RESULTS OF THE SONOMA COUNTY WATER AGENCY'S MIRABEL RUBBER DAM/WOHLER POOL RECONNAISSANCE FISH SAMPLING PROGRAM 1999

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EXECUTIVE SUMMARY

The Sonoma County Water Agency (Agency) diverts water from the Russian River to meet residential and municipal demands. Water diverted is a combination of releases from upstream storage reservoirs and instream flow. The Agency's water diversion facilities are located near Mirabel and Wohler Road. The Agency operates five Ranney collector wells (large groundwater pumps) adjacent to the Russian River near Wohler Road and Mirabel that extract water from the aquifer beneath the streambed. The ability of the Russian River aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed. To augment this rate of recharge, the Agency has constructed several infiltration ponds. An inflatable dam located in the Mirabel area, raises the water level and submerges the intakes to a series of canals that feed infiltration ponds located at the Mirabel and Wohler facilities. The backwater created by the Inflatable Dam also raises the upstream water level and submerges a larger streambed area along the river. This increased depth and enlargement of the submerged area significantly increases infiltration to the aquifer.

Three species of fish (chinook salmon, coho salmon, and steelhead) listed as threatened under the Federal Endangered Species Act (ESA) inhabit the Russian River Drainage. In accordance with Section 7(a)(2) of the ESA, federal agencies must consult with either the USFWS and/or the NMFS to "insure that any action authorized, funded, or carried out by such an agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat..." As a result, the Agency is preparing a Biological Assessment of its operations and facilities to assess potential impacts to ESA protected species. The three listed species are anadromous, meaning they spawn and rear in freshwater, then migrate to the ocean where they grow and mature. They then migrate back to their natal freshwater habitat where they spawn and complete their life cycle. The Russian River in the Mirabel Reach serves primarily as a migration corridor for adult and juvenile salmon and steelhead. Thus, the Inflatable Dam has the potential to impact salmon and steelhead primarily during their upstream and downstream migrations.

The Inflatable Dam has the potential to impact salmon and steelhead through; 1) altering habitat composition, 2) altering water temperature and water quality in the lower river, 3) impeding downstream migration of juveniles, 4) impeding upstream migration of adults, and 5) altering habitat to favor predatory fish. This preliminary study was developed in cooperation with the National Marine Fisheries Service and the California Department of Fish and Game to assess the potential for the dam to adversely impact listed species, and to identify sampling methodologies to study the potential impacts associated with the inflation of the dam. This report presents the results of the 1999 reconnaissance study, and presents refinements to the methodologies for the five-year study plan.

HABITAT SURVEY

The Inflatable Dam impounds water over an approximate 4.8-kilometer (km) (3.0 mile) reach of the river. Within the impounded reach, riverine habitat is altered from its natural composition of pool/riffle/run habitats to solely pool habitat (the pool formed behind the Inflatable Dam is referred to as the Wohler Pool in this report). This change in habitat may adversely impact salmonids in three ways. First, impounding water behind a dam can lead to an increase in water temperature. Secondly, predatory fish such as smallmouth bass and Sacramento pikeminnow prefer pool habitat. A change in habitat to include warmer temperatures and an increase in pools may alter species composition and improve conditions for these predators. Finally, emigrating smolts drift downstream with the current. A decrease in stream current within the impounded reach may adversely delay smolts emigrating from the river. The objective of this study was to estimate the change in habitat composition resulting from the inflation of the dam compared to free flowing conditions. Habitat was classified above and below the Wohler Pool in order to estimate the potential change in habitat as resulting from the dam.

Above the impoundment, aquatic habitat consisted primarily of runs (68.1 percent) and pools (29.0 percent), while downstream of the Inflatable Dam habitat consisted primarily of pools (67.3 percent) and run (30.3). Based on this analysis, the inflation of the dam likely results in an increase in pool habitat on the order of 30 to 70 percent over free flowing conditions.

WATER QUALITY

As rivers flow from their headwaters to the ocean, water temperature increases naturally, depending on meteorological conditions. The impoundment formed by the Inflatable Dam may affect water quality, primarily by increasing the rate at which water temperature increases. Impoundments such as Wohler Pool slow the flow of water through the basin. The longer the residence time, the greater the opportunity for water to be warmed by solar radiation. Therefore, the key consideration for this task was to determine to what degree, if any, the Wohler Pool increases water temperature compared to free flowing riverine conditions.

This study was conducted using a series of continuously recording water temperature monitors (data loggers) located within the study area. Data loggers were placed in three locations, at the upstream extent of the impoundment (at a depth of 0.5 m), mid-way through the impoundment (at a depth of 3.0 m), and at the dam at depths of 0.5 and 3.0 m. In addition, water temperature profiles were recorded at several stations above and within the Wohler Pool. Temperature profiles were taken to determine if Wohler Pool becomes thermally stratified during the summer (i.e., does a layer of cold water remain near the bottom of the impoundment throughout the summer, providing a thermal refuge for salmon and steelhead).

The daily average water temperature recorded at a depth of 0.5 m ranged from 18.7 to 24.3°C at the most upstream station, to 19.4 to 25.2°C at the downstream most station. The maximum hourly temperature recorded was 27.1°C at the upstream most station and 25.9°C at the most downstream station. Overall, the average daily water temperature increased 0.5°C over the length of the Wohler Pool. The results of the profiling study indicated that Wohler Pool does not become thermally stratified during the summer.

Data loggers provided high quality data to evaluate water temperatures longitudinally across the study area, while the profile data provided information on water temperature vertically (i.e., at depth) within the study area. The water temperature monitoring program will be expanded in the five-year study to include water temperature monitoring stations upstream and downstream of Wohler Pool to assess water temperature in free flowing sections of the river.

GRAVEL BAR GRADING

The Agency annually grades gravel bars within the Wohler Pool footprint, both upstream and downstream of the Inflatable Dam. Upstream of the dam, grading consists of spreading large gravel deposits out to facilitate infiltration. Gravel is not removed from the area, and all work is conducted within the inundation footprint of the reservoir prior to dam inflation. Downstream of the dam, gravel is removed from the gravel bar that forms the Riverside Infiltration Pond. Gravel bar grading has the potential to adversely impact listed species primarily through increasing turbidity and sediment input into the river. These potential impacts are short-term in nature.

A set of Best Management Practices (BMPs) has been developed to reduce or avoid potential impacts associated with gravel bar grading. BMPs include biological oversight by qualified biologists, leaving permanent riparian vegetation, installing sediment fences, and contouring graded shoreline areas to a 2 percent slope. The water quality monitoring task will include a turbidity monitoring program to assess the effectiveness of the BMPs to control turbidity levels downstream of the grading operations.

Turbidity monitoring revealed that breaching of the Riverside Infiltration Pond below the dam results in a short-term increase in turbidity. In response to this finding, an additional BMP will be added to the program to reduce this potential impact. In addition, continuously recording turbidity meters will be installed upstream and downstream of the grading operations in the future to better monitor turbidity levels.

SMOLT EMIGRATION

The Inflatable Dam can potentially impact juvenile salmonids as they migrate to the ocean. When in place, the dam forms an impoundment approximately 4.8 km in length. Salmonid smolts drift downstream with the current during emigration. The Wohler Pool decreases current velocities that may delay emigrating smolts. Smolts have a seasonal "window of opportunity" to complete the physiological process (smoltification) necessary to survive in the marine environment. A substantial delay in migration may result in smolts reverting to a "resident form" thus spending an additional year in freshwater. Depending on summertime conditions, this may greatly increase mortality of smolts failing to successfully migrate to the ocean. The objective of this study is to measure the length of time required for steelhead smolts to emigrate through the impounded reach of the river just before and after the inflation of the dam.

Steelhead smolts bearing distinguishing marks were released at the upstream end of the impounded reach and recaptured in a rotary screw fish trap downstream of the dam. The amount of time elapsing between release and recapture of the smolts was recorded.

Insufficient numbers of marked smolts were recaptured to determine migration rates through the study area. The trapping study did result in the capture of emigrating wild steelhead and chinook salmon smolts. Wild smolts were captured after the dam was inflated, demonstrating that at least some of them were able to successfully emigrate pass the dam. This data provided an insight into the age and length of smolts at the time of emigration. In addition, tissue samples were collected and sent to the University of California's Bodega Bay Marine Lab for analysis to determine their genetic origin (e.g., hatchery or native stocks).

Refinements to the sampling methodology include increasing the number of marked smolts from 9,000 to 20,000. In addition, a study employing radio telemetry methodologies will be conducted in order to determine emigration rates before and after the dam is inflated. Radio telemetry involves implanting miniature radio transmitters into hatchery steelhead smolts, then tracking the movement of these fish with receivers.

ADULT UPSTREAM MIGRATION

The dam may be inflated during the adult migration season of chinook salmon, coho salmon and steelhead. Although the dam is equipped with two denil type fish ladders to provide access around the dam, the effectiveness of the ladders had not been tested.

The objective of this task was to evaluate fish passage through the denil fish ladders using time-lapse video monitoring equipment. Underwater video cameras were installed at the upstream ends of the fish ladders. The cameras recorded the movement of fish through the ladders 24 hours a day throughout the time-period that the dam was inflated (May 20 through November 16). Snorkel surveys were conducted below the dam to determine if adult salmonids were present. These surveys were necessary to determine if adult salmonids were holding below the dam for long periods of time, which could indicate that the fish were having a difficult time finding and negotiating the fish ladders.

Approximately 300 chinook salmon and 36 juvenile steelhead were recorded swimming upstream through the fish ladders in 1999. In addition, several other species were also observed using the fish ladders, including Pacific lamprey, American shad and Sacramento squawfish.

Overall, this sampling strategy proved to be an excellent method for assessing adult salmonid passage through the fish ladders. Proposed modifications to the methodology will include modifying the camera housing to reduce blind spots and adding a reflective coating to the bottom and sides of the fish exit to increase the contrast with fish passing through the ladder. No adult salmonids were observed below the dam during dive surveys.

PREDATOR POPULATION ASSESSMENT

Since pools are the preferred habitat of adult predatory fish (e.g., pikeminnow and smallmouth bass), the habitat created behind the Inflatable Dam may result in an increase in the predator population. Concentrating numbers of adult predators may lead to an increase in predation on salmonid smolts. This may be particularly true if smolts have difficulty migrating through the Wohler Pool. Predator populations were assessed using boat electrofishing. Electrofishing employs an electric current to stun fish, allowing for easy capture. This method is particularly effective on large fish that inhabit relatively shallow habitat (< ten feet deep).

Thirteen species of fish, including 716 individuals, were captured in the four reaches during boat electrofishing sampling. Six native and seven non-native species were captured. Overall, three species dominated the catch at all stations. Sacramento suckers and smallmouth bass comprised 37.7 percent and 34.4 percent of the overall catch rate, respectively. Hardhead accounted for 13.4 percent of the overall catch. No other species accounted for more than 3.8 percent of the fish captured.

Three predatory species were captured during the study, smallmouth bass, Sacramento pikeminnow, and striped bass. Smallmouth bass, an introduced species, comprised between 21.6 and 50.2 percent of the catch in the four reaches. However, smallmouth bass large enough to prey on salmonid smolts accounted for 5.3 percent (38 of 716) of the fish captured. Sacramento pikeminnow comprised between 0.0 and 3.5 percent (1.8 percent overall) of the catch at each station. Of the 13 pikeminnow captured, only three were large enough to prey on salmonid smolts. One striped bass was collected during the study, measuring 655 mm fork length.

Boat electrofishing proved to be an excellent method for sampling fish populations in the Wohler Pool and in the Russian River upstream of the impoundment, and will be employed during the five year monitoring program. Modifications proposed for the five-year monitoring study include sampling defined stations of equal lengths and adding a station downstream of the dam if a suitable site can be located.

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1.0 INTRODUCTION

The Russian River provides habitat for several special status fish species, including three that are protected under the Endangered Species Act (ESA). On October 31, 1996, the National Marine Fisheries Service (NMFS) listed coho salmon as threatened under the ESA within the Central California Coast Evolutionarily Significant Unit (ESU). On August 10, 1997, NMFS listed steelhead as threatened under the ESA within the Central California Coast ESU. On September 16 1999, NMFS listed chinook salmon as threatened under the ESA within the California coastal ESU. The Russian River is included in all three ESUs listed above.

In accordance with Section 7(a)(2) of the ESA, federal agencies must consult with either the USFWS or the NMFS to "insure that any action authorized, funded, or carried out by such an agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat..." In the present case, the endangered species are anadromous, which are managed by the NMFS. The U.S. Army Corp. of Engineers, as the federal sponsor, and the Sonoma County Water Agency (Agency), as the local sponsor, entered into a Memorandum of Understanding (MOU) with the NMFS to begin the consultation process in December 1997. The MOU covers the Agency's flood control and water supply projects throughout the Russian River Basin.

The Agency is preparing a Biological Assessment of its operations and facilities to assess potential impacts to ESA protected species. The scope of this study is limited to assessing the potential for the Agency's Mirabel and Wohler diversion facility to adversely impact coho salmon, chinook salmon and steelhead. Results from this study will be incorporated into the Agency's overall Biological Assessment as required under the ESA.

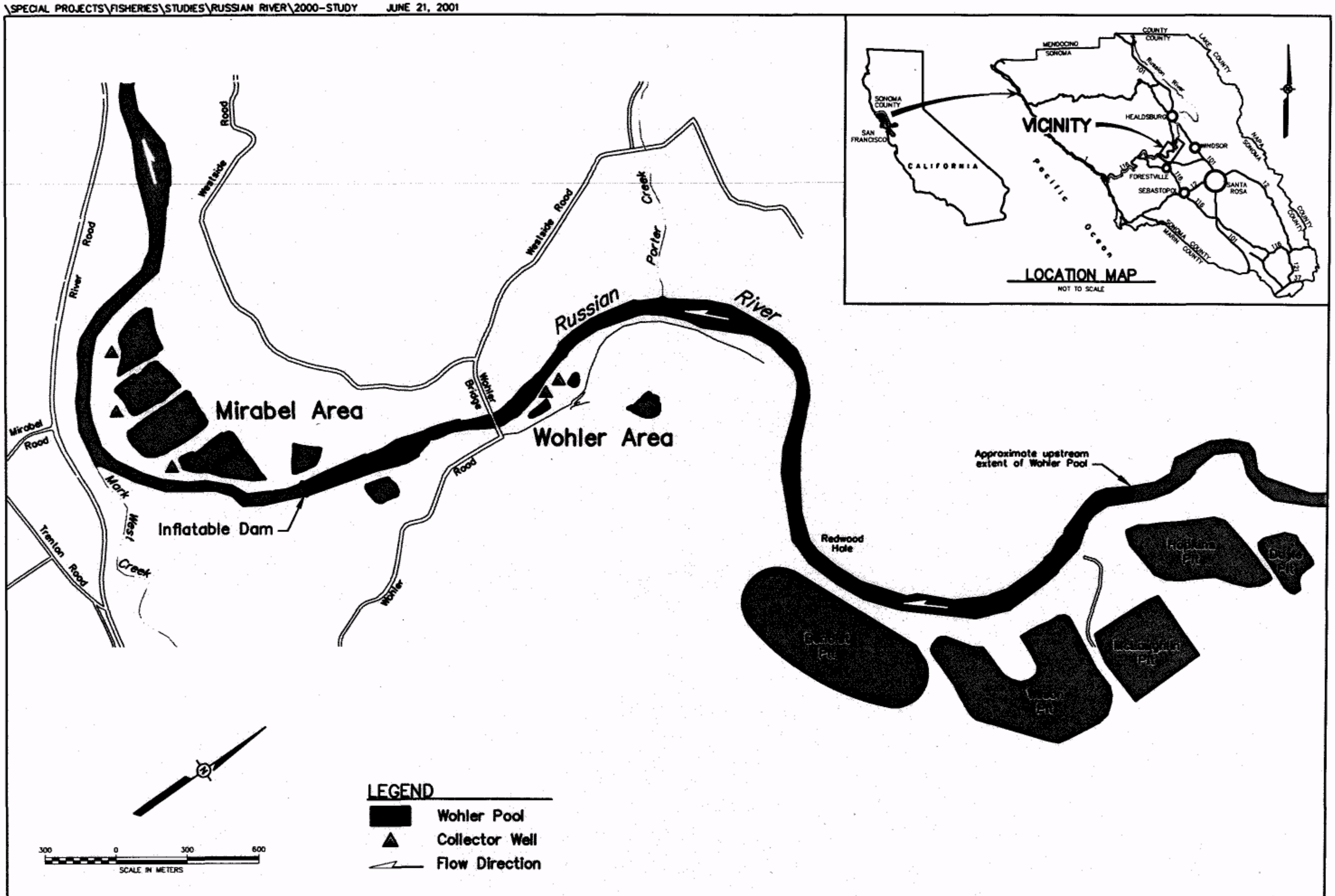
1.1 SCOPE OF WORK

Several uncertainties exist over the potential for the Mirabel and Wohler facilities to adversely affect steelhead, coho salmon, and chinook salmon. In light of these uncertainties, the Agency proposes to conduct a five-year study to assess the potential impacts associated with the facilities, and to develop mitigation measures as appropriate. Several sampling techniques are available to monitor fish communities in relatively large river systems such as the Russian. Each technique has its own set of advantages and disadvantages, as well as their own set of sampling biases. Prior to adopting specific sampling methodologies, this reconnaissance level sampling program was conducted to determine those sampling methodologies that best assess the fish community and water quality in the Russian River near the Mirabel and Wohler facilities. Information collected in this reconnaissance level program will be used to develop the five-year biological monitoring program.

