning and rearing habitat in Cottonwood Creek and South Fork Cottonwood Creek. Optimum spawning flow was about 180 cfs and optimum rearing flow was 200 cfs from the mouth of Cottonwood Creek to the confluence of Cottonwood Creek and South Fork Cottonwood Creek. Optimum spawning flow was about 80 cfs and optimum rearing flow was 100 cfs in the lower seven miles of South Fork (Brown 1979). Natural monthly stream flow averages 295 cfs during fall-run chinook spawning in November near the mouth of Cottonwood Creek (Table 6). Average monthly flows range from 604 to 2,174 cfs when salmon rear from January through May.

Table 6. Average Monthly Stream Flow in Cottonwood Creek at the Cottonwood Gage

Month	Average Monthly Flow (cfs)
January	1,744
February	2,174
March	1,590
April	1,205
May	604
June	283
July	112
August	66
September	66
October	108
November	295
December	955

Thomes-Newville Project Fish Studies

DFG initiated studies of the impacts on fish and wildlife of a Thomes-Newville Project in 1979 as part of DWR's Thomes-Newville Reservoir planning studies. However, the planning studies were halted in 1982. DFG completed a report of its abbreviated studies in 1983 (Brown et al. 1983). In 1998, DFG initiated studies of fish and wildlife resources of a Thomes-Newville Project as part of the North of Delta Offstream Storage Program. A brief survey of spring-run chinook salmon was conducted during the recent investigations. This section discusses recent findings and recapitulates the effort and results of the 1982 study (Brown et al. 1983).

Methodology

Juvenile Salmon

Seining for juvenile chinook salmon in Stony and Thomes Creeks was done over a period of three years, 1980 to 1982. Ten sample stations were selected on Thomes and Stony Creeks. Each station was seined weekly from February to June, with 50-foot delta mesh seines (Brown et al. 1983).

Fyke nets were used to sample for juvenile salmonids during the 1981 and 1982 seasons on Thomes Creek only. Irregular and frequent floodflow releases from Black Butte Reservoir made it impractical to fyke net in Stony Creek. Two fyke nets were used in Thomes Creek. One was placed in the mainstem and another near the confluence to the discharge channel from the Tehama-Colusa Canal. The nets were fished continuously from Monday to Friday and were removed during weekends or during high water. Each net in the mainstem was fished from February through March. Captured fish were measured for fork length to the nearest millimeter and weighed by water displacement to the nearest gram (Brown et al. 1983).

Adult Salmon and Steelhead

Adult chinook salmon carcasses were counted to estimate the number of salmon in Stony and Thomes Creeks. Stony Creek was surveyed for carcasses between the Sacramento River confluence and the North Diversion Dam. Thomes Creek was surveyed between the Sacramento River confluence and Paskenta and in a channel from the discharge point of the Tehama-Colusa Canal to its confluence with Thomes Creek. Counts were taken once per week from November through January in 1980-81 and 1981-82 on Thomes Creek and from December through February in 1981-82 on Stony Creek. Each carcass was tagged by fastening a number 3 hog ring to its mandible. Tick marks were notched into the hog rings with wire cutters to identify the appropriate week of tagging. The sex and fork length of each carcass was noted. The date and location of where each carcass was found was recorded; each carcass was then returned to the same area where it was tagged. On successive surveys, tagged fish that were recovered were cut in half to avoid recounting in subsequent surveys. The 1980-81 spawning escapement estimate for Thomes Creek was calculated with the Schaefer method (Ricker 1975), while the 1981-82 estimates for both Stony and Thomes Creeks were estimated with the Peterson method (Ricker 1975) (Brown et al. 1983).

On June 13, 1979; August 18, 1980; and August 12, 1998, Thomes Creek was surveyed to enumerate adult spring-run chinook salmon and summer-steelhead. The area surveyed was from the gorge to the fjord at Hatch Flat near Paskenta. Each pool was examined by snorkel diving. All fish were identified and their size range and relative abundance estimated. No habitat suitable for spring-run salmon and summer steelhead exists in Stony Creek; therefore, no survey was conducted (Brown et al. 1983). Historical estimates for fall-run chinook salmon for both Stony and Thomes Creeks were compiled from DFG salmon-spawning stock reports.

Resident Fish and Migratory Nongame Fish

A fyke net consisting of 0.03 inch oval mesh netting mounted on a 0.01 inch x 0.02 inch metal tubing frame was placed in the creek near the mouth of Thomes Creek. The purpose of the net was to capture juveniles, larval Sacramento suckers, and Sacramento pike minnows migrating to the Sacramento River. A perforated aluminum box—1.6 feet x 1.6 feet x 3.3 feet—was attached to the cod end of the net to receive captured fish. The net was fished 24 hours per day during weekdays from January to June 1981 (Brown et al. 1983).

To estimate the population of spawning Sacramento suckers and Sacramento pike minnows, adult fish were captured in Thomes Creek and its tributary, Mill Creek. From December 1980 through June 1981, 17 samples were taken at 10-day intervals via electrofishing. A 12-foot Avon rubber raft was retrofitted with a Smith-Root Type VII electroshocker. The battery and electroshocking unit were placed inside an ice chest and secured to the raft's rowing frame. Prove arrays were constructed of 0.08-inch stainless steel cable, attached to the bow of the raft, and fished at a depth of 4.9 feet. (Brown et al. 1983).

Captured fish were weighed to the nearest 0.3 ounce and fork lengths were measured to the nearest millimeter. Each fish was marked with a floy spaghetti tag and released. The tag was inserted under the dorsal fin and tied in a loop. The Jolly-Seber method was used to determine the population estimate for Sacramento suckers while the Schaefer method (Ricker 1975) was used to estimate the population of Sacramento pike minnows (Brown et al. 1983).

Electrofishing was done in streams in the footprint of proposed Newville Reservoir in 1981 and 1982. Seven sections were sampled in streams within the project area. These include North Fork Stony, Salt, and Heifer Camp Creeks. Ten sections in Stony Creek and 15 in Thomes Creek were sampled. Fish were captured by backpack electrofishing. Population number and biomass estimates for each species for the Thomes-Newville data were developed using the two-pass method of Seber and LeCren (1967) (Brown et al. 1983).

Thomes Creek Fish Resources

Juvenile Chinook Salmon

1980 Emigration. Thirteen juvenile chinook salmon were captured by seining during the 1980 sample period (Table 7). These fish were caught in the lowermost stations of Thomes Creek from March 20 to May 24, 1980.

1981 Emigration. Six juvenile chinook salmon were captured by seining during the 1981 sample period (Table 7). One of these fish was from Coleman National Fish Hatchery.

In 1981, 206 juvenile chinook salmon were captured by fyke netting in Thomes Creek, 20 from the mainstem and 186 from the discharge canal (Tables 8 and 9).

Table 7. Juvenile Chinook Salmon Seined from Thomes Creek in 1980 and 1981 [1]

Sample Period	Number of Weekly Seinings	Number of Fish	Average Length of Fish (inches)
1980			
March	4	5	2.8
April	5	8	2.8
Total	**9**	**13**	
1981			
March	2	5	4.1
April	1	1	2.3
Total	**3**	**6**	

[1] Brown et al. 1983

Table 8. Fyke Net Catches of Juvenile Chinook Salmon from Mainstem of Thomes Creek in 1981[1]

Sample Period	Hours Fished	Number of Salmon	Average Length of Fish (inches)
February	672	0	0
March	744	9	2.7
April	648	10	3.1
May	336	1	2.7
Total	**2,400**	**20**	

[1] Brown et al. 1983

Table 9. Fyke Net Catches of Juvenile Chinook Salmon from the Tehama-Colusa Canal Discharge Channel in Thomes Creek in 1981 and 1982[1]

Sample Period	Number of Fish	Average Length of Fish (inches)
1981		
January	1	1.4
February	126	1.3
March	59	1.3
Total	**186**	
1982		
January	2	1.4
February	45	1.4
March	337	1.5
Total	**384**	

[1] Brown et al. 1983

The catches from the mainstem occurred over a nine-week period beginnning the first week of March and ending the first week of May. Salmon from these catches ranged in size from 2.7 to 3.1 inches fork length (Table 8). Except for the time when the migration occurred, no real descriptive trends can be derived from these data. These fish, however, appear to be much larger than expected for fall-run fish spawned in Thomes Creek. Some fish may have spawned earlier in the mainstem Sacramento River and moved upstream into Thomes Creek. It is common for juvenile salmonids from the Sacramento River to swim upstream into tributaries (Richard Hallock, DFG, personal communication).

