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DEPARTMENT OF FISH AND GAME

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Fisheries Studies at Stony Creek, Thomes Creek, Sites and Newville Projects, and Colusa Basin Drain

Progress Report

May 2003

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FOREWORD

In the 1990's the California Department of Water Resources (DWR) began to study the means of and locations for developing additional water projects in the northern Sacramento Valley of California. The emphasis was on storing water in reservoirs on small streams on the west side of the Sacramento River, from which most of the water would come. This stored water would be used to provide releases for local agricultural irrigation and wetland use in exchange for water that would have been diverted from the Sacramento River. Several alternatives for developing additional water sources have been identified. Sites and Newville projects are two of them. This report provides part of the fisheries information that would be required in the event that construction of one of these projects is pursued. At present, studies are continuing through June, 2003.

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DEPARTMENT OF FISH AND GAME

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CHAPTER 1

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This report describes the physical and operational features of two potential water projects and studies to date on fisheries resources in these areas. The report includes the following:

- descriptions of the fishery resources,
- preliminary estimates of project effects on habitat for these resources,
- estimates of measures that might be required to offset adverse effects,
- recommendations on studies needed if project planning is pursued further.

Fish studies were conducted in the Sites and Newville project areas from 1998-2001. Seven species of fish were caught or observed in the Newville project area in 2001. Twelve species of fish were caught in the Sites project area in 1998 and 1999. Most of the fish caught were juveniles; however, in the spring of 1998, a single spring-run chinook salmon (*Onchorynchus tshawytscha)* was observed in Antelope Creek in the Sites project area.

As part of the Newville Project, fish studies were conducted on Thomes Creek in the 1980's and several surveys were conducted after 1998. Construction of the Thomes Creek diversion and conveyance would alter flows in lower Thomes creek and affect any chinook salmon or steelhead trout present. In 1980, thirteen juvenile chinook salmon were caught in Thomes Creek by seining. In 1981, six juvenile chinook salmon and seven juvenile steelhead were caught by seining; 206 juvenile chinook salmon were caught in fyke nets. In 1982, 384 juvenile chinook salmon were caught in fyke nets. In the 1980-1981 fall-run surveys, DFG staff tagged fifty-nine chinook salmon carcasses. In the 1981-1982 surveys, staff tagged thirty-eight carcasses. In the 1999 spring-run snorkel surveys, one chinook salmon was seen in Thomes Creek. In 2002, four spring-run chinook salmon were sighted. Twenty-two species of resident fish and migratory nongame fish were found on Thomes Creek in 1982.

As part of the Newville Project, the Department of Fish and Game (DFG) and the United States Bureau of Reclamation (USBR) are conducting a cooperative monitoring project on lower Stony Creek to determine the presence or absence of special status spring-run, fall-run, late-fall-run and winter-run chinook salmon and steelhead trout (*Onchorynchus mykiss*). Construction of Newville Reservoir would alter flows in lower Stony Creek and affect any chinook salmon or steelhead trout present. In 2001, two hundred and sixteen juvenile chinook salmon were caught in seines and thirteen other fish species were caught. Two hundred and seventeen juvenile salmon were caught in 2002 along with seventeen other fish species.

As part of the Sites Project, studies were done on the Colusa Basin Drain (CBD), a potential water source for Sites Reservoir. Twenty-seven species of fish were caught in 1998 and 1999 during these studies. Most of these fish were also juveniles. Spring- and fall-run chinook salmon were observed in the CBD during the studies, as well as Sacramento splittail (*Pogonichthys macrolepidotus*), a federally threatened species.

In the five study areas discussed in this report, DFG caught or observed a total of four special status fish species (Table 1).

Table 1. Special status fish species found in the study areas.

SPECIES	STATUS	SITES	NEWVILLE	COLUSA BASIN DRAIN	THOMES CREEK	STONY CREEK
Sacramento splittail	Federal threatened species, state "Species of Concern"			X		
Hardhead	State "Species of Concern"				X	X
Steelhead	Federal threatened species		X		X	
Chinook salmon (spring-run)	Federal and State threatened species	X		X	X	X
Chinook salmon (fall/late fall-run)	Federal candidate species			X	X	X

DFG conducted stream habitat typing on four creeks in the Sites project area in 1998 and 1999 to quantify physical aquatic habitat and to provide information for the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) processes. This quantification will determine what habitat would be lost by inundation and will form the basis for mitigation.

Conclusions and Recommendations

1. We conclude that of the two projects evaluated, the Sites project would have less overall impact on fish habitat.
2. Modification of flows could reduce habitat for late fall-run chinook salmon in Stony Creek.
3. Modification of flows could reduce habitat for hardheads, a state "Species of Concern," that spawn and rear in Stony Creek
4. Modification of flows could also reduce habitat for Sacramento suckers and Sacramento pikeminnows that spawn and rear in Stony Creek.
5. Flow reduction would limit spawning and rearing opportunities for chinook salmon in Thomes Creek.
6. Reduction of flows on Thomes Creek could also limit spawning and rearing opportunities for hardheads, a state "Species of Concern."
7. Reduction of flows in Thomes Creek could limit spawning and rearing opportunities for Sacramento suckers and Sacramento pikeminnows.
8. A dam on Thomes Creek would block small populations of spring-run salmon from reaching their holding and spawning grounds.
9. A dam on Thomes Creek would block small populations of steelhead from reaching their holding and spawning grounds.
10. The creation of Newville Reservoir could eliminate a population of resident rainbow trout that live in a tributary of Stony Creek.
11. Altering flow patterns in the Colusa Basin Drain could affect migration and reproduction patterns of fall- and late fall-run chinook salmon, spring-run chinook salmon and splittail.
12. Further studies should be conducted downstream of the dam sites on Funks and Stone Corral Creeks.
13. Further studies should be conducted on Funks reservoir.
14. Specific fish compensation plans should be prepared.

CHAPTER 2

INTRODUCTION

In late 1997, DWR began a two-year reconnaissance level study of North of the Delta Offstream Storage projects, authorized by Proposition 204 - the Safe, Clean, Reliable Water Supply Act approved by voters in 1996. DFG began fisheries studies in 1998. In early 1999, CALFED consolidated all storage investigations under a comprehensive program called Integrated Storage Investigations (ISI). 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 analyzes engineering, economic, and environmental impacts to determine the feasibility of four north-of-the-delta storage projects. The four potential alternatives (Figure 1) selected were the following:

- Sites Reservoir
- Colusa Project
- Thomes-Newville Project
- Red Bank Project

Phase I of the North of the Delta Offstream Storage Investigation included preliminary field surveys of environmental resources and extensive field surveys of cultural

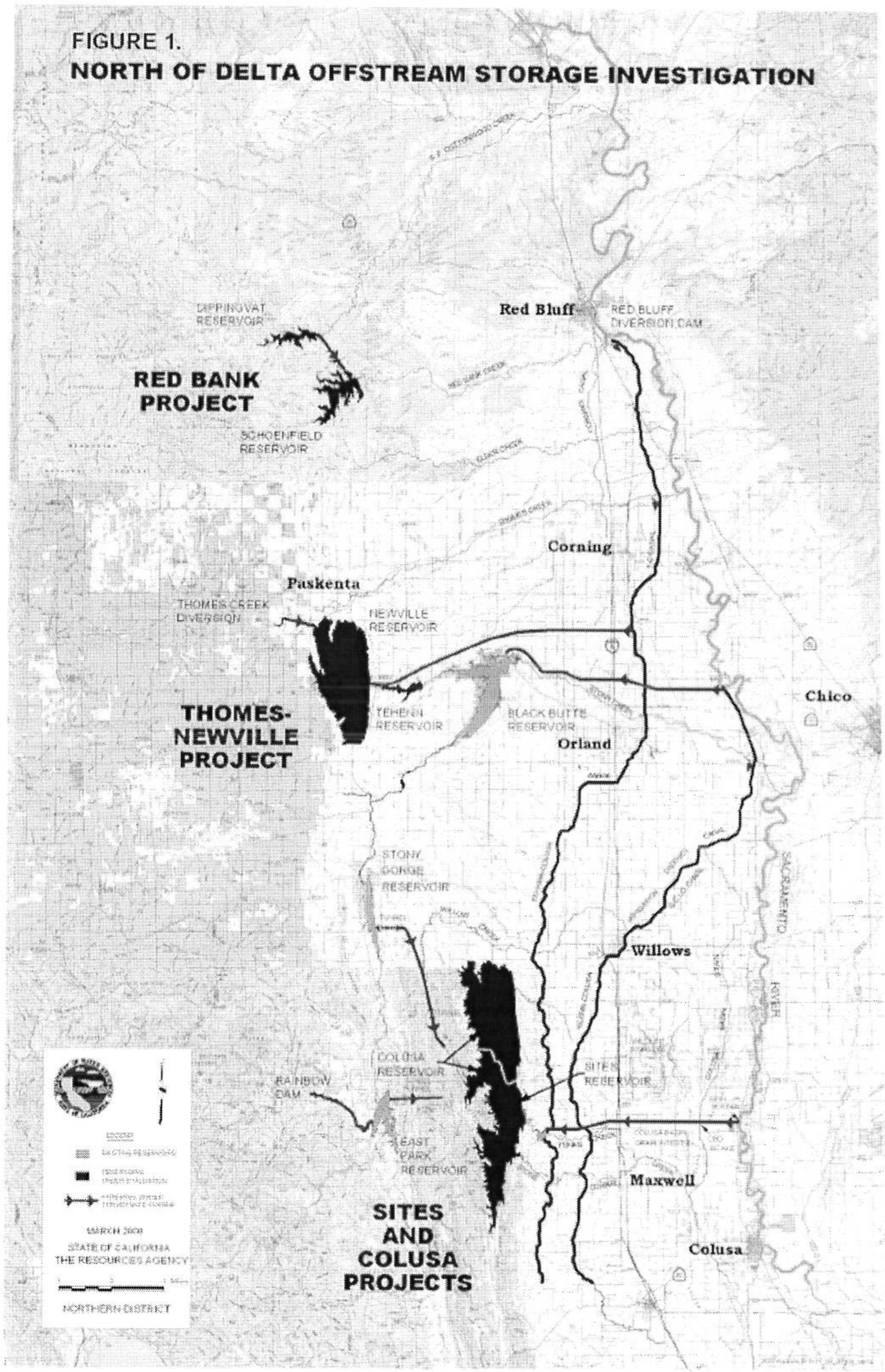


FIGURE 1.
NORTH OF DELTA OFFSTREAM STORAGE INVESTIGATION

resources; geological, seismic and foundation studies; and engineering feasibility evaluation. Phase II will begin when CALFED's Record of Decision and Certification for the Programmatic EIR/EIS are completed. Phase II includes completion of necessary fish and wildlife surveys; evaluation of potential mitigation sites; preparation of project-specific environmental documentation and final project feasibility reports; and the acquisition of permits necessary to implement the project.

Under Phase I, DFG conducted studies of fish and wildlife resources in each project area. Red Bank, Colusa and Sites project areas were the focus of studies until DWR selected Sites and Newville as preferred projects in 2001. Studies focused on those projects in 2001 and 2002. This report describes fisheries studies conducted by the DFG study team during 1998-2002, and it covers studies previously conducted in each project area. It describes studies on fish populations within potential inundation areas, studies of salmonid and non-salmonid fishes of Stony and Thomes Creeks, and studies of the fishes of the Colusa Basin Drain. A description of aquatic habitat of streams in the Sites inundation area is also included. Funding was not available for stream habitat typing in the Newville project area.

This information will be used to describe impacts on fish resources during the planning process.

CHAPTER 3

PROJECT DESCRIPTION

This study area was identified in the August 2000 CALFED Programmatic Environmental Impact Study/Environmental Impact Report and Record of Decision. The CALFED Preferred Programmatic Alternative identified a need for up to 7.4 billion cubic meters (six million acre-feet) of new storage in California, including up to 3.7 billion cubic meters (three million acre-feet) of storage to be located North-of-the-Delta. The North-of-the-Delta Offstream Storage Investigation is a continuation of studies started by CALFED agencies and will be used to support the completion of a site specific Environmental Impact Study/Environmental Impact Report.

As a matter of policy, CALFED surface storage programs focus on offstream reservoir sites for new surface storage, as well as expansion of existing onstream reservoirs. Onstream reservoir sites are not being pursued due to environmental impacts and implementation difficulties. This policy decision is based on the CALFED Solution Principle that prohibits redirecting impacts. Since construction of new onstream reservoirs could significantly limit the success of the CALFED Ecosystem Restoration Program by redirecting impacts, onstream reservoirs were eliminated from further consideration.

Offstream Storage

Traditionally, reservoirs are created by constructing dams accross major streams. These reservoirs are considered onstream storage. Offstream storage involves diverting water out of a major stream and transporting the water through various conveyance systems to a reservoir. An offstream storage reservoir is typically constructed off a major stream, but at times may be located on a small or seasonal stream that contributes a minor share of the water supply of the reservoir. Offstream storage investigations include extensive evaluation of the diversions and conveyance facilities required to carry the water to the reservoirs.

Storing water in offstream reservoirs under excess flow conditions can provide opportunities to increase dry-year water supply reliability for environmental, urban and agricultural water users and improve the timing of its availability for multiple uses in an environmentally sensitive manner. It may also improve water quality for all beneficial uses.

Offstream storage would allow water to be diverted and stored outside of the irrigation season when streamflows are highest or at times that are not critical to fish migration. This stored water can be released for local agricultural and refuge use in exchange for water diversions that would have been diverted from the Sacramento River when fish migration could be impaired. Such an exchange program and the associated reduction in water diversions from the Sacramento River during the irrigation season would reduce diversion impacts to the Sacramento River fishery.

