

Technical Memorandum

Prepared for: **City of Albany, California**
Prepared by **Hagar Environmental Science**

Codornices Creek – Restoration Activities between 2nd Street and 5th Street Fish Removal Activities

Phase I of the stream restoration of Lower Codornices Creek by the City of Albany (City) required draining and re-contouring of the active stream channel in a section of the creek between 5th Street and the UPRR right of way. Permitting for the project requires relocation of steelhead/rainbow trout (*Oncorhynchus mykiss*), possibly part of the Central California Coast steelhead ESU, present in the creek. Additional stream channel alterations were completed in conjunction with this project by Target in the reach between the UPRR right of way and 2nd Street, and by the UPRR within its right of way. Fish relocation was completed primarily between September 1 and September 3, 2004, although additional removals were completed on September 8 and September 15, and following early season runoff and additional work at the Kinder-Morgan gas line crossing on October 30. Fish were captured by electrofishing and released to adjacent stream sections outside the planned construction work area. This work was completed in compliance with permits obtained by the City of Albany from the San Francisco Regional Water Quality Control Board, California Department of Fish and Game, and U.S. Army Corps of Engineers (in consultation with NOAA Fisheries).

Prior to fish removal, overhanging vegetation and instream debris was cleared by Pacific Open Space, Inc. as part of the initial construction site clearing process and to increase the efficiency of fish removal. Following brush and debris removal, the entire construction reach was isolated by placing block nets upstream of the diversion intake at 5th Street and just upstream of the diversion outfall at 2nd Street.

Initial Fish Relocation

A total of 127 *O. mykiss* were captured in the construction area. Threespine stickleback and goldfish were the only fish species captured in addition to the trout. No frogs or turtles were encountered during the fish removal. Large numbers of crayfish were present throughout the construction area. Some stickleback were moved along with the trout but relocation efforts focused on the trout. Five discrete sections of Codornices Creek between 5th Street and 2nd Street were cleared of fish.

The most downstream reach of the project area (referred to here as the Target reach) is a section of stream 348 feet long and situated between 2nd Street and the Union Pacific Railroad (UPRR) tracks. It supported riparian vegetation (e.g., tules and willows), with some habitat complexity and cover, including two very small pools. Substrate in the lower portion of this reach consisted of fine silt and clay, whereas there were some gravel areas in the shallower sections in the upper portion of the reach. Nineteen rainbow trout/steelhead parr were captured in the Target Reach (Table 1). The majority were in

the 70 mm to 100 mm (3 inch to 4 inch) size class (likely young-of-year or 1 year old) though several were smolt size (150 mm or 6 inches) or larger. The majority of the trout were captured in the most downstream pool near the downstream end of the reach. The substrate was sandy and muddy and visibility poor once the bottom was disturbed. The pattern of removals on three complete passes with the electrofisher gave a population estimate of 19 *O. mykiss* with an upper 95% confidence limit of 19 fish (Zippen 1958). The fish were released to pools downstream of 9th Street and 10th Street. Threespine stickleback were the only other species captured in the Target reach.

Table 1. Summary of trout captured from the Target Reach

	Date	Number
Pass 1	1-Sept-2004	17
Pass 2	2-Sept-2004	2
Pass 3	8-Sept-2004	0
Total Captured		19
Population Estimate		19
Upper 95% Confidence Limit		19

The UPRR reach, immediately upstream of the Target reach, was 56 feet long and required electrofishing underneath the railroad tracks. There was some emergent vegetation at the edges of the railroad bridge but none under the tracks and the substrate was primarily sand and silt. No rainbow trout/steelhead were captured underneath the UPRR tracks. One pass was considered sufficient as the area was shallow and lacked vegetation or other cover. Threespine stickleback and one large goldfish were captured in the UPRR reach.