Juveniles captured in the discharge channel spawned there. The presence of live adults, carcasses, and redds in the channel together with the presence of juveniles is strong evidence that successful spawning occurred in the channel.

The migration of juvenile chinook salmon from the discharge channel occurred from late February through the third week of March. At this time the discharge was terminated by the U.S. Bureau of Reclamation and no water flowed to indicate newly hatched fish. These fish were of the fall-run spawn. Although the migration was halted by lack of flow, it could have continued if discharge had been extended. In response to the lack of flow, DFG regional personnel rescued in excess of 3,000 juvenile salmon.

1982 Emigration – No juvenile chinook salmon were captured by seining or fyke netting in the mainstem of Thomes Creek during the 1982 sample period. High flows and other duties limited efforts.

As indicated in Table 9, 384 juvenile chinook salmon were captured by fyke netting in the discharge channel from the Tehama-Colusa Canal. The first fish was captured during the first week of January, but the bulk of the migration did not occur until the third week of February. The migration continued until March 30, 1982, when the discharge was terminated by USBR.

Juvenile Steelhead

Seven juvenile steelhead were captured by seining in Thomes Creek in 1981. Four of these fish were probably from Coleman National Fish Hatchery. They had rounded fins and deformed dorsal fins, which are a characteristic of hatchery-grown fish. Juvenile salmonids from the Sacramento River commonly ascend tributaries (Richard Hallock, DFG, personal communication).

Adult Chinook Salmon

Review of past reports show little information on historic salmon runs in Thomes Creek. Only seven surveys were documented between 1955 and 1979. In 1957, the fall-run escapement estimate was 25, and in 1975 the estimate was 170 fish (Mahoney 1958, Hoopaugh 1978a). Estimates of fall-run salmon for survey years 1959, 1960, 1964, 1965, and 1976 were zero (Mahoney 1960, 1962; Menchen 1965, 1966; Hoopaugh 1978b).

1980-81 Fall-Run Estimate. Fifty-nine chinook salmon carcasses were tagged during 12 surveys of Thomes Creek. Of these 59, 17 fish (29 percent) were males while 42 fish (71 percent) were females. This represented a male-female ratio of 1:2.5. Twenty-three carcasses were recovered in fall 1980. From these data an estimated 155 salmon spawned in Thomes Creek during the sample period.

Live fish were first observed in the creek November 11, 1980, but no carcass was tagged until nine days later. The last carcass was tagged on January 12, 1981. Fifty-seven (97 percent) of the fish tagged were located in the Tehama-Colusa Canal outlet channel. Only two fish (3 percent) were tagged in the mainstem. Observation of six redds and four live fish indicates there was some spawning activity in areas below Henleyville.

1981-82 Fall-Run Estimates. Thirty-eight chinook salmon carcasses were tagged during 10 surveys of Thomes Creek. Of these 38, 16 fish (42 percent) were males while 22 fish (58 percent) were females. This represents a male-female ratio of 1:1.4. All of the fish tagged were located in the Tehama-Colusa Canal outlet channel. Twenty tagged carcasses were recovered. From these data an estimated 167 salmon spawned in Thomes Creek during the sample period. No live fish or redd was seen in the mainstem.

1979-1980 Spring-Run Estimates. No adult anadromous salmonid was seen during the June 1979 or August 1980 spring-run chinook salmon surveys in Thomes Creek. Numerous juvenile steelhead and brown trout were seen in the area of the survey which may indicate that habitat for spring-run chinook salmon or summer steelhead may exist. Although surface water temperatures generally approach 77ºF in these areas, cooler water (59-68ºF) can be found near the bottom of larger pools that could support salmonids.

1999 Spring-Run Estimates. One adult spring-run chinook salmon was seen during August 1999 diving surveys in Thomes Creek. As in 1980, numerous juvenile steelhead and brown trout were seen in the area of the survey.

1980 Late Fall-Run. The late spawning characteristics of a few chinook salmon indicate that they were of the late fall-run. Those that spawned in late December and January were salmon of this race.

Resident Fish and Migratory Nongame Fish

Twenty-two species of fish were observed in Thomes Creek (Table 10). DFG staff developed population and biomass estimates for 13 of these species (Table 11). Three species were game fish and 10 were nongame fish. Steelhead were the most abundant fish above the gorge, while Sacramento pike minnow, Sacramento suckers, hardhead, California roach, and speckled dace were the more common fish below the gorge.

Most of the nongame fish caught in the reach below the gorge were juveniles, indicating that this reach serves mainly as a spawning and rearing area. Adult Sacramento suckers, Sacramento pike minnow, California roach, and hardhead annually migrate from the Sacramento River into Thomes Creek and its tributaries to spawn. Juveniles that do not migrate immediately after hatching remain to rear until the following rainy season when water flows to the mouth.

Thomes Creek below Paskenta usually dries up except for a few residual pools scattered along the streambed during the late summer, making it impossible for resident adult fish to live throughout the summer months. Some adult game fish such as largemouth and smallmouth bass, bluegill, and green sunfish ascend the creek from the Sacramento River during late spring and early summer to use these pools as spawning areas.

Table 10. Fish Species Found in Thomes Creek in 1982[1]

Common Name	Scientific name
Bluegill	*Lepomis machrochirus*
Brown bullhead	*Ictalurus nebulosus*
California roach	*Lavinia symmetricus*
Carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
Golden shiner	*Notemigomus crysoleucus*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Hardhead	*Mylopharodon conocephalus*
Hitch	*Lavinia exilicauda*
Largemouth bass	*Micropterus salmoides*
Mosquitofish	*Gambusia affinis*
Pacific lamprey	*Lampetra tredentata*
Prickly sculpin	*Cottus asper*
Sacramento pike minnow	*Ptychocheilus grandis*
Sacramento sucker	*Catostomus occidentatlis*
Smallmouth bass	*Micropterus dolomeiu*
Speckled dace	*Rhinicthys osculus*
Steelhead	*Onchorynchus mykiss*
Threespine stickleback	*Gasterosteus aculeatus*
Tule perch	*Hysterocarpus traski*
White catfish	*Ictalurus catus*

[1] Brown et al. 1983

Table 11. Average Population Estimates and Biomass Estimates for Fish Caught in Sections of Thomes Creek in 1982[1]

Species	Average Population Estimate	Average Biomass (lb/acre)
Bluegill	3	4.5
California roach	41	10.7
Carp	90	64.2
Goldfish	1	19.2
Green sunfish	14	15.2
Hardhead	47	47.3
Hitch	1	0.4
Largemouth bass	5	8
Prickly sculpin	1	1.8
Sacramento pike minnow	337	89.2
Sacramento sucker	143	16.1
Speckled dace	229	16.1
Tule perch	1	0.2

[1] Brown et al. 1983

Stony Creek Fish Resources

Juvenile Chinook Salmon

1980 Emigration. During the 1980 sample period, 181 juvenile chinook salmon were caught by seining (Table 12). Salmon were first caught during the second week of February and the last salmon was caught during the first week of May.

1981 Emigration. During the 1981 sample period, 73 juvenile chinook salmon were captured by seining (Table 12). Fish were first captured during the third week of February and the last fish were captured during the second week of April.

1982 Emigration. During the 1982 sample period, only four juvenile chinook salmon were captured by seining (Table 12). Two fish were captured during January and two were captured during the first week of March.

Adult Salmon Studies

1981-82 Fall-Run Estimates. Thirty-six chinook salmon carcasses were tagged during five surveys. Two of these salmon were recovered. From these data DFG estimates that 393 salmon spawned in Stony Creek during the sample period. Of the 36 tagged, 11 fish (31 percent) were males while 25 fish (69 percent) were females. This represents a male-female ratio of 1:2.3.

Most of the spawning activity was located in lower Stony Creek in the reach between the Interstate-5 bridge and the mouth. At least 35 redds and 29 carcasses were counted in this area.

Table 12. Juvenile Chinook Salmon Seined from Stony Creek in 1980, 1981, and 1982[1]

Sample Period	Number of Fish	Average Length of Fish (in)
1980		
February	64	**1.7**
March	51	1.8
April	60	2.0
May	6	3.0
Total	**181**	
1981		
February	5	1.5
March	64	2.1
April	4	3.0
Total	**73**	
1982		
January	2	3.3
March	2	1.7
Total	**4**	

[1] Brown et al. 1983

Resident Fish Surveys

Six species of fish, two game and four nongame, were captured in streams potentially inundated by the Newville Reservoir (Tables 13 and 14). These streams include North Fork Stony Creek, Salt Creek, and Heifer Camp Creek. Rainbow trout were captured in sections of streams above the inundation line where the water is cool and cover is abundant. California roach, Sacramento pike minnow, Sacramento sucker, carp, and green sunfish were captured in sections of streams below the inundation line. California roach, Sacramento pike minnows, and Sacramento suckers were more abundant species, while carp and green sunfish are relatively uncommon (Brown et al. 1983).