Sites Reservoir

Sites Reservoir would be located about 16 kilometers (10 miles) west of Maxwell and would be formed by constructing dams on Stone Corral Creek and Funks Creek (Figure 2). Evaluation of a Sites Project has focused on a 2.22 billion cubic meter (1.8 million acre-foot [maf]) reservoir, although a 1480 cubic meter (1.2 maf) reservoir has also been considered. A 2.22 billion cubic meter (1.8 maf) Sites Reservoir would require construction of nine saddle-dams to block saddles between hills along the southern edge of the Hunters Creek watershed. Flows occurring outside the irrigation season in the Colusa Basin Drain, the Sacramento River and local tributaries are potential sources of water supply for the Sites Project. A potential conveyance system from these sources to the reservoir includes existing and/or enlarged Tehama-Colusa and Glenn-Colusa Irrigation District canals and a new conveyance facility from the Sacramento River near Moulton Weir. A new conveyance facility from the Colusa Basin Drain to Funks Reservoir on the Tehama-Colusa canal is another potential conveyance system. All conveyance alternatives would require enlargement of the existing Funks Reservoir. Major project facilities would be situated at the Golden Gate Damsite; including outlet works, powerplant, intake structure and maintenance facilities. The Sites Project would also require relocation of two county roads (Maxwell-Lodoga and Huffmaster Roads) and the community of Sites. Recreational use has not been identified as a project purpose; however, five potential recreation facility locations have been identified.

Figure 2. Sites Reservoir and surrounding features.

Newville Reservoir

Newville Reservoir would be located about 29 kilometers (18 miles) west of the community of Orland on North Fork Stony Creek, upstream from the existing Black Butte Reservoir (Figure 3). Construction of a dam on North Fork Stony Creek at Newville and a saddle dam at Burrows Gap would form Newville Reservoir. The alternative reservoir sizes being evaluated are 2.34 billion cubic meters (1.9 maf) and 3.7 billion cubic meters (3.0 maf). Up to five additional saddle dams would be required for the 3.7 billion cubic meter (3.0 maf) alternative. Potential water sources include the Sacramento River, Black Butte Reservoir and Thomes Creek. Potential conveyances include the following:

- the existing, or an enlarged, Tehama-Colusa canal with a new conveyance between the Glenn-Colusa and Tehama-Colusa canals,
- a new conveyance from Tehama-Colusa canal to Black Butte Reservoir and from Black Butte Reservoir to Newville Reservoir, or
- diversion and conveyance from Thomes Creek at a location north and west of the Newville Reservoir.

Newville Reservoir would require relocation of portions of three county roads including Round Valley Road, Garland Road and County Road 306. Recreational use has not been identified as a project purpose; however, five potential recreation areas have been identified.

Figure 3. Newville Reservoir and surrounding features.

CHAPTER 4

NEWVILLE PROJECT FISH STUDIES

Introduction

In 1998, DFG initiated studies of fish and wildlife resources of the Newville Project as part of the North of Delta Offstream Storage Program. This section discusses recent findings and recapitulates the effort and results of the 2001 fish study.

Methods

During May and June of 2001, DFG staff conducted seining and electrofishing in three of the streams which run through the inundation area of the proposed Newville Reservoir. The streams sampled include North Fork Stony, Salt and Heifer Camp Creeks. Nine sites were sampled in streams within the inundation area. An additional six sites were sampled along the conveyance route, between the proposed dam site on the North Fork of Stony Creek and Black Butte Reservoir.

Fish were captured by either beach seining according to the method described by Everhart et al (1953), or backpack electrofishing according to the method described by Cowx and Lamarque (1990). Population estimates for each species were developed using the method of Seber and LeCren (1967).

Seining

One of the following three different sized seines was used, depending on the width of the sample site. Seines used included the following:

- The largest seine was 18.3 meters (60 feet) long and 1.5 meters (5 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a 2.1 by 2.1 meter (7-foot-by - 7-foot) pocket.
- The medium-sized seine was 8.8 meters (29 feet) long and 1.8 meters (6 feet high), with a mesh size of 6.4 millimeters (one-quarter inch) and a pocket size of 2.1 meters (7 feet) by 1.5 meters (5 feet).
- The smallest seine, used only for small pools and ponds, was 3.7 meters (12 feet) long and 1.2 meters (4 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a 2.1 by 1.5 meter (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 and identified. The first twenty of each species were measured for fork length as described by Lagler (1956) to the nearest millimeter and then released downstream. The remaining fish were tallied. The seine was pulled a total of three times at each site. Representative specimens were either preserved or photographed for positive identification.

Electrofishing

A backpack electrofisher (Smith and Root model 12B) was used at only one site due to the high conductivity of the water in the streams of the project area which caused overloading of the machine and poor catch results.

Results

In 2001, five species of non-game fish and two species of game fish were captured during surveys in streams that would potentially be inundated by the Newville Reservoir (Table 2). These streams include:

- North Fork Stony Creek
- Salt Creek
- Heifer Camp Creek.

California roach (*Hesperoleucus symmetricus*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis)* (Figure 4) and prickly sculpin (*Cottus asper)* were captured in selected reaches of all the streams, both within the inundation area and along the conveyance route to Black Butte Reservoir. Population estimates were calculated for these four species (Table 3). Based on these population estimates, California roach was the most abundant species in North Fork Stony and Heifer Camp Creeks. For Salt Creek, the Sacramento pikeminnow had the highest estimated population. In addition to the four species of fish captured during surveys, DFG biologists observed common carp (*Cyprinus carpio)* (Figure 5), green sunfish (*Lepomis* *cyanellus)* (Figure 6) and black bullhead (*Ameiurus melas)* during other biological surveys along the conveyance route. The California roach, Sacramento pikeminnow and Sacramento sucker were the most abundant species. Most of the fish captured during the 2001 fish sampling were juveniles, which is indicated by their size ranges.

Figure 4. Sacramento sucker

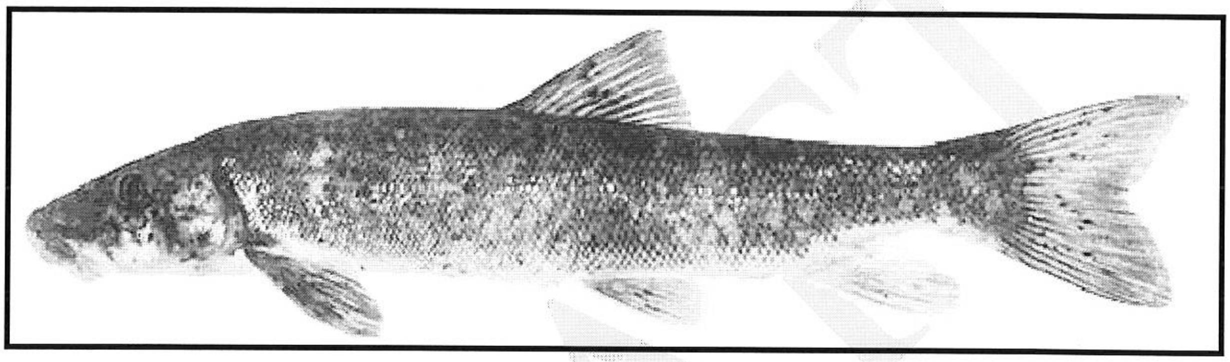


Figure 5. Common carp

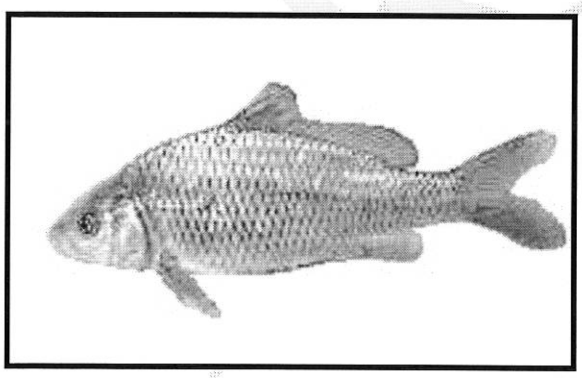


Figure 6. Green sunfish

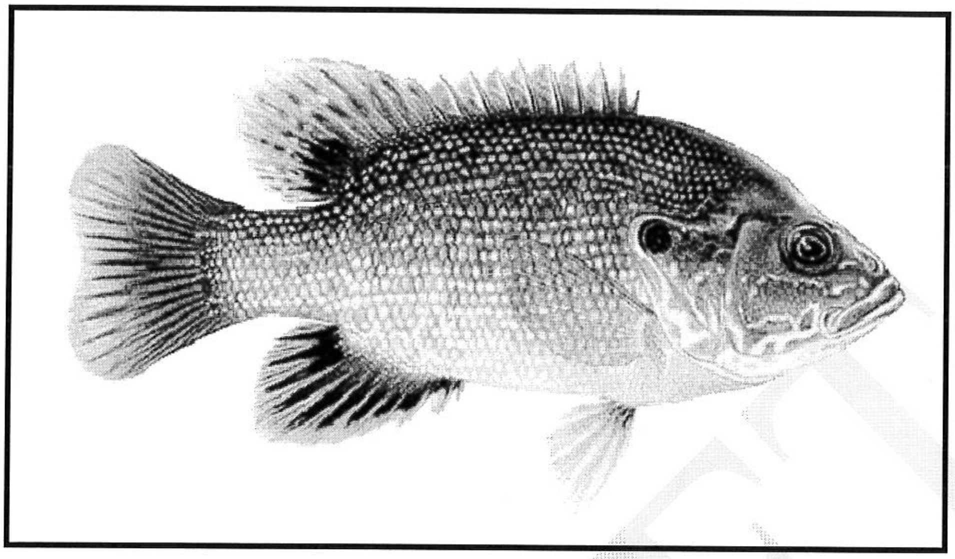


Table 2. Common and scientific names of fishes captured or observed in streams within the Newville Reservoir site in 2001.

COMMON NAME	SCIENTIFIC NAME
California roach	*Hesperoleucus symmetricus*
Common carp	*Cyprinus carpio*
Sacramento pikeminnow*	*Ptychocheilus grandis*
Sacramento sucker*	*Catostomus occidentalis*
Black bullhead	*Ameiurus melas*
Prickly sculpin	*Cottus asper*
Green sunfish	*Lepomis cyanellus*

* migratory species (Brown et al.1983)

Table 3. Population estimates (fish/meter^2) for fish captured in selected sections of streams within the Newville Reservoir site in 2001.

SPECIES	NORTH FORK STONY CREEK	SALT CREEK	HEIFER CAMP CREEK
California roach	0.3	0.8	0.2
Sacramento pikeminnow	0.1	1.2	0.1
Sacramento sucker	0.004	0.7	0.2
Prickly sculpin	0.0003	0	0.002

Discussion

All three streams sampled in the Newville inundation area are typical of the "west side" tributaries of the Sacramento River. Their year-round flow is intermittent. The main channels dry up by early summer except for isolated pools. California roach are the only fish adapted to this harsh environment (Moyle 1976) and were abundant during the sampling period. Sections of stream within the inundation area are used by non-game species (mainly in the minnow family) primarily for spawning and rearing when flow is adequate. It is likely that during high water, adult cyprinids ascend these tributaries from Black Butte Reservoir to spawn (Brown et al. 1983).

Salt Crk Drains into Stoney Crk which flows into BBR

During sampling efforts in 1983, DFG biologists captured rainbow trout (steelhead) in upper Salt Creek above the inundation line. Non-game fish were not found in this area. Neither were migratory cyprinids, as 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's height may be decreased, which would allow non-game fish to swim upstream. Competition with non-game fish could then reduce the rainbow trout populations (Brown et al. 1983).

CHAPTER 5

THOMES CREEK FISH STUDIES

Introduction

In 1979, as part of DWR's Thomes-Newville Reservoir planning studies, DFG initiated studies of the impacts on fish and wildlife of a Thomes-Newville Project. 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 Newville Project as part of the North of Delta Offstream Storage Program. This section discusses the most recent findings from surveys on Thomes Creek and recapitulates the effort and results of the 1982 study (Brown et al. 1983).

Methods

In the 1980's studies on Thomes Creek, juvenile salmon were captured by weekly seining at sample stations and in two fyke nets that were fished continuously on weekdays. Adult salmon and steelhead were counted with carcass and snorkel surveys. Resident fish and migratory nongame fish were captured in fyke nets or by electrofishing.

Juvenile Salmon

Seining

DFG seined for juvenile chinook salmon Thomes Creeks over a three-year period, from 1980 to 1982, using the method described by Everhart et al (1953). Sample stations were selected, and each station was seined weekly with 50-foot delta mesh seines from February until June (Brown et al. 1983).

Fyke netting

Two fyke nets were set up as described by Everhart et al (1953) to sample for juvenile salmonids during the 1981 and 1982 seasons on Thomes Creek. One was placed in the mainstem and another near the confluence to the discharge channel from the Tehama-Colusa Canal (TCC). The nets were fished continuously Mondays through Fridays and were removed on weekends and during high water. Each net in the mainstem was fished from February through March. Captured fish were measured for fork length as described by Lagler (1956) 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 in order to estimate the number of salmon in Thomes Creek. DFG staff surveyed Thomes Creek between the Sacramento River confluence and Paskenta, and in a channel from the discharge point of the TCC to its confluence with Thomes Creek. Counts were taken once each week from November through January in 1980-81 and 1981-82. DFG biologists tagged each carcass by fastening a number 3 hog ring to its mandible. Tick marks were notched into the hog rings with wire cutters to identify the week of tagging. The fork length of each carcass was recorded, using the method described by Lagler (1956), along with the sex, date and location of where each carcass was found. 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. The 1980-81 spawning escapement estimate for Thomes Creek was calculated with the Schaefer method (Ricker 1975), while the 1981-82 estimates were estimated with the Peterson method (Ricker 1975) (Brown et al. 1983).

DFG staff surveyed Thomes Creek by snorkeling (Schreck and Moyle 1990) to enumerate adult spring-run chinook salmon and summer-steelhead each summer from 1979-1980 and from 1998-2002. Snorkel divers examined each pool in the area from the gorge to the ford crossing at Hatch Flat near Paskenta. Fish were identified and their size range and relative abundance estimated. Historical estimates for fall-run chinook salmon for Thomes Creeks were compiled from DFG salmon-spawning stock reports.