The objective of this report is to evaluate each sampling technique identified in the "Sonoma County Water Agency's Mirabel Rubber Dam/Wohler Pool Reconnaissance Fish Sampling Program" (Chase et al. 1999). The results of the various studies are provided in this report as additional information. However, the data should be viewed as preliminary since the primary goal of the study was to evaluate the effectiveness of the sampling methodologies employed.

1.2 STUDY AREA

The Agency diverts water from the Russian River to meet residential, municipal, and agricultural demands. Water diverted is a combination of releases from upstream storage reservoirs and instream flow. The Agency's water diversion facilities are located near Mirabel and Wohler Road (Figure 1). The Agency operates five Ranney collector wells (large groundwater pumps) adjacent to the Russian River near Wohler Road and Mirabel that extract water from the aquifer beneath the streambed.



SONOMA COUNTY WATER AGENCY

Figure 1. Map of Study Area

The ability of the Russian River aquifer to produce water is limited by the rate of recharge to the aquifer through the streambed. To augment this rate of recharge, the Agency has constructed several infiltration ponds. An inflatable dam raises the water level and submerges the intakes to three diversion pumps. The water is pumped through a dike into a system of canals that supply water to four infiltration ponds. The backwater created by the inflatable dam also raises the upstream water level and submerges a larger streambed area along the river. This increase in depth and enlargement of the submerged area significantly increases infiltration to the aquifer. Water is also diverted through two screened control gates that feed two additional infiltration ponds at the Wohler facility.

The Inflatable Dam is generally inflated in May and is deflated by late-September/October of most years. Actual timing varies annually depending on a number of factors including, air temperature, precipitation, and river flow. The dam creates an impoundment (Wohler Pool) that extends approximately three miles upstream (Figure 2). Within the impounded reach, water depth is increased and current velocity is decreased, compared to free flowing conditions. These changes have the potential to alter species composition, distribution, and relative abundance within the affected reach.

1.3 BACKGROUND

Seasonal streamflow conditions in the Russian River have been altered from their historical state by a variety of water development facilities; including, Warm Springs Dam, Coyote Dam, diversion of Eel River water into the Russian River Basin, and other private or public diversions. The result of water management operations in the basin is a reduction in overall streamflow during winter months and an increase in streamflow during summer months, compared to unimpaired levels. In addition, several hundred smaller summer dams, including the Inflatable Dam, are erected annually in the Russian River basin. Although unimpaired streamflow observations are lacking, it is believed that pre-development summer streamflows in the lower Russian River were relatively low, possibly intermittent in some years (Heckel et al. 1994). However, the deeper pools in the pre-developed Russian River may have become stratified, possibly providing over summer habitat for salmonids. Currently, the annual minimum summer low flow in the Russian River downstream of the Mirabel Facility has been set by the State Water Resources Control Board (SWRCB 1986) as:

- 135 cfs during normal water supply conditions
- 85 cfs during dry water supply conditions, and
- 35 cfs during critical water supply conditions.

In addition, a number of exotic species have been introduced into the Russian River. The increased flow and warm temperatures have altered habitat conditions in the lower river, providing a more stable warm water habitat that potentially benefits many of the introduced species.

Twenty-nine species of fish inhabit the Russian River for all or part of their life cycle (Table 1). Of these, 16 are native to the Russian River and 13 are introduced. Target species for this program are ESA listed species and those fish that prey on them. However, information will be collected on all species inhabiting the river, when possible.

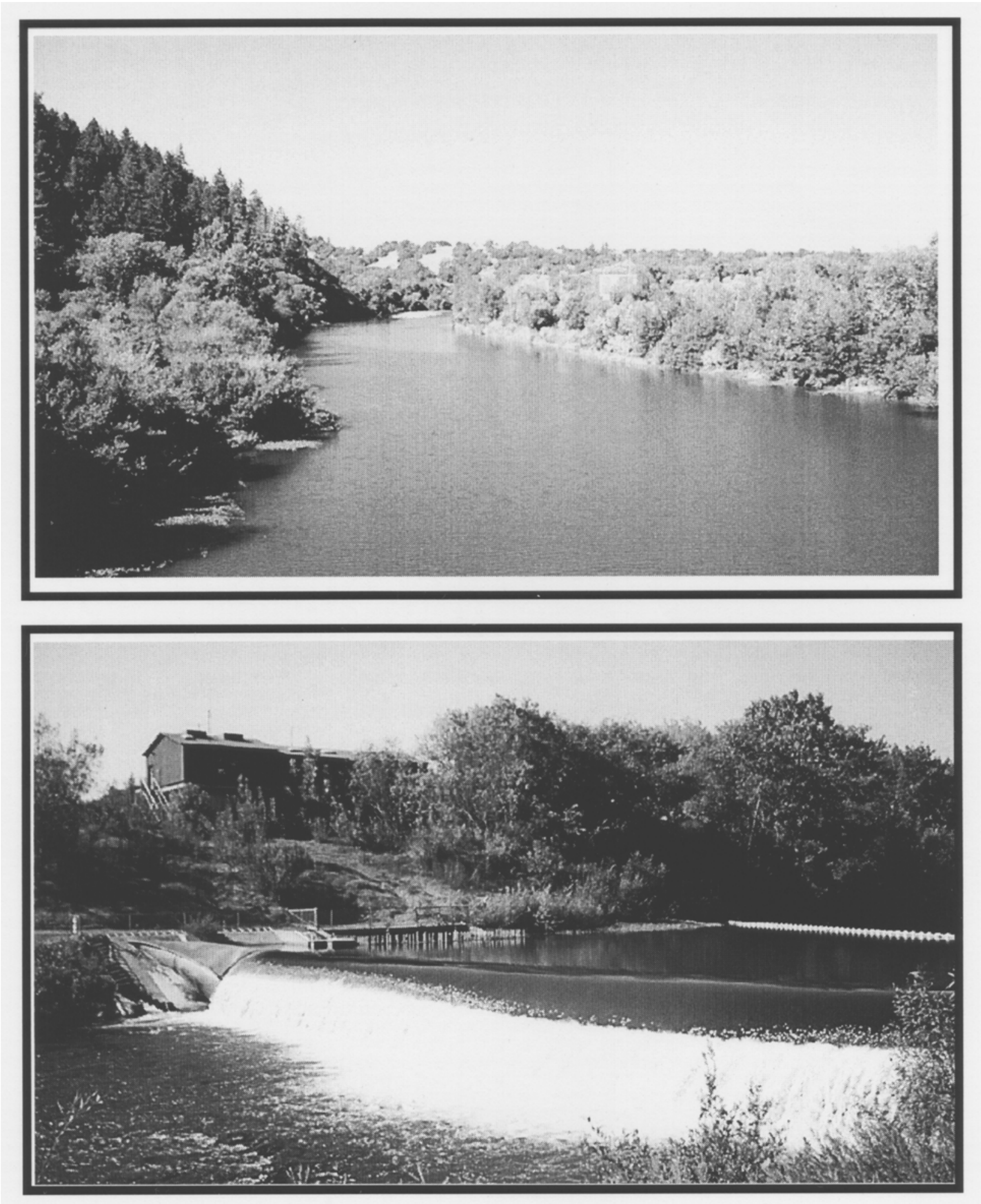


Figure 2. The Mirabel Inflatable Dam (lower picture) and a portion of Wohler Pool (upper picture)

Table 1. Common and scientific names of fish captured or observed in the study area, including status (native or introduced), life history strategy (anadromous or resident), and regulatory status.

Common Name	Scientific Name	Status	Life history Strategy	Regulatory status[1]
American shad	*Alosa sapidissima*	Introduced	Anadromous	—
Sacramento sucker	*Catostomus occidentalis*	Native	Resident	—
California roach	*Lavinia symmetricus*	Native	Resident	CSC[1]
Hardhead	*Mylopharodon conocephalus*	Native	Resident	CSC
California blackfish	*Orthodon microlepidotus*	Native	Resident	
Hitch	*Lavinia exilicauda*	Native	Resident	—
Pikeminnow	*Ptychocheilus grandis*	Native	Resident	—
Fathead minnow	*Pimephales promelas*	Introduced	Resident	—
Golden shiner	*Notemigonus crysoleucas*	Introduced	Resident	—
Carp	*Cyprinus carpio*	Introduced	Resident	—
Threespine stickleback	*Gasterosteus aculeatus*	Native	Resident	—
Bluegill	*Lepomis macrochirus*	Introduced	Resident	—
Green sunfish	*Lepomis cyanellus*	Introduced	Resident	—
Black crappie	*Pomoxis nigromaculatus*	Introduced	Resident	—
Smallmouth bass	*Micropterus dolomuieu*	Introduced	Resident	—
Largemouth bass	*Micropterus salmoides*	Introduced	Resident	—
Sculpin	*Cottus spp.*	Native	Resident	—
Tule perch	*Hysterocarpus traski*	Native	Resident	CSC
Channel catfish	*Ictalurus punctatus*	Introduced	Resident	—
Bullhead	*Ameiurus spp.*	Introduced	Resident	—
Mosquitofish	*Gambusia affinis*	Introduced	Resident	—
Pacific lamprey	*Lampetra tridentata*	Native	Anadromous	—
Coho salmon	*Oncorhynchus kisutch*	Native	Anadromous	FT[2]
Chinook salmon	*Oncorhynchus tshawytscha*	Native	Anadromous	FT
Steelhead	*Oncorhynchus mykiss*	Native	Anadromous	FT
Striped bass	*Morone saxitalis*	Introduced	Anadromous	

[1] California species of special concern

[2] Listed as Threatened under the Federal endangered Species Act

2.0 HABITAT MAPPING

2.1 POTENTIAL IMPACT

The Inflatable Dam impounds water over an approximately 3.2 kilometer (km) (2.0 mile) reach of the river. Within the impounded reach, riverine habitat is altered from its natural composition of pool/riffle/run habitats to solely pool habitat. This change in habitat may adversely impact salmonids three ways. First, impounding water behind a dam can lead to an increase in water temperature. Secondly, predatory fish such as smallmouth bass and Sacramento squawfish prefer pool habitat. Finally, emigrating smolts drift downstream with the current. A decrease in stream current within the impounded reach may adversely delay smolts emigrating from the river.

2.2 STUDY OBJECTIVE

The objective of this study was to estimate the change in habitat composition resulting from the inflation of the dam compared to free flowing conditions. Habitat was classified above and below the Wohler Pool in order to characterize the type of habitat that may have been lost due to the impoundment. The dam is inflated prior to river flow reaching summer base flow conditions. As a result, the low flow habitat conditions in the Wohler Pool imprint cannot be assessed. A habitat mapping survey was conducted to classify available habitat (e.g., pool, riffle, run) in the Russian River immediately above and below the Wohler Pool during the summer low flow period to assess macro-habitat changes resulting from impoundment. The changes in habitat composition resulting from the inflation of the dam were extrapolated from the habitat composition of the river above and below the impounded reach. In addition, this information forms the foundation for selecting fish sampling locations above and below the impoundment.

2.3 METHODS EVALUATED

Habitat mapping procedures essentially followed those described in CDFG's *California Salmonid Stream Restoration Manual: Part III Habitat Inventory Methods* (CDFG 1994). Habitat mapping was conducted at the basin-level habitat inventory (i.e., habitats types were classified into broad groups of pool, riffle, and run). Habitat mapping procedures available were designed for relatively small streams (compared to the Russian River). As a result, the habitat mapping procedures had to be modified slightly to be applicable to the current situation.

Habitat types were defined as:

Low Gradient Riffle: "Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient < 4%, substrate is usually cobble dominated." This definition was modified to include units that did not have exposed substrate, but had a relatively high gradient and considerable surface turbulence (e.g., standing waves and/or white water).

High Gradient Riffle: "Steep reaches of moderately deep, swift and very turbulent water. Amount of exposed substrate is relatively high. Gradient is > 4% ...." This definition was modified to include units that did not have exposed substrate, but had a relatively high gradient and considerable surface turbulence (e.g., standing waves and/or white water).

Glide: "A wide, uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel, and sand."

Run: "Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appear as flooded riffles. Typical substrate consists of gravel, cobble, and boulders."

Mid-Channel Pool: "Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable."

Since the numbers of individual habitat types encountered within the areas mapped were low, habitat types were lumped together into three the major habitat types, pool, riffle, and run. Pool type habitats consistent primarily of "Main Channel Pools" and all pools were lumped in this category. Run and glide habitats are similar, and one often graded into the other. As a result, these habitat types were lumped together as Run habitat. Riffle habitat was dominated by low gradient riffles, and low and high gradient riffles were lumped together as "Riffle."

Data collected at each unit included:

- mean length
- mean width
- mean depth
- maximum depth (pools only)
- Dominant and subdominant substrate composition
- Shelter rating

The survey was conducted by two biologists floating down the river in kayaks. Habitat lengths were measured with a hip chain. Width was measured with an optical range finder or estimated visually. Average and maximum depths were measured with a calibrated cord or a stadia rod.

Substrate classification was classified as follows:

Particle size	Inches
Boulder	> 10
Large cobble	5 - 10
Small cobble	2.5 - 5
Gravel	0.08 - 2.5
Sand	< 0.08

Habitat complexity (cover) was visually assessed. Habitat complexity is a measure of the amount of cover that provides fish with shelter from predators and resting areas out of the current. Cover included large woody debris, overhanging vegetation, aquatic vegetation, undercut banks, boulders, bubble curtains, etc. Percentage of the riverbanks covered with vegetation was visually assessed.

2.4 HABITAT MAPPING STUDY RESULTS

Two habitat mapping surveys were conducted, one upstream (1998) and one downstream (1999) of Wohler Pool. In 1998, the Russian River was mapped from Highway 101 bridge (Healdsburg) downstream to Wohler Pool as part of the Aggregate Resources Monitoring Program (Parsons and Chase 1999). Habitat data for the lower 8,875 feet of river was included in this report for comparison purposes. In 1999, 8,230 feet of stream was habitat mapped downstream of the Inflatable Dam.

The composition of pool/riffle/run differed substantially upstream and downstream of the Wohler Pool (Table 2). Upstream from Wohler Pool, aquatic habitat is dominated by Run (68.1 percent). Downstream from the Inflatable Dam, stream gradient decreases, and habitat is dominated by relatively long, wide pools (67.8 percent). Summer (impounded) habitat in the Wohler Pool Reach is 100 percent pool habitat.

2.5 CONCLUSIONS

The overall affect of the impoundment is an increase in pool habitat. The inflation of the dam likely results in an increase in pool habitat on the order of 30 to 70 percent over free flowing conditions. The magnitude of change depends on if river morphology within the Wohler Pool is closer in similarity to that immediately above the influence of the dam or below the dam. The increase in pool habitat has the potential to adversely impact water temperatures, species composition, and smolt emigration. This task is completed and will not be repeated in subsequent years.

Table 2. Comparison of habitat classification in the mainstem Russian River, above and below Wohler Pool

Habitat Type	% comp.	Avg. length	Avg. width	Avg. depth	Shelter rating	% cover	Dom. substrate	Subdom. substrate	Percent Right Bank Veg. cover	Percent Left Bank Veg. cover
Upstream of Wohler Pool										
Pool	29.0	644	75	5.7	3.0	5.3	Sand	Silt	95	79
Run	68.1	1,007	73	2.5	2.5	4.7	Sand	Gravel	86	88
Riffle	2.9	130	60	1.3	0.5	0.5	SMC	Gravel	55	45
Down stream of Wohler Pool										
Pool	67.8	1,394	123	4.5	1.8	5.5	Silt	Sand	99	99
Run	30.3	623	76	2.1	1.7	1.5	Sand	Gravel	98	83
Riffle	1.9	53	47	0.5	1.0	4.3	Gravel	SMC	99	88

3.0 WATER QUALITY

3.1 POTENTIAL IMPACT

As rivers flow from their headwaters to the ocean, water temperature increases naturally, depending on meteorological conditions. The impoundment formed by the Inflatable Dam may degrade water quality, primarily by increasing the rate at which water temperature increases. Impoundments such as Wohler Pool slow the flow of water through the basin. The longer the residence time, the greater the opportunity for water to be warmed by solar radiation.

3.2 STUDY OBJECTIVES

The primary objective of this study was to evaluate the effectiveness of using continuously recording water temperature monitors to assess the rate at which water warms as it flows through the Wohler Pool. This information will be used to develop a water temperature monitoring program to determine to what degree, if any, the impoundment increases water temperature in the impoundment compared to free flowing riverine conditions.

A second element of this study was to determine if the Wohler Pool becomes thermally stratified during the summer. The density of water decreases as the temperature increases. The change in density results in the warmer surface water "floating" on top of cooler water below. The cooler layer of water, if present, may provide suitable temperatures for salmonids rearing in the mainstem river.