Table 13. Population Estimates for Fish Caught in Selected Sections of Streams within the Newville Reservoir Site in 1983[1]

Species	North Fork Stony Creek	Salt Creek	Heifer Camp Creek
California roach	4	546	120
Carp	1		
Green sunfish	-	13	
Rainbow trout	-	24	8
Sacramento pike minnow	12	24	85
Sacramento sucker	> 2	45	6

[1] Brown et al. 1983

Table 14. Average Biomass Estimates (lb/acre) for Fish Caught in Selected Sections of Streams within the Newville Reservoir Site in 1983[1]

Species	North Fork Stony Creek	Salt Creek	Heifer Camp Creek
California roach	0.9	427.3	72.3
Carp	145.4	-	
Green sunfish	-	33.9	
Rainbow trout	-	74.9	18.7
Sacramento pike minnow	8	339.9	775.1
Sacramento sucker	0.09	88.3	

[1] Brown et al. 1983

The sections of stream within the inundation area are used primarily for spawning and rearing by nongame species (mainly the minnow family), although some green sunfish were observed spawning during the late spring in nonflowing areas of the stream. It is likely that, during high water, adult cyprinids ascend these tributaries from Black Butte Reservoir to spawn (Brown et al. 1983).

Upper Salt Creek supports a population of rainbow trout. Nongame fish were not found in this area nor were migratory cyprinids because they cannot ascend the creek due to a waterfall. This waterfall is not in the inundation area.

However, if Newville Reservoir is built, the waterfall could be flooded, which would allow nongame fish to swim upstream. This may reduce the rainbow trout populations because of competiton with nongame fish (Brown et al. 1983).

Twenty-eight species of fish were observed in Stony Creek (Table 15). DFG developed population and biomass estimates for 21 of these species (Table 16). Eight species were game fish and 13 were nongame fish. Largemouth bass and bluegill were the most abundant gamefish below Black Butte Reservoir; channel catfish and white catfish were the most abundant game fish above the Sacramento River. Sacramento pike minnows and suckers were found in all stations throughout Stony Creek, were the most abundant, and had the highest biomass for all species of fish. Prickly sculpin were found in all sections, but made up a very small portion of the total biomass.

Most nongame fish caught in the reach below Black Butte Reservoir were juveniles, indicating that this reach serves mainly as a spawning and rearing area. Adult Sacramento suckers, Sacramento pike minnow, California roach, and hardhead annually migrate from the Sacramento River into Stony Creek to spawn. Juveniles that do not migrate immediately after hatching remain to rear until the following season when water flows to the mouth. Other game fish such as largemouth bass, smallmouth bass, bluegill, and green sunfish were also observed spawning in backwater areas of Stony Creek. These adult fish may have migrated upstream from the Sacramento River, may have washed downstream from Black Butte Reservoir, or may reside throughout the year in the creek.

Table 15. Fish of the Stony Creek Drainage (Excludes Fish within Newville Reservoir Site)[1]

Common Name	Scientific Name
Black bullhead	*Ictalurus melas*
Black crappie	*Pomoxis melas*
Bluegill	*Lepomis machrochirus*
Brown bullhead	*Ictalurus nebulosus*
California roach	*Lavinia symmetricus*
Carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
Golden shiner	*Notemigomus crysoleucus*
Goldfish	*Carassius auratus*
Green sunfish	*Lepomis cyanellus*
Hardhead	*Mylopharodon conocephalus*
Hitch	*Lavinia exilicauda*
Largemouth bass	*Micropterus salmoides*
Mosquitofish	*Gambusia affinis*
Pacific lamprey	*Lampetra tridentata*
Prickly sculpin	*Cottus asper*
Rainbow trout	*Onchorynchus mykiss*
Redear sunfish	*Lepomis microlophus*
Sacramento blackfish	*Orthodon microlepidotus*
Sacramento pike minnow	*Ptychocheilus grandis*
Sacramento sucker	*Catostomus occidentatlis*
Smallmouth bass	*Micropterus dolomeiu*
Speckled dace	*Rhinicthys osculus*
Threadfin shad	*Dorosoma petenense*
Threespine stickleback	*Gasterosteus aculeatus*
Tule perch	*Hysterocarpus traski*
White catfish	*Ictalurus catus*
White crappie	*Pomoxis annularis*

[1] Brown et al. 1983

Table 16. Average Population Estimates and Biomass Estimates for Fish Caught in Selected Sections of Stony Creek in 1982 [1]

Species	Average Population Estimate	Average Biomass (lb/acre)
Black crappie	8	87.4
Bluegill	19	8
California roach	200	54.4
Carp	5	64.2
Channel catfish	57	47.3
Goldfish	8	33.9
Green sunfish	7	2.7
Hardhead	9	24.1
Hitch	32	20.5
Largemouth bass	13	11.6
Mosquitofish	3	0.09
Prickly sculpin	57	11.6
Sacramento pike minnow	146	91
Sacramento sucker	96	256.9
Smallmouth bass	5	16.1
Speckled dace	318	41.9
Threadfin shad	2	0.9
Threespine stickleback	3	0.05
Tule perch	6	5.4
White catfish	30	34.8
White crappie	5	17.8

[1] Brown et al. 1983

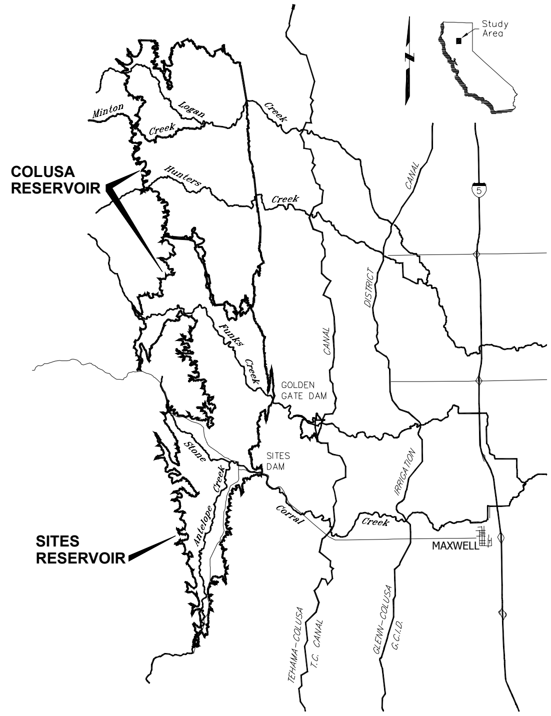
Sites and Colusa Project Fish Studies

Fish studies for the Sites and Colusa Projects included three basic areas of study: fish resources in streams within the proposed reservoirs and in the Colusa Basin Drain, and habitat typing of the dominant streams in the proposed reservoirs.

Sites and Colusa Project Stream Fish Resources

This section summarizes studies of fish in streams that flow through the proposed Sites and Colusa Projects. Studies were conducted in 1998 and 1999. Information gathered in these streams will be used to describe impacts on fish resources during the planning process.

Figure 3. Streams in the Sites-Colusa Project



Methodology

Stone Corral Creek, Funks Creek, Logan Creek, and Hunters Creek and their tributaries originate in oak woodland habitat in western Colusa and Glenn Counties (Figure 3). The creeks flow downstream through annual grassland and cultivated rice fields before flowing into the Colusa Basin Drain. Deeply incised channels characterize these streams with little vegetation on the banks and little cover in streambeds. Streamflow is seasonal with periods of high flow during winter storms, declining flows through spring and early summer, and intermittent flow in late summer. Water quality is poor and high in dissolved minerals. The total dissolved solids in the water are so high that electrofishing as a means of sampling is not possible in the streams.

Pools were seined at specific stations on all creeks surveyed to determine species composition. All sample stations were within the footprint of the Sites-Colusa Project. Thirty-six stations were spread out among Hunter, Minton, Logan, Antelope, and particularly Stone Corral and Funks Creeks. Seven stock ponds in the Sites and Colusa area were also seined for fish.

Twelve species of fish were caught in the Sites and Colusa study area in 1998 and 1999. Five species were game fish and seven species were nongame fish (Table 17). A single spring-run chinook salmon was observed in Antelope Creek, a tributary to Stone Corral Creek in spring 1998. It died a few weeks later and was identified by its carcass.