Resident Fish and Migratory Nongame Fish

Fyke netting

DFG staff placed a fyke net consisting of 0.08 centimeter (0.03 inch) oval mesh netting mounted on a 0.03 centimeter by 0.05 centimeter (0.01inch by 0.02 inch) metal tubing frame in Thomes Creek near the mouth. The fyke net was set up as described by Everhart et al (1953). The purpose of the net was to capture juvenile salmon, larval Sacramento suckers and Sacramento pike minnows migrating to the Sacramento River. A perforated aluminum box - 0.5 meter by 0.5 meter by 1.0 meter (1.6 feet by 1.6 feet by 3.3 feet) - was attached to the cod end of the net to receive captured fish. The net was fished 24 hours per day on weekdays from January to June 1981 (Brown et al. 1983).

Electrofishing

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, seventeen samples were taken at ten-day intervals using the electrofishing method described by Cowx and Lamarque (1990). A 3.7 meter (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. Probe arrays were constructed of 0.2 centimeter (0.08-inch) stainless steel cable, attached to the bow of the raft, and fished at a depth of 1.5 meters (4.9 feet) (Brown et al. 1983).

Captured fish were weighed to the nearest 8.5 grams (0.3 ounce) and fork lengths were measured to the nearest millimeter, as described by Lagler (1956). Each fish was marked with a floy spaghetti tag. The tag was inserted under the dorsal fin and tied in a loop, as described by Everhart et al (1953). Fish were then released. 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).

DFG staff sampled fifteen sections in Thomes Creek with a backpack electrofisher in 1981 and 1982, according to the method described by Cowx and Lamarque (1990).

Population number and biomass estimates for each species were developed using the two-pass method of Seber and LeCren (1967) (Brown et al. 1983).

Results

Juvenile Chinook Salmon

1980 Emigration

Thirteen juvenile chinook salmon were captured by seining during the 1980 sample period (Table 4). 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 4). One of these fish had clipped fins, indicating that it was a hatchery fish from the Coleman National Fish Hatchery. In 1981, 206 juvenile chinook salmon were captured by fyke netting in Thomes Creek. Twenty of these were caught in the mainstem and 186 in the TCC discharge channel (Tables 5 and 6).

Table 4. Juvenile chinook salmon seined from Thomes Creek in 1980 and 1981*

SAMPLE PERIOD	NUMBER CAUGHT	AVERAGE LENGTH OF FISH (CENTIMETERS)
1980		
March	5	2.8
April	8	2.8
Total	13	
1981		
March	5	4.1
April	1	2.3
Total	6	

*Brown et al. 1983

Table 5. Fyke net catches of juvenile chinook salmon from the mainstem of Thomes Creek in 1981*

SAMPLE PERIOD	NUMBER CAUGHT	AVERAGE LENGTH OF FISH (CENTIMETERS)
February	0	0
March	9	2.7
April	10	3.1
May	1	2.7
Total	20	

*Brown et al. 1983

Table 6. Fyke net catches of juvenile chinook salmon from the TCC discharge channel in Thomes Creek in 1981 and 1982*

SAMPLE PERIOD	NUMBER OF FISH	AVERAGE LENGTH OF FISH (CENTIMETERS)
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	

*Brown et al. 1983

DFG staff caught juvenile chinook salmon in the mainstem of Thomes Creek over a nine-week period beginning in the first week of March and ending in the first week of May. Salmon from these catches ranged in size from 6.9 to 7.9 centimeters (2.7 to 3.1 inches) fork length (Table 5). 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 of these 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 TCC 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 fall-run spawned juvenile chinook salmon from the TCC discharge channel occurred from late February through the third week of March, until the discharge was terminated by the USBR. The migration was halted by lack of flow, but 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 in the mainstem. In the discharge channel from the TCC, 384 juvenile chinook salmon were captured by fyke netting in 1982 (Table 6). 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, 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 the Coleman National Fish Hatchery, as indicated by their 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

A review of past reports shows 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 twenty-five fish, and in 1975 the estimate was 170 (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 Estimates

DFG staff tagged fifty-nine chinook salmon carcasses during twelve surveys of Thomes Creek. Of these fifty-nine, seventeen fish (29 percent) were males while forty-two 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 on November 11, 1980. No carcass was tagged until nine days later. The last carcass was tagged on January 12, 1981. Fifty-seven of the fish tagged (97 percent) were located in the TCC outlet channel. Only two fish (3 percent) were tagged in the mainstem. DFG staff observed six redds and four live fish, indicating that there was some spawning activity in areas below Henleyville.

1981-82 Fall-Run Estimates

Thirty-eight chinook salmon carcasses were tagged during ten surveys of Thomes Creek. Of these thirty-eight, sixteen 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 TCC 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 redds were 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. This could indicate that habitat for spring-run chinook salmon or summer steelhead exists in the creek. Although surface water temperatures generally approach 25°C (77°F) in these areas, cooler water (15-20°C [59-68°F]) that could support salmonids can be found near the bottom of larger pools.

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.

2002 Spring-Run Estimates

DFG Region 1 biologists sighted two adult spring-run chinook salmon in Thomes Creek on May 14th. These fish were sighted above "The Gorge," which is approximately seventeen stream kilometers (10.5 stream miles) above Paskenta. Another two adult fish were sighted on June 12th approximately 1.6 kilometers (1 mile) upstream of "The Gorge" (Doug Killam, DFG, personal communication).

1980 Late Fall-Run

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

Resident Fish and Migratory Nongame Fish

Twenty-two species of fish were observed in Thomes Creek (Table 7). DFG staff developed population and biomass estimates for 13 of these species (Table 8). Three species were game fish and ten were nongame fish. Steelhead were the most abundant fish above "The Gorge", while Sacramento pikeminnow, 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 reach 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 adult fish to survive 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 7. Fish species found in Thomes Creek in 1982*

COMMON NAME	SCIENTIFIC NAME
Pacific lamprey**	*Lampetra tredentata*
California roach	*Hesperoleucus symmetricus*
Hitch	*Lavinia exilicauda*
Speckled dace	*Rhinicthys osculus*
Common carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Golden shiner	*Notemigomus crysoleucus*
Sacramento pikeminnow**	*Ptychocheilus grandis*
Hardhead	*Mylopharodon conocephalus*
Sacramento sucker**	*Catostomus occidentatlis*
White catfish	*Ameiurus catus*
Brown bullhead	*Ameiurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Steelhead (rainbow trout)**	*Onchorynchus mykiss*
Mosquitofish	*Gambusia affinis*
Threespine stickleback	*Gasterosteus aculeatus*
Prickly sculpin	*Cottus asper*
Bluegill	*Lepomis machrochirus*
Green sunfish	*Lepomis cyanellus*
Smallmouth bass	*Micropterus dolomeiui*
Largemouth bass	*Micropterus salmoides*
Tule perch	*Hysterocarpus traski*

*Brown et al. 1983
**migratory species

Table 8. Average population and biomass estimates for selected fish species caught in sections of Thomes Creek in 1982*

SPECIES	AVERAGE POPULATION ESTIMATE	AVERAGE BIOMASS KG/HECTARE (LB/ACRE)
California roach	41	12.0 (10.7)
Hitch	1	0.5 (0.4)
Speckled dace	229	18.0 (16.1)
Common carp	90	71.9 (64.2)
Goldfish	1	21.5 (19.2)
Sacramento pikeminnow**	337	100.1 (89.2)
Hardhead	47	53.1 (47.3)
Sacramento sucker**	143	18.0 (16.1)
Prickly sculpin	1	2.0 (1.8)
Bluegill	3	4.9 (4.5)
Green sunfish	14	17.0 (15.2)
Largemouth bass	5	8.9 (8.0)
Tule perch	1	0.1 (0.2)

*Brown et al. 1983
**migratory species

CHAPTER 6

STONY CREEK FISH STUDIES

Introduction

In 2001 the USBR, in cooperation with DFG, initiated a three-year fish monitoring program on lower Stony Creek (Figure 8). During the 2001 and 2002 sampling seasons, monitoring was conducted on several public access and privately permitted sites on lower Stony Creek to determine the presence or absence of special status anadromous chinook salmon (Figure 7) and steelhead trout. While all salmon caught and recorded here were juveniles, DFG biologists did observe a single spring-run adult in Stony Creek at the North Side Diversion Dam in June, 2001. Other fish species captured were also counted and measured. Twenty-nine fish species occur in the Stony Creek drainage, excluding fish within the Newville Reservoir site (Table 9).

Figure 7. Chinook salmon

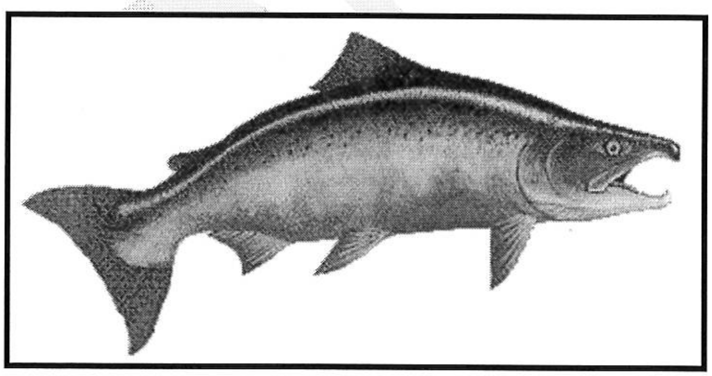


Figure 8. Stony Creek and surrounding features.

Table 9. Fish of the Stony Creek Drainage (excludes fish within Newville Reservoir site).

COMMON NAME	SCIENTIFIC NAME
Pacific lamprey*	*Lampetra tridentata*
Threadfin shad	*Dorosoma petenense*
California roach	*Hesperoleucus symmetricus*
Hitch	*Lavinia exilicauda*
Speckled dace	*Rhinicthys osculus*
Common carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Golden shiner	*Notemigonus crysoleucas*
Sacramento pikeminnow*	*Ptychocheilus grandis*
Sacramento blackfish	*Orthodon microlepidotus*
Hardhead	*Mylopharodon conocephalus*
Sacramento sucker*	*Catostomus occidentalis*
White catfish	*Ameiurus catus*
Brown bullhead	*Ameiurus nebulosus*
Black bullhead	*Ameiurus melas*
Channel catfish	*Ictalurus punctatus*
Steelhead (rainbow trout)*	*Onchorynchus mykiss*
Chinook salmon*	*Onchorynchus tshawytscha*
Inland silverside	*Menidia beryllina*
Mosquitofish	*Gambusia affinis*
Threespine stickleback	*Gasterosteus aculeatus*
Prickly sculpin	*Cottus asper*
Bluegill	*Lepomis macrochirus*
Green sunfish	*Lepomis cyanellus*
Redear sunfish	*Lepomis microlophus*
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
Black crappie	*Pomoxis nigromaculatus*
White crappie	*Pomoxis annularis*
Tule perch	*Hysterocarpus traskii*

* migratory species

Methods

DFG staff, in cooperation with USBR, caught juvenile chinook salmon, game fish and nongame fish by seining and in fyke nets in Stony Creek in the 2001-2002 period. Fyke nets were set up as described by Everhart et al (1953). Seining was also conducted as described by Everhart et al (1953).

Fyke netting

Fyke nets were placed in Stony Creek to capture a variety of fishes, especially juvenile chinook salmon, larval Sacramento suckers and Sacramento pikeminnows migrating to the Sacramento River. Each fyke net had a wooden live-box attached to the cod end of the net to receive captured fish. The overall dimensions for each net were 488 centimeters (192 inches) long by 168 centimeters (66 inches) wide by 91 centimeters (36 inches) high; the cod opening was 30.5 centimeters by 30.5 centimeters (12 inches by 12 inches) and the mesh size was 2.5 centimeters (1 inch) to 6.4 millimeters (¼ inch). Live-box dimensions were 91 centimeters (36 inches) long by 51 centimeters (20 inches) wide by 41 centimeters (16 inches) high. The fyke nets were held in fishing position by rope bridles attached to ropes that were secured to metal fencing posts and/or a tree or utility pole on the bank. The fyke nets were fished 24 hours per day and checked daily on weekdays from January to June, in 2001 and 2002. Captured specimens were identified and the first twenty of each species were measured for fork length to the nearest millimeter, as described by Lagler (1956). Further specimens of each species were tallied.

Seining

Seven seining sites were established on Stony Creek. Five of the sites were sampled weekly. Two sites were sampled daily. When water releases from the Black Butte Dam increased for diversion via the Constant Head Orifice (CHO) into the TCC, seining was suspended. The releases made water levels in Stony Creek too high to seine safely. Seining was resumed on a weekly basis when high flows ceased. The average flows for Stony Creek for 2001 and 2002 were recorded (Table10). Average flows in Stony Creek were estimated from the average outflow from Black Butte Reservoir. The highest average flow recorded was in January of 2002. The lowest average flow recorded was in November of 2001.

Table 10. Average flows in Stony Creek in 2001 and 2002.

	AVERAGE OUTFLOW FROM BLACK BUTTE RESERVOIR IN CUBIC METERS PER SECOND (cms)	
	Year	
Month	2001	2002
January	1.5	69.9
February	2.5	1.8
March	28.5	2.3
April	6.6	13.9
May	18.2	11.9
June	10.1	9.6
July	9.4	10.0
August	8.9	9.0
September	7.8	
October	5.0	
November	1.3	
December	39.9	

Seines were used to sample fish. One of the following three sizes of seines was used, depending on the size of the pool:

- The largest seine was 18.3 meters (60 feet) long and 1.5 meters (5 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a 2.1 by 2.1 meter (7-foot-by - 7-foot) pocket.
- The medium-sized seine was 8.8 meters (29 feet) long and 1.8 meters (6 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a pocket size of 2.1 meters by 1.5 meters (7 feet by 5 feet).
- The smallest seine, used only for small pools and ponds, was 3.7 meters (12 feet) long and 1.2 meters (4 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a 2.1 by 1.5 meter (7-foot-by-5-foot) pocket.

The 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 and identified. The first twenty of each species were measured for fork length to the nearest millimeter, as described by Lagler (1956), and then released downstream. The remaining fish were tallied.

<u>Juvenile Salmon</u>

Biologists seined for juvenile chinook salmon in Stony Creek over a period of two years, from January 2001 to June 2002. Sampling will continue for one more year. Seven sampling stations were selected on the creek. Each station was seined weekly from January to June, with 15.2 meter (50-foot) delta mesh seines (Brown et al. 1983).