3.3 METHODS EVALUATED

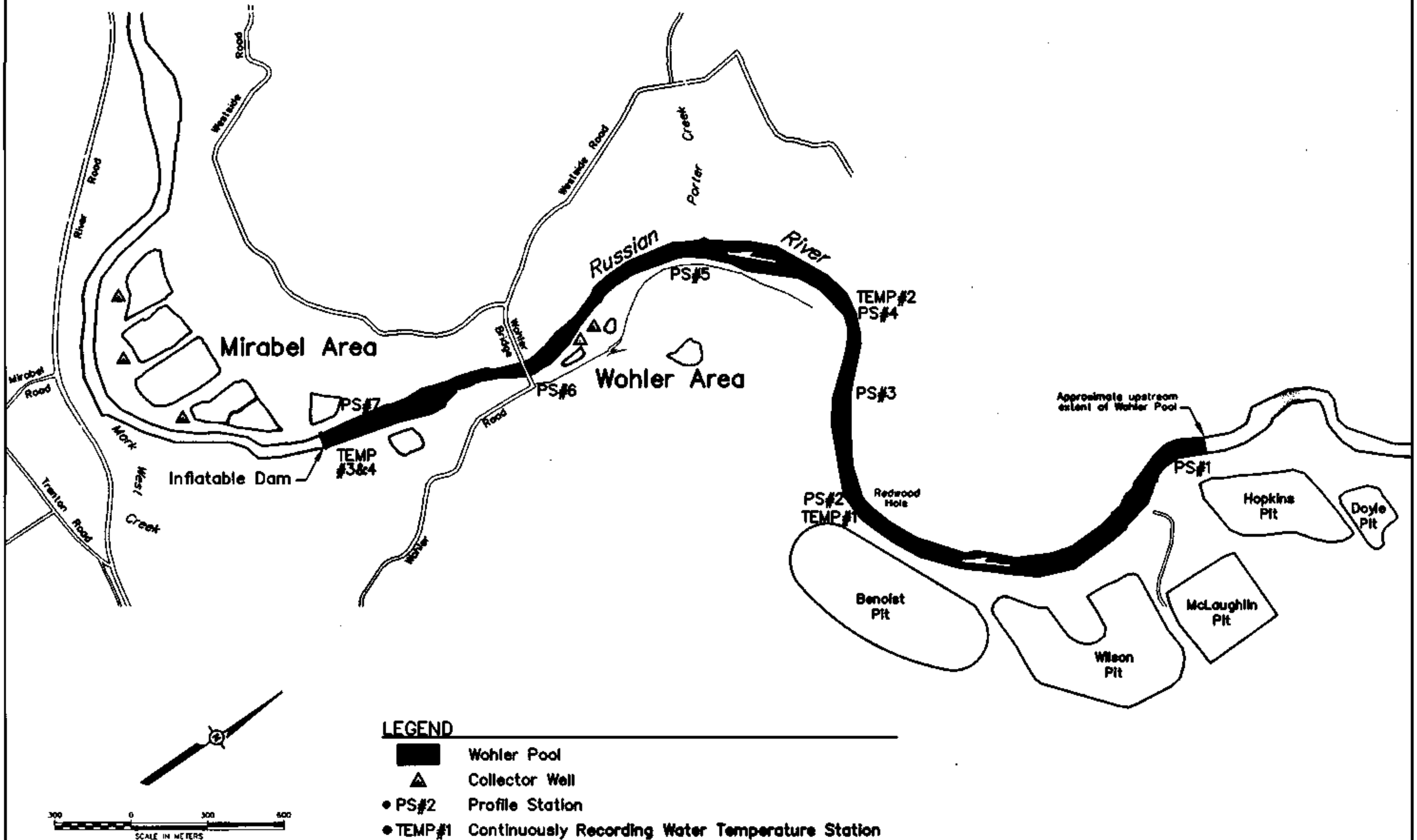
This study was designed to evaluate the feasibility of using continuously recording water temperature monitoring probes (data loggers) to compare the rate of temperature increase within the Wohler Pool Reach compared to free flowing sections of the river. This was achieved by setting up a series of water temperature monitoring stations above and within the Wohler Pool Reach.

Profile sampling was conducted using a portable water quality meter. Data were collected at seven sites to determine if the Wohler Pool becomes thermally stratified during the summer. Water temperature, dissolved oxygen, and conductivity measurements were recorded from the surface to the bottom, at 1.0-meter intervals.

3.3.1 Continuous Water Temperature Monitoring

Three continuously recording water temperature monitoring stations were established to measure water temperature within Wohler Pool (Figure 3). Water temperature data was collected using Hobo H8 2K data loggers (Onset Computers, Inc.). Two data loggers were deployed at a depth of 0.5 meters, one at the upstream end of the Wohler Pool and one at the dam. Two additional data loggers were deployed at a depth of 3.0 meters, one mid way through the impoundment, and one at the dam.

- Data logger #1 was located in a relatively shallow glide (maximum depth approximately 1.0 m) just above the upstream extent of the Wohler Pool. This station served as a control site, recording the temperature of water as it enters the impoundment.
- Data logger #2 was located near the mid point of the impoundment in 3.0 meters of water.
- Data logger #3 was suspended at a depth of 0.5 m from a chain attached to a float 10 m upstream from the Inflatable Dam. This station recorded temperature of water at the downstream end of the impoundment.
- Data logger #4 was located at a depth of 3.0 m at the same location as data logger #3.



SONOMA COUNTY WATER AGENCY

Figure 3. Continuous water temperature and water quality profile stations – 1999

Deploying data loggers at the two depths provided information on potential warming of surface waters as well as the potential for cool water refuges to form at depth. The data loggers were set to record a temperature every 1.5 hours.

3.3.2 Water Profile Monitoring

Water quality (water temperature, dissolved oxygen, and conductivity) profile data were collected at seven stations spaced from the dam to approximately 6.5 km (4 miles) upstream of the dam (Figure 3). Water quality parameters were collected over the deepest section of each sampling station, and water quality profiles will be taken from the surface to the bottom at 1.0-meter intervals. Water quality profiles were collected on a biweekly basis, using a Yellow Springs, Inc., (YSI) Portable Temperature/ DO/Conductivity meter.

3.4 RESULTS

3.4.1 Continuous Water Temperature Monitoring

At the upstream station (#1), daily average surface water temperatures ranged from 18.7 to 24.3°C between June 10 and September 16 (Figure 4). The maximum hourly temperature recorded was 27.1°C. The average daily water temperature at the lower station (#3) ranged from 19.4 to 25.2°C between June 10 and September 16 (Figure 5). The maximum hourly temperature recorded was 25.9°C.

The average daily water temperature (recorded at a depth of 0.5 ft.) at the Inflatable Dam was 0.5°C warmer than the temperature recorded at the upstream station (i.e., water warmed, on average, 0.5°C as it passed through the Wohler Pool during the study period). The change in the daily water temperature ranged from 0.0 to 1.1°C over the length of the impoundment (approximately two river miles) (Figure 6).

At the middle station (#2), daily average water temperatures at 3.0 m ranged from 18.8 to 25.4°C between June 10 and September 16 (Figure 7). The maximum hourly temperature recorded was 26.7°C. The average daily water temperature at the lower station (#4) ranged from 19.4 to 24.6°C between June 10 and September 16 (Figure 8). The maximum hourly temperature recorded was 25.6°C.

The average daily water surface temperature (recorded at a depth of 3.0 meters) remained constant between the middle and lower stations during the study. The change in the daily average water temperature ranged from -0.4 to 0.7°C between the middle and downstream stations (Figure 9).

3.4.2 Water Profile Monitoring

Profile data were collected at seven stations. Pools in the study area did not thermally stratify during the 2000 sampling season (Table 3). The impoundment is relatively shallow (generally less than 3.0 meters in depth), combined with a couple of shallow bars that force the water to mix as it moves downstream appears to prevent the development of thermal stratification. Daytime dissolved oxygen levels and conductivity were also measured (results are provided in tabular form in Appendix A).

3.5 CONCLUSIONS

Data loggers provided high quality data to evaluate water temperatures longitudinally across the Wohler Pool. This sampling technique is low maintenance and cost effective. The water temperature monitoring program will be expanded in the five year study to assess the rate of increase in water temperature above and below the study area, and to assess the effect of the dam on this variable.

Water quality profile data also provided high quality data to evaluate the potential for the Wohler Pool to become thermally stratified. The water quality profile program will be expanded in the five-year study to evaluate the potential for naturally formed pools upstream and downstream of the Wohler Pool to become thermally stratified.

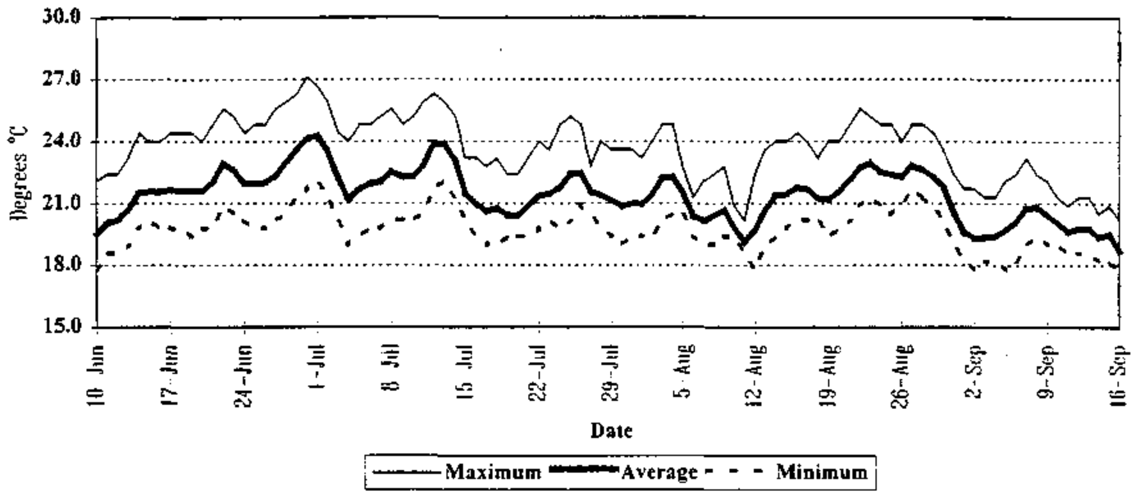


Figure 4. Average, maximum and minimum daily water temperatures recorded at Temperature Station #1, 10 June to 16 September 1999.

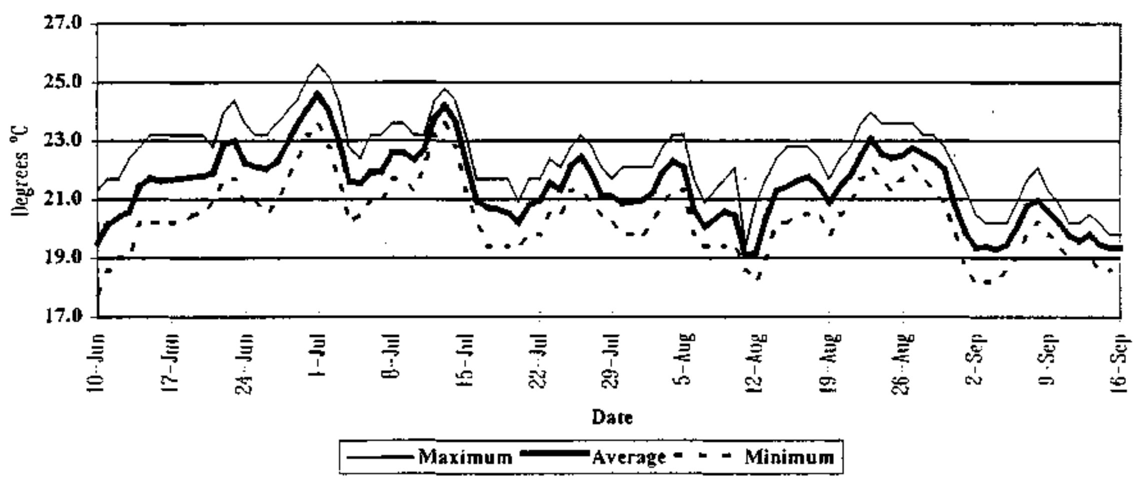


Figure 5. Average, maximum and minimum daily water temperatures recorded at Temperature Station #3, 10 June to 16 September 1999.

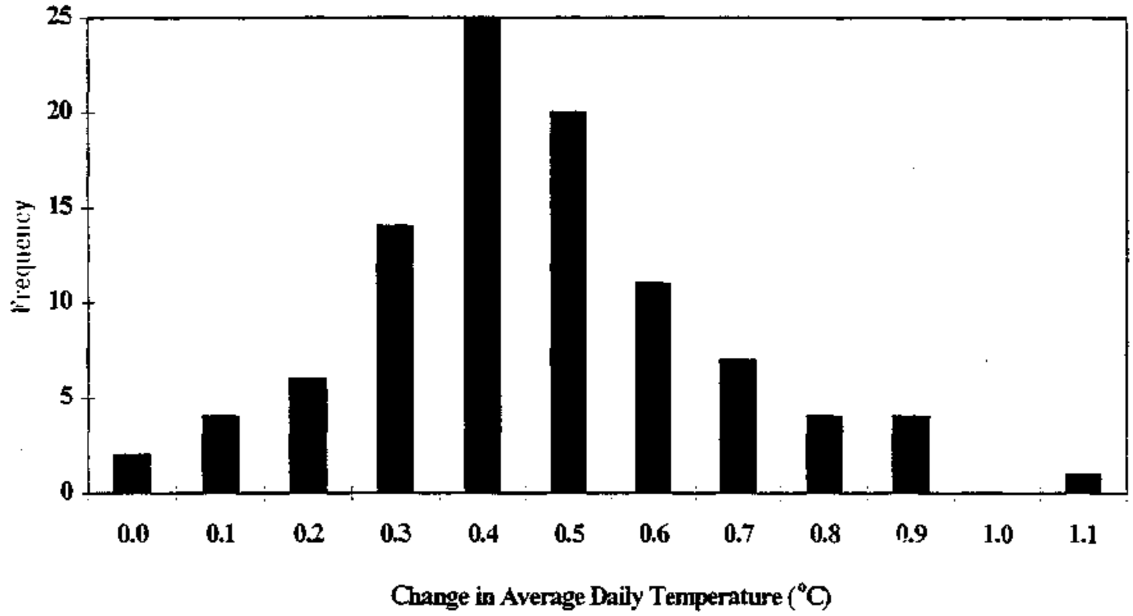


Figure 6. Frequency and magnitude of the change in the daily average water temperature between Temperature Station #1 and Temperature Station #3, 10 June to 16 September 1999

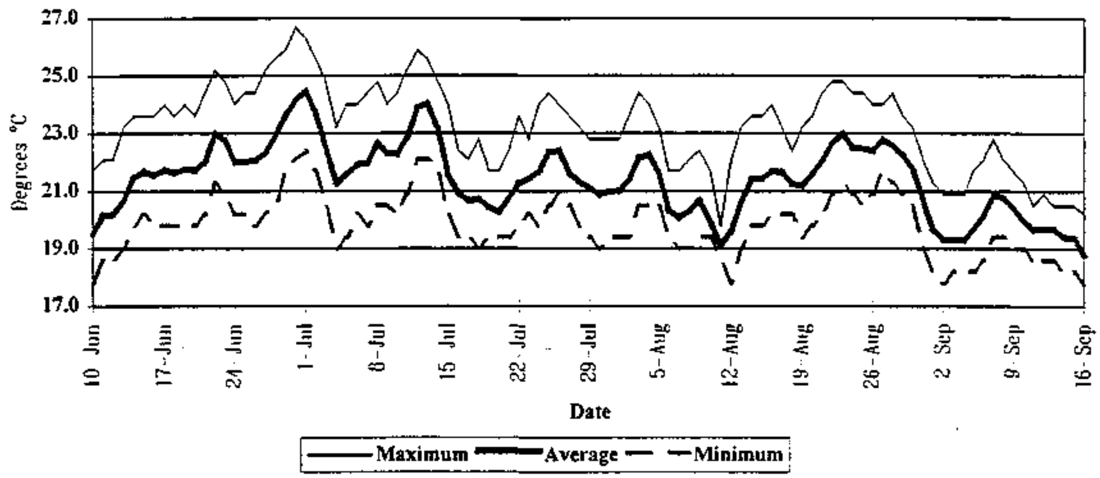


Figure 7. Average, maximum and minimum daily water temperatures recorded at Temperature Station #2, 10 June to 16 September 1999.