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Table 17. Fish Caught in the Sites Study Area in 1998 and 1999

Common Name	Scientific Name
Bluegill	*Lepomis macrochirus*
California roach	*Hesperoleucus symmetricus*
Chinook salmon	*Oncorhynchus tschawtscha*
Green sunfish	*Lepomis cyanellus*
Hitch	*Lavinia exilicauda*
Largemouth bass	*Micropterus salmoides*
Mosquitofish	*Gambusia affinis*
Redear sunfish	*Lepomis microlophus*
Sacramento blackfish	*Orthodon microlepidotus*
Sacramento pike minnow	*Ptychocheilus grandis*
Sacramento sucker	*Catostomus occidentalis*
Sculpin sp.	*Cottus sp.*

Funks Creek. Fifteen stations were sampled on Funks Creek between July 22, 1998, and January 8, 1999. Stations were evenly spaced between the Golden Gate damsite and the upper limit of flow in Funks Creek. Streamflow was intermittent. Five species of fish were found in Funks Creek, including one type of game fish, largemouth bass (Table 18). The most common fish in Funks Creek was the hitch, with an average density of 3.1 fish/yd^2 (Table 18). Hitch were caught in 11 out of 15 stations seined (Table 18).

Table 18. Species Caught at Each Sample Station and Relative Abundance on Funks Creek

Species	Station Sampled															Fish/yd^2
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Hitch			X	X	X	X	X	X	X	X	X	X	X			3.1
Largemouth bass									X			X				0.001
Sacramento pike minnow					X	X			X				X			0.06
Sacramento Sucker					X	X			X	X			X			0.02
Sculpin														X		---

The most diverse sampled sections of Funks Creek were in the lower reaches, stations 5, 6, 9, 10, 12, and 13. The upper reaches of Funks Creek either lacked fish or only one species was found. Hitch densities varied widely throughout the creek, and no one area seemed to maintain a higher population.

Hunters Creek. Three stations on lower Hunters Creek were seined between July 22, 1998, and August 3, 1998. No water was present above these sites. Only two species of fish were found on Hunters Creek, green sunfish and mosquitofish. Both species were found in two of the three stations (Table 19).

Mosquitofish were found in a relative abundance of 3.8 fish/yd^2, but they only occurred in abundance at one station. Green sunfish were found to have an average density of 2.3 fish/yd^2.

Table 19. Relative Abundance of Fish Caught at Hunters Creek

Species	Fish/yd^2
Green sunfish	2.3
Mosquitofish	3.8

Minton Creek. Minton Creek was sampled in two places on August 12, 1998. Samples were taken in lower reaches of the creek because areas of the creek above the sample sites were dry. Hitch were found in only one of those stations, at a density of 0.5 fish/yd^2 .

Stone Corral Creek. Eleven stations were sampled on Stone Corral Creek between July 15, 1998, and January 6, 1999. Stations were located from the damsite to about 1 mile above. Flows were less than 1 cfs. Eight species of fish were found in Stone Corral Creek, including two species of game fish, green sunfish and bluegill (Table 20).

The fish most common fish among the stations was the Sacramento pike minnow followed by the hitch (Table 20). Fish density on Stone Corral was relatively low for all species at all stations. Hitch were the dominant species in terms of density 0.8 fish/yd^2.

Table 20. Species Caught at Each Station and Relative Abundance on Stone Corral Creek

Species	Station Sampled											Fish/yd2
	1	2	3	4	5	6	7	8	9	10	11	
Bluegill				X								0.002
California roach		X		X								0.02
Green sunfish			X					X	X	X	X	0.03
Hitch		X	X					X	X	X	X	0.8
Mosquitofish				X								0.002
Sacramento blackfish											X	0.2
Sacramento pike minnow			X	X	X	X		X	X		X	0.2
Sacramento sucker			X	X		X					X	0.02

Most seining stations on Stone Corral Creek were clustered around the same region. Station 1 was far upstream from the others and yielded no fish. The diversity of species caught was highest at stations 4 and 11.

Antelope Creek. Five seining stations were sampled on Antelope Creek between July 14, 1998, and November 25, 1998. Stations were evenly spaced between the mouth of Antelope Creek and the boundary of Sites Reservoir.

Streamflow was less than 5 cfs. Three species of fish were captured on Antelope Creek: green sunfish, hitch, and Sacramento pike minnow (Table 21). Hitch were the most abundant fish with an average density of 3.8 fish/yd^2. The Sacramento pike minnow and the green sunfish both had a relative abundance of 0.2 fish/yd^2.

Table 21. Species Caught at Each Station and Relative Abundance on Antelope Creek

Species	Station Sampled					Fish/yd2
	1	2	3	4	5	
Green sunfish		X		X	X	0.2
Hitch	X	X	X	X	X	3.8
Sacramento pike minnow				X	X	0.2

Logan Creek. Four stations were sampled on Logan Creek over two days in August 1998. Stations were located in and near the footprint of the proposed Colusa Reservoir. Streamflow was less than 1 cfs. Hitch were caught in stations 1 and 2. The average density of hitch on Logan Creek was 0.4 fish/yd^2.

Ponds. DFG biologist seined seven stock-watering ponds in the study area. The ponds seined do not dry up during the summer. Three game fish were found in the ponds, red-eared sunfish, bluegill, and largemouth bass. Redear sunfish were found in one pond, bluegill were found in abundance in two ponds, and largemouth bass were found in three ponds. No other fish were found in these ponds.

Discussion

Hitch were found in all the creeks in the Sites and Colusa Project area. Hitch were also present in the greatest numbers. Stone Corral Creek had the greatest diversity of fish throughout the year—eight species—including two species of introduced game fish, bluegill and green sunfish. However fish densities were lower, particularly for hitch in Stone Corral than in other creeks. Funks Creek, the next most diverse creek, had only five species of fish, including one introduced game fish, largemouth bass.

Most fish captured during seining were minnows, members of the Cyprinid family. California roach are the only fish present that are adapted to spending summers in the remaining pools of intermittent streams (Moyle 1976). Very few fish found while seining, including game fish, were above 5.9 inches in lengths, suggesting that juvenile fish only rear in these areas. Adult fish typically ascend seasonal creeks in the study area in winter and spawn there in early spring. Most adults migrate downstream after spawning.

No species of concern or threatened or endangered species were found in this study. The species caught during the study are common in California.

Colusa Basin Drain Fish Studies

This section describes the fish resources of the Colusa Basin Drain. Colusa Basin Drain is a natural channel that historically transported water from west side tributaries such as Willow, Funks, Stone Corral, and Freshwater Creeks to the Sacramento River. It also carried overflowing floodwater from the Sacramento River. With the advent of agriculture in the Sacramento Valley, the Colusa Basin Drain was channelized and dredged to carry agricultural runoff in addition to natural flows.

Streamflow in the CBD peaks in winter months when storms swell the small streams that feed the CBD. Flow also reaches high levels in late summer when rice fields are drained into the CBD. Table 22 shows average monthly streamflow in CBD from 1976 to 1997. Daily and instantaneous flows in the CBD may be much higher.

The CBD provides little bank cover for fish; however, some instream cover is provided by large and small woody debris. Its banks are scoured by periodic high flows and roads often run along the dikes that contain the waters of the CBD. The bottom of the CBD is largely mud. Water in the CBD is turbid and warm in the summer, and turbid and cool during the winter. The proposed diversion from the CBD for Sites and Colusa Reservoirs will be east of the town of Maxwell along the CBD.