Fyke nets were also used to sample for juvenile salmonids in Stony Creek. Three fyke net sites were established, as described by Everhart et al (1953). One fyke net was placed at the mouth; one at the North Canal, 31.7 kilometers upstream from the mouth; and one at the TCC-CHO. In the 2002 sampling season (April 4 to May 15), the single fyke net at TCC-CHO was replaced with two larger fyke nets placed side by side in the CHO channel to salvage juvenile salmonids. The dimensions of these nets were 3.7 meters (12 feet) wide by 9.1 meters (30 feet) long by 1.2 meters (4 feet) high with a cod opening of 26.7 centimeters by 26.7 centimeters (10.5 inches by 10.5 inches) and a mesh size of 0.48 centimeters (3/16 inch). Live-box dimensions were 137.2 centimeters (54 inches) long by 31.8 centimeters (12.5 inches) high by 35.6 centimeters (14 inches) wide at the front and 123.8 centimeters (48.75 inches) wide at the rear.

The nets were fished continuously Monday through Friday and were removed on weekends and during high water. Each net was fished from January through June. Captured fish were measured for fork length to the nearest millimeter, as described by Lagler (1956), and weighed by water displacement to the nearest gram.

Results

Juvenile Salmon

During the 2001 sample period, two hundred and sixteen juvenile chinook salmon were caught by seining. The highest numbers of salmon were caught in March. The largest salmon were caught in April. The fewest and smallest salmon were caught in January (Table 11). The first salmon was caught during the last week of January and the last salmon was caught during the last week of April (Figure 9, Table 12). The average lengths of the juvenile salmon caught by seining each week were recorded (Figure 10). Weights for juvenile salmon caught were not recorded in 2001.

Table 11. Monthly seining catch of juvenile chinook salmon in Stony Creek in 2001.

MONTH	NUMBER	AVERAGE LENGTH (mm)	LENGTH RANGE (mm)
January	14	37.2	30-41
February	34	43.7	32-57
March	107	61.2	35-83
April	61	72.1	56-93
Total	216		

Figure 9. Number of chinook salmon caught by seining in Stony Creek in 2001, graphed by week.

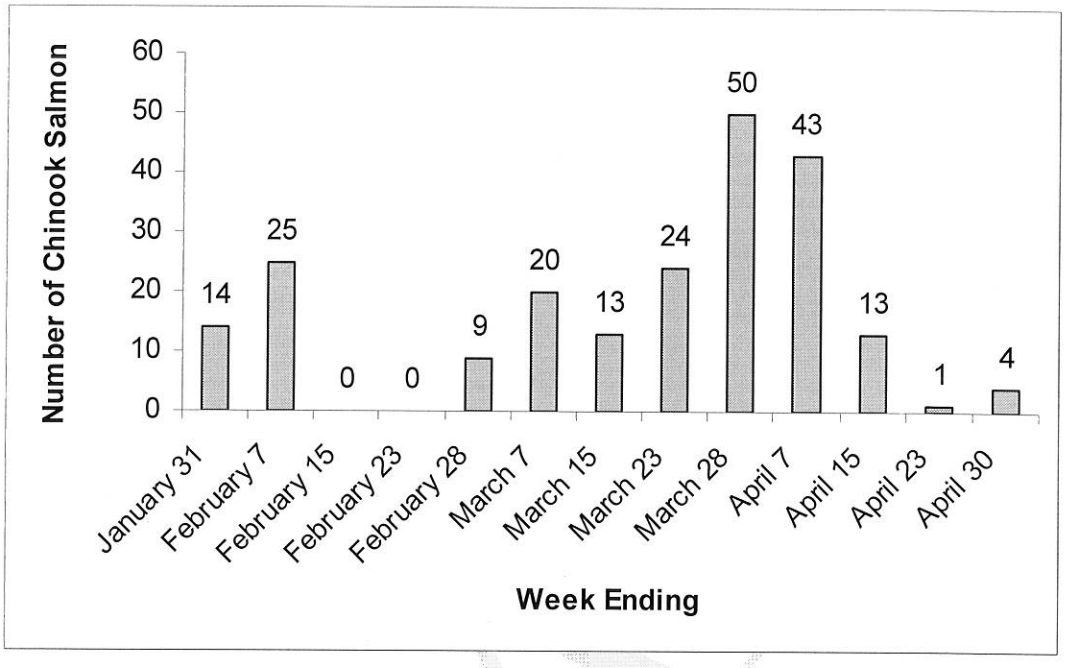
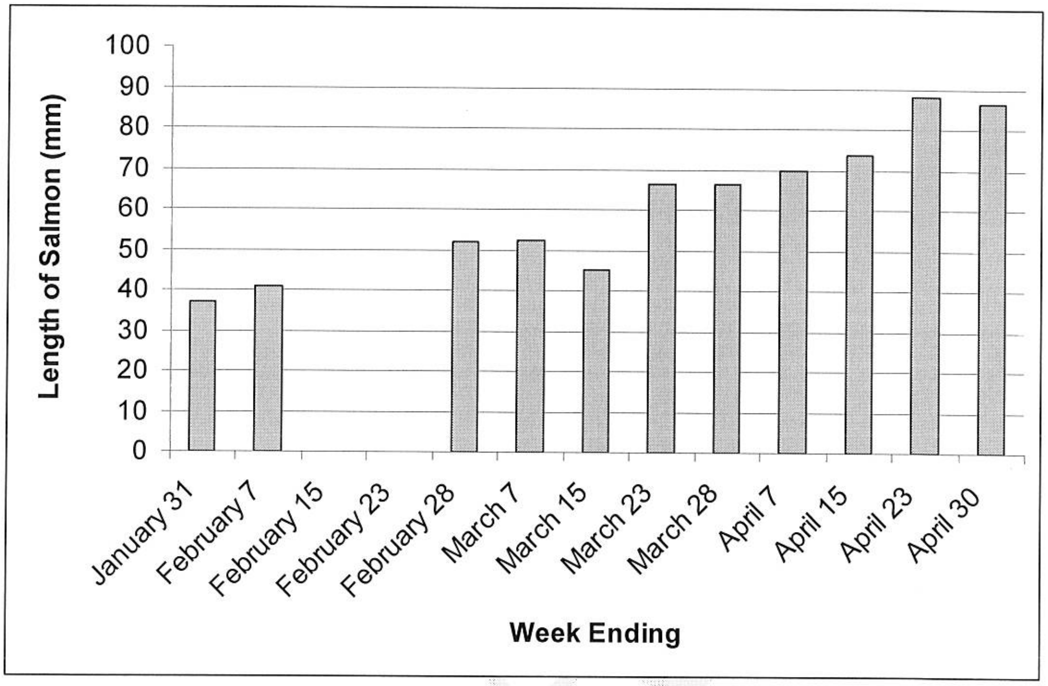


Table12. Average length and length ranges of the weekly seining catch of juvenile chinook salmon in Stony Creek in 2001.

MONTH	WEEK	NUMBER	AVERAGE LENGTH (mm)	LENGTH RANGE (mm)
January	24-31	14	37.2	30-41
February	1-7	25	40.8	32-42
	8-15	0		
	16-23	0		
	24-28	9	51.9	49-57
March	1-7	20	52.2	44-65
	8-15	13	45.2	37-61
	16-23	24	66.3	56-77
	24-30	50	66.4	35-83
April	1-7	43	69.9	56-81
	8-15	13	73.6	62-86
	16-23	1	88	
	24-30	4	86.3	74-93

Figure 10. Average length (mm) by week for juvenile chinook salmon caught by seining in Stony Creek in 2001.



During the 2002 sample period, 217 juvenile chinook salmon were captured in Stony Creek. The highest numbers of salmon were caught in March. The fewest salmon were caught in January (Table 13). The first fish was captured during the last week of January and the last fish was captured during the third week of May (Table 14). The largest salmon were caught in May (Table 15 and 16). Juvenile chinook salmon that were caught increased in size as the sampling period progressed. The larger fish caught in January and early February were fish that moved up into Stony Creek from the Sacramento River and therefore were not included in the data for calculating the increasing fork lengths of juvenile salmon hatched in Stony Creek (Figure 11).

Table 13. Monthly catch of juvenile chinook salmon in Stony Creek in 2002.

	NUMBER	AVERAGE LENGTH (mm)	LENGTH RANGE (mm)
January	1	74	
February	40	50.7	36-85
March	109	44.5	34-61
April	54	45.4	33-88
May	13	71	33-110
Total	217		

Table 14. Weekly catch of juvenile chinook salmon in Stony Creek in 2002.

MONTH	WEEK	NUMBER	AVERAGE LENGTH (mm)	LENGTH RANGE (mm)
January	24-28	1	74	
February	1-7	4	71.8	66-78
	8-15	7	81.6	75-85
	16-23	19	40.3	36-44
	24-28	10	45.5	37-61
March	1-7	26	45.4	40-52
	8-15	75	43.4	34-56
	16-23	6	53.6	49-61
	24-30	2	49.5	48-51
April	1-7			
	8-15	16	66.7	33-88
	16-23	11	38.5	34-79
	24-31	27	36.5	33-50
May	1-7	4	55.8	33-74
	8-15	7	73.1	51-104
	16-23	2	82.5	64-110

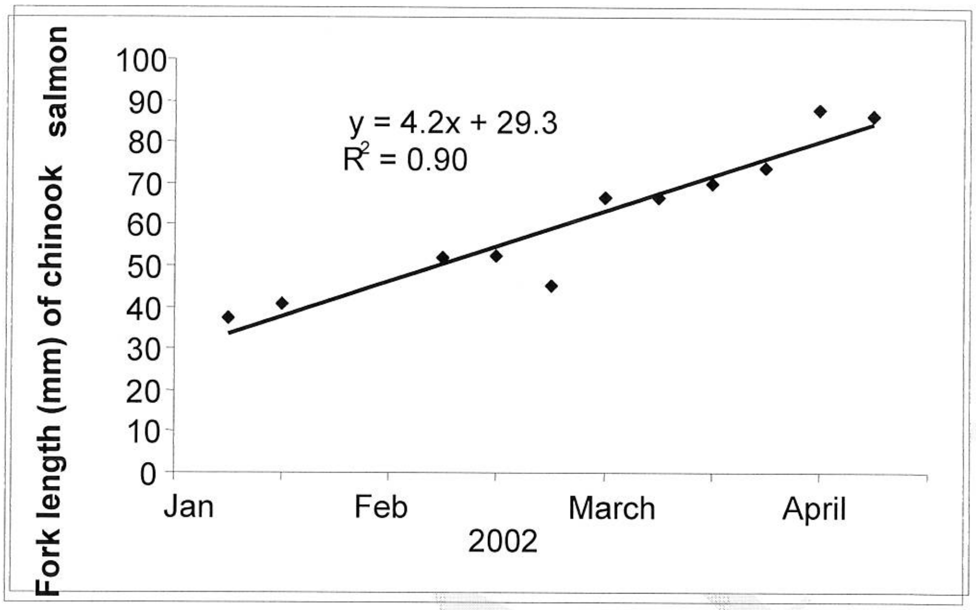
Table 15. Length and weight of juvenile chinook salmon caught in Stony Creek in 2002.

DATE	LENGTH (mm)	WEIGHT (gm)	DATE	LENGTH (mm)	WEIGHT (gm)	DATE	LENGTH (mm)	WEIGHT (gm)
January			February			March		
24	74	4.4	26	44	0.8	11	50	1.0
February			March			11	43	1.0
5	75	4.0	4	46	1.1	11	41	1.0
5	66	2.9	4	48	1.0	11	45	1.0
6	78	5.4	4	49	1.3	11	38	1.0
6	68	3.1	4	45	0.9	11	37	1.0
13	82	5.8	4	49	1.2	11	45	1.0
13	85	6.6	4	45	0.8	11	48	1.0
13	84	6.5	4	52	1.0	11	36	1.0
13	82	5.1	4	44	0.6	11	38	1.0
13	75	4.0	4	45	0.9	11	50	1.0
13	110	16	4	45	0.9	11	50	1.0
13	78	5.2	4	47	1.1	11	38	1.0
20	41	0.6	4	40	0.5	11	42	1.0
20	36	0.4	4	40	0.5	11	37	1.0
20	39	0.6	4	49	1.1	11	37	1.0
20	37	0.5	4	43	0.7	11	36	1.0
20	43	0.7	5	41	1.0	11	37	1.0
20	39	0.5	6	45	0.9	11	37	1.0
20	39	0.7	6	48	1.0	11	36	1.0
20	43	0.7	6	44	0.8	11	34	1.0
20	40	0.6	6	47	1.1	11	37	1.0
20	39	0.7	6	49	1.1	11	38	1.0
20	43	0.7	6	45	0.9	11	39	1.0
20	38	0.5	6	44	0.8	11	39	1.0
20	44	0.7	6	44	0.8	11	38	1.0
20	39	0.5	7	45	0.8	11	40	1.0
20	42	0.7	7	42	0.7	11	46	1.2
20	38	0.5	11	41	1.0	11	44	0.8
20	44	1.1	11	39	1.0	11	34	0.3
20	40	0.7	11	47	1.0	11	36	0.3
22	39	0.8	11	44	1.0	11	38	0.5
25	47	1.0	11	55	1.0	11	36	0.3
25	47	1.4	11	43	1.0	11	47	1.1
25	37	0.6	11	49	1.0	11	44	0.9
25	48	1.2	11	51	1.0	11	52	1.4
25	61	1.8	11	43	1.0	11	47	1.0
25	37	0.5	11	47	1.0	11	50	1.3
26	42	0.8	11	38	1.0	11	40	0.7
26	46	0.8	11	45	1.0	11	36	0.3
26	46	1.0	11	43	1.0			

Table 16. Length and weight of juvenile chinook salmon caught in Stony Creek in 2002 (continued).