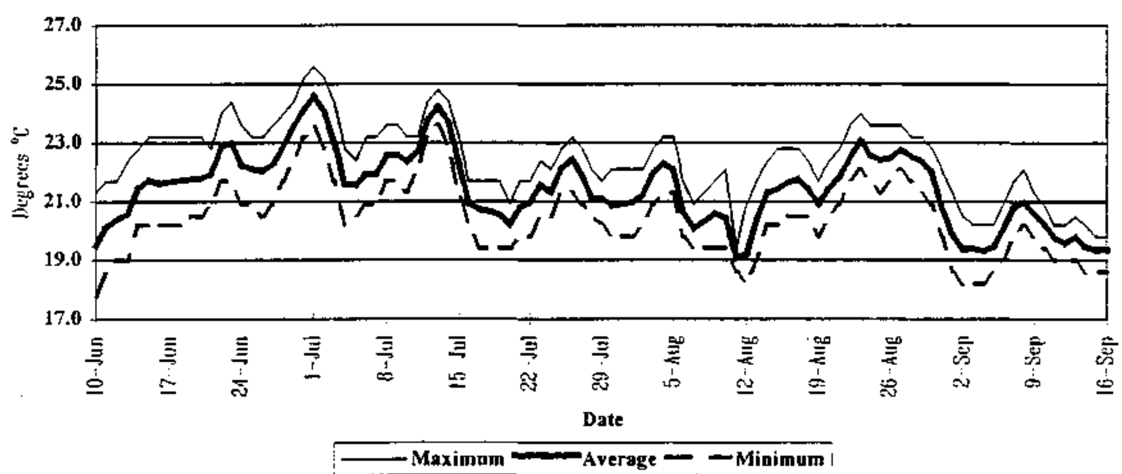


Figure 8. Average, maximum and minimum daily water temperatures recorded at Temperature Station #4, 10 June to 16 September 1999.

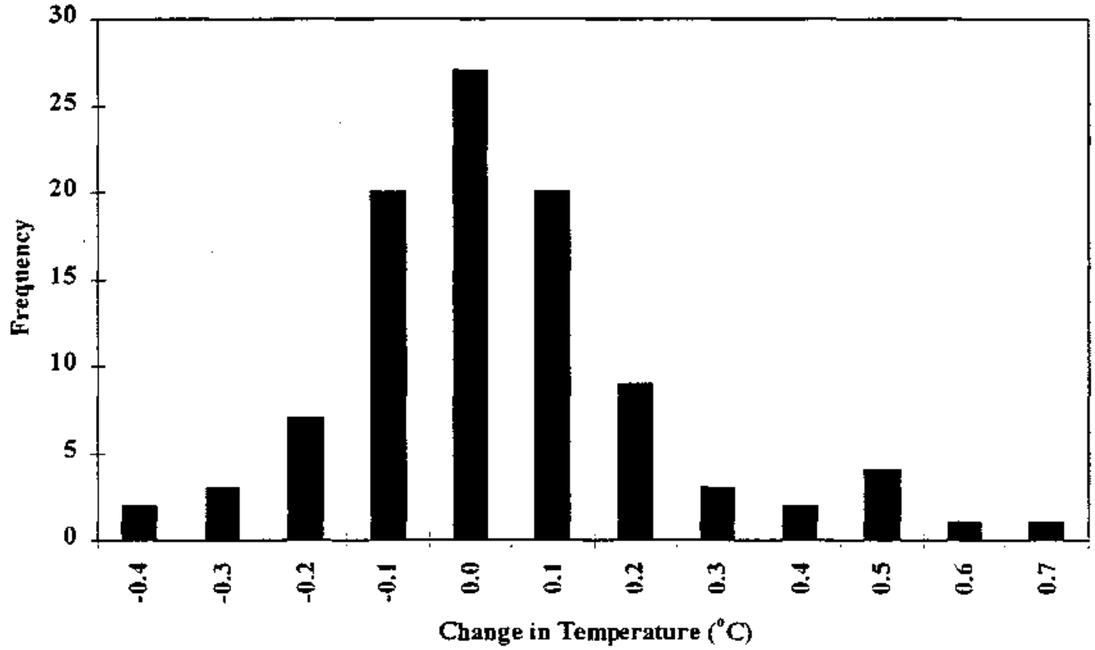


Figure 9. Frequency and magnitude of the change in the daily average water temperature between Temperature Station #2 and Temperature Station #4, 10 June to 16 September 1999

Table 3. Water temperature data collected at profile stations.

Water Quality Station #1								
Depth	9-Jun	24-Jun	9-Jul	22-Jul	4-Aug	17-Aug	2-Sept	16- Sept
0.1	N/S	N/S	N/S	23.5	24.0	20.5	18.4	20.1
1.0				23.4	24.2	20.5	18.4	20.0
1.6				23.4	24.0	20.5	18.3	20.5

Water Quality Station #2								
Depth	9-Jun	24-Jun	9-Jul	22-Jul	4-Aug	17-Aug	2-Sept	16-Sept
0.1	18.5	22.4	20.5	23.0	23.4	20.5	18.9	19.8
1.0		22.4	20.5	23.1	23.5	20.5	18.8	19.8
2.0		22.4	20.5	23.0	23.5	20.5	18.8	19.7
3.0		22.4	20.5	23.0	23.5	20.5	18.6	19.7
4.0		22.4	20.5	23.0		20.5	18.6	19.7
4.6	18.5		20.5	23.0		20.5		

Water Quality Station #3								
Depth	9-Jun	24-Jun	9-Jul	22-Jul	4-Aug	17-Aug	2-Sept	16-Sept
0.1	N/S	22.3	20.6	22.6	22.9	20.5	18.8	19.6
1.0			20.6	22.6	22.8	20.5	18.8	19.6
1.25		22.3	20.6	22.5	22.8	20.5	18.7	19.6

Water Quality Station #4								
Depth	9-Jun	24-Jun	9-Jul	22-Jul	4-Aug	17-Aug	2-Sept	16-Sept
0.1	18.8	22.6	21.0	22.6	23.1	20.5	18.8	19.7
1.0			20.8	22.5		20.5	18.8	19.6
2.0				22.5	22.8	20.5	18.8	19.5
3.0			20.8	22.5	22.8	20.5	18.8	19.5
3.5	18.5	22.3	20.8	22.5			18.8	

Water Quality Station #5								
Depth	9-Jun	24-Jun	9-Jul	22-Jul	4-Aug	17-Aug	2-Sept	16-Sept
0.1	18.3	22.8	20.8	22.8	22.9	20.4	19.1	20.0
1.0			20.7	22.6	22.8	20.5	18.9	19.7
2.0	18.0		20.7	22.5	22.8	20.4	18.8	19.6
2.8		22.6	20.7	22.4	22.7	20.4		

Water Quality Station #6								
Depth	9-Jun	24-Jun	9-Jul	22-Jul	4-Aug	17-Aug	2-Sept	16-Sept
0.1	18.3	22.9	21.4	23.0	23.2	20.5	19.2	20.6
1.0			21.2	22.4	23.1	20.6	18.9	19.5
2.0	17.6	22.2	21.2	22.0	22.3	20.6	18.8	19.3
2:5			21.2	22.1	22.3	20.6	18.9	19.3

Water Quality Station #7								
Depth	9-Jun	24-Jun	9-Jul	22-Jul	4-Aug	17-Aug	2-Sept	16-Sept
0.1	18.2	23.1	22.9	23.1	23.4	21.2	19.7	20.4
1.0	17.4	21.9	22.2	21.7	22.3	21.2	18.8	19.5
2.0			22.1	21.1	21.8	21.2	18.6	19.0
2.7	17.3	21.6	22.1	20.9	21.7	21.	18.6	18.9

4.0 GRAVEL BAR GRADING

The Agency annually conducts gravel bar grading activities in the Study Area, both upstream and downstream of the Inflatable Dam. Upstream of the dam, gravel bar grading operations are limited to areas outside of the active low flow channel that are submerged once the dam is inflated. Downstream of the dam, grading operations are limited to one gravel bar. At this site, gravel is removed to an elevation below the low flow water surface elevation of the river. Water is diverted across the bar, forming a shallow infiltration pond ("Riverside Infiltration Pond" (RIP)) next to the river (Figure 10). The RIP is connected to the river on the upstream and downstream ends to allow the flow of water through the pond.

4.1 POTENTIAL IMPACTS

In general, gravel bar grading operations have the potential to adversely affect aquatic resources by increasing turbidity, removing spawning gravel and disrupting spawning habitat, stranding of juvenile fish, burial of benthic macroinvertebrates, and mechanical injury resulting from the operation of heavy equipment in the active channel.

Increasing turbidity can adversely impact aquatic organisms by reducing water clarity. Many species, including salmonids, are "sight feeders." A reduction in water clarity can decrease feeding success, and over the long run, can result in a decrease in growth and survival of aquatic organisms. An increase in turbidity can also decrease light penetration, resulting in a decrease in aquatic plant production. Extremely high turbidity levels can directly injure fish (e.g., eroding and/or clogging of gills). Over an extended time-period, this can result in a decrease in growth and an increase in mortality.

Aquatic plants provide habitat for invertebrates that are utilized as food by other aquatic organisms, and rearing habitat for a variety of juvenile fish. Increased sediment input into the river can fill in the interstitial areas in spawning gravel, and result in decreased survival of developing embryos (however, little, if any spawning habitat is available in the project area. Excessive sediment input can fill in the interstitial areas around cobble substrate, decreasing their suitability as rearing habitat for juvenile fish. Excessive sedimentation can also bury benthic organisms that provide food for fish and other aquatic organisms (see Waters 1995 for a detailed discussion of the effects of stream sediments).

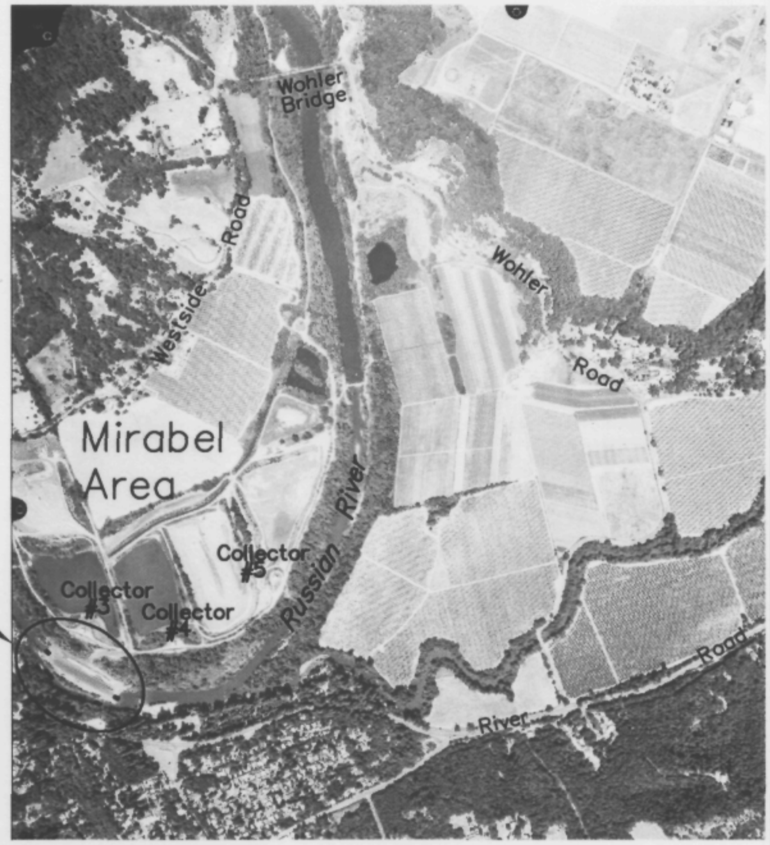
Improper grading of streambanks following bar grading can result in conditions that are conducive to stranding of juvenile fish. Juvenile fish typically inhabit shallow sections of rivers. Conditions conducive to stranding include large, flat, shallow areas along the stream margin that are inundated at high flow (or when the Inflatable Dam is in operation) and large depressions along the stream margin that become dewatered at low flow. Juvenile fish that take refuge in these areas during high water conditions can be stranded as the water level drops, becoming vulnerable to desiccation and predation.

Potential impacts associated with gravel bar grading operations upstream of the Inflatable Dam are essentially confined to short-term increases in turbidity and sediment input into the river. Potential impacts associated with the construction and operation of the RIP also include entrapment of emigrating smolts and an increase in water temperature as the water flows through the shallow pool and reenters the river.

4.2 STUDY OBJECTIVES

The objectives of this study are four fold. First, to evaluate the current Best Management Practices (BMPs) used to reduce turbidity at the gravel grading operations. Second, to develop a turbidity-monitoring program to assess the potential impacts associated with gravel bar grading operations. Third, to evaluate the potential for water temperature to increase as it flows through the RIP. Fourth, to evaluate the potential for smolts to become trap in the RIP.

See Site Below



DATE OF PHOTOGRAPHY: AUGUST 9, 1999

Figure 10. Aerial photograph of Riverside Infiltration Pond under construction

\SPECIAL PROJECTS\FISHERIES\STUDIES\RUSSIAN RIVER\2000-AERIAL APRIL 6, 2001

4.3 METHODS EVALUATED

Turbidity samples were collected at two locations, just above the confluence of the channel draining the RIP and the mainstem river (approximately 50 feet downstream of the pond), and approximately 500 feet downstream of the confluence (adjacent to the Steelhead Beach County Park boat launch). Samples were collected just below the surface using water quality sample jars. Samples were analyzed with a YSI Turbidity meter. Turbidity was recorded in Nephlometric Turbidity Units (NTUs).

Water temperature was monitored using data loggers as described above in Section 3.3. Data loggers were placed at the upstream and downstream ends of the RIP. The downstream data logger was not recovered, thus comparisons between the temperature entering and exiting the pond could not be made.

Fish populations in the RIP were assessed using beach seines and baited minnow traps. Fish collected were identified to species, counted, and measured to the nearest millimeter (mm) fork length (FL), and released into the mainstem river.

4.4 RESULTS

Monitoring of the gravel bar grading operations included assessing turbidity levels during construction and filling of the RIP, assessing fish populations within the pond, and measuring water temperature entering and exiting the pond. In addition, biological oversight was provided to assess the effectiveness of, and compliance with, established BMPs.

4.4.1 Turbidity

A relatively small side channel continued to flow across the RIP after streamflow stabilized at the summer base flow. The side channel flowing across the RIP was closed by a bulldozer pushing gravel and sand across the channel. The operation of the tractor resulted in the input of sediment to the channel. However, closing the upstream end of the bar shut off the flow of water in the side channel. As a result, there was insufficient flow to carry the sediment to the river downstream of the gravel bar.

Background turbidity levels recorded above the gravel bar measured 3.4 NTUs. Turbidity recorded 500 feet downstream of the gravel bar grading operation was 3.3 NTUs 30 minutes after the side channel was closed. Turbidity levels measured at the confluence of the side channel and the mainstem Russian River (approximately 50 feet of the lower end of the Riverside Infiltration Pond) increased to 4.2 NTUs 30 minutes after the upstream end of the channel was closed off. After this time, residual flow through the side channel ceased, and no additional turbidity was introduced to the river.

The RIP was reconnected to the mainstem Russian River on August 25 and 26. The upstream end of the RIP was breached on August 25, and the pond was allowed to fill. During the filling process, inflowing water scoured the entrance channel, and entrained a substantial amount of sediment. The lower end of the pond was not opened until the following day in order to allow the entrained sediment to settle out prior to opening the pond to the river on the downstream end. On the morning of August 26, the lower end of the RIP was breached with a hand crew using shovels. A small channel was cut to allow water to flow out of the pond, and scour its own channel. However, as the water flowed out of the newly filled RIP, sediment was entrained, and turbidity levels in the out flowing water were significantly increased.

The outflow channel was completed at 08:20 on the morning of August 26. Background turbidity recorded above the RIP ranged between 2.1 and 3.8 NTUs between the mornings of August 26 and 27 (Table 4). Turbidity levels measured 500 feet downstream of the RIP were recorded 2.0 hours (after water had the opportunity to flow through the pool immediately below the pond), 3.5 hours, and 5.75 hours after breaching. Turbidity levels ranged from 37.6 (2 hours after breaching) to 4.3 NTUs (5.75 hours after breaching). Turbidity levels had declined to 7.3 NTUs after 3.5 hours. A final turbidity reading was

Table 4. Turbidity levels measured at 50 and 500 feet downstream of the Riverside Infiltration Pond after breaching of lower berm.

Time	Background	50 feet	500 feet
8/26/99			
8:00	2.1		
8:30		1.9	
8:45		3.0	
9:00		93.9	
9:15		861.0	
9:45		92.4	
10:00		114.0	
10:20			37.6
11:30	2.5	8.9	
11:45			7.3
13:45	2.6	4.3	
14:00			4.3
8/27/99			
10:40	3.8	4.1	3.8

taken at 10:45 on the following day, when turbidity levels returned to background levels (3.8 NTUs above and below the RIP). Turbidity levels recorded 50 feet below the lower breached (at the confluence with the mainstem) peaked at 861 NTUs at 09:15, then decreased rapidly to below 10.0 NTUs by 11:30. By the following morning, turbidity levels at the confluence were similar to background levels.

4.4.2 Water temperature

Two data loggers were installed to monitor water temperature entering and exiting the RIP. Unfortunately, the downstream data logger was not recovered (lost or stolen), thus comparisons between temperature of water entering and exiting the pond could not be made.