Table 22. Average Monthly Streamflow (cfs) in the Colusa Basin Drain at the Highway 20 Crossing

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1976	237	249	160	185	177	371	312	879	239	434	926	904
1977	169	255	138	312	181	256	90	642	121	121	424	388
1978	116	272	254	3121	2133	1429	365	684	469	711	1056	1028
1979	201	312	113	689	940	407	328	802	424	803	1211	1029
1980	200	563	837	1874	2888	1305	326	1048	603	805	1307	1160
1981	275	328	359	1017	840	433	342	1039	446	1057	1464	1182
1982	284	877	1115	1939	472	383	682	743	908	n.r.	1393	1356
1983	467	778	1225	2331	3028	5304	990	n.r.	n.r.	907	1168	1198
1984	315	1302	3623	1523	493	265	547	1190	851	1310	1580	1041
1985	376	1160	683	285	170	196	409	1048	768	1237	1442	1442
1986	316	663	700	754	4214	1833	449	921	834	1052	1338	1338
1987	318	459	235	249	319	508	495	913	707	907	1175	1175
1988	341	668	462	1365	287	431	666	849	515	586	972	972
1989	345	617	354	342	212	404	438	572	587	800	995	995
1990	303	411	181	346	203	n.r.	n.r.	583	439	533	913	913
1991	247	n.r.	n.r.	153	217	916	423	477	353	371	535	535
1992	159	319	291	261	932	670	256	167	250	149	186	186
1993	116	267	347	2900	3049	762	322	279	290	201	489	489
1994	203	419	466	315	740	331	300	191	147	61	418	418
1995	155	565	549	6612	2020	3823	591	551	364	297	416	416
1996	255	368	749	972	2668	1092	493	771	472	249	660	660
1997	229	643	643	3698	1464	357	321	286	152	368	953	953
AVG	**256**	**547**	**642**	**1420**	**1257**	**1023**	**435**	**697**	**473**	**617**	**956**	**956**

Methodology

Two fyke nets were placed in the CBD, one upstream of the proposed diversion point and one downstream. The first net was put in at the confluence of Willow Creek and the CBD. The second was placed just south of Hwy 20 on the CBD. The fyke nets have a 3 foot-by-5 foot opening, and a 12-foot funnel. Galvanized pipe frames support the net opening. Nets of variable size stretched mesh were used: 1 inch, 0.25 inch, and 0.125 inch. The largest sized mesh was at the front of the funnel, and smallest size mesh was at the back. The narrow end of each net is connected to a wooden live box, 2.5 feet by 1.5 feet by 1.6 feet. Holes in the side and back of the box were covered by screening with a mesh size of 0.19 inch. The fyke nets were held in fishing position by rope bridles attached to ropes secured to metal fencing posts and/or a tree or utility pole on the bank. The nets were installed on January 19, 1999, and checked daily Monday through Friday. The nets were removed from the canal during periods of high water. Captured specimens were identified and measured for fork length to the nearest millimeter for the first 20 of each species, after which species were only tallied. Representatives of each species were either photographed or preserved for future positive identification.

Periodic seining using the medium sized—29-feet long, 6-feet high, one-quarter inch mesh; seine, and hook and line sampling were also used to sample the fish of the Colusa Basin Drain at the upper net location. Two hoop nets and a gill net were also placed at the upper fyke net location February 1, 1999. The hoop nets were installed upstream of the fyke net. The hoop nets were 7 feet long with six hoops 2 feet in diameter set 1 foot apart, with a net mesh size of 1 inch. They had two finger funnels each. These nets were secured to a wooden bridge and placed on either side of the channel. The hoop nets were baited with fish carcasses. The gill net spanned the entire distance of the drain downstream of the fyke net. These nets were removed March 10, 1999. One hoop was replaced at the bridge on March 19, 1999.

Results

A total of 9 game fish and 17 nongame fish were caught in the CBD (Tables 23 and 24). The warmouth (*Lepomis gulosus*) and the largemouth bass (*Micropterus salmoides)*, which were caught by U.S. Geological Survey in 1996, were not observed in this recent survey.

Table 23. Resident Game Fish of the Colusa Basin Drain

Common Name	Scientific Name
Black bullhead	*Ictalurus melas*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Brown bullhead	*Ictalurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Chinook salmon	*Oncorhynchus tschawtscha*
Green sunfish	*Lepomis cyanellus*
White catfish	*Ictalurus catus*
White crappie	*Pomoxis annularis*

Table 24. Resident Nongame Fish of the Colusa Basin Drain

Common Name	Scientific Name
Big scale logperch	*Percina macrolepida*
California roach	*Hesperoleucus symmetricus*
Carp	*Cyprinus carpio*
Flathead minnow	*Pimephales promelas*
Goldfish	*Carassius auratus*
Hitch	*Lavinia exilicauda*
Inland silversides	*Menidia beryllina*
Mosquitofish	*Gambusia affinis*
Pacific lamprey	*Lampetra tridentata*
Sacramento blackfish	*Orthodon microlepidotus*
Sacramento pike minnow	*Ptycholcheilus grandis*
Sacramento splittail	*Pogonichthys macrolepidotus*
Sacramento sucker	*Catostomus occidentalis*
Sculpin sp.	*Cottus sp.*
Threadfin shad	*Dorosoma pretenense*
Tui chub	*Gila bicolor*
Tule perch	*Hysterocarpus traski*

One late fall-run chinook salmon carcass was found in the upper fyke net. In October 1998, fall-run chinook salmon were observed migrating up the CBD at the Delevan Wildlife Area. DWR biologists saw spring-run chinook salmon in Walker Creek, a tributary to Willow Creek, in spring 1998. Four splittail were caught in the fyke net located just below Highway 20 in July and August, 1999. All four were young-of-the-year splittail. They averaged 1.4 inches, and ranged from 0.9 to 2.0 inches fork length.

The greatest diversity of fish was caught in the upper fyke net, at the confluence of Willow Creek and the CBD. The gill net and the hoop net caught only a few different species of fish (Table 25). Various tadpoles, mostly bullfrog, (*Rana catesbieana)*, were by far the most numerous animal caught by any method, but particularly the fyke nets. Channel catfish were the most frequently caught fish, the majority of which were juveniles. Mostly juvenile fish were caught in the nets. Rarely did fish exceed 5.9 inches, with the exception of the goldfish. Adult channel catfish, up to 17.7 inches, were caught by hook and line. Carp, up to 20 inches, were also caught with hook and line.

Seining was the most efficient form of sampling in the Colusa Basin Drain, with a catch per hour effort ratio of 21.8. The hoop net was the least efficient method of capture, with a catch per hour effort ratio of 0.01 (Table 26).

Table 25. Number of Species Captured at Each Trapping Station

Species	Gill net	Hoop net	Seine	Hook & line	Fyke nets	Total
Big scale logperch			2		3	5
Black bullhead				1	7	8
Black crappie			1		2	3
Bluegill	1	1	10	1	23	36
Brown bullhead				20	18	38
California roach			15		1	16
Carp				69	2	71
Channel catfish	2	1		28	195	226
Chinook salmon					1	1
Flathead minnow					1	1
Goldfish				16	15	31
Green sunfish			8		48	56
Hitch			40	1	52	93
Inland silversides			1		4	5
Mosquitofish			3		6	9
Pacific lamprey					7	7
Sacramento blackfish			96		23	119
Sacramento pike minnow	1				2	3
Sacramento splittail					4	4
Sacramento sucker	1	1	1		3	6
Sculpin sp.			1		1	2
Threadfin shad					6	6
Tui chub						1
Tule perch		1			4	5
White catfish				7	18	25
White crappie					3	3

Table 26. Catch Per Hour Effort for Each Trapping Method

Trapping Method	Total Effort Hours	Catch per Hour Effort
Gill net	336	0.02
Hoop net	576	0.01
Seine	8	21.8
Hook and line	41	3.5
Fyke net	2500	0.25

Discussion

Four Sacramento splittail were caught. This species were federally listed as threatened in March 1999. Numerous fall-run chinook salmon were observed in the CBD and the carcass of one late fall-run chinook salmon was found. Fall-run chinook salmon and late fall-run chinook salmon are federally proposed for listing as threatened. Spring-run chinook salmon were observed in Walker Creek, a tributary to the CBD. They were listed as a State of California Threatened Species in February 1999. They are also proposed for listing as a federally endangered species.

Willow and Freshwater Creeks are tributaries to the CBD. They flow all year in their upper reaches and have deep pools suitable for steelhead juveniles. Steelhead smolts migrate during high stream flows in the winter. The nets set up in the CBD might not have caught them because larger fish and migrating yearling steelhead avoid fixed fyke nets. Willow and Freshwater Creeks should be sampled during summer to detect rearing steelhead fry.

Sites and Colusa Project Habitat Types

This section summarizes studies of habitat types along the streams in the proposed Sites and Colusa Project areas conducted in 1998 and 1999.

Methodology

An initial channel type survey, including an evaluation of the overall channel morphology, was made at the beginning of the study of each creek. Channel type was subsequently determined when the overall character of the channel changed for over 20 bankfull widths.

Channel type surveys began by first noting if the stream is a threaded or single channel. Then the bankfull width was measured at the prominent scour marks and sedimentation on the bank substrate with a 100-foot vinyl tape. Ten depths were taken at the study section to obtain the average bankfull depth. The substrate type was noted (Table 27).