DATE	LENGTH (mm)	WEIGHT (gm)	DATE	LENGTH (mm)	WEIGHT (gm)	DATE	LENGTH (mm)	WEIGHT (gm)
March			April			April		
11	38	0.4	10	88	7.7	26	50	1.3
11	46	0.9	10	68	3.4	26	41	0.5
11	40	0.4	10	80	5.7	26	43	0.9
11	37	0.6	10	84	6.9	30	34	1.0
11	38	0.5	15	68	3.3	30	45	1.0
11	38	0.5	15	79	5.6	May		
11	45	1.0	15	69	3.4	2	33	0.3
11	46	0.9	19	35	1.0	3	46	1.0
11	50	1.3	19	35	1.0	7	70	4.2
11	50	1.2	19	35	1.0	7	74	5.5
11	49	1.1	19	34	1.0	9	73	4.3
11	46	0.9	19	34	1.0	10	104	1.0
11	42	0.7	19	35	1.0	10	80	1.0
12	53	1.3	19	35	1.0	10	68	1.0
12	56	1.5	23	35	0.5	14	64	1.0
12	48	1.1	23	34	0.4	15	51	1.4
12	51	1.1	23	36	0.6	15	72	1.0
12	56	1.8	23	35	0.5	20	64	2.5
12	53	1.5	24	35	0.3	22	78	5.9
12	50	1.5	24	35	0.4			
12	52	1.5	24	35	0.4			
12	48	1.2	24	34	0.4			
18	51	1.4	24	35	0.4			
18	50	1.3	24	37	0.5			
18	61	2.3	24	38	0.4			
18	49	1.2	24	35	0.3			
18	57	1.7	24	35	0.4			
18	119	11.9	24	34	0.3			
26	51	1.5	24	36	0.4			
26	48	1.1	24	33	0.3			
April			25	35	0.4			
8	56	1.7	25	35	0.5			
8	68	4.3	25	36	0.4			
8	62	2.8	25	34	0.4			
8	61	2.5	25	35	0.3			
8	52	1.7	25	35	0.4			
8	53	1.8	25	35	0.4			
9	33	0.2	26	36	0.4			
10	78	5.2	26	36	1.0			
10	81	5.7	26	34	1.0			

Figure 11. Fork lengths (mm) of juvenile chinook salmon caught in the 2002 sampling period.



Other fish species

During the 2001 sampling season, four species of game fish other than chinook salmon were caught, the most common of which were channel catfish (*Ictalurus punctatus)* (eighteen caught). Green sunfish were the least common. Only three specimens of this species were caught (Table 17 and Table 18).

During the 2001 sampling season, nine species of non-game fish were caught. Sacramento suckers were the most common with eight hundred and seventy-four caught. Mosquitofish (*Gambusia affinis)* and common carp were the least common. Only one specimen of each of these species was caught (Table 19 and Table 20).

During the 2002 sampling season, eight species of game fish other than chinook salmon were caught. Of these, white crappie were the most common, with eighty-two caught. Black bullhead and smallmouth bass (*Micropterus dolomieui)* were the least common. Only one specimen of each of these species was caught (Table 21, 22, 23 and 24).

During the 2002 sampling season, twelve species of non-game fish were caught. Again, Sacramento suckers were the most common, with sixteen thousand, three-hundred and eight caught. Fourteen thousand, four hundred and sixty-five Sacramento suckers were caught. The threespine stickleback (*Gasterosteus aculeatus)* was the least common. Only one specimen of this species was caught (Table 25, 26, 27, 28 and 29).

Table 17. Sample dates, trapping methods, streamflows, water temperatures and game fish catches in Stony Creek in 2001.

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	White Catfish	Channel Catfish	Chinook Salmon*	Green Sunfish	Smallmouth Bass
January 2001								
26	seine	1.5	12			14		
February								
1	seine	1.5	10			7		
5	seine	1.5	14			7		
7	seine	1.5	8			9		
14	fyke	1.5	9			26		
15	fyke	1.5	11			17		
16	fyke	1.5	12			2		
21	seine	1.6	11			9		
March								
2	fyke	9.3	12					
2	seine	9.3	11			7		
7	seine	193.6	12			8		
8	seine	116.6	12			2		
12	seine	26.3	13			10		
14	fyke	17.4	13	1		1		
15	seine	12.4	11			1		
16	fyke	8.9	12			1		
16	seine	8.9	14					
20	fyke	1.2	17	2	2	1		
20	seine	1.2	17			29		
21	fyke	0.9	18					
21	seine	0.9	18			6		
22	fyke	0.6	17					
23	fyke	0.5	17		1			
26	seine	0.5	15			21		
27	seine	0.5	17			4		
28	seine	0.4	18	1		21	1	
29	fyke	0.8	19			1		
29	seine	0.8	18			3		
April								
2	seine	7.2	18			16		
3	fyke	8.0	16					1
3	seine	8.0	18			12		
4	fyke	8.4	16					
4	seine	8.4	16			4		
5	seine	8.1	16			11		
6	seine	7.8	14			7		
9	seine	6.2	15			2		
10	fyke	6.2	14					
10	seine	6.2	15		1	11		
11	fyke	7.4	16			1		

*migratory species

Table 18. Sample dates, trapping methods, streamflows, water temperatures and game fish catches in Stony Creek in 2001 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	White Catfish	Channel Catfish	Chinook Salmon*	Green Sunfish	Smallmouth Bass
April								
11	seine	7.4	14			1		
13	fyke	6.3	14		2			
17	fyke	7.8	13				1	
18	fyke	8.1	17		1			
18	seine	8.1	19			1		
19	fyke	8.2	19		4			
24	seine	4.2	20					
25	fyke	4.9	16	1	1			1
25	seine	4.9	21			2		
26	fyke	5.4	17	2				
27	fyke	5.8	22	1	1			
30	seine	5.7	23			2		
May								
2	fyke	14.9	21		1			
3	fyke	16.3	17		1			
4	fyke	19.1	18				1	
4	fyke	19.1	21					
8	fyke	27.4	20		2			
10	fyke	27.8	22		1			
11	fyke	30.1	21					
14	seine	31.5	21					
23	seine	9.8	25					
24	seine	10.6	22					
25	fyke	10.6	29					
29	seine	10.3	26					
30	fyke	9.8	25					
30	seine	9.8	23					
31	seine	9.6	23					
June								
6	seine	10.7	22					
8	seine	11.0	24					7
16	seine	10.3	27					2
17	seine	10.3	26					
Total				8	18	277	3	11

* migratory species

Table 19. Sample dates, trapping methods, streamflows, water temperatures and non-game fish catches in Stony Creek in 2001.

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	Pacific Lamprey*	Hitch	Speckled Dace	Common Carp	Sacramento Pikeminnow*	Hardhead	Sacramento Sucker*	Mosquitofish	Prickly Sculpin
February												
1	seine	1.5	10							2		2
14	fyke	1.5	9					1				
15	fyke	1.5	11					1				
21	seine	1.6	11	1				2				
March												
2	seine	9.3	11					3				
7	seine	193.6	12					2				
8	seine	116.6	12			1		1				
12	seine	26.3	13							2		
16	seine	8.9	14			1						
20	seine	1.2	17		1					1		2
22	fyke	0.6	17					1		1		
23	fyke	0.5	17	1								1
April												
2	seine	7.2	18					1				
4	fyke	8.4	16						1			
6	seine	7.8	14					5	3			
9	seine	6.2	15									
11	fyke	7.4	16					1		1		
17	fyke	7.8	13									
24	seine	4.2	20							2		
25	fyke	4.9	16					1		1		

*migratory species

Table 20. Sample dates, trapping methods, streamflows, water temperatures and non-game fish catches in Stony Creek in 2001 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	Pacific Lamprey*	Hitch	Speckled Dace	Common Carp	Sacramento Pikeminnow*	Hardhead	Sacramento Sucker*	Mosquitofish	Prickly Sculpin
May												
2	fyke	14.9	21									1
3	fyke	16.3	17							1		
4	fyke	19.1	21							500		
8	fyke	27.4	20							2		
11	fyke	30.1	21							1		
14	seine	31.5	21							54		
23	seine	9.8	25					13		22		
24	seine	10.6	22		1					21		
25	Fyke	10.6	29					2		109		
29	seine	10.3	26					6		4		
30	fyke	9.8	25					1				
30	seine	9.8	23					34		3		
31	seine	9.6	23					5		54		
June												
6	seine	10.7	22					1		12		
8	seine	11.0	24					331		74		1
16	seine	10.3	27					5		3	1	
17	seine	10.3	26		3		1	119		4		
Total				2	5	2	1	536	4	874	1	7

* migratory species

Table 21. Sample dates, trapping methods, streamflows, water temperatures and game fish catches in Stony Creek in 2002.

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	White Catfish	Black Bullhead	Channel Catfish	Steelhead Trout	Chinook Salmon*	Bluegill	Green Sunfish	Smallmouth Bass	White Crappie
January												
10	seine	127.3	10			1				2		
16	seine	27.5	9				1					
17	seine	26.4	9							1		
24	seine	17.4	9					1				
February												
5	fyke	1.5	9					2				
6	fyke	1.5	11					1				
6	seine	1.5	11					1				
13	seine	1.5	12					7				
20	seine	1.5	13					18				
22	seine	1.5	14					1				
25	seine	1.5	14					6				
26	fyke	1.5	14					4				

*migratory species

Table 22. Sample dates, trapping methods, streamflows, water temperatures and game fish catches in Stony Creek in 2002 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	White Catfish	Black Bullhead	Channel Catfish	Steelhead Trout	Chinook Salmon*	Bluegill	Green Sunfish	Smallmouth Bass	White Crappie
March												
3	fyke	1.5	15			5						3
4	seine	1.5	14					15				
5	fyke	1.5	14					1				
6	fyke	1.5	15					8				
7	fyke	1.5	14					2				
11	seine	1.4	14				1	66				
12	seine	1.4	14					9				
18	seine	1.2	11					6				
26	seine	2.5	14					2				
27	fyke	3.5	14							1		
April												
3	fyke	12.3	14			1						
5	fyke	15.1	14			7						1
8	seine	12.2	20					6				

* migratory species

Table 23. Sample dates, trapping methods, streamflows, water temperatures and game fish catches in Stony Creek in 2002 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	White Catfish	Black Bullhead	Channel Catfish	Steelhead Trout	Chinook Salmon*	Bluegill	Green Sunfish	Smallmouth Bass	White Crappie
April												
9	fyke	8.6	14			1		1				6
10	fyke	6.4	17					6				2
10	seine	6.4	17			6						
12	fyke	7.5	18			1						
15	seine	7.5	18					3				
16	fyke	12.2	13			5						1
17	fyke	15.7	15			3				1		1
18	fyke	16.1	14									4
19	fyke	15.9	14			8		7	3			21
23	fyke	16.7	16					4				1
24	fyke	18.8	15					12	1			2
25	fyke	19.8	16					7	1	3		3
26	fyke	20.4	15			5		3	4	2		12
26	seine	20.4	15					3				
30	fyke	15.4	15	1	1	6		2				
May												
1	fyke	14.9	16			6						1
1	Seine	14.9	17									1
2	fyke	14.7	15			9		1	1			3
3	seine	14.2	16					1				
3	fyke	14.2	21			1						
7	seine	12.2	22					2				
7	Fyke	12.2	16									3
8	fyke	15.7	21	3		4						1

* migratory species

Table 24. Sample dates, trapping methods, streamflows, water temperatures and game fish catches in Stony Creek in 2002 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	White Catfish	Black Bullhead	Channel Catfish	Steelhead Trout	Chinook Salmon*	Bluegill	Green Sunfish	Smallmouth Bass	White Crappie
May												
9	fyke	15.7	15	2		7		1				
10	seine	19.4	20					1				
10	fyke	19.4	15	2				2				6
11	fyke	20.3	15	1		1						
14	fyke	21.2	16					1	1			7
15	fyke	14.5	17			2		2	1			3
20	seine	5.6	16					1				
22	seine	1.0	21					1				
29	fyke	9.1	24			1			1			
June												
4	seine	9.5	26								1	
6	fyke	8.6	21			1						
Total				9	1	81	2	217	13	10	1	82

* migratory species

Table 25. Sample dates, trapping methods, streamflows, water temperatures and non-game fish catches in Stony Creek in 2002.

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	Pacific Lamprey*	Threadfin Shad	California Roach	Speckled Dace	Common Carp	Sacramento Pikeminnow*	Sacramento Sucker*	Inland Silverside	Mosquito Fish	Threespine Stickleback	Prickly Sculpin	Riffle Sculpin
January															
7	seine	128.4	10			3								1	
10	seine	127.3	11			1			3			1			
16	seine	27.5	9						1					1	
17	seine	26.4	9						2						
23	seine	20.3	9						2						
24	seine	17.5	8				1								
30	seine	11.9	8			1			1						
February															
5	fyke	1.5	9							1				2	
6	fyke	1.5	11						1			1		3	1
6	seine	1.5	11	1					1	1					1
14	seine	1.5	13											2	
25	seine	1.5	14												
26	Fyke	1.5	14											1	
March															
3	fyke	1.5	15	1					1	1057	1			5	
19	fyke	1.3	12											1	
22	fyke	2.4	13											1	
29	seine	6.0	15			1									

* migratory species

Table 26. Sample dates, trapping methods, streamflows, water temperatures and non-game fish catches in Stony Creek in 2002 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	Pacific Lamprey*	Threadfin Shad	California Roach	Speckled Dace	Common Carp	Sacramento Pikeminnow*	Sacramento Sucker*	Inland Silverside	Mosquito Fish	Threespine Stickleback	Prickly Sculpin	Riffle Sculpin
April															
4	fyke	14.3	15		1				1						
5	fyke	15.1	14								1				
8	seine	12.2	20							1					
10	fyke	6.4	17											1	
10	seine	6.4	17							1					
11	fyke	7.1	20							2				1	
11	seine	7.1	15									1			
12	seine	7.5	18							13					
16	fyke	12.2	13							1					
16	seine	12.2	15							415					
18	fyke	16.1	14							472					
19	fyke	15.9	14						4	20		1			
19	seine	16.1	17								1				
22	seine	15.1	15			2				117					
23	fyke	16.7	16							103				1	
23	seine	16.7	23							229					

* migratory species

Table 27. Sample dates, trapping methods, streamflows, water temperatures and non-game fish catches in Stony Creek in 2002 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	Pacific Lamprey*	Threadfin Shad	California Roach	Speckled Dace	Common Carp	Sacramento Pikeminnow*	Sacramento Sucker*	Inland Silverside	Mosquito Fish	Threespine Stickleback	Prickly Sculpin	Riffle Sculpin
April															
24	fyke	18.8	15							74		1			
24	seine	18.8	21							313					
25	fyke	19.8	16			1				578	1				
26	fyke	20.4	15							880	3				
29	seine	16.0	16							1725					
30	fyke	15.4	15							371				1	
May															
1	fyke	14.9	16	2						450					
1	Seine	14.9	17							304					
2	fyke	14.7	15	1					1	759				3	
3	seine	14.2	16							153					
3	fyke	14.2	21							81					

* migratory species

Table 28. Sample dates, trapping methods, streamflows, water temperatures and non-game fish catches in Stony Creek in 2002 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	Pacific Lamprey*	Threadfin Shad	California Roach	Speckled Dace	Common Carp	Sacramento Pikeminnow*	Sacramento Sucker*	Inland Silverside	Mosquito Fish	Threespine Stickleback	Prickly Sculpin	Riffle Sculpin
May															
7	fyke	11.6	22							1225				2	
7	seine	12.2	22						50	77					
8	fyke	15.7	21	2						969	1				
8	seine	15.7	21						74	358					
9	fyke	15.7	15	3						548				1	
10	seine	19.4	20							944					
10	fyke	19.4	15		3			1		286		1		5	
11	fyke	20.3	15							121				3	
12	seine	20.7	21						13	4					
13	seine	20.4	23						178	125					
14	fyke	21.2	16		1				2	328				4	
15	fyke	21.2	17		5					174	1			3	
15	seine	14.2	24								1				
17	seine	9.4	21						37	121				2	
20	seine	5.6	16						43	126					

* migratory species

Table 29. Sample dates, trapping methods, streamflows, water temperatures, and non-game fish catches in Stony Creek in 2002 (continued).