The third section of creek consisted of a concrete channel, approximately 3½ feet deep and 4 feet wide, extending from just upstream of the UPRR tracks to just downstream of 4th Street. The reach was 282 feet long. Before electrofishing, the concrete channel had been entirely overgrown by low vegetation. The vegetation was cleared by Pacific Open Space as part of site preparation before fish removal. A total of three passes were completed on September 1 through 3 in the concrete channel reach and a total of 47 *O. mykiss* were removed at that time (Table 2). Many of these fish ranged from 180 mm (7 inches) to 270 mm (10.5 inches). The largest *O. mykiss* captured were 310 mm (12.2 inches) and 329 mm (13 inches). These trout were unusually large for a stream the size of Codornices Creek. A population estimate was generated from the three removals (Zippen 1958), although it was somewhat complicated by procedural difficulties. The first pass resulted in capture of 36 trout, although 3 of these had to be returned to the channel due to overcrowding in the holding container. A second pass on September 2 captured 7 trout and another individual was found dead in the channel. On September 3, a third pass resulted in capture of 6 additional trout. The population estimate generated from these removals is 49 trout with an upper 95% confidence limit of 53 trout. On September 8, the concrete channel reach was partially de-watered by pumping and HES removed nine more *O. mykiss*, bringing the total removed from the concrete channel

section to 56 trout or three more than the maximum predicted population for the reach. The best estimate of the population present is therefore the 56 fish removed. Trout captured in the first three removals were released to pools downstream of the 10th Street entrance to University Village. Trout captured on September 8 were placed in the deep pool adjacent to the 5th Street culvert.

Table 2. Summary of trout captured from the Culvert Reach

	Date	Number
Pass 1	1-Sept-2004	33
Pass 2	2-Sept-2004	8
Pass 3	3-Sept-2004	6
Total captured in first removals		47
Population estimate		49
Upper 95% Confidence Limit		53
Removed after partial de-watering	8-Sept-2004	9
Total removed		56

The fourth section, approximately 353 feet long, was between 4th Street and 5th Street and consisted of a short box culvert (about 30 feet) and a shallow stream section bounded by willows, blackberry, and other riparian vegetation. The substrate consisted primarily of sand, gravel, and silt. A total of 17 *O. mykiss* were removed from the reach between 4th Street and 5th Street (Table 3) and the majority were captured within the box culvert at 4th Street. The population estimate for the reach is 19 trout based on removal method population estimation with 2 removals (Seber and LeCren 1967). The upper 95% confidence interval for the total population is 24 trout. All fish were released to pools downstream of the 10th Street entrance to University Village. Following the final electrofishing pass on September 3, a block net was placed at the upper part of the reach, in the tail of the pool at the 5th Street culvert, to prevent fish from moving downstream.

Table 3. Summary of trout captured from the reach between 4th Street and 5th Street.

	Date	Number
Pass 1	2-Sept-2004	13
Pass 2	3-Sept-2004	4
Total Captured		17
Population Estimate		19
Upper 95% Confidence Limit		24

The most upstream section was a 4 foot diameter culvert at the 5th Street crossing. The culvert and associated pools at 5th Street had to be partially de-watered in order to effectively electrofish and remove the fish. On September 3, 2004 a partial pass was completed in the 5th Street culvert and associated pools after the water level had been

drawn down by pumping. Twenty-one *O. mykiss* were removed and re-located to pools downstream of the 10th Street entrance to University Village. At that point, 107 trout had been re-located to the reach between 10th Street and 8th Street. This reach contained the best habitat for trout since few significant pools with adequate cover were present anywhere upstream of 10th Street or downstream of 2nd Street. In conferring with the contractor and the City of Albany, it was determined that there would not be instream work conducted at 5th Street that would interfere with conditions in the pools or culvert there. It was therefore concluded that, due to potential for over-crowding upstream, it would be best to simply leave the remaining trout at 5th Street in place. A block net was placed at the lower end of the 5th Street pool and the pumps were re-positioned to allow the water level to rise in the pool to the initial level.

On September 13th, 3 *O. mykiss* were found dead within the 5th Street culvert pool. The lengths of two of these fish was consistent with fish removed from the concrete channel section downstream on September 8. Although water quality conditions appeared suitable and the cause of death of these fish could not be determined, it was decided that it would be prudent to re-locate the remaining fish at this time. On September 15, after the culvert and pools had been partially pumped down, three passes were completed and a total of 20 *O. mykiss* were captured. These fish were re-located to 2 pools near the BART line and 1 pool just downstream of San Pablo Avenue. Based on the three passes conducted on September 15, 22 fish were estimated to be in the culvert/pools at that time. The upper 95% confidence interval for the population at that date is 27 fish. Accounting for the three mortalities and removal of 21 fish on September 3, a total of 44 *O. mykiss* were removed from the culvert/pool. There were likely 2 fish remaining after September 15 and possibly as many as 7 based on the population estimate and upper 95% confidence limit calculated from the three removal passes on September 15. Accounting for the 9 fish re-located to the 5th Street pool from the concrete channel section on September 8, it is estimated that between 37 and 42 trout were originally present in the 5th Street culvert/pool.