Table 27. Substrate Type and Size Used[1]

Substrate Type	Size in inches
Boulder	> 10
Large Cobble	5-10
Small Cobble	2.5-5
Gravel	0.08-2.5
Sand	<0.08

[1] Flosi et al. 1998

Habitat type evaluation on Funks Creek began at Golden Gate damsite on January 12, 1999, and proceeded upstream to a point just above the mouth of Grapevine Creek on February 25, 1999. After this point, Funks Creek no longer contained water. Habitat typing continued on Grapevine Creek from the confluence with Funks Creek on February 26, 1999, and concluded at the reservoir inundation line on April 28, 1999. Stone Corral Creek habitat typing began on February 10, 1999, and continued until the channel no longer contained water, just past the confluence of Antelope Creek. Habitat typing concluded for Stone Corral and began on Antelope Creek on February 23, 1999. Habitat typing concluded on Antelope Creek on April 22, 1999, at the reservoir inundation line.

Each habitat unit was described as a pool, flat water, or riffle. All data was recorded on a standardized habitat typing data sheet (Flosi et al. 1998). Side channels were evaluated separately only when they demonstrated a different habitat type due to the small nature of the creek bed and intermittent water flow. Once the habitat unit type was identified it was assigned a unit number. For each unit, a mean length (measured as the thalweg length), width, and depth were taken, as well a maximum depth. All measurements were made and recorded in feet and tenths of feet using standard engineering measuring tapes and stadia rods. For pools, the tail-crest depth, type of pool-tail substrate, and the percent the substrate is embedded were also evaluated.

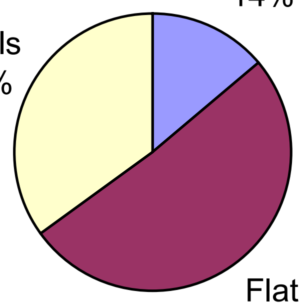
In addition to unit type data, the time surveying began, air and water temperature, date, and surveyors present were all recorded daily. Yellow flags were left at the end of the last habitat unit surveyed each day. The substrate type and percent exposed substrate was recorded. A shelter value for the unit was given based on the quantity and composition of the cover. The total percent cover for the habitat unit was recorded, then broken down into the percentages of the total that each cover element represented.

The bank composition was evaluated and dominant vegetation for right and left banks was recorded. Plant species and bank substrates were entered. The percent of the bank vegetated was evaluated up to bankfull width plus 20 feet. The percent and type, (deciduous or coniferous), of cover by tree canopy at midday was also evaluated. This was done for the entire part of each stream studied.

Results

Funks Creek. Flat water constituted 51 percent of the total creek measured. The average flat water length on Funks Creek was 212 feet. Pools at 35 percent of the total length with an average length of 146 feet, were the second most dominant habitat type. Riffles constituted 14 percent of the creek, with an average unit length of 57 feet (Figure 4).

Figure 4. Relative Occurrence of Habitat Types in Funks Creek



Gravel was the most common substrate (Table 28). Small cobble substrate was the second most common substrate type, occurring at 28 percent of the units surveyed. Silt/clay type substrate was most commonly associated with the gravel substrate, either as the primary or secondary substrate. It also frequently occurred as a layer over bedrock or boulder substrates. Silt/clay was the dominant substrate in the lower reaches of Funks Creek, giving way to gravel as the dominant substrate in the upper reaches of the stream.

Table 28. Summary of Substrates (%) by Habitat Type on Funks Creek

Habitat type	Silt/Clay	Sand	Gravel	Small cobble	Large cobble	Boulder	Bedrock
Riffle	19	0	26	21	10	1	24
Flat water	11	1	33	21	5	8	21
Pool	6	1	41	43	5	2	2
Average	12	1	33	28	7	4	15

The bank composition was overwhelmingly silt/clay. Occasional areas of bedrock bank or cobble bank occurred; where roads passed through or near the creek, boulders dominated the bank. Greater variability of bank composition occurred in the lower reaches of the creek. Most bedrock banks occurred in major blocks where bedrock ridges rose through the valley floor.

Star thistle and grasses dominated both banks. The average percent bank covered by vegetation was 52 percent for the right bank and 53 percent for the left bank. Occasional cottonwoods, willows, oaks, and walnut trees punctuate the bank. Only 18 percent of the habitat units had some degree of canopy. The average canopy cover was 5 percent, or 26 percent when considering only those units that had any canopy cover at all. Trees were concentrated at Golden Gate, where habitat typing began on Funks Creek, and in the upper reaches of the creek.

The average of the total units covered by all cover combined was 27 percent. Aquatic vegetation was the prevalent type of cover, boulders were the most common large cover item. Aquatic vegetation and boulders each comprised an average of 25 percent of the total cover (Table 29). Large woody debris and root masses occurred relatively infrequently. Undercut banks occurred in 17 percent of the habitat units. Pools overall had a large degree and variety of cover, while flat water and riffles had less cover.

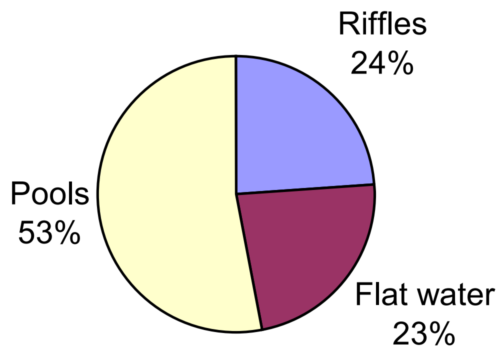
Table 29. Summary of Habitat Cover in Funks Creek

	Percent of each habitat having cover	Percent of Cover Type									
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Riffles	20	-	-	1	-	20	15	30	28	6
Flat water	38	34	1	1	-	1	27	10	25	1
Pools	24	18	3	1	1	1	34	2	21	19
Average	27	17	1	1	-	7	25	14	25	9

Grapevine Creek. Riffles made up 24 percent of the total creek measured (Figure 5). The average riffle length on Grapevine Creek was 72 feet. Flat water made up 23 percent of the total length with an average length of 143 feet, and was the least dominant habitat type. Pools made up just over half, 53 percent, of the total length of Grapevine Creek within the reservoir footprint.

Small cobble was the most common substrate in Grapevine Creek. Gravel was also common, occurring as the substrate in 30 percent of the habitat units. Large cobble was the dominant substrate in 13 percent of the units surveyed. Small cobble substrate was spread throughout the creek system; however, there were no distinct pockets of this or any other substrate.

Figure 5. Relative Occurrence of Habitat Types in Grapevine Creek



Thirty-two percent of the pools on Grapevine Creek were dominated by small cobble substrate. Gravel was dominant in 22 percent of these. Flat water was dominated by gravel and small cobbles (Table 30).

Table 30. Summary of Substrates on Grapevine Creek

	Silt/Clay	Sand	Gravel	Small cobble	Large cobble	Boulder	Bedrock
Riffle	5		32	24	11	1	27
Flat water	12	1	35	41	7	2	2
Pool	6		22	32	21	5	14
Average	8		30	32	13	3	14

Bank composition was overwhelmingly silt/clay. Frequent patches of gravel/cobble banks occurred throughout the creek channel surveyed. Most bedrock banks occurred in major blocks where bedrock ridges rise through the valley floor.

Grasses and star thistle dominated both banks. The average percent bank covered by vegetation was 56 percent for the right bank and 54 percent for the left bank. Occasional oaks, willows, cottonwoods, walnuts, and gray pines punctuate the bank. Thirty-nine percent of the habitat units examined on Grapevine Creek had some degree of canopy—38 percent from deciduous trees and shrubs, and 1 percent from pines. The average canopy cover was 12 percent. Trees were more concentrated at the upstream end where Grapevine Creek starts to climb in elevation toward the edge of the reservoir footprint.

The average of the total unit covered by all cover combined was 29 percent. Aquatic vegetation was the most prevalent type of cover, occurring in 72 percent of the flat water units surveyed. Aquatic vegetation comprised an average 53 percent of the total unit cover (Table 31).

Pools had the largest mean total coverage at 32 percent. Aquatic vegetation comprised 46 percent of the cover in pools. Riffles had a mean total cover 28 percent, 40 percent of which was aquatic vegetation. Terrestrial vegetation, boulders, and bubble curtains also provided cover in riffles—14 percent, 17 percent, and 7 percent, respectively. Flat water averaged 26 percent total coverage, of this 72 percent of the cover was aquatic vegetation.

Aquatic vegetation was the most common large cover item, occurring in 53 percent of the units surveyed. Root masses were another large cover item that occurred with some frequency at 7 percent. Terrestrial vegetation occurred in 9 percent of the habitat units, and bedrock ledges in 4 percent of the units. Riffles and pools contained all of the major types of cover (Table 31).