4.4.3 Fish Sampling

Two types offish sampling were conducted in 1999 at the RIP, fish rescue and smolt presence or absence surveys. Fish rescue operations were conducted on two occasions. During the summer (low flow) period, two small side channels flow across the gravel bar that was graded to form the RIP. One side channel becomes isolated and dries up naturally as streamflow decreases during the summer. Beach seining was conducted in the side channels on June 24, and in the remaining side channel after the upstream end was blocked off prior to gravel bar grading operations on July 29. Smolt presence or absence studies were conducted to determine if smolts enter the RIP and become entrapped or delayed during their migration to the ocean.

Fish Rescue: Fish rescue efforts were conducted in the isolated pool and side channel after construction of the berm blocking flow across the gravel bar. Data from the two efforts were lumped together. Seven species including 797 individual fish were collected during fish rescue operations. Fish consisted entirely of young-of-the-year (Table 5). No salmonids were captured or observed during the fish rescue operations. All fish captured were released into the Russian River.

Fish Sampling in RIP: Fish sampling using beach seines and baited minnow traps was conducted on September 9, and baited minnow traps were also fished on September 15 and 16. Three species including 23 individuals were collected during this sampling event (Table 6). No fish were captured using

Table 5. Results offish rescue operations, Mirabel Gravel Bar side channel.

Species	24-Jun-99	7-July-99	2-Aug-99	Total	Percentage	Size range	Average length
Sacramento sucker	366	4	265	635	79.7	21-60	34
Tule perch	1	0	0	1	0.1	49	49
Stickleback	1	2	0	3	0.4	39-46	43
California Roach	0	1	0	1	0.1	34	34
Pikeminnow	1	0	36	37	4.6	30-64	50
Largemouth bass	2	5	0	7	0.9	34-65	51
Carp	1	112	0	113	14.2	29-58	44
TOTALS	372	124	301	797	100.0	-	-

Table 6. Results of fish sampling in the Riverside Infiltration Pond.

Species	Seine 1	Seine 2	Seine 3	Seine 4	Seine 5	Seine 6	TOTAL	Percentage
Sacramento sucker	6	4	4	1	1	2	18	78.3
Hardhead	0	0	2	0	0	0	2	8.7
Smallmouth bass	1	1	1	0	0	0	3	13.0
TOTALS	7	5	7	1	1	2	23	100.0

baited minnow traps on either night. No salmonids were captured or observed. Sampling was limited for a couple of reasons. First, the RIP was not opened until the end of August, when few if any emigrating salmonids are expected to be present in the river. Secondly, a relatively strong current flows through the RIP. Smolts entering the RIP would likely be able to find the downstream exit.

4.5 CONCLUSIONS

Several improvements to the sampling methodology were identified during the 1999 surveys. These improvements include:

- Installing continuously recording turbidity meters upstream and downstream of gravel bar grading operations to assess turbidity associated with gravel bar grading. Continuously recording turbidity meters had been purchased, but not received, by the Agency prior to the onset of gravel bar grading operations in 1999. This will provide a continuous record of turbidity levels during gravel bar grading operations, and improve our ability to evaluate the potential for gravel bar grading operations to impact salmonid resources in the Russian River.
- As much of the lower berm as possible should be removed prior to breaching. This should reduce the amount of sediment available to be scoured and transported downstream.
- Breaching of the lower berm should be conducted late in the evening or early in the morning to reduce visual impacts to recreational visitors to Steelhead Beach. Based on observations made during the 1999 breaching event, turbidity levels should clear sufficiently within 3.5 hours so as not to constitute a visual impairment to Steelhead Beach visitors.
- Based on the short residence time and the proportionally small amount of water flowing through the RIP (compared to river flow), the water temperature portion of the study should be dropped.

5.0 SMOLT EMIGRATION

5.1 POTENTIAL IMPACT

The impoundment formed by the Inflatable Dam can potentially impact juvenile salmonids as they emigrate to the ocean. When in place, the Inflatable Dam impounds water upstream approximately three miles. Salmonid smolts drift downstream with the current during emigration. The impoundment decreases current velocities that may delay emigrating smolts. Smolts have a seasonal "window of opportunity" to complete the physiological process (smoltification) necessary to survive in the marine environment. A substantial delay in migration may result in smolts reverting to a "resident form," thus spending an additional year in freshwater. Depending on summertime conditions, this may greatly increase mortality of smolts failing to successfully migrate to the ocean.

5.2 STUDY OBJECTIVE

There were two objectives to this study. First, to measure the length of time required for hatchery steelhead smolts to emigrate through the impounded reach of the river just before and after the inflation of the dam. Second, to collect information on wild salmonid smolts emigrating through the study reach.

5.3 METHOD EVALUATED

This study employed a mark and recapture strategy to estimate the rate at which salmonids emigrate through the Wohler Pool reach of the river before and after the dam is inflated. Hatchery reared steelhead smolts bearing distinguishing marks were released at the upstream end of the impounded reach, and were captured in a rotary screw trap (described below) downstream of the dam. The amount of time elapsing between release and recapture of the smolts was recorded. Wild salmonid smolts were also captured in the downstream fish trap. The effectiveness of the trap at capturing hatchery and wild smolts was also evaluated.

5.3.1 Fish Marking

All steelhead released from the Warm Springs Fish Hatchery are "marked" with an adipose fin clip, including those released for this study. In this report, the term "marked" refers to fish that received a mark in addition to the adipose fin clip as described below. All smolts used in the study were reared at the Warm Springs Fish Hatchery. Prior to marking, fish were anesthetized in water containing MS-222 (tricaine methanesulfonate). Anesthetized fish were then placed on a ceramic plate submerged in water. A commercially available micro-jet marker was used to inject a photonic dye into the fin rays of each fish marked. The dye remains visible to the naked eye for several months. Marked fish were then placed in a tub containing freshwater and allowed to recover (regain equilibrium). After regaining equilibrium, fish were checked to insure that they were successfully marked, and released in a separate raceway. Marked fish were then held in the raceway (grouped together by lot) until released into the Russian River.

In 1999, 9,270 steelhead smolts were divided into three uniquely marked Lots (Table 7). Steelhead were distinguished by marking either the anal fin (Lot 1), caudal fin (Lot 2), or right pelvic fin (Lot 3). There was insufficient dye on hand to mark all of the fish in Lot 3, and the remaining fish were marked with a caudal clip. Lot 1 consisted of 1,708 marked steelhead smolts, Lot 2 consisted of 1,667 smolts, and lot 3 consisted of 4,077 dye marked smolts, and 1,818 caudal fin clipped smolts (for a total of 5,898 marked smolts for Lot 3).

Table 7. Number of marked hatchery steelhead released during mark-recapture study

Lot Number	Date Released	Fin Marked	Number Marked
Lot 1	April 21	Anal	1,708
Lot 2	April 27	Caudal	1,667
Lot 3	May 11	Pelvic	4,077
Lot 3	May 11	Caudal-clip	1,818
Total			9,270

Smolts were transported to the release site in CDFG's fish transportation truck. The water tank on the truck is equipped with a chiller to maintain suitably cool water temperatures and an oxygen (DO) injection system to maintain suitable DO levels during transportation. The release point was located at the Hanson Sand and Gravel facility. The site is approximately 0.25 mile above the upstream end of the Wohler Impoundment. The river immediately upstream of the impounded section is bordered by a levee approximately 30 feet high. To facilitate the release of fish, three-20 foot long, 8-inch diameter, PVC pipes were fastened together to provide a chute for the fish to pass through from the truck to the river. The PVC pipe was set at an approximately 45° angle so that the smolts dropped no more than five feet before landing in the river. This system appears to function adequately as there were no observed mortalities (e.g., no fish were observed floating downstream of the release point).

5.3.2 Marking Quality Control

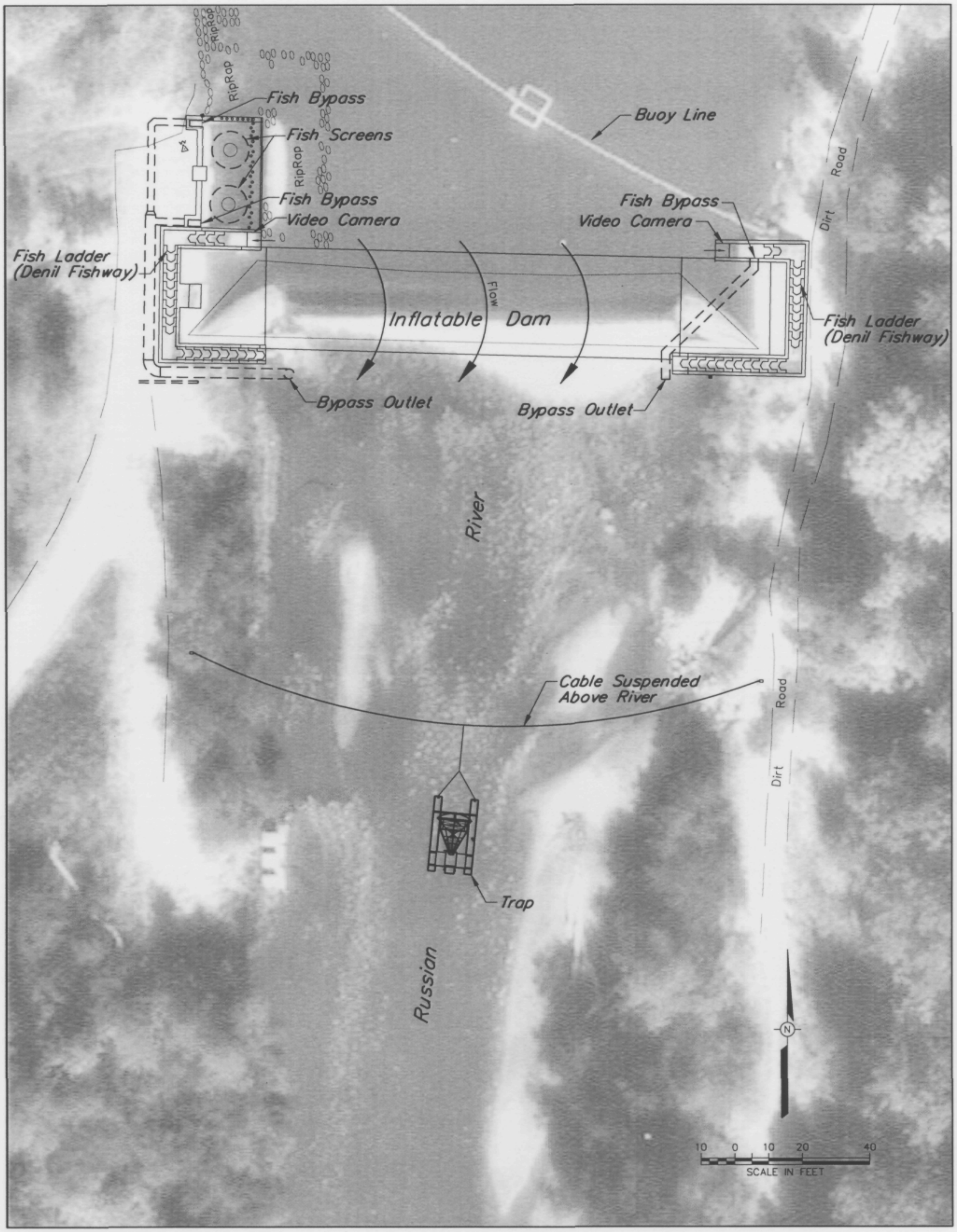
Marked fish from Lot 2 were subsampled to determine the percentage that had marks readily detectable to the eye. A subsample of 124 fish (from a pool of approximately 1,400 marked fish) (8.9 percent) were randomly sampled by dip netting fish from the raceway. Caudal fins were examined, and categorized either as "Marked" (mark was readily apparent), "barely marked" (mark was visible upon close inspection), or "not marked" (mark was not visible). Of the 124 fish examined, 106 (85 percent) had readily apparent marks, and an additional 15 (12 percent) fish were classified as barely marked. The remaining fish (3) were not marked. A small number of fish evaded the marking process by "flipping away" from the marking crew and landing in the slide leading to the raceway. Thus, the number of fish (2.4 percent) that were found unmarked during the quality control process over represents the number of fish that may have lost their photonic tag, or were missed in the quality control phase of the operation.

5.3.3 Rotary Screw Trap

The rotary screw traps were located approximately 60 m downstream of the dam site (Figure 11). Rotary screw traps are designed to capture downstream migrating juvenile fish. The screw traps are generally fished in the main channel where the water velocities are highest and the water column is the deepest (thalweg) since emigrating smolts are likely to be concentrated in these areas. Maintaining the trap in the desired location within the channel required a series of cables secured to the shoreline.

5.3.3.1 Rotary screw fish trap infrastructure

The cable infrastructure and support system consisted of two anchors and a series of cables to maintain the trap in place as well as to move the trap across the channel. The cable system was anchored to two 30-foot by 10-inch H-beam piles driven approximately 27 feet (vertically) into the riverbank directly across from each other. The cabling system consisted of four components; the main line, the bridle, the lateral adjustment cable, and the visual barrier support cable.



DATE OF PHOTOGRAPHY: SEPT 30, 1999

\SPECIAL PROJECTS\FISHERIES\STUDIES\RUSSIAN RIVER\2000-TRAP JUNE 21, 2001

SONOMA COUNTY WATER AGENCY

Figure 11. Plan view of rotary screw fish trap, video cameras, and fish passage structures at Inflatable Dam

The main line consists of a 170-foot long, 0.75-inch steel cable. The cable was pulled across the river, stretched taunt, and secured to the anchors. The bridle consisted of a 20-foot length of 0.75-inch steel cable attached the rotary trap to the main line. The lateral adjustment cable consisted of a continuous length of 0.38-inch galvanized steel cable. The cable was run through two 4-inch blocks attached to the piles. The ends of the cable were attached to the block on the main line, creating a continuous loop (similar in theory to a clothes line). This looped cable was used to move the trap into position and to adjust the traps position when required. Once the trap was positioned appropriately, a cable clamp was used to secure the lateral cable in position. A 0.38-inch safety break-a-way cable was connected to the rear corner of the trap and to an anchor point on the shoreline.

Orange floats were attached to a cable stretched across the river above the other cables. The floats were strung out along this cable at 10-foot intervals to provide a warning for canoeist/kayakers (prior to the inflation of the dam) and low flying aircraft (e.g., helicopters) that a potential obstruction was placed across the river.

5.3.3.2 Operation of the rotary screw fish trap

Two rotary screw traps were used during the study. An 8-foot diameter trap was fished prior to the inflation of the dam, and a five-foot diameter trap was used after the inflation of the dam. The rotary screw fish trap is a cone consisting of perforated stainless steel panels which houses an internal Archimedes screw. Water striking the angled surface of the internal screw rotates the cone and screw assembly. As the assembly rotates, fish are trapped within the chambers formed by the screw and moved rearward into the live box at the back of the trap. The live box is constructed such that areas of very low water velocity are provided as resting areas for fish held in the box. Debris such as leaves and small twigs entering the live box are impinged on a rotating debris screen located at the back of the live box. As the screen rotates, debris is carried out of the box, maintaining a relatively clean environment for the fish held in the live box. The cone is mounted between two pontoons and is lowered and raised with a bipod and windlass located at the front of the cone.

Rotary screw trap cones are lowered into the water column until half of the cone is submerged. Thus, an 8-foot diameter trap requires a minimum depth greater than four feet to operate. The 8-foot diameter trap was operated until the river depth decreased below the minimum four-foot level. At this point, a 5-foot diameter traps (requiring a minimum depth of 2.5 feet) was fished.

Fish captured in the screw trap were netted and placed in five gallon buckets containing freshwater. Alka-seltzer was added to the bucket as an anesthetic. Fish captured were identified to species, measured to the nearest mm (FL) and placed in a recovery bucket containing fresh river water. Recovery buckets were equipped with a small aerator to maintain dissolved oxygen levels. Once the fish regained equilibrium, they were released into the river.

The eight-foot rotary screw trap was operated continuously for 3 days following each of the three fish releases. The 5-foot (diameter) rotary screw trap was fished for 10 days during the final trapping event. Trapping operations generally began by noon of the first day, and the trap was generally removed from operation during the morning of the last day. An exception to this occurred on May 13, when the dam was inflated. The inflation of the dam resulted in the scour of sand and gravel at the base of the dam. The sand and gravel were deposited downstream at the trap site, resulting in a loss of depth so that the 8-foot trap could not be operated. The trap was decommissioned at 1900 hours on this date. After this date, river depth was sufficient only for the operation of the 5-foot rotary screw trap.

5.4 RESULTS

Overall, the mark-recapture study did not perform as designed. The study design will require significant modifications prior to implementation of the 2000 study to effectively evaluate the rate of smolt emigration through the Wohler Pool. Conversely, the fish trap showed promise that this method could provide valuable information on the timing, size, and age of emigrating smolts, as well as provide the opportunity to collect tissue samples for DNA analysis.