Sample Day	Trap Type	Streamflow (cms)	Water Temperature C	Pacific Lamprey*	Threadfin Shad	California Roach	Speckled Dace	Common Carp	Sacramento Pikeminnow*	Sacramento Sucker*	Inland Silverside	Mosquito Fish	Threespine Stickleback	Prickly Sculpin	Riffle Sculpin
May															
21	fyke	2.4	16			1			7	71					
22	seine	1.0	21			1			54	795					
22	fyke	1.0	18					1	246	261					
23	fyke	2.3	19						19	34					
28	seine	9.1	26						1129	854					
29	fyke	9.1	24						2	4	1			3	
29	seine	9.1	25			2			14	33					
30	fyke	11.2	21		1					7			1	1	
30	seine	11.2	25						72	28					
June															
4	seine	9.5	26						84	312					
5	fyke	9.1	22							34				1	
5	seine	9.0	24			19	2		95	321					
6	fyke	8.6	21							22				1	
6	seine	8.6	21						9	5					
Total				10	11	32	3	2	2146	16308	11	6	1	50	2

* migratory species

CHAPTER 7
SITES PROJECT FISH STUDIES

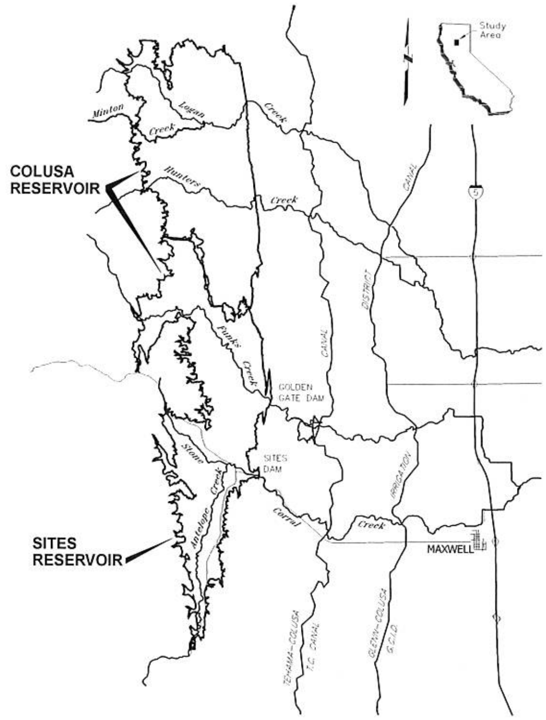
Introduction

Stone Corral Creek, Funks Creek and their tributaries originate in oak woodland habitat in western Colusa and Glenn Counties. The creeks flow downstream through annual grassland and cultivated rice fields before flowing into the Colusa Basin Drain. These streams are characterized by deeply incised channels with little vegetation on the banks and little cover in the streambeds. Stream flow 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 the water is high in dissolved minerals. The total dissolved solids in the water are so high that electrofishing as a means of sampling is difficult in these streams.

Fish studies for the Sites Project included two 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 reservoir.

This section summarizes the studies of fish in streams that flow through the proposed Sites Project (Figure 12). Studies were conducted in 1998 and 1999. Information gathered from these studies will be used to describe and evaluate impacts on fish resources during the planning process.

Figure 12. Streams in the Sites project area



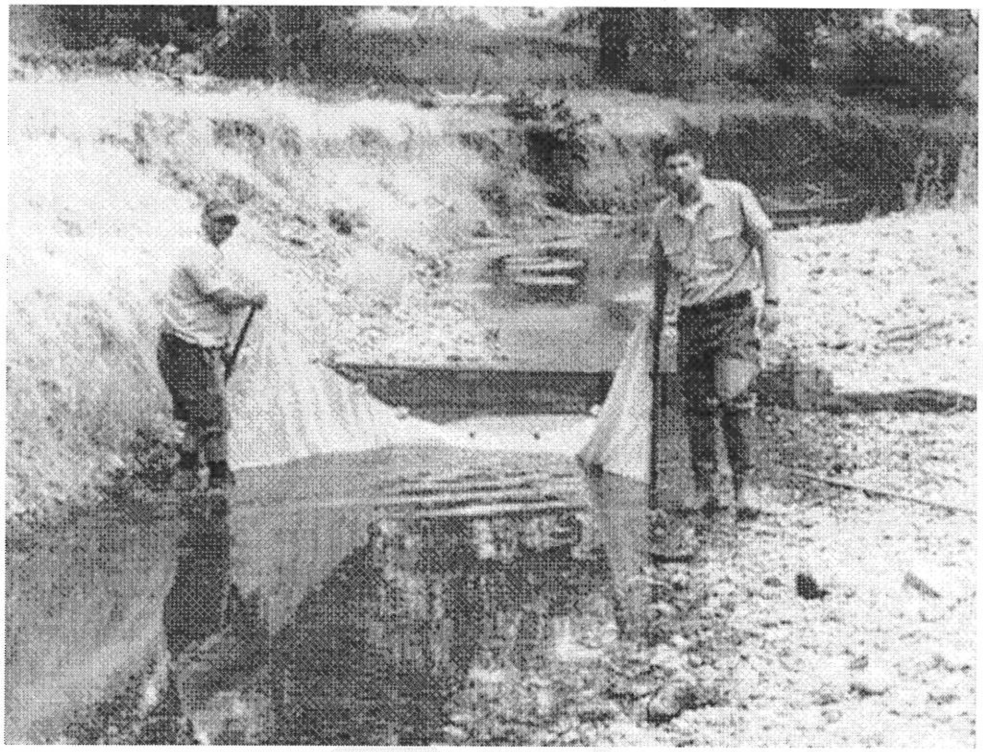
Methods

Pools on streams in the Sites Project area (Figure 13) were seined and electrofished to determine species composition at specific stations on all creeks surveyed. All sampling stations were within the inundation area of the Sites Project. Thirty-six stations were spread out among Stone Corral, Antelope and Funks Creeks. Seven stock ponds in the Sites and Colusa area were also seined for fish.

All samples w/in sites footprint

North Fork Stony Crk

Figure13. DFG staff seining a pool on Stone Corral Creek in the Sites project area



Electrofishing

Electrofishing was done with a Smith-Root Type VII electroshocker. Sections of creek varying from 10.1 meters (33 feet) to 42.1 meters (138 feet) were netted off upstream and downstream. DFG biologists waded upstream from the lower net with a backpack electroshocker. The anode of the electrofisher was inserted into likely fish habitat (Cowx and Lamarque 1990). Stunned fish were collected in buckets. The first twenty of each species were measured for fork length to the nearest millimeter, as described by Lagler (1956), and then the rest of the fish were tallied. Fish were weighed to the nearest gram using water displacement. The surface area of each station was calculated in square feet and then converted to square meters for fish density analysis or relative abundance.

Seining

Fish were also collected by seining (Everhart et al 1953). Three different sized seines were used, depending on the size of the pool. The sizes were as follows:

- The largest seine was 18.3 meters (60 feet) long and 1.5 meters (5 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a 2.1 by 2.1 meter (7-foot-by -7-foot) pocket.
- The medium sized seine was 8.8 meters (29 feet) long and 1.8 meters (6 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a pocket size of 2.1 meters by 1.5 meters (7 feet by 5 feet).
- The smallest seine, used only for small pools and ponds, was 3.7 meters (12 feet) long and 1.2 meters (4 feet) high, with a mesh size of 6.4 millimeters (one-quarter inch) and a 2.1 meter by 1.5 meter (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, barrier nets were stretched across the creek upstream and downstream from the pool to be seined. Captured fish specimens were stored in a bucket of water until they could be examined and identified. The first twenty of each species were measured for fork length to the nearest millimeter, as described by Lagler (1956), and then released downstream. The remaining fish were tallied. The seine was pulled a total of three times at each site. Representative specimens were either preserved or photographed for positive identification.

Results

Twelve species of fish were caught in the Sites study area in 1998 and 1999. Five species were game fish and seven species were non-game fish (Table 30). In spring 1998, a single spring-run chinook salmon was observed in Antelope Creek, a tributary to Stone Corral Creek. It died a few weeks later and was identified by its carcass.

Table 30. Fish caught in the Sites study area in 1998 and 1999.

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

* migratory species

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 dam site and the upper limit of flow in Funks Creek. Streamflow was intermittent. Five species of fish were found in Funks Creek, including one species of game fish, the largemouth bass (*Micropterus salmoides)* (Table 31). The most common fish in Funks Creek was the hitch (*Lavinia exilicauda)*, with an average density of 3.7 fish/m^2 (3.1 fish/yd^2). Hitch were caught in 11 out of 15 stations seined.

Table 31. Relative abundance of species caught at each station on Funks Creek.

SPECIES	STATION SAMPLED															FISH/M^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			3.7
Sacramento pikeminnow					X	X			X				X			0.07
Sacramento sucker					X	X			X	X			X			0.02
Sculpin														X		---
Largemouth bass									X			X				0.001

The most diverse sections of Funks Creek sampled were in the lower reaches. In the upper reaches of Funks Creek, samples 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.

Stone Corral Creek

Eleven stations were sampled on Stone Corral Creek between July 15, 1998, and January 6, 1999. Stations were located from the dam site to about 1.6 kilometers (1 mile) above. Flows were less than 0.03 cubic meters per second (1 cfs). Eight species of fish were found in Stone Corral Creek, including two species of game fish: the green sunfish and the bluegill (*Lepomis macrochirus*).

The most common fish found at the stations was the Sacramento pikeminnow, followed by the hitch (Table 32). Fish density on Stone Corral Creek was relatively low for all species at all stations. Hitch were the dominant species in terms of density. Average density for hitch was 1.0 fish/m^2 (0.8 fish/yd^2).

Table 32. Relative abundance of species caught at each station on Stone Corral Creek.

SPECIES	STATION SAMPLED											FISH/M^2
	1	2	3	4	5	6	7	8	9	10	11	
California roach		X		X								0.02
Hitch		X	X					X	X	X	X	1.0
Sacramento pikeminnow			X	X	X	X		X	X		X	0.2
Sacramento blackfish											X	0.2
Sacramento sucker			X	X		X					X	0.02
Mosquitofish				X								0.002
Bluegill				X								0.002
Green sunfish			X					X	X	X	X	0.04

Most of the 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 in the middle reaches of the creek and near the proposed dam site.

Fisheries studies on Stone Corral Creek have yet to be completed. Sampling must still be conducted on Stone Corral Creek downstream of the proposed dam site.

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 0.14 cms (5 cfs). The following three species of fish (Table 33) were captured on Antelope Creek:

- hitch
- Sacramento pikeminnow
- green sunfish

Hitch were the most abundant fish, with an average density of 4.5 fish/m^2 (3.8 fish/yd^2). The Sacramento pikeminnow and the green sunfish both had a relative abundance of 0.2 fish/m^2 (0.2 fish/yd^2).

Table 33. Relative abundance of species caught at each station on Antelope Creek.

SPECIES	STATION SAMPLED					FISH/M^2
	1	2	3	4	5	
Hitch	X	X	X	X	X	4.5
Sacramento pikeminnow				X	X	0.2
Green sunfish		X		X	X	0.2

Ponds

DFG biologists seined seven stock-watering ponds in the study area. The ponds seined do not dry up during the summer. The following three game fish were found in the ponds:

- bluegill
- red-eared sunfish (*Lepomis microlophus*)
- 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.

Discussion

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

Most fish captured during seining were minnows, members of the Cyprinid family. California roach were the only fish present that are adapted to spending summers in the pools of intermittent streams (Moyle 1976). Most fish captured with seining, including game fish, were less than 14.9 centimeters (5.9 inches) in length, suggesting that only juvenile fish 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 back downstream after spawning.

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

CHAPTER 8

COLUSA BASIN DRAIN FISH STUDIES

Introduction

This section describes the fish resources of the Colusa Basin Drain. The 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. The average monthly streamflow in the CBD from 1976 to 1997 has been recorded (Table 34). January shows the highest average monthly streamflow, while October shows the lowest average. 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. The CBD's banks are scoured by periodic high flows, and roads run along many of 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 Reservoir will be east of the town of Maxwell along the CBD.

Table 34. Average monthly streamflow (cms) in the Colusa Basin Drain at the Highway 20 crossing (1976-1997).