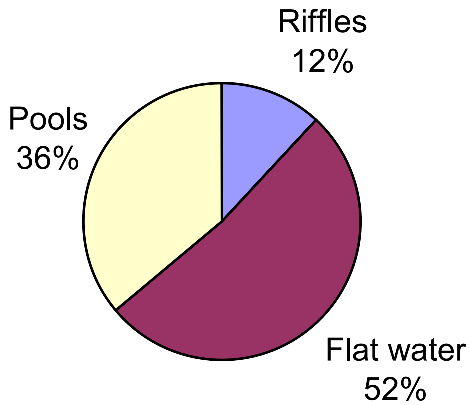
Table 31. Summary of Habitat Cover in Grapevine Creek

	Percent of each habitat having cover	Percent of Cover Type								
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Riffles	28	1	3	3	13	14	40	7	17	2
Flat water	26	5	3	-	4	8	72	4	4	-
Pools	32	7	3	12	4	4	46	4	9	11
Average	29	4	3	5	7	9	53	5	10	4

Stone Corral Creek. Flat water made up the majority of habitat type measured, comprising 52 percent of the total creek. The average flat water length on Stone Corral Creek was 213 feet. Pools, making up 36 percent of the total length and with an average length of 145 feet, were the second most dominant habitat type in terms of total footage. Riffles made up 12 percent of the creek's total length, with an average unit length of 48 feet (Figure 6).

Bedrock was the most common substrate, occurring as the primary substrate in 31 percent of the total units surveyed on Stone Corral Creek. Gravel substrate was the second most common substrate type, occurring in 24 percent of units surveyed. Silt/clay type substrate was commonly associated with bedrock or gravel, occurring as a layer over the other substrates. The lower reach of Stone Corral Creek was heavily dominated by bedrock, giving way to a more gravel base near the confluence with Antelope Creek. Silt/clay substrate is spread consistently throughout the creek system.

Figure 6. Relative Occurrence of Habitat Types in Stone Corral Creek



Thirty-three percent of pools had silt/clay as the dominant substrate (Table 32). Fifty-two percent of flat water had gravel as the dominant substrate. Riffles had 56 percent bedrock dominant and 17 percent silt/clay dominant substrate. The most common occurring pool tail substrate was bedrock.

Table 32. Summary of Substrates on Stone Corral Creek

	Silt/Clay	Sand	Gravel	Small cobble	Large cobble	Boulder	Bedrock
Riffle	17		9	1		17	56
Flat water	20		52		14	14	
Pool	33	5	12	2		12	36
Average	23	2	24	1	5	14	31

The bank composition was overwhelmingly silt/clay. Occasional areas of bedrock bank or cobble bank occurred; where roads passed through or near the creek, boulders dominated the bank. Greater variability of bank composition then occurred in the lower reaches of the creek, where cobbled banks frequently occurred. Most bedrock banks occurred in major blocks where bedrock ridges rise through the valley floor.

Bank vegetation included grasses and star thistle, which dominated both banks. The average percent bank covered by vegetation was 62 percent for the right bank and 63 percent for the left bank. Occasional oaks, willows, cottonwoods, and walnut trees punctuate the bank. Only 11 percent of the habitat units surveyed had some degree of canopy. The average canopy cover was 4 percent, all deciduous trees and shrubs. Trees were more concentrated at the lower end where habitat typing began on Stone Corral Creek.

The average of the total unit covered by all cover types combined was 33 percent. Aquatic vegetation was the most prevalent type of cover, comprising an average of 56 percent of the total unit coverage.

Riffles had a mean total cover of 39 percent, 49 percent of which was aquatic vegetation. An average of 7 percent of the cover in riffles was comprised of boulders. Flat water averaged 34 percent total coverage, of this 61 percent of the cover was aquatic vegetation. Pools had a mean percent total coverage of 26 percent.

Aquatic vegetation was the most common large cover item, occurring in 56 percent of the units surveyed. Boulders and terrestrial vegetation were the next most common cover items at 16 percent and 12 percent, respectively. Undercut banks occurred in 6 percent of the habitat units, and bedrock ledges in 4 percent of the units. No habitat unit types contained all major types of cover (Table 33).

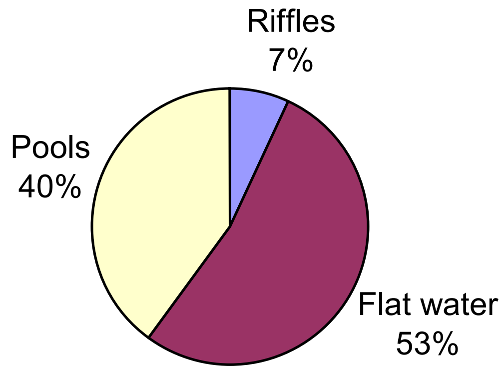
Table 33. Summary of Habitat Cover in Stone Corral Creek

	Percent of each habitat having cover	Percent of Cover Type								
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Riffles	39	-	-	-	-	25	49	18	7	2
Flat water	34	5	5	-	-	6	61	-	21	3
Pools	26	12	-	-	1	4	57	-	19	7
Average	33	6	2	-	-	12	56	6	16	4

Antelope Creek. Flat water made up the majority of the total footage measured, comprising 53 percent of the total creek measured. The average flat water length on Antelope Creek was 135 feet. Riffles made up 7 percent of the creek's total length, with an average unit length of 18 feet. Pools comprised 40 percent of the total length measured with an average length of 103 feet (Figure 7).

Silt/clay was the most common substrate, occurring as the primary substrate in 24 percent of Antelope Creek. Gravel and small cobble were also common substrates at 22 percent each. Silt/clay type substrate was commonly associated with gravel. Small cobble increased in frequency of occurrence in the upper reaches of Antelope Creek. Gravel substrate occurred uniformly throughout Antelope Creek (Table 34).

Figure 7. Relative Occurrence of Habitat Types in Antelope Creek



Silt/clay dominated the majority of pools. Twenty-nine percent of flat water units had silt/clay as the dominant substrate. Gravel and small cobbles at 23 percent and 22 percent respectively (Table 34) dominated riffles.

Table 34. Summary of Substrates on Antelope Creek

	Silt/Clay	Sand	Gravel	Small cobble	Large cobble	Boulder	Bedrock
Riffle	7	2	23	22	7	9	30
Flat water	29	3	25	27	7	2	7
Pool	35	3	18	16	10	14	4
Average	24	3	22	22	8	8	14

Bank composition was largely silt/clay. Occasional areas of bedrock bank or cobble bank occurred; where roads passed through or near the creek, boulders dominated the bank. The diversity of bank substrate increased, particularly gravel and cobble, in the upper reaches of Antelope Creek.

Grasses and star thistle dominated both banks. The average percent bank covered by vegetation was 80 percent for the right bank and 80 percent for the left bank. Oaks, willows, cottonwoods, walnut trees, and gray pines punctuate and occasionally line the bank. Forty-seven percent of the habitat units surveyed had some degree of canopy. The average canopy cover was 20 percent. Trees were more concentrated at the middle to upper reaches.

The average of the total stream habitat covered was 31 percent (Table 35). Aquatic vegetation was the most prevalent type of cover, occurring in 65 percent of the units surveyed. Aquatic vegetation comprised an average of 46 percent of the total unit cover.

Riffles had an average total cover of 34 percent, with 43 percent aquatic vegetation. Flat water averaged 30 percent total coverage—58 percent aquatic vegetation. The primary cover for all units was aquatic vegetation. Some units indicated a higher percentage of cover, but these occur on an infrequent basis in this creek.

Aquatic vegetation and terrestrial vegetation were the most common large cover items, occurring in 46 percent and 17 percent respectively of the units surveyed. Most units surveyed had small amounts of a variety of cover types.