5.4.1 Results of Mark-Recapture Study

A total of seven of the 9,270 marked smolts released into the Russian River were subsequently captured in the rotary screw trap. Five of the marked smolts were recovered within 24 hours of being released (Table 8). A fourth marked smolt was recovered the following night (approximately 36 hours after release). One smolt, released on April 21, was captured on April 28, approximately 7.5 days after release. The trap was checked every four hours during the first three sampling events, and once every 24 hours during the final (post) sampling event (Thus, the length of time required to emigrate through the study reach are approximates). The number of recaptures was too low to evaluate the average length of time required for steelhead smolts to migrate through the Wohler Pool Reach.

Table 8. Dates of release and of capture for seven marked smolts

Recaptures	Fin Marked	Date Released[1]	Date Recaptured	Number of hours[2]
Fish 1	Anal	April 21	April 21	12 hours
Fish 2	Anal	April 21	April 22	16 hours
Fish 3	Anal	April 21	April 22	16 hours
Fish 4	Anal	April 21	April 22	36 hours
Fish 5	Anal	April 21	April 28	180 hours
Fish 6	Caudal	April 27	April 27	12 hours
Fish 7	Pelvic	May 11	May 12	20 hours

[1] Releases were made at approximately 1200 hours.

[2] The fish trap was checked every four hours during the first three sampling events.

5.4.2 Rotary Screw Trapping Results

The 8-foot trap was operated on three intervals, each spanning a three-day period (Table 9). The trap was staffed 24 hours a day during these sampling intervals. The 8-foot trap operated in flows ranging from 1,750 cfs (4/22/99) to 656 cfs (5/13/99). The trap was removed on 5/13 due to changes in channel morphology related to the inflation of the dam. The 5-foot trap operated continuously between 5/20/99 and 5/29/99. During operation of the smaller trap, flows ranged from 496 cfs (5/20/99) to 410 cfs (5/29/99).

Sixteen species of fish were captured during the four sampling events (Table 10). Fourteen species, including 445 individuals, were captured during the pre-dam inflation sampling events and 13 species including 155 individuals, were captured during the post dam inflation sampling events. Salmonids comprised 68.6 and 62.0 percent of the catch for the pre- and post-dam sampling events. Pacific lamprey (primarily ammocoetes) comprised 21.5 percent of the catch during the pre-dam sampling events, but only 1.9 percent of the catch during the post dam sampling events. Resident native species accounted for 8.1 percent of the catch during the pre-dam sampling events, and 30.3 percent of the catch during the post-dam sampling event. Non-native species comprised 1.8 and 5.8 of the pre- and post- sampling events.

Table 9. **Days that the rotary screw trap was in operation[1].**

April														
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
					▒	▒	▒	▒			▒	▒	▒	▒
May														
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
									▒	▒	▒	▒		
May														
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
			■	■	■	■	■	■	■	■	■	■	■	

▒ Eight-foot diameter trap in operations

■ Five-foot diameter trap in operation

[1]Dam inflated on May 13

Table 10. Rotary screw trap catch and percentage composition, pre- and post- dam.

Species	Pre-Dam	Percentage	Post Dam	Percentage
Hatchery steelhead - smolts	31	7.0	0	0.0
Wild steelhead - smolts	101	22.7	6	3.9
Wild steelhead - young-of-the-year	52	11.7	17	11.0
Wild steelhead - adult	1	0.2	0	0.0
Wild Chinook salmon	120	27.0	73	47.1
Pacific lamprey adult	6	1.3	2	1.3
Pacific lamprey - eyed	2	0.4	0	0.0
Pacific lamprey - ammocoetes	88	19.8	1	0.6
Sacramento pikeminnow	22	4.9	1	0.6
Hardhead	4	0.9	3	1.9
Sacramento blackfish	1	0.2	0	0.0
Sacramento sucker	5	1.1	4	2.6
Tule perch	3	0.7	3	1.9
Bluegill	1	0.2	0	0.0
Green sunfish	2	0.4	5	3.2
White crappie	1	0.2	3	1.9
Sculpin	1	0.2	23	14.8
Channel catfish	3	0.7	1	0.6
Carp	1	0.2	0	0.0
Threespine stickleback	0	0.0	11	7.1
California roach	0	0.0	2	1.3
Total	445	100.0	155	100.0

5.4.1 Salmonids

<u>Hatchery Steelhead Smolts:</u> Including steelhead marked and released for this study, 31-hatchery reared steelhead were captured during the first three sampling events (Table 10). The last planting of hatchery steelhead smolts made by the Warm Springs Fish Hatchery occurred on April 12 into Dry Creek (A. Quinones, Assistant Hatchery Manager, Warm Springs Fish Hatchery, June 3 1999), and the last hatchery steelhead was captured on 29 April. Thus, hatchery steelhead apparently migrated from the released site in Dry Creek near Warm Springs Dam past the Inflatable Dam within 14 days (a distance of approximately 21 miles).

<u>Wild Steelhead Smolts:</u> A total of 101 (22.7 percent of the total catch) wild steelhead smolts were captured during the pre-dam sampling events (Table 10). The daily number of wild steelhead captured decreased as sampling progressed. Fifty-two wild steelhead smolts were captured during the first sampling event, compared to eight during the third sampling event (both with the eight-foot trap). After the dam was inflated, six smolts were captured. Steelhead smolts ranged in length from 147 to 250 mm FL, averaging 174 mm. Scale samples were collected from 30 smolts ranging in length from 147 to 191 mm FL. Preliminary scale analysis show that steelhead primarily emigrate at Age 2+. A few steelhead may have emigrated as 1+ or 3+ fish, however, scales were not collected from the smallest and largest individuals to verify this.

Several young-of-the-year steelhead were also captured in the trap. Although it is generally believed that steelhead are unable to rear in the mainstem Russian River below Cloverdale, this should be verified through sampling in the river above and below the Inflatable Dam. Sampling for juvenile steelhead should be conducted during late summer/early fall period to determine if young-of-the-year steelhead are able to over summer in the mainstem.

One adult steelhead was captured in the trap on April 24. This fish appeared to be a spawned fish returning to the ocean. The adult measured approximately 560 mm FL.

<u>Chinook Salmon Smolts:</u> A total of 193 chinook smolts were captured in the screw trap, 120 prior to dam inflation, and 73-post dam inflation (Table 10). The daily number of chinook smolts captured in the trap remained fairly constant throughout the trapping period, with one exception. On May 13, 59 smolts were captured (compared to the next highest daily total of 14). Chinook smolts ranged in length from 55 to 106, averaging 89 mm FL. Chinook salmon smolts emigrate as 0+ fish. Tissue samples were collected from 79 chinook salmon for microsatellite DNA analysis by the Bodega Bay Marine Lab to determine stock origin (e.g., stocks native to the Russian River, descendants of hatchery reared fish, strays, etc.).

5.4.2 Non Salmonid Species

<u>Pacific Lamprey:</u> Pacific lamprey are an anadromous species with a life history strategy similar to steelhead and salmon in that the young hatch and rear in freshwater, undergo a physiological metamorphosis, then emigrate to the ocean where they grow and mature. Three life history phases of the Pacific lamprey were captured during the trapping operation, juveniles, eyed lamprey (newly metamorphosed adults), and adults. Juvenile lamprey, called ammocoetes, lack eyes and well developed jaws, and rear in freshwater. Ammocoetes were the most prevalent non-salmonid species captured in the trap (88 individuals captured during the study). Ammocoetes spend three to seven years in freshwater before they metamorphose into adults (Moyle 1976). During this metamorphosis, the juvenile lamprey developed eyes and a sucking disc, and are referred to as "eyed." Eyed lamprey emigrate to the ocean similar to salmonid smolts. Adult lamprey grow and mature in the marine environment, then return to freshwater. Ammocoetes are known to move throughout the year (Moyle 1976) within a river system. Ammocoetes ranged in length from approximately 60 to 120 mm in length (total length (TL)), averaging around 90 mm TL. The number of ammocoetes captured in the trap declined as the study progressed. After the dam was inflated, only one ammocoetes was collected. Ammocoetes are poor swimmers, and likely depend on the stream current to aid in relocating downstream. The inflation of the dam with its

concurrent decrease in current velocity would likely deter further downstream movement. In addition, to ammocoetes, two "eyed" Pacific lamprey were captured. The eyed lamprey measured approximately 110 mm TL. Eight adult Pacific lamprey were captured in the screw trap.

<u>Native Resident Species:</u> The native resident complex comprised a relatively small component of the overall catch (83 individuals for all four sampling events combined) (Table 10). Only two native resident species accounted for as much as 3.0 percent of the total catch, Sacramento pikeminnow (3.8 percent) and riffle sculpin (3.9 percent).

<u>Non-Native Species:</u> Five exotic species were captured during the study, comprising 17 individuals (Table 10). The non native species collected, primarily sunfish and catfish, tend to occupy areas of heavy cover during periods of high streamflow and have a relatively low potential to be swept downstream under conditions present during the screw trap sampling period. Thus, the low numbers of these species captured during the study was expected.

5.5 CONCLUSIONS

The mark-recapture phase of the study failed to provide data necessary to evaluate the rate of smolt emigration through the Wohler Impoundment. The major problem with this technique was the low recapture efficiency encountered during the study. A suitable sampling site (briefly described in Section 4.9) could not be located on Agency property, and this resulted in a lower catch efficiency (0.08 percent) than expected. Thus, the number of fish released was insufficient to allow for a large enough recapture to provide statistically meaningful results.

Rotary screw traps are generally more efficient when fished in a narrow (constricted) stream channel with a defined thalweg to concentrate the fish in a relatively narrow band within the river. Unfortunately, such a location does not exist on property owned by the Agency. As a result, recapture rates were considerably lower than anticipated. Secondly, the inflation of the dam resulted in the scouring of gravel and sand at the base of the dam. The scoured material was deposited a short distance downstream of the screw trap. The deposited material decreased depths to a point where the eight-foot diameter trap could not be operated. As a result, the eight-foot trap was removed, and a five-foot diameter screw trap was operated in its place. The rotary screw trap did provided excellent information on species emigrating through the Russian River, including, timing of emigration, age at emigration, and tissue samples for DNA analysis.

The mark-recapture methodology should be repeated in 2000. Twenty thousand steelhead smolts will be marked and released similar to 1999. It is recommended that two additional screw traps be fished in 2000 in an attempted to increase recaptures. Along with the eight-foot screw trap fished in 1999, two five-foot traps will also be fished prior to the dam inflation. After dam inflation, the two five foot traps will be fished (the eight foot trap will be fished if suitable depths are present).

A radio telemetry study will also be conducted in 2000 (Manning 2000). Eighty hatchery steelhead will be fitted with surgically implanted radio tags and released with the dye marked fish as part of the mark-recapture study. Radio tagged fish will be tracked with a hand held receiver to determine movement of fish after release. In addition, a stationary receiver will be placed downstream of the Inflatable Dam to record the passage offish out of the study area. Four batches of 20 fish each will be released and tracked during the study. Two releases will be made prior to inflation of the dam, and two releases will be made after the dam is inflated.

6.0 ADULT UPSTREAM MIGRATION

6.1 POTENTIAL IMPACT

The dam may be inflated during the salmon and steelhead migration period. The Inflatable Dam is approximately 11-feet high when fully inflated, and may form a barrier to upstream migrating fish. The dam is equipped with two denil type fish ladders to provide upstream passage for migrating fish, however, the effectiveness of the ladders has not been tested.

6.2 STUDY OBJECTIVE

The objective of this task was to evaluate the effectiveness of using underwater video cameras to assess fish passage through the denil fish ladders. Snorkel surveys were also conducted below the dam to determine if the number of fish holding below the dam could be visually assessed.

6.3 METHODS EVALUATED

Two methodologies were employed to evaluate fish passage through the fish ladders. Time-lapse video photography was used to document fish passage through the fish ladders. Direct (snorkel) observations were conducted to determine if salmonids were holding below the dam.

6.3.1 Time-Lapse Video Photography

Adult salmonid passage through the fish ladders was assessed using underwater video cameras (Figure 11). The video system utilized at the fish ladders was designed specifically for this project. The system consists of two Sony™ ultra-high resolution monochrome video cameras with wide angle (105°) lenses housed in waterproof cases. The images captured by the cameras were recorded on two Sony S-VHS time-lapse videocassette recorders. The taped images were viewed on a Sony ultra-high resolution dual input monochrome monitor. Lighting for each video camera was provided by two 36 LED high intensity red illuminators in waterproof housings that were mounted directly onto the camera housings.

A square metal extension (exit box), measuring 4'x4'x7', was mounted to the upstream end of the each fish ladder. The exit boxes were smooth-sided, conformed to the sides of the fish ladders, and were designed such that the hydraulics of the ladders were not altered. To facilitate fish identification, a highly reflective background was attached to the back wall exit boxes. The cameras were mounted in custom manufactured boxes extending off the downstream side of the exit boxes. The boxes were constructed of 3/16" steel. A plexiglass window was inserted between the exit and the camera boxes. The cameras were in operation continuously while the dam was inflated.

The recording speed (number of images recorded per second) for the time-lapse photography was varied during the study. The time lapse settings evaluated ranged from one image recorded every 0.2 seconds to 0.8 seconds. At a setting of one image every 0.2 seconds, 24 hours of video surveillance can be recorded on a standard two-hour videotape. For every incremental increase of 0.2 seconds, an additional 24 hours can be recorded on a 24-hour tape (recording one image every 0.4 seconds provided 48 hours of coverage on a two hour tape, recording one image every 0.6 seconds provided 72 hours of coverage on a two hour tape, etc.). This was an important consideration because the length of time required to review a tape remained fairly constant regardless of the time-lapse setting (e.g., reviewing a tape covering a 24 hour time period takes approximately the same length of time as reviewing a tape covering a 96 hour time period). However, the number of images recorded of a fish passing through the fish ladder decreases as the time setting is increased. Different recording speeds were evaluated to see if a tape setting longer than 24 hours would provide adequate coverage offish usage of the ladders. Tape settings were alternated weekly, either with a 24-hour or 48-hour setting used Monday through Friday mornings. A setting of 76 (rarely 96) hour was used Friday through Monday mornings. However, once chinook salmon began showing up on the tapes in mid-October, it became readily apparent that the 24-hour recording speed was far superior to the slower recording speeds. After this point, all tapes were set to record an image once every 0.2 seconds.

Every time the tapes were changed, the camera lens was cleaned with a soft rag, and the plexiglass and reflective background opposite the cameras were cleaned with a long handled squeegee.

Videotapes of the fish ladders were reviewed on high quality VCRs having a wide range of slow motion and freeze frame capabilities. When a fish was observed, tapes were reviewed frame by frame to determine the species and direction (upstream or downstream) of the fish. For each salmonid observed, the tape reviewer records the species, age class (juvenile or adult), direction (upstream or downstream), date, and time of passage out of the ladder.

6.3.2 Direct Observation Surveys

Direct observation surveys were also conducted to determine if upstream migrants were present in the river below the dam. This was an important consideration because the observation of salmonids migrating through the ladder does not guarantee that all fish in the river are able to detect and ascend the ladder. Conversely, the lack offish passing through the ladder may indicate a lack offish in the river at that time, and not reflect the operation of the fish passage facilities. Direct observation (snorkel surveys) techniques were utilized to assess adult salmonid numbers below the dam. Survey teams consisted of two divers. The divers entered the river below the dam and searched for salmonids in the pool at the base of the structure. The third team member stood on the bluff on the west side of the river. This site offered a good vantage point to observe salmon that might be spooked away from the dam by the divers (the river just below the dam becomes very shallow, and an adult salmonid swimming downstream from this area should be readily visible to the spotter. Three surveys were conducted, once each in September, October, and November.

6.4 RESULTS

Video monitoring and direct observation survey techniques demonstrated that adult salmon and steelhead were able to detect and ascend the fish ladders around the Inflatable Dam. Video monitoring provided conclusive evidence that salmonids plus a variety of other species were able to negotiate the ladders. Direct observation surveys were not as effective in determining if salmonids were delayed below the dam (that is, large numbers of fish holding below the dam prior to moving upstream through the fish ladders) as desired due to low water clarity. However, no large groups of large (adult salmonid-sized) fish were observed.

6.4.1 Video Monitoring

For the 1999 study season, 221 tapes were generated. Video monitoring was continuous throughout the study period with rare exceptions. On a few occasions, the end of the tape was reached prior to the tapes being changed, and on one occasion, the system malfunctioned, and one camera failed to record images for one day.

Ten species of fish were identified entering the fish ladders. Species observed included, chinook salmon, steelhead, Pacific lamprey, American shad, hardhead, Sacramento pikeminnow, Sacramento sucker, smallmouth bass, common carp, and channel catfish. Most of the non-anadromous species were noted as "milling about" in the exit boxes, as opposed to migrating upstream or downstream through the fish ladders. Detailed counts were made of anadromous fish only. These counts were broken out by species, with a general category defined as salmonid (fish could not be identified to species, but had identifiable characteristics (e.g., general body shape, adipose fin, etc.) of the family Salmonidae.