Table 4. Summary of trout captured from the 5th Street Culvert.

	Date	Number
Removed September 3	3-Sept-2004	21
Removed September 15		
Pass 1	15-Sept-2004	13
Pass 2	15-Sept-2004	4
Pass 3	15-Sept-2004	3
Total removed Sept 15		20
Population estimate on Sep 15		22
Upper 95% Confidence Limit		27
Mortalities removed Sept. 13		3
Total removed		44
Sept. 15 Population estimate plus previous removals		46
Sept. 15 Upper 95% estimate plus previous removals		51
Introduced from concrete culvert reach Sept. 8	8-Sept-2004	9
Total removed minus total introduced		35
Estimated original population		37
Maximum estimated original population		42

Overall there were 127 trout removed from the project reach (Table 5). The best estimate of the number of *O. mykiss* remaining after the fish re-location efforts were completed is 4 fish or about 3% of the estimated population in the project reach. However, 2 of those fish were in the culvert/pool at 5th Street and were not directly impacted by construction activities. Therefore the best estimate of the number of trout lost due to construction activities in the stream is 2 fish or about 1.5% of the pre-construction population. We can be 95% certain that no more than 14 *O. mykiss* remained after the removal efforts. Again, 7 of these would have been in the 5th Street culvert/pool leaving a total of 7 (5% of the upper 95% confidence limit for the pre-construction population estimate) that could have been lost to instream construction activities.

In addition to the three mortalities in the 5th Street culvert found on September 13 and the mortality found in the concrete channel on September 2, an additional *O. mykiss* was found dead on the morning of September 2 in the area where fish had been released downstream of 10th Street. The total of 5 trout mortalities during the re-location activities, amounts to 4% of total number removed.

NOAA Fisheries authorized incidental take of up to 28 juvenile steelhead during the two-year duration of this project's fish relocation activities. The total take of 12 trout during 2004, consisting of an estimated seven trout remaining within the project reach after the relocation activities and the five documented mortalities, is within the expected amount of take.

Table 5. Summary of *O. mykiss* removal activities.

Reach	Number Removed	Population Estimate	95% Upper C.L.	Estimated Number Remaining	Estimated Maximum Remaining	Mortality
Target	19	19	19	0	0	
UPRR	0	0	0	0	0	
Concrete Culvert	56	56	56	0	0	
4 th St. to 5 th St.	17	19	24	2	7	
5 th St. culvert	35	37	42	2	7	
Total	127	131	141	4	14	5

The largest numbers (over 80% of the total number of fish captured) were found in the artificial stream reaches including the concrete culvert between 4th Street and the UPRR, the 4th Street culvert and 5th Street culvert. It is uncertain whether the stream channels where these fish were re-located can support such large numbers of large trout. It is also uncertain whether the restored stream channel downstream of 5th Street will support a similar population structure as was present originally.

There were a surprising number of large trout in the project reach, particularly in the concrete culvert reach (Figure 1). Although overall population density was not particularly high for coastal streams in the region, the density of large fish, particularly in the concrete culvert reach and 5th Street culvert was high (Table 6).

Table 6. *O. mykiss* density in Codornices Creek.

Reach	Length (ft)	Number Removed	Trout per 100 ft
Target	348	19	5.4
UPRR	56	0	0
Concrete Culvert	282	56	19.8
4 th Street to 5 th Street	353	19	5.4
5 th Street culvert	~50	37	74
Average for Central Coast Streams (1980s-90s)			13
Maximum for Central Coast Streams (1980s-90s)			40

It is unclear whether the trout present were part of an anadromous steelhead population or a resident spawning rainbow trout population. The project reach is very close to San Francisco Bay and there appear to be no migration barriers in the intervening stream

reaches. The culvert under I-80 is low gradient and its floor is embedded below the stream bed. In most steelhead populations in Central California, the transformation from parr to smolt typically occurs after two seasons of rearing at a size of about 150mm (6 inches). The large size of many of the trout captured suggests that they remained in the stream past the typical stage of transformation and were following a resident or non-migratory life-history strategy. It is also possible, however, that these fish had obtained their unusual size by spending some period of time feeding in the San Francisco Bay, which is readily accessible on the other side of Highway 80. The species has a great diversity of life history variation ranging from fully anadromous to non-migratory and estuary migrating strategies are known in other *O. mykiss* populations (Savvaitova et al. 1973, 1997).