Table 35. Summary of Cover in Antelope Creek

Habitat type	Percent of each habitat having cover	Percent of each habitat type								
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Riffles	34	4	5	4	15	16	43	1	12	-
Flat water	30	4	3	1	8	19	58	1	5	1
Pools	29	18	7	1	7	15	37	1	13	1
Average	31	9	5	2	10	17	46	1	10	1

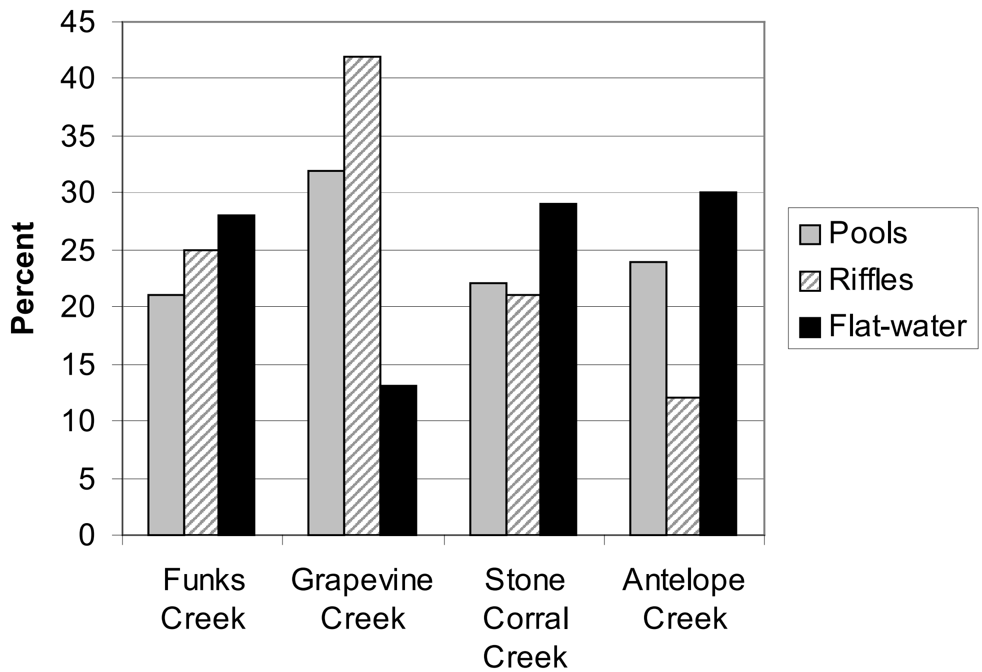
Discussion

Habitat typing was done to quantify physical aquatic habitat to provide information for the NEPA and CEQA process. This quantification will determine habitat lost by inundation and will form the basis for mitigation. Grapevine Creek had more pools and riffles. Grapevine Creek also had the least amount of flat water. Funks Creek and Stone Corral Creek had similar amounts of pools, flat water, and riffles. Antelope Creek was more like Stone Corral and Funks Creeks than Grapevine Creek. Grapevine Creek flows from springs in hills to the west of Sites-Colusa and is steeper than the other creeks. That causes Grapevine Creek to have less flat water than the other creeks (Table 36 and Figure 8).

Table 36. Comparison of Relative Occurrence of Pools, Flat Water, and Riffles in Creeks in the Sites-Colusa Project Area

	Funks	Grapevine	Stone Corral	Antelope
Pools	21	32	22	24
Riffles	25	42	21	12
Flat water	28	13	29	30

Figure 8. Relative Occurrence of Habitat Types in Sites-Colusa



Stone Corral Creek had a high abundance of larger substrates. Grapevine Creek had the lowest percentage of silt. Grapevine Creek also had the most gravel, small cobble, and large cobble substrate. Fine materials are abundant in Stone Corral and Antelope Creeks. The relatively steep nature of Grapevine Creek washes fine materials away and leaves coarser materials behind (Table 37).

Table 37. Summary of Substrates (%) by Habitat Type on Creeks in the Sites-Colusa Study Area

Creek	Habitat type						
	Silt/Clay	Sand	Gravel	Small cobble	Large cobble	Boulder	Bedrock
Funks	12	3	32	28	7	3	15
Grapevine	8	1	30	32	13	3	13
Stone Corral	23	2	24	1	5	14	31
Antelope	24	3	22	22	8	8	13

The occurrence of cover types followed the same trends for all four creeks surveyed. Aquatic vegetation was the dominant cover type in each creek. Stone Corral Creek showed a higher percent occurrence of boulders—nearly twice as many as Antelope Creek and nearly five times as many as Funks and Grapevine Creeks.

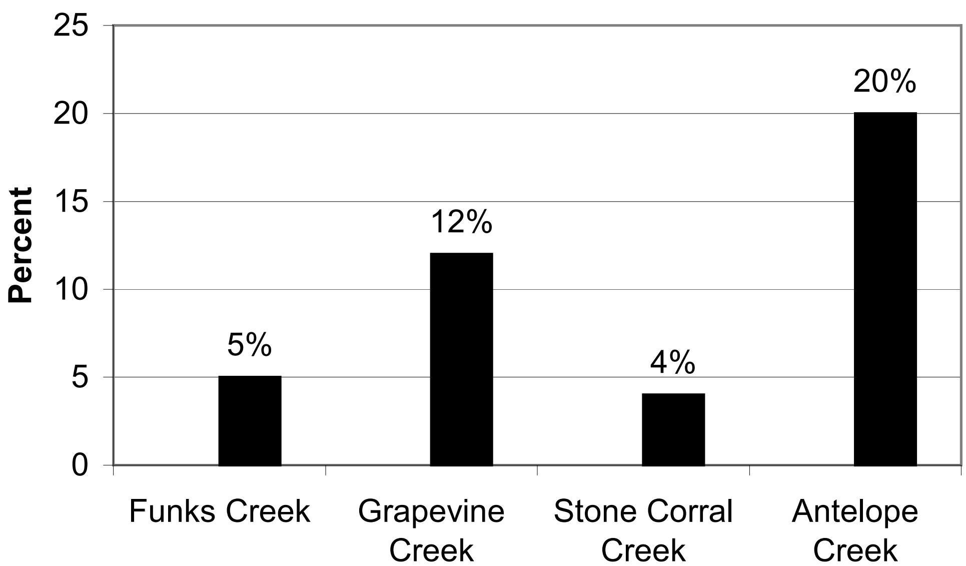
Bubble curtains were more common in Funks Creek. Antelope Creek had more cover provided by root masses than the other creeks (Table 38).

Table 38. Summary of Cover (percent of each habitat type) on Creeks in the Sites-Colusa Study Area

Creek	Percent of each habitat having cover	Percent of Habitat Cover								
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Funks	27	17	1	1	1	7	25	14	25	9
Grapevine	29	4	3	4	7	10	53	6	10	4
Stone Corral	33	6	1	-	1	10	54	6	16	4
Antelope	31	9	5	2	10	17	46	1	9	1

The pools of all four creeks had similar degrees of cover for all habitats, which were spread very closely to 30 percent coverage. Notable spikes in percent unit covered occurred in unit types that have a very low frequency of occurrence. Grapevine and Antelope Creeks show an increase in the occurrence of canopy (Figure 9).

Figure 9. Percent of Canopy Over Creeks Measured at Sites-Colusa Project Area



Creek flows varied widely with lack of rainfall, forcing activity to be suspended on some areas of Funks, Stone Corral, and Antelope Creeks until further rain revived the stream flow. This suggests that streams on the floor of the Antelope Valley are intermittent and only flow during the summers of particularly wet years. Antelope Creek, and particularly Grapevine Creek, could flow year round. The majority of the fish found in this area were juvenile fish that would probably use the creeks only as rearing areas. The high concentration of sediments and aquatic vegetation would also raise the biological oxygen demand in the creeks during the summer months in any remaining deeper pools, making them uninhabitable to most fish, with the exception of the California roach, *Lavinia exilicauda* (Moyle 1976).

Both Grapevine and Antelope Creeks are the continuations of the main creek channels of those systems. Both creeks also show an increase in canopy and larger substrates. When viewed as just two creek systems, Funks-Grapevine and Stone Corral-Antelope both show a trend toward more canopy and larger substrates. The increased canopy and decreased sedimentation in the upper reaches of Antelope Creek and Grapevine Creek may provide sufficient cooling factors for year-long fish inhabitants. Eight-to-10 inch largemouth bass, *Micropterus salmoides*, were seen in the upper reaches of Grapevine Creek, which suggests a year-round flow capable of supporting larger fish. The larger substrate size also provides cover for the minnow fry that occupy the creeks in the spring.

Very little riparian vegetation, such as rushes, essential cover for aquatic amphibians and reptiles, exists on the banks of any of the creeks in the Sites-Colusa Project area, with the exceptions of the upper reaches of Antelope and Grapevine Creeks.

Summary of Fish Studies for Proposed Projects

Thomes Creek has runs of fall-run, late fall-run, and limited numbers of spring-run chinook salmon. Steelhead also spawn in Thomes Creek. Large runs of Sacramento suckers and Sacramento pike minnows migrate up Thomes Creek. Fall-run salmon, Sacramento suckers, and Sacramento pike minnow also migrate up Stony Creek. Cottonwood Creek has larger runs of fall-run, late fall-run, and spring-run chinook salmon. Cottonwood Creek has a run of steelhead, as well as annual migrations of Sacramento suckers and Sacramento pike minnows. Stone Corral Creek and Funks Creek have no established runs of chinook salmon but have small runs of Sacramento suckers and Sacramento pike minnows.

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