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1976	6.7	7.1	4.5	5.2	5.0	10.5	8.8	24.9	6.8	12.3	26.2	25.6
1977	4.8	7.2	3.9	8.8	5.1	7.2	2.5	18.2	3.4	3.4	12.0	11.0
1978	3.3	7.7	7.2	88.4	60.4	40.5	10.3	19.4	13.3	20.1	29.9	29.1
1979	5.7	8.8	3.2	19.5	26.6	11.5	9.3	22.7	12.0	22.7	34.3	29.1
1980	5.7	15.9	23.7	53.1	81.8	37.0	9.2	29.7	17.1	22.8	37.0	32.9
1981	7.8	9.3	10.2	28.8	23.8	12.3	9.7	29.4	12.6	29.9	41.5	33.5
1982	8.0	24.8	31.6	54.9	13.4	10.9	19.3	21.0	25.7	n.r.*	39.4	38.4
1983	13.2	22.0	34.7	66.0	85.7	150.2	28.0	n.r.	n.r.	25.7	33.1	33.9
1984	8.9	36.9	102.6	43.1	14.0	7.5	15.5	33.7	24.1	37.1	44.7	29.5
1985	10.7	32.9	19.3	8.1	4.8	5.6	11.6	29.7	21.7	35.0	40.8	40.8
1986	8.9	18.8	19.8	21.4	119.3	51.9	12.7	26.1	23.6	29.8	37.9	37.9
1987	9.0	13.0	6.7	7.1	9.0	14.4	14.0	25.9	20.0	25.7	33.3	33.3
1988	9.7	18.9	13.1	38.7	8.1	12.2	18.9	24.0	14.6	16.6	27.5	27.5
1989	9.8	17.5	10.0	9.7	6.0	11.4	12.4	16.2	16.6	22.7	28.2	28.2
1990	8.6	11.6	5.1	9.8	5.7	n.r.	n.r.	16.5	12.4	15.1	25.9	25.9
1991	7.0	n.r.	n.r.	4.3	6.1	25.9	12.0	13.5	10.0	10.5	15.2	15.2
1992	4.5	9.0	8.2	7.4	26.4	19.0	7.2	4.7	7.1	4.2	5.3	5.3
1993	3.3	7.6	9.8	82.1	86.3	21.6	9.1	7.9	8.2	5.7	13.8	13.8
1994	5.7	11.9	13.2	8.9	21.0	9.4	8.5	5.4	4.2	1.7	11.8	11.8
1995	4.4	16.0	15.6	187.2	57.2	108.3	16.7	15.6	10.3	8.4	11.8	11.8
1996	7.2	10.4	21.2	27.5	75.6	30.9	14.0	21.8	13.4	7.1	18.7	18.7
1997	6.5	18.2	18.2	104.7	41.5	10.1	9.1	8.1	4.3	10.4	27.0	27.0
AVG	7.2	15.5	18.2	40.2	35.6	29.0	12.3	19.7	13.4	17.5	27.1	27.1

*not recorded

Methods

DFG staff used several methods to sample the fish of the Colusa Basin Drain. These techniques included the following:

- fyke nets
- seines
- hook and line
- hoop nets
- gill nets.

Fyke Netting

Two fyke nets were placed in the CBD as described by Everhart et al (1953), 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 had a 0.9 by 1.5 meter (3 foot-by-5 foot) opening, and a 3.7 meter (12-foot) funnel. Galvanized pipe frames support the net opening. Nets of variable size stretched mesh were used, including the following sizes:

- 2.5 centimeters (1 inch)
- 0.64 centimeters (0.25 inch)
- 0.32 centimeters (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 measuring 0.76 meters by 0.46 meters by 0.49 meters (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 0.48 centimeters (0.19 inch). The fyke nets were held in fishing position by rope bridles attached to ropes that were 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 the first twenty of each species were measured for fork length to the nearest millimeter, as described by Lagler (1956). Further specimens of each species were tallied. Representatives of each species were either photographed or preserved for future positive identification.

Fishing during emigration period

Other methods

At the upper fyke net location, periodic seining using the medium-sized seine (Figure 14) and hook and line sampling as described by Everhart et al (1953) were also used to sample the fish of the Colusa Basin Drain. Two hoop nets and a gill net were also placed at the upper fyke net location on February 1, 1999. The hoop nets were installed as described by Lagler (1956) upstream of the fyke net. The hoop nets were 2.1 meters (7 feet) long with six hoops each. The hoops were 0.6 meters (2 feet) in diameter and set 0.3 meters (1 foot) apart, with a 2.5 centimeter (1 inch) net mesh size. 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 and was set up according to the method described by Everhart et al (1953). These nets were removed on March 10, 1999. One hoop was replaced at the bridge on March 19, 1999.

Figure 14. DFG staff seining in the Colusa Basin Drain

Results

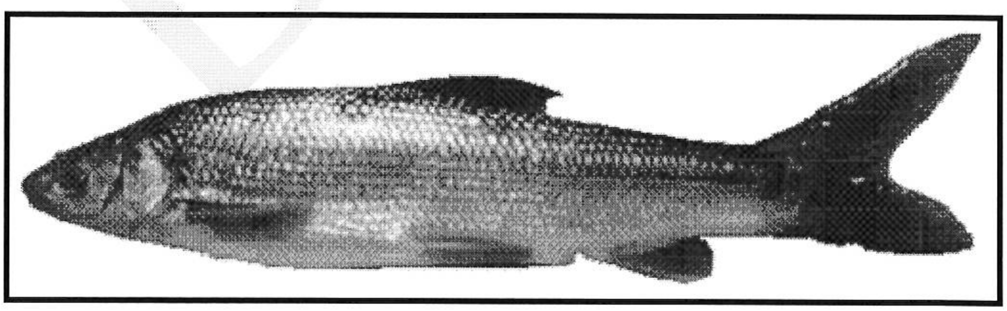
Species caught

A total of ten game fish and seventeen non-game fish were caught in the CBD (Tables 35 and 36). The warmouth (*Lepomis gulosus)* was not observed in this recent survey, although they were caught by the U.S. Geological Survey in 1996.

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 spring 1998 in Walker Creek, a tributary of Willow Creek.

Four Sacramento splittail (*Pogonichthys macrolepidotus*) (Figure15) 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 3.6 centimeters (1.4 inches) in length, and ranged from 2.3 to 5.1 centimeters (0.9 to 2.0 inches) fork length.

Figure15. Sacramento splittail



Bullfrog tadpoles, (*Rana catesbieana)*, were the most numerous species caught by any method, particularly by the fyke nets. Channel catfish were the most frequently caught fish. Most fish caught in the nets, including the channel catfish, were juveniles. Fish caught rarely exceeded 15 centimeters (5.9 inches), with the exception of goldfish (*Carassius auratus)*.

Table 35. Game fish caught in the Colusa Basin Drain.

COMMON NAME	SCIENTIFIC NAME
White catfish	*Ictalurus catus*
Brown bullhead	*Ameiurus nebulosus*
Black bullhead	*Ameiurus melas*
Channel catfish	*Ictalurus punctatus*
Chinook salmon*	*Oncorhynchus tschawtscha*
Bluegill	*Lepomis macrochirus*
Green sunfish	*Lepomis cyanellus*
Largemouth bass	*Micropterus salmoides*
Black crappie	*Pomoxis nigromaculatus*
White crappie	*Pomoxis annularis*

* migratory species

Table 36. Non-game fish caught in the Colusa Basin Drain.

COMMON NAME	SCIENTIFIC NAME
Pacific lamprey*	*Lampetra tridentata*
Threadfin shad	*Dorosoma pretenense*
California roach	*Hesperoleucus symmetricus*
Hitch	*Lavinia exilicauda*
Fathead minnow	*Pimephales promelas*
Common carp	*Cyprinus carpio carpio*
Goldfish	*Carassius auratus auratus*
Sacramento pikeminnow*	*Ptycholcheilus grandis*
Sacramento blackfish	*Orthodon microlepidotus*
Sacramento splittail*	*Pogonichthys macrolepidotus*
Hardhead	*Milopharodon conocephalus*
Sacramento sucker*	*Catostomus occidentalis*
Inland silverside	*Menidia beryllina*
Mosquitofish	*Gambusia affinis*
Sculpin sp.	*Cottus sp.*
Tule perch	*Hysterocarpus traskii*
Big scale logperch	*Percina macrolepida*

* migratory species

Success of sampling methods

The greatest diversity of fish - twenty-seven species - 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 four different species of fish each (Table 37). Ten different species were caught with hook and line. Carp up to 51 centimeters (20 inches) in length and adult channel catfish up to 45 centimeters (17.7 inches) were 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 33.89. The hoop net and gill net were the least efficient methods of capture, with a catch per hour effort ratio of 0.01 (Table 38).

Table 37. Number of each species captured at each trapping station in the Colusa Basin Drain.

SPECIES	GILL NET	HOOP NET	SEINE	HOOK & LINE	FYKE NETS	TOTAL SPECIMENS
Pacific lamprey					6	6
Threadfin shad					2	2
California roach			2		1	3
Hitch			40	1	52	93
Fathead minnow					1	1
Common carp				89	31	120
Goldfish				17	14	31
Sacramento pikeminnow	1			1	4	6
Sacramento blackfish			96		5	101
Sacramento splittail					4	4
Hardhead					122	122
Sacramento sucker	1	1	1		5	8
White catfish				33	5	38
Brown bullhead				39	7	46
Black bullhead				3	1	4
Channel catfish	2	1	14	54	166	237
Chinook salmon					1	1
Inland silverside			1		3	4
Mosquitofish			3		12	15
Sculpin sp.			1		2	3
Bluegill	1	1	10	1	23	38
Green sunfish			8		51	59
Largemouth bass				2	3	5
Black crappie			1		4	5
White crappie					3	3
Tule perch		1			6	7
Big scale logperch			2		4	6
Total number of species	4	4	12	10	27	

Table 38. Catch per hour effort for each trapping method.

TRAPPING METHOD	TOTAL EFFORT HOURS	CATCH PER HOUR EFFORT
Gill net	336	0.01
Hoop net	528	0.01
Seine	9	33.89
Hook and line	86	5.52
Fyke net	2804	0.38

Discussion

Four Sacramento splittail were caught in the CBD. This species was 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. This species was 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 did not yield any steelhead smolts. This may be 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.

CHAPTER 9

SITES PROJECT STREAM HABITAT TYPING

Introduction

This section summarizes studies of habitat types conducted in 1998 and 1999 along the streams in the proposed Sites Project area, using the methods described by Flosi et al (1998). DFG conducted stream habitat typing on four creeks in the Sites project area in 1998 and 1999 to quantify physical aquatic habitat and provide information for the NEPA and CEQA processes. This quantification will determine habitat that would be lost by inundation and will form the basis for mitigation.

Methods

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 twenty bankfull widths, using the method described by Flosi et al (1998).

Channel type surveys began by first noting the stream as a threaded or single channel stream. Then the bankfull width was measured with a 30.5 meter (100-foot) vinyl tape at the prominent scour marks and sedimentation on the bank substrate. Ten depths were taken at the study section to obtain the average bankfull depth. The substrate type was noted (Table 39).

Table 39. Substrate type and size used*

SUBSTRATE TYPE	SIZE IN CENTIMETERS
Boulder	> 25
Large Cobble	13-25
Small Cobble	6.4-13
Gravel	.2-6.4
Sand	<.2

*Flosi et al. 1998

Habitat type evaluation on Funks Creek began at the Golden Gate dam site on January 12, 1999. Habitat typing continued upstream until a point just above the mouth of Grapevine Creek was reached 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 Creek and began on Antelope Creek on February 23, 1999. Habitat typing concluded on Antelope Creek on April 22, 1999, at the reservoir inundation line.

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. Each habitat unit was described as a pool, flat water, or riffle. 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 was embedded were also evaluated.

In addition to unit type data, the following were recorded:

- start time for surveying
- air and water temperature
- date
- surveyors present

Yellow flags were left at the end of the last habitat unit surveyed each day. The substrate type and percent exposed substrate were 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, and then broken down into the percentages of the total that each cover element represented.

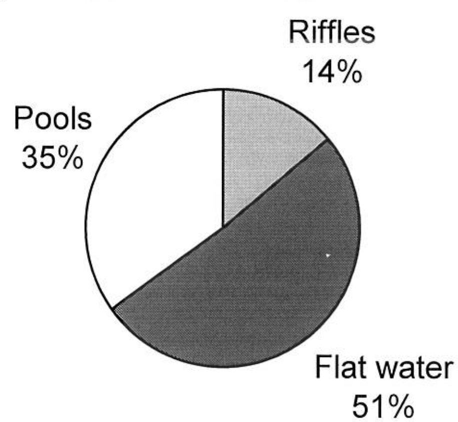
The bank composition was evaluated and dominant vegetation for right and left banks was recorded. Plant species and bank substrates were entered. The percent of the bank vegetated was evaluated up to bankfull width plus 6.1 meters (20 feet). The percent and type (deciduous or coniferous) of cover by tree canopy at midday was also evaluated. This was done for the entire part of each stream studied.

Results

Funks Creek

Flat water constituted fifty-one percent of the total creek measured. The average flat water length on Funks Creek was 64.6 meters (212 feet). Pools were the second most dominant habitat type, comprising thirty-five percent of the total creek length measured. Pools had an average length of 44.5 meters (146 feet). Riffles constituted fourteen percent of the creek, with an average unit length of 17.4 meters (57 feet) (Figure16).

Figure 16. Relative occurrence of habitat types in Funks Creek.



Gravel was the most common substrate, occurring at an average of thirty-three percent of the units surveyed (Table 40). Small cobble substrate was the second most common type, occurring at an average of twenty-eight 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 40. 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 percentage of the bank covered by vegetation was fifty-two percent for the right bank and fifty-three percent for the left bank. Occasional cottonwoods, willows, oaks and walnut trees punctuate the banks. Only eighteen percent of the habitat units had some degree of canopy. The average canopy cover was five percent, or twenty-six 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 twenty-seven percent. Aquatic vegetation was the prevalent type of cover, and boulders were the most common large cover item. Aquatic vegetation and boulders each comprised an average of twenty-five percent of the total cover (Table 41). Large woody debris and root masses occurred relatively infrequently. Undercut banks occurred in an average of seventeen percent of the habitat units. Pools overall had a large degree and variety of cover, while flat water and riffles had less cover.

Table 41. Summary of habitat cover in Funks Creek.