Otoliths (earstones) can be used to determine maternal origin (resident or anadromous) based on ratios of strontium:calcium since there is approximately a threefold increase in otolith Sr:Ca ratio between freshwater stream environments and the marine environment. High Sr:Ca ratios in the otolith core reflect the marine environment in which yolk precursors develop for anadromous forms. Otoliths from four of the trout mortalities were analyzed by the John Muir Institute of the Environment at U.C. Davis. The results indicate that all four fish were the progeny of non-anadromous (resident) rainbow trout. Growth patterns in the otoliths also indicated that two of these fish had completed three years of life and one had completed 4 years (the fourth fish was not analyzed for growth). These results, together with the length frequency distribution (Figure 1), indicates the presence of multiple age classes of trout in the project area (as many as 5 to 6 year classes including young-of-year).

Most of the trout were in good condition and showed no external signs of disease or parasites. No trout had any indication of black spot disease (BSD). Black spot disease is indicated by external dark spots attributed to the resting stage of trematodes that encyst under the scales of fish and occurs in trout populations in the Bay Area and elsewhere where warmer water temperatures occur (the trematode requires temperatures above 18°C to complete its life history). The largest trout had very faint parr marks and moderate silvering indicating that it may have begun the process of smolting.

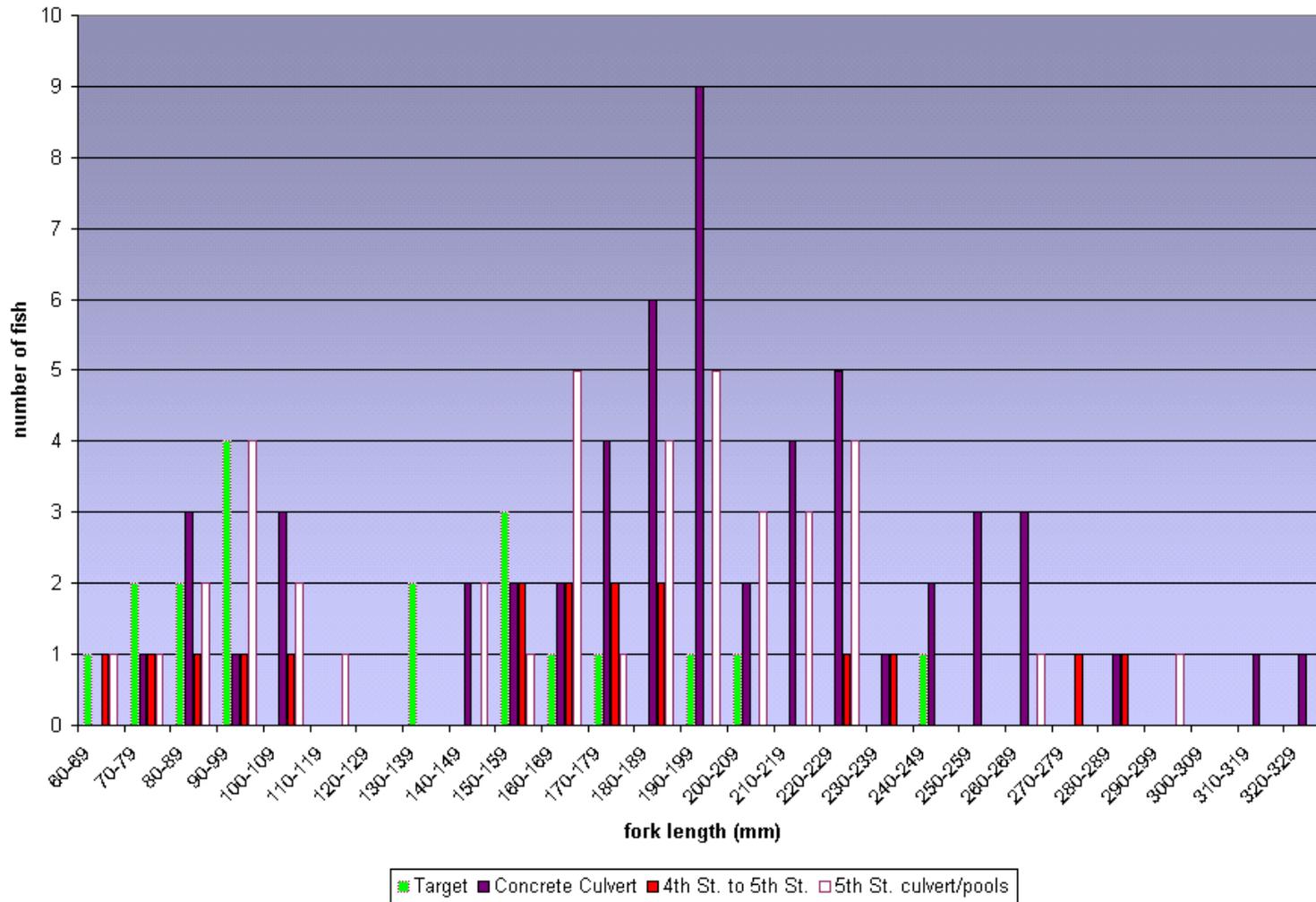


Figure 1. Size distribution of *O. mykiss* removed from Codornices Creek between Second Street and Fifth Street, Summer 2004

Subsequent Fish Removals for KMEP Gas Line Work

Completion of the project was delayed past the original October 15 completion date due to the need secure a high pressure gas pipeline discovered in the UPRR right-of-way. Early season storms beginning on October 19 overwhelmed the diversion system and resulted in streamflows through the project reach. The block nets set at either end of the project reach to prevent fish from entering the construction area were also washed out. A large pool of standing water remained in the project area, extending from upstream of the UPRR right-of-way through the UPRR culverts and downstream to the sandbag coffer dam at Second Street. There was a possibility that steelhead/rainbow trout had re-entered the construction area and were present in this pool.