The results of the video monitoring task clearly demonstrated that adult chinook salmon, steelhead, and Pacific lamprey are able to locate and ascend the Mirabel fish passage facilities. The total number of adult anadromous fish passing through the fish ladder can only be estimated from the data collected, however, owing to a few minor problems inherent in the current system. For example:

- The bottom of the fish ladder exit provided poor contrast of fish passing through the ladder. Thus, on some occasions, it was difficult to clearly identify fish (although it was generally clear that a relatively large fish was passing through the field of vision).
- Algae and debris also tended to build up on the fish ladder exits floor and back wall, further degrading the picture quality. Although the camera housing and fish ladder exit were cleaned daily, the current configuration did not allow for a thorough cleaning.
- The cameras were mounted such that a small blind spot existed along the bottom of the exit boxes on the side closest to the cameras. Fish may have been able to move both upstream and downstream along the near wall without being detected. Thus, some fish may have moved upstream without being detected, while other fish may have moved upstream past the camera, been counted, then dropped back downstream and counted a second time as it moved back upstream a second time. The tape reviewers made a concerted effort to keep track of fish that may have moved downstream and been recounted. However, the possibility of recounting some fish cannot be dismissed.
- Turbidity was occasionally a problem, particularly during storm events. On at least two occasions, turbidity levels increased to the point where the back wall could not be observed, thus fish could have passed undetected. This is particularly troublesome because this limitation can only be minimally addressed by increasing the lighting in the exit box, and because salmon and steelhead tend to migrate during freshets which are associated with higher turbidity levels. However, the study objective was to determine if salmonids find and ascend the fish passage facilities, only. Data on the numbers of salmonids and the timing of upstream migration past the dam is ancillary to the study objectives.
- Counts only represent numbers of fish migrating in the river during periods when the Inflatable Dam is inflated (late-May to mid-November). Much of the adult salmonid migration occurs after fall and winter rains substantially increase streamflow in the river when the dam is deflated.

A total of 205 adult chinook salmon, 38 juvenile steelhead, and 98 salmonids were counted passing upstream through the fish ladder (Table 11). The majority (91) of the salmonids were observed during the peak of the chinook salmon run. These were relatively large fish that were likely chinook salmon. The remaining eight salmonids were observed in the fish ladder prior to July 2, were relatively small, and were likely juvenile steelhead. Thus, the finally tally for chinook salmon was estimated to be 296.

6.4.1.1 Chinook Salmon

Fall-run chinook salmon typically migrate upstream in August (Klamath River) and September and October (Sacramento River) (Groot and Margolis 1991). In the Russian River, chinook salmon were first observed in the fish ladder on August 26, however, only five chinook salmon were counted prior to September 26 (Table 11, Figure 12). The chinook salmon run continued sporadically until October 11 (a total of 16 chinook salmon (including salmonids) were observed migrating through the fish ladders prior to this date). After this date, three clearly defined pulses offish were observed. The majority of the chinook salmon observed in the fish ladders were counted over a four day period (October 27-30). During this time-period, 154 (52.0 percent) chinook salmon and salmonids were observed. Two secondary pulses occurred between October 12-16 (29 salmon (9.8 percent)) and November 6-9 (49 salmon (16.6 percent)). Although the number of salmon observed in the fish ladders declined steadily after the November 6-9 time period, 14 chinook salmon and salmonids were observed in the fish ladder prior to the deflation of the dam on November 16. Thus, the end of the chinook salmon run may have occurred after the dam was deflated.

Table 11. Weekly counts of salmonids video tapped migrating upstream through the Mirabel Inflatable Dam fish passage facilities.

Date	Chinook	Steelhead smolts	Salmonids	Pacific lamprey	American Shad
20-May	0	1	0	0	1
23-May	0	5	0	5	1
30-May	0	1	0	2	0
6-Jun	0	1	0	2	2
13-Jun	0	2	3	10	9
20-Jun	0	1	0	3	1
27-Jun	0	14	4	0	1
4-Jul	0	1	0	0	2
11-Jul	0	4	0	0	0
18-Jul	0	1	0	0	0
25-Jul	0	1	0	0	0
1-Aug	0	0	0	0	0
8-Aug	0	0	0	0	0
15-Aug	0	1	0	0	0
22-Aug	1	0	0	0	0
29-Aug	0	0	0	0	0
5-Sep	1	3	0	0	0
12-Sep	3	0	0	0	0
19-Sep	0	0	0	0	0
26-Sep	8	0	3	0	0
3-Oct	0	0	0	0	0
10-Oct	28	0	2	1	0
17-Oct	7	0	0	0	0
24-Oct	102	0	62	23	0
31-Oct	8	0	12	13	0
7-Nov	44	0	12	9	0
14-Nov	3	0	0	0	0
Totals	205	36	98	68	17

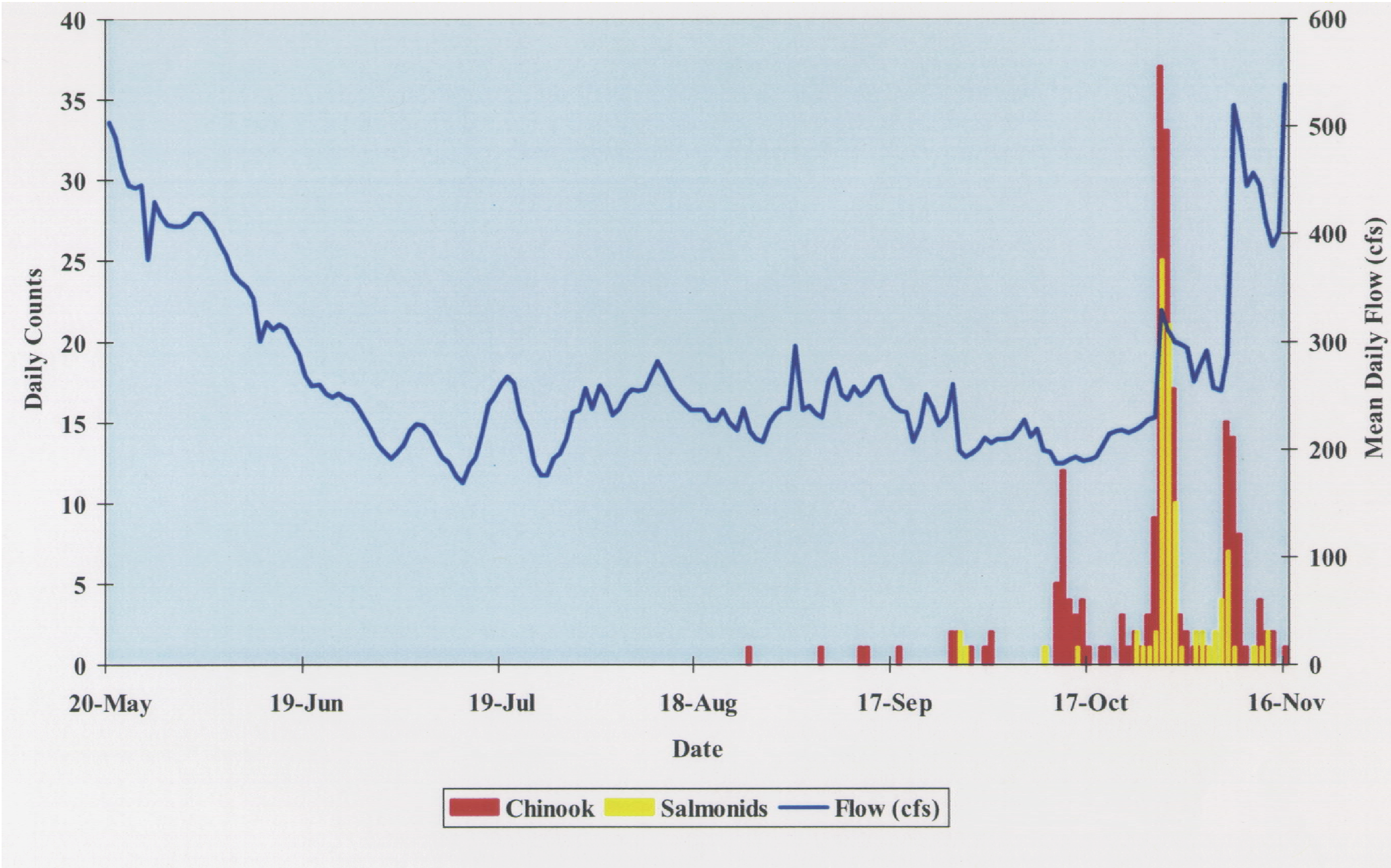


Figure 12. Daily counts of chinook salmon and fish that were identifiable as salmonids, but could not be identified to species, recorded during video monitoring at the Mirabel Dam fish ladders, 1999.

The start of the upstream migration period may be limited by water temperature. Upstream migration by chinook salmon in the San Joaquin River was halted when temperatures exceeded 21.1°C, but resumed when temperatures declined below 18.3°C (Halleck 1970, cited by D.W. Kelly and Associates and Entrix, Inc. (1992). Fall chinook salmon reportedly migrate at temperatures ranging from 10.6 to 19.5°C, with an optimal temperature of 12.2°C (Bell 1986). On August 26 (date of first chinook salmon observed in the fish ladder), the surface water temperature measured at the Inflatable Dam ranged from 21.1 to 23.6°C (average 22.8°C). The average daily water temperature remained above 21.1°C until August 31, and daily maximum water temperatures exceeded 21.1°C as late as September 9 (although it did drop below this level for a few days in early September). On September 15 (the last full day of water temperature collection), water temperature ranged from 19.0 to 20.2°C, averaging 19.7°C. Prior to September 15, a total of four chinook salmon were observed in the fish ladder.

6.4.1.2 Steelhead

Steelhead typically enter coastal streams between November and April. No adult steelhead were observed in the videotapes. Thirty-six steelhead and seven salmonids in the parr to smolt-sized category were identified as passing upstream through the fish ladders between May 20 and November 16 (Table 11). A few of the fish on the larger end of this range may have been fish returning after one year in the estuary/ocean. The majority (15, salmonids included) of the steelhead observations occurred between June 27 and July 3. During the late June to early July time-period, the average daily water temperatures recorded at the Inflatable Dam (0.5 meters deep) ranged from 23.0 to 25.2°C (maximum temperature recorded during this time period was 25.9°C).

6.4.1.3 Pacific lamprey

Sixty-eight Pacific lamprey were counted migrating upstream through the fish ladder during the 1999 study. Pacific lamprey migrated past the dam in two separate pulses, late May through June (22) and from late October through mid November (48) when the video cameras were removed with the deflation of the dam. Pacific lamprey reportedly migrate upstream primarily in April and late July (Moyle 1976, Wang 1986), although in the Trinity River Moffett and Smith (1950, cited by Moyle 1976) reported that some adult lamprey migrate upstream in August and September. Although studying Pacific lamprey is outside the scope of this project, life history information will be collected when possible.

6.4.1.4 American shad

Seventeen adult American shad were observed migrating upstream through the fish ladder between May 21 and July 6. In California, spawning migration of American shad generally occurs between late March and early July, peaking in late May and early June (Moyle 1976). CDFG (1978) reported that shad migrate upstream in the Russian River between the first-week of April through early August, although peak numbers of upstream migrants occur in May and early June. American shad spawning migrations tend to peak at water temperatures between 15 and 20°C (Moyle 1976, Stier and Crance 1985). Although studying American shad is outside the scope of this project, life history information will be collected when possible.

6.4.2 Snorkel Surveys

No salmonids were observed during snorkel surveys. Fish observed included centrarchids and Sacramento suckers. Snorkel surveys were deemed sufficient to determine if large numbers of adult salmonids are present below the dam, but are not sufficient to verify the presence of relatively low numbers of fish. The main concern associated with direct observation was water clarity. Visibility was limited to approximately five feet. Although the system of two divers and one spotter located on the bluff above the dam was believed to provide adequate coverage of the river below the dam, the suitability of this method could not be validated. In addition, streamflow was increased during November; The increase in flow pouring over the dam increased turbulence and the entrainment of air in the water forming a sizable "bubble curtain" that further limited visibility. However, no other suitable sampling methods were identified during the study. Other methods available to sample fish below the dam include various fish traps. Traps would require the capture and handling of adult salmonids, which may be stressful to the fish. Therefore, in light of the fact that anadromous fish were observed ascending the ladder, and the apparent lack of large numbers if salmonids below the dam, the current sampling method (direct observation) will be conducted for a second year (in 2000) to determine the effectiveness of this method.

6.5 CONCLUSIONS

The video monitoring technique provided high quality data for assessing fish utilization of the Mirabel Inflatable Dam fish passage facilities. This study will be continued with minor modifications made to improve picture quality. Modifications made prior to the start of the 2000 sampling season will include:

- Set the VCRs to record an image every 0.2 seconds (24 hour setting).
- The bottom of the fish exit will be painted white to increase the contrast with fish.
- The exit boxes will be modified to facilitate cleaning of the reflective panel along the back wall.
- Additional lighting will be added to improve visibility of fish passing through the ladder.

The direct observation survey data was of limited usefulness. Water clarity during the summer/early fall was moderate (generally around five-feet), and the consensus among the snorkel team was that if the numbers of salmon below the dam were low, then it would be possible to miss them. In addition, fall rains that stimulate upstream migration of chinook salmon also increase turbidity. Water clarity below the dam is further reduced by an increase in the bubble curtain that forms below the Inflatable Dam during the late fall. Streamflow in the Russian River increases in November due to a reduced demand for irrigation. The higher streamflow over the Inflatable Dam results in an increase in the bubble curtain (air entrained in the water column as water flows over the dam) that further limits visibility below the dam. The decrease in visibility significantly reduces the effectiveness of the snorkel surveys when salmon are most likely to be present below the Inflatable Dam.

Due to the constraints on visibility and the number and diversity offish observed migrating through he fish ladders in 1999, we recommend discontinuing snorkel surveys below the Inflatable Dam.

7.0 BOAT ELECTROFISHING

7.1 POTENTIAL IMPACT

The impoundment has the potential to alter water temperature and aquatic habitat. These alterations may improve habitat conditions for predatory fish such as smallmouth and largemouth bass and Sacramento pikeminnow. These fish have the potential to prey on emigrating smolts, especially chinook salmon smolts, which emigrate in their first year of life at a relatively small size.

7.2 STUDY OBJECTIVE

The objective of this task is to assess predator abundance and overall species composition within, above, and below the Wohler Impoundment. Data collected during this study will be used to determine if predator populations are larger in the impounded section of the river compared to unimpounded sections of the river.

7.3 METHOD EVALUATED

The fish population near the Inflatable Dam was sampled with an electrofishing boat. A 16-foot Smith-Root, Inc. electrofishing boat (model SR 16S) was employed to collect fish. The electrofishing boat has an onboard generator that sends an electric current through two anodes mounted to the front of the boat. A series of cathodes are also mounted on the front of the boat to complete the current. The strength of the current is controlled by the boat operator, and is maintained at the minimum level required to effectively capture fish. The front of the boat is designed as a flat platform enclosed on the front and sides with safety railing. The platform is large enough to allow two crewmembers to net fish stunned during electrofishing. Fish were collected using nets that measure 17" X 17", mounted on eight-foot long fiberglass handles. A series of floodlights mounted on the front and rear of the boat allow for safe operation during nighttime sampling efforts.

Electrofishing was conducted in early August to minimize the potential of encountering adult salmonids. Electrofishing was conducted during hours of darkness. Adult predatory fish tend to move inshore at night to feed, and are thus more vulnerable to electrofishing. In addition, the potential to encounter kayakers and other recreational user groups was greatly reduced. Electrofishing was begun at the downstream end of each station, and preceded upstream. Along banks with cover (e.g., overhanging and aquatic vegetation), the boat was maneuvered such that the anodes were placed in the cover prior to the current being delivered to the water. This minimizes the potential of alerting fish to the presence of the current, and increases capture rates. One of the two netters stationed at the front of the boat controlled the operation of the electrofishing unit. In this way, the current was applied only when the anodes were in the desired position. A timer recorded the effort (i.e., number of seconds that the electrofisher was in operation) at each station.

During electrofishing, an attempt was made to net all fish stunned. However, special emphasis was placed on capturing target species (adult and juvenile piscivorous fish) and juvenile salmonids. Captured fish were held in a live well. The live well was equipped with a recirculating pump and an aerator to supply fresh, well oxygenated water to the holding tank. Captured fish were identified to species and measured to the nearest 0.5 cm. FL. Scale samples were collected from representative specimens to determine the age structure of the fish community.

7.3.1 Study Area

Four basic sampling areas were separated out based on similarities hi habitat (Figure 13). These sites were:

- Reach #1 (Lower Wohler) - approximately RM 22.75 to RM 23.75. Lower half of Wohler Pool.