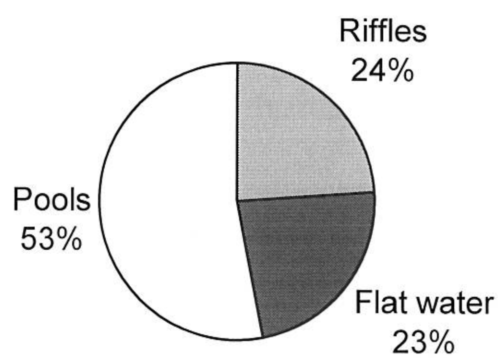
Habitat type	Percent of each habitat having cover	PERCENT OF COVER TYPE								
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Riffles	20	-	-	1	-	20	15	30	28	6
Flat water	38	34	1	1	-	1	27	10	25	1
Pools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

Grapevine Creek

Pools made up fifty-three percent of the total length of Grapevine Creek measured within the reservoir inundation area. Riffles made up twenty-four percent of the total creek measured (Figure17). The average riffle length on Grapevine Creek was 22 meters (72 feet). Flat water was the least dominant habitat type. Flat water made up twenty-three percent of the total creek length measured, and had an average length of 43.6 meters (143 feet).

Small cobble was the most common substrate in Grapevine Creek. Gravel was also common, occurring as the substrate in thirty percent of the habitat units. Large cobble was the dominant substrate in thirteen 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 17. 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 twenty-two percent of the pools. Flat water was dominated by gravel and small cobbles (Table 42).

Table 42. Summary of substrates (%) by habitat type on Grapevine Creek.

HABITAT TYPE	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 fifty-six percent for the right bank and fifty-four percent for the left bank. Occasional oaks, willows, cottonwoods, walnuts and gray pines punctuate the banks. Thirty-nine percent of the habitat units examined on Grapevine Creek had some degree of canopy - thirty-eight percent from deciduous trees and shrubs, and one percent from pines. The average canopy cover was twelve percent. Trees were more concentrated at the upstream end where Grapevine Creek starts to climb in elevation toward the edge of the reservoir inundation area.

The average of the total unit covered by all cover combined was twenty-nine percent. Aquatic vegetation was the most prevalent type of cover, occurring in seventy-two percent of the flat water units surveyed. Aquatic vegetation comprised an average of fifty-three percent of the total unit cover (Table 43).

Pools had the largest mean total coverage at thirty-two percent. Aquatic vegetation comprised forty-six percent of the cover in pools. Riffles had a mean total coverage of twenty-eight percent, forty percent of which was aquatic vegetation. Terrestrial vegetation, boulders and bubble curtains also provided cover in riffles - fourteen percent, seventeen percent and seven percent, respectively. Flat water averaged twenty-six percent total coverage; seventy-two percent of this coverage was aquatic vegetation.

Aquatic vegetation was the most common large cover item, occurring in fifty-three percent of the units surveyed. Root masses were another large cover item that occurred with some frequency (seven percent). Terrestrial vegetation occurred in nine percent of the habitat units, and bedrock ledges in four percent of the units. Riffles and pools contained all of the major types of cover (Table 43).

Table 43. Summary of habitat cover in Grapevine Creek.

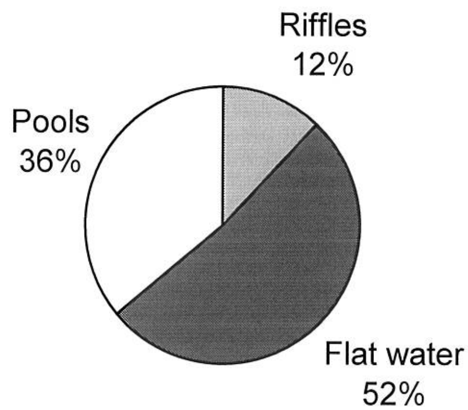
Habitat type	Percent of each habitat having cover	PERCENT OF COVER TYPE								
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Riffles	28	1	3	3	13	14	40	7	17	2
Flat water	26	5	3	-	4	8	72	4	4	-
Pools	32	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 types measured, comprising fifty-two percent of the total creek. The average flat water length on Stone Corral Creek was 64.9 meters (213 feet). Pools were the second most dominant habitat type in terms of total footage. They made up thirty-six percent of the total length and had an average length of 44.2 meters (145 feet). Riffles made up twelve percent of the creek's total length and had an average unit length of 14.6 meters (48 feet) (Figure 18).

Bedrock was the most common substrate, occurring as the primary substrate in thirty-one percent of the total units surveyed on Stone Corral Creek. Gravel substrate was the second most common substrate type, occurring in twenty-four 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 18. Relative occurrence of habitat types in Stone Corral Creek.



Thirty-three percent of pools had silt/clay as the dominant substrate (Table 44). Fifty-two percent of flat water had gravel as the dominant substrate. Riffles had fifty-six percent bedrock dominant and seventeen percent silt/clay dominant substrate. The most common occurring pool tail substrate was bedrock.

Table 44. Summary of substrates (%) by habitat type on Stone Corral Creek.

HABITAT TYPE	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 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 sixty-two percent for the right bank and sixty-three percent for the left bank. Occasional oaks, willows, cottonwoods and walnut trees punctuate the banks. Only eleven percent of the habitat units surveyed had some degree of canopy. The average canopy cover was four 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 thirty-three percent. Aquatic vegetation was the most prevalent type of cover, comprising an average of fifty-six percent of the total unit coverage.

Riffles had a mean total cover of thirty-nine percent, forty-nine percent of which was aquatic vegetation. An average of seven percent of the cover in riffles was comprised of boulders. Flat water averaged thirty-four percent total coverage; sixty-one percent of this cover was aquatic vegetation. Pools had a mean percent total coverage of twenty-six percent.

Aquatic vegetation was the most common large cover item, occurring in fifty-six percent of the units surveyed. Boulders and terrestrial vegetation were the next most common cover items at sixteen percent and twelve percent, respectively. Undercut banks occurred in six percent of the habitat units, and bedrock ledges in four percent of the units. No habitat unit types contained all major types of cover (Table 45).

Table 45. Summary of habitat cover in Stone Corral Creek.

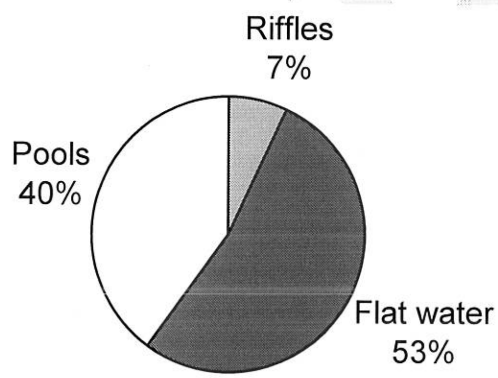
Habitat type	Percent of each habitat having cover	PERCENT OF COVER TYPE								
		Undercut banks	Small woody debris	Large woody debris	Root masses	Terrestrial vegetation	Aquatic vegetation	Bubble curtain	Boulders	Bedrock ledges
Riffles	39	-	-	-	-	25	49	18	7	2
Flat water	34	5	5	-	-	6	61	-	21	3
Pools	26	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 fifty-three percent of the total creek measured. The average flat water length on Antelope Creek was 41.2 meters (135 feet). Riffles made up seven percent of the creek's total length, with an average unit length of 5.5 meters (18 feet). Pools comprised forty percent of the total length measured with an average length of 31.4 meters (103 feet) (Figure 19).

Silt/clay was the most common substrate, occurring as the primary substrate in twenty-four percent of Antelope Creek. Gravel and small cobble, at twenty-two percent each, were also common substrates. 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 46).

Figure 19. 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 dominated riffles, at twenty-three percent and twenty-two percent respectively (Table 46).

Table 46. Summary of substrates (%) by habitat type on Antelope Creek.

HABITAT TYPE	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, particularly gravel and cobble, increased in the upper reaches of Antelope Creek.

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

The average of the total stream habitat covered was thirty-one percent (Table 47). Aquatic vegetation was the most prevalent type of cover, occurring in sixty-five percent of the units surveyed. Aquatic vegetation comprised an average of forty-six percent of the total unit cover.

Riffles had an average total cover of thirty-four percent, forty-three percent of which was aquatic vegetation. Flat water averaged thirty percent total coverage with fifty-eight percent aquatic vegetation. The primary cover for all units was aquatic vegetation. Some units indicated a higher percentage of cover, but these occured on an infrequent basis in this creek.

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

Table 47. Summary of habitat 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

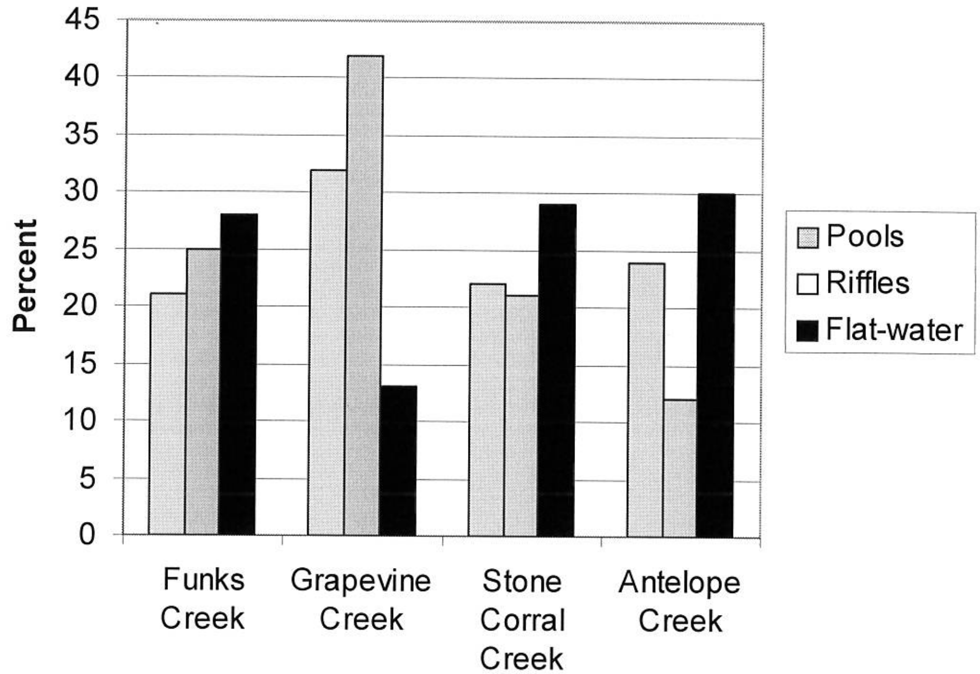
Habitat typing was done in order to quantify physical aquatic habitat to provide information for the NEPA and CEQA process. This quantification will determine habitat lost by inundation and will form the basis for mitigation.

Grapevine Creek had the most 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 the hills to the west of Sites-Colusa and is steeper than the other creeks. This causes Grapevine Creek to have less flat water than the other creeks (Table 48 and Figure 20).

Table 48. Comparison of relative occurrence of pools, flat water and riffles in creeks in the Sites Project Area.

	FUNKS	GRAPEVINE	STONE CORRAL	ANTELOPE
Pools	21	32	22	24
Riffles	25	42	21	12
Flat water	28	13	29	30

Figure 20. Relative occurrence of habitat types in streams of the Sites project area.



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 were abundant in Stone Corral and Antelope Creeks. The relatively steep nature of Grapevine Creek washes fine materials away and leaves coarser materials behind (Table 49).

Table 49. Summary of substrates (%) by habitat type on creeks in the Sites 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

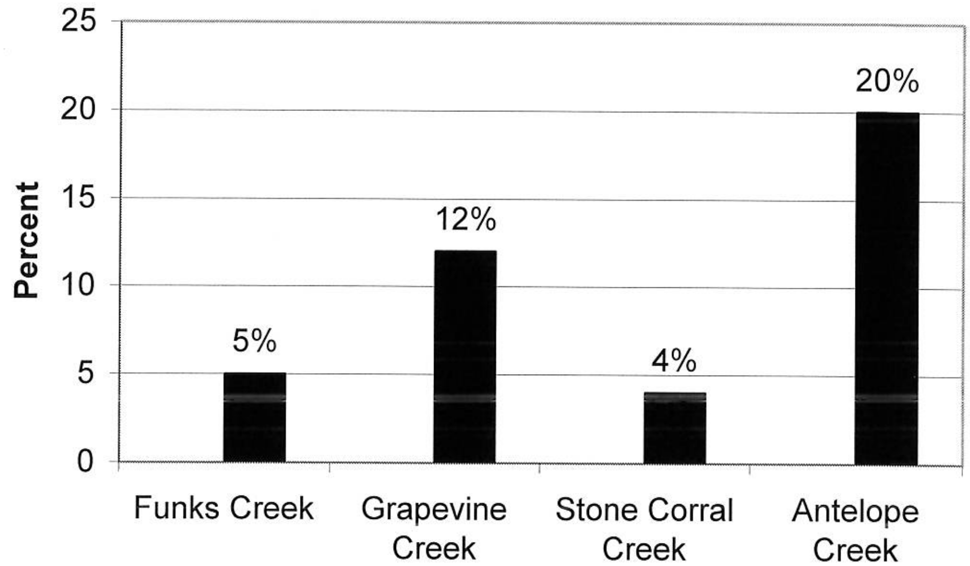
The occurrence of cover types followed the same trends for all four creeks surveyed. Aquatic vegetation was the dominant cover type in each creek. Stone Corral Creek showed a higher percent occurrence of boulders - nearly twice as many as Antelope Creek and nearly five times as many as Funks and Grapevine Creeks. Bubble curtains were the most common in Funks Creek. Antelope Creek had the most cover provided by root masses than the other creeks (Table 50).

Table 50. Summary of cover (percent of each habitat type) on creeks in the Sites 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 thirty 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 21).

Figure 21. Percent canopy over creeks measured at the Sites 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 probably use the creeks only as rearing areas. The high concentration of sediments and aquatic vegetation raises the biological oxygen demand in the creeks during the summer months in any remaining deeper pools. This makes them uninhabitable to most fish, with the exception of the California roach (Moyle 1976).

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-ten inch largemouth bass 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.

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