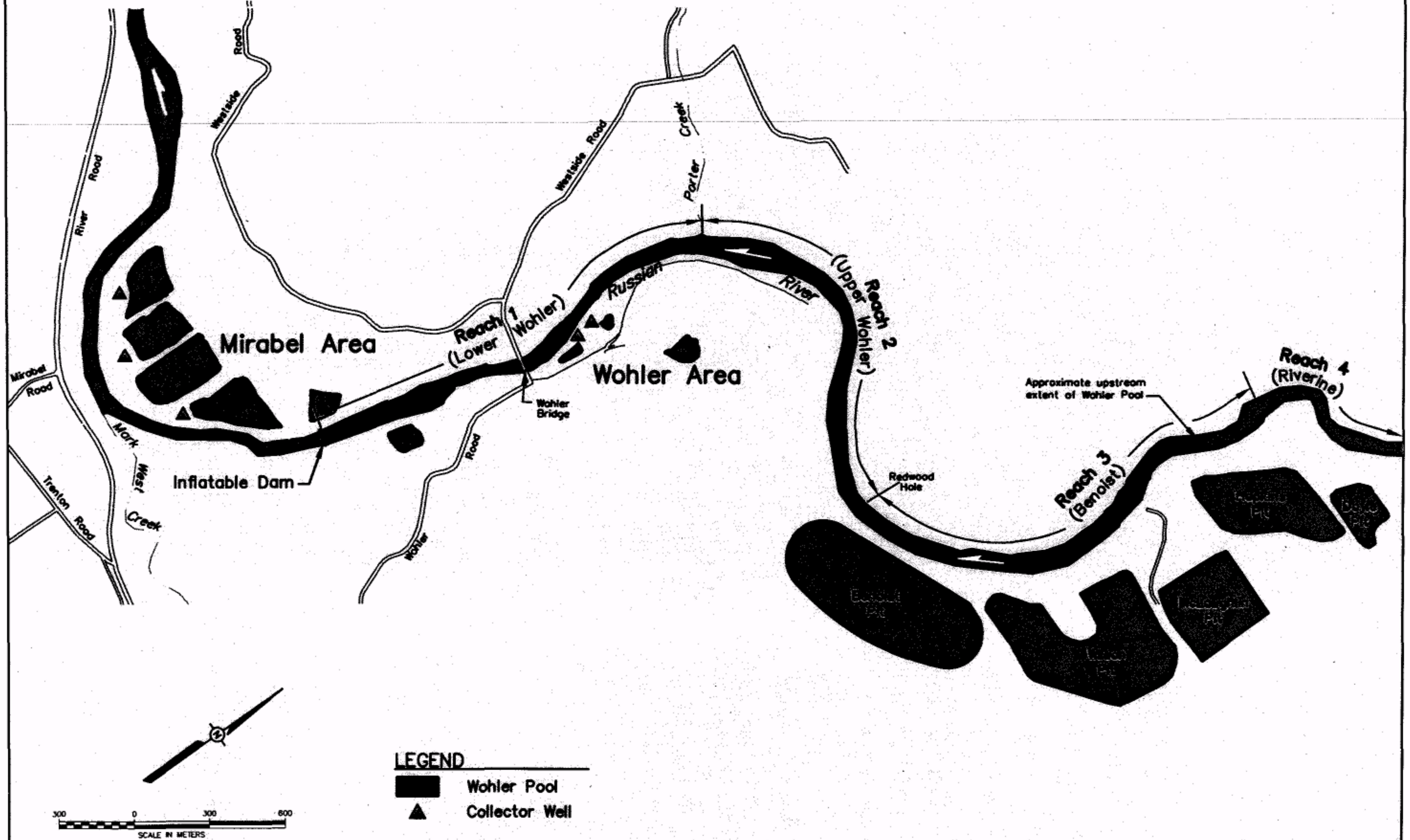
- Reach #2 (Upper Wohler) - approximately RM 23.75 to RM 24.75. Upper half of Wohler Pool
- Reach #3 (Benoist) - approximately RM 24.75 to RM 25.75. Located approximately 500 meters upstream of Wohler Pool, dominated by pool habitat.
- Station # 4 (Riverine) - approximately RM 25.75 to RM 26.75. Upstream end of the Benoist Reach to the first riffle was too shallow to navigate in the electrofishing boat. This reach of the river is characterized by relatively higher current velocities and an overall narrower channel, compared to the other reaches.

The amount of effort exerted within each sampling station was not equal. In addition, the timer on the electrofishing boat malfunctioned for a short time-period, and the length of time that the shocker was operated in a few sites was not recorded. Thus, it is not possible to compare each location based on a catch-per-unit-effort. The information collected is useful in that it provides information on species composition and distribution of fish inhabiting the Russian River in the Wohler Pool and upstream. The data are presented to facilitate the selection of sampling stations to be used during the five-year monitoring study, and as an exercise to determine the best analytical tool to analyze the data.

7.3.2 Predator Analysis

The primary consideration of this study was to determine if the Wohler Pool provides conditions that lead to an increase in predator populations compared to the river upstream and downstream of the impoundment. The Wohler Pool may influence predator populations through providing habitat for adult (piscivorous fish), and/or by providing habitat for juvenile fish that disperse to other parts of the river. Both of these possibilities will be considered in this study.

Both the size of the prey and the predator must be taken into account in assessing potential impacts due to predation (e.g., the predator must be large enough to consume the prey). The main species and life stage of concern are chinook smolts. Chinook salmon in the Russian River emigrate through the Wohler Pool at about 90 mm FL (range 65 to 106 mm) (Section 5.0). Steelhead smolts emigrate through the Wohler Pool at an average size of 175 mm FL (range 145 to 250 mm). Thus, chinook smolts are more vulnerable (based on size) than steelhead smolts. Zimmerman (1999) developed a linear regression for the size of salmonids that could be consumed by smallmouth bass between 200 and 400 mm FL, and northern pikeminnow between 250 and 550 mm FL (the northern pikeminnow is closely related and similar in morphology to the Sacramento pikeminnow). Based on this regression, a 200 mm smallmouth bass can consume a 100 mm salmonid, and a 383 mm FL smallmouth bass (largest smallmouth bass captured in this study) can consume a 134 mm salmonid. Based on a similar regression, northern pikeminnow ranging in size from 250 and 530 mm FL (largest Sacramento pikeminnow captured in this study) can consume salmonids ranging in length from 116 to 220 mm FL. Moyle (1976) states that Sacramento pikeminnow feed primarily on fish at lengths greater than 180 mm standard length (approximately 200 mm FL). Based on a brief review of the literature, it was assumed that smallmouth bass could become predaceous on salmonid smolts (primarily chinook salmon) at 150 mm FL, and that Sacramento pikeminnow can become predaceous on chinook salmon at a length of 200 mm FL. These assumptions will have to be verified through a more thorough search of the literature or the collection of site-specific food habitat data. Another important consideration for the future is determining growth rates of predators through back-calculating length at age. This has particular relevance for smallmouth bass. Smallmouth bass average 85 mm FL in August of their first year (all sites combined), and 179 mm FL in August of their second year (all sites combined).



SONOMA COUNTY WATER AGENCY

Figure 13. Boat electrofishing reaches, August 1999

The point at which they become large enough to feed on chinook salmon smolts must occur prior to the emigration period for this age class to have the potential to adversely impact chinook smolts. The importance of this is that 50 percent of the smallmouth bass greater than 150 mm FL fall into the Age 1+ category.

7.4 RESULTS OF BOAT ELECTROFISHING

An important consideration to keep in mind while reviewing the data is that effort between areas was not equal. Therefore, catch data between sites is not directly comparable. The data is valuable in that it provides a description of the fish assemblages (species composition, relative abundance, size structure etc.) within the various reaches.

Thirteen species including 716 individual fish were captured in the four reaches during boat electrofishing sampling (Table 12). Six native and seven non-native species were captured. Overall, three species dominated the catch at all stations. Sacramento suckers and smallmouth bass comprised 37.7 percent and 34.4 percent of the overall catch rate, respectively (Table 13). Hardhead accounted for 13.4 percent of the overall catch. No other species accounted for more than 3.8 percent of the fish captured.

Three predatory species were captured during the study, smallmouth bass, Sacramento pikeminnow, and striped bass. Smallmouth bass, an introduced species, comprised between 21.6 and 50.2 percent of the catch in the four reaches. However, smallmouth bass large enough to prey on salmonid smolts accounted for 5.3 percent (38 of 716) of the fish captured (length-frequency histograms are presented in Appendix B for all species captured during boat electrofishing). Sacramento pikeminnow comprised between 0.0 and 3.5 percent (1.8 percent overall) of the catch at each station (Table 12). Of the 13 pikeminnow captured, three were large enough to prey on salmonid smolts. One striped bass was collected during the study, measuring 655 mm FL.

7.4.1 Riverine Reach

Twelve species (six native and six introduced) comprising 160 individual fish were captured in the Riverine Reach (Table 12). Native species comprised 66.9 percent of the fish collected. The fish community in the Riverine Reach was dominated by Sacramento sucker (50.0 percent) and smallmouth bass (28.1 percent) (Table 13). Hardhead comprised 9.4 percent of the population. Four steelhead were captured in this reach.

Eight (5.0 percent) potential salmonid smolt predators (six smallmouth bass, one pikeminnow, and one striped bass) were captured hi the Riverine Reach. The six smallmouth bass were evenly distributed between ages 1+, 2+, and 3+ (Table 14). Only one of three pikeminnow were captured in the Riverine Reach was large enough to prey on salmonid smolts (Table 15). The striped bass was the largest fish captured in during the 1999 sampling effort, and was the only striped bass collected during the survey.

Table 12. Species abundance in five boat electrofishing sites, Wohler Pool Area, Russian River, August 1999 (N = Native, I = Introduced).

Numbers Caught						
Species		Riverine	Benoist	Upper Wohler	Lower Wohler	TOTALS
Steelhead	N	4	0	0	5	9
Tule perch	N	4	7	7	9	27
Sac. sucker	N	80	39	60	90	269
Hardhead	N	15	27	30	23	95
Sac. pikeminnow	N	3	0	3	7	13
Prickly sculpin	N	1	0	0	0	1
Smallmouth bass	I	45	40	118	43	246
Green sunfish	I	3	4	8	2	17
Bluegill	I	1	0	1	5	7
White crappie	I	1	1	0	1	3
Common carp	I	2	2	5	7	16
American shad	I	0	0	3	7	10
Striped bass	I	1	0	0	0	1
TOTALS		160	120	235	199	714

Table 13. Species composition in four boat electrofishing sites, Wohler Pool Study Area Russian River, August 1999 (N = Native, I = Introduced).

Percentage of Catch						
Species		Riverine	Benoist	Upper Wohler	Lower Wohler	TOTALS
Steelhead	N	2.5	0.0	0.0	2.5	1.3
Tule perch	N	2.5	5.8	3.0	4.5	3.8
Sac. sucker	N	50.0	32.5	25.5	45.2	37.7
Hardhead	N	9.4	22.5	12.8	11.6	13.4
Sac. pikeminnow	N	1.9	0.0	1.3	3.5	1.8
Prickly sculpin	N	0.6	0.0	0.0	0.0	0.1
Smallmouth bass	I	28.1	33.3	50.2	21.6	34.4
Green sunfish		1.9	3.3	3.4	1.0	2.4
Bluegill		0.6	0.0	0.4	2.5	1.0
White crappie		0.6	0.8	0.0	0.5	0.4
Common carp		1.3	1.7	2.1	3.5	2.2
American shad		0.0	0.0	1.3	3.5	1.4
Striped bass		0.6	0.0	0.0	0.0	0.1
Total		100.0	100.0	100.0	100.0	100.0

Table 14. Size and age structure of smallmouth bass in the Mirabel study area.

Riverine				
Age	Number	Average length	Minimum length	Maximum length
Age 0+	39	89	70	115
Age 1 +	2	184	182	185
Age 2+	2	255	240	270
Age 3+	2	318	310	325
Benoist				
Age	Number	Average length	Minimum length	Maximum length
Age 0+	34	80	60	110
Age l+	4	172	160	186
Age 2+	2	270	260	280
Age 3+	2	316	315	317
Upper Wohler Pool				
Age	Number	Average length	Minimum length	Maximum length
Age 0+	104	84	55	120
Age l+	7	176	150	210
Age 2+	5	261	250	275
Age 3+	2	363	350	375
Lower Wohler Pool				
Age	Number	Average length	Minimum	Maximum
Age 0+	33	91	60	120
Age 1+	7	187	170	210
Age 2+	2	274	252	295
Age 3+	2	359	335	383

[1] Ages based on length-frequency histogram and scale analysis

Table 15. Size and age structure of Sacramento pikeminnow in the Mirabel study Area.

Riverine				
Age	Number	Average length	Minimum	Maximum
Age 0+	0	0	0	0
Age 1+	2	138	120	155
Age 2+	0	0	0	0
Age 3 (or older)	1	530	530	530
Benoist				
Age	Number	Average length	Minimum	Maximum
Age 0+	0	0	0	0
Age 1+	0	0	0	0
Age 2+	0	0	0	0
Age 3 (or older)	0	0	0	0
Upper Wohler Pool				
Age	Number	Average length	Minimum	Maximum
Age 0+	0	0	0	0
Age l+	2	113	95	130
Age 2+	0	0	0	0
Age 3 (or older)	1	530	530	530
Lower Wohler Pool				
Age	Number	Average length	Minimum	Maximum
Age 0+	3	70	66	73
Age 1+	3	131	115	150
Age 2+	0	--	--	--
Age 3 (or older)	1	385	385	385
[1] Ages based on length-frequency histogram				

7.4.2 Benoist Reach

Seven species (three native and four introduced) comprising 120 individual fish were captured in the Benoist Reach (Table 12). Native species comprised 60.8 percent of the fish collected. The fish community in the Benoist Reach was dominated by smallmouth bass (33.3 percent) and Sacramento sucker (32.5 percent). Hardhead comprised 22.5 percent of the population (Table 13). No steelhead were captured in this reach.

Eight (6.7 percent) potential salmonid smolt predators were captured in the Benoist Reach, all of which were smallmouth bass. Half of the eight smallmouth bass were aged as 1+ (averaging 172 mm FL) (Table 14). The remaining four smallmouth bass were split between Age 2+ and Age 3+. No pikeminnow were captured in the Lower Wohler Reach (Table 15).

7.4.3 Upper Wohler Reach

Nine species (four native and five introduced) comprising 235 individual fish were captured in the Upper Wohler Reach (Table 12). Native species comprised 41.0 percent of the fish collected. The fish community in the Upper Wohler Reach was dominated by smallmouth bass (50.2 percent) and Sacramento sucker (25.5 percent) (Table 13). Hardhead comprised 12.8 percent of the population. No steelhead were captured in this reach.

Fifteen (6.4 percent) potential salmonid smolt predators were captured in the Upper Wohler Reach. Smallmouth bass accounted for 14 of the 15 potential predators, with pikeminnow accounting for the fifteenth fish (Table 13). Seven of the 15 smallmouth bass were Age 1+ (averaging 176 mm FL). Five of the remaining seven smallmouth bass were Age 2+ (Table 14). The one pikeminnow large enough to prey on salmonid smolts was the largest of this species collected during the study (530 mm FL).

7.4.4 Lower Wohler

Eleven species (five native and six introduced) comprising 199 individual fish were captured in the Lower Wohler Reach (Table 12). Native species comprised 67.3 percent of the fish collected. Sacramento sucker and smallmouth bass comprised 45.2 and 21.6 percent of the catch in the Lower Wohler Reach, respectively (Table 13). Hardhead were the third most abundant fish captured in this reach, comprising 11.6 percent of the catch. Five steelhead were captured in the Lower Wohler Reach, comprising 2.5 percent of the catch.

Of the 199 fish collected, 11 (5.5 percent) were considered potential predators of salmonid smolts. Smallmouth bass accounted for 10 of the 11 potential predators, with pikeminnow accounting for the twelfth fish. Six of the ten smallmouth bass were Age 1+, averaging 187 mm FL in August (Table 14).

7.5 CONCLUSIONS

Boat electrofishing proved to be an excellent method for sampling fish populations in the Wohler Pool and in the Russian River upstream of the impoundment. This methodology allowed a large section of the river (approximately four miles of habitat) to sampled in a relatively short time frame (three nights). Boat electrofishing effectively collected a variety of species and the size ranges (35 to 655 mm FL). Electrofishing technology is more effective at capturing larger fish than smaller fish. Although this is beneficial in capturing the target species (adult pikeminnow and smallmouth bass), the catch data may be biased towards larger fish. Thus, alternative sampling techniques to sample smaller species should be considered (for example, baited minnow traps). Electrofishing is also more efficient at capturing species that live in the upper water column, thus species such as catfish and sculpin will be under represented in the catch.

Electrofishing boats are designed to have a shallow draft that allows for operation in shallow water. The rental boat used in this years sampling effort was able to operate efficiently in water less than two feet in depth. The boat recently purchased by the Agency was constructed with a transom jack and an engine tilt feature that will allow the engine/propeller to be positioned in such a way to allow the boat to be operated with minimal draft, while providing sufficient power to operate the boat in habitats with relatively strong currents.

Boat electrofishing sampling will be conducted in 2000. Sampling methods will be similar to those used in 1999. Changes to the sampling protocol will include:

- Conduct a detail literature review of the food habitats of all potential piscivores inhabiting the Russian River with regards for their potential to prey on salmonids.
- Sampling stations of equal lengths will be randomly selected in the four reaches (Riverine, Benoist, Upper and Lower Wohler). A fifth reach, below the Inflatable Dam, will be included if suitable sites and access points can be located.
- Additional scale samples will be collected for finer resolution of age structure, particularly in predator populations.

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