On October 30 the stream reach within the UPRR right-of-way was de-watered to allow for construction activity to secure the gas pipeline. The streambed upstream from the pool was mostly dry as flow in Codornices Creek had receded to the point that it could be diverted through the diversion system in place. The reach downstream of the UPRR right-of-way was isolated from the pool at the UPRR culverts by placement of sandbags across the channel. HES conducted fish removals in the area to be de-watered after the pool was partially pumped down. The pool and culverts held less than a foot of water during the fish removal effort and there was little cover except for the rip-rap along the northeast edge of the UPRR right-of-way (Figure 2). Air temperature was 17°C and water temperature was 13°C. Visibility was good in the upstream part of the pool but poor in the culverts and associated pool due to high turbidity. Water depth in the culverts was relatively uniform and only about 0.5 foot so the presence of fish in the culverts would have been apparent from surface ripples as the fish moved.

A trout was sighted near the rock rip-rap in the upper pool and later captured by electrofishing. The fish was in good condition and measured 227 mm fork length. It was released downstream of the sandbag coffer dam at Second Street. No fish were captured in the UPRR culverts and associated pool and there was no indication that fish were present there.



Fig. 2 Upper pool, October 30. KM pipeline crossing is high spot between pools.



Fig. 3 UPRR culverts and associated pool, October 30.



Fig. 4 Trout captured in upper pool. (arrow indicates approximate capture location at higher water level).

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Technical Memorandum

Codornices Creek 5th Street Culvert Removal and Channel Modification Fish Salvage Activities, August 2006

Prepared for: **City of Albany**

Prepared by **Hagar Environmental Science**

Phase II of the Codornices Creek Restoration Project required removal of the existing culvert at 5th Street and modification of the creek channel between 5th Street and 6th Street.. Codornices Creek was dewatered in the project area to enable instream work. HES completed removal of steelhead/rainbow trout (*Oncorhynchus mykiss*) from the project area in two stages. The initial fish removal was completed upstream of the 5th Street culvert on the morning of August 21, prior to construction of the coffer dam and dewatering of the work area. Removal of fish from the 5th Street culvert and associated pool required pumping to partially draw down the water level and was completed on August 30. An electrofisher, a small seine and dip nets were used in these removals. A total of 285 feet of stream between 5th Street and 6th Street was cleared, as well as approximately 100 feet in the 5th Street culvert/pool complex.

August 21, 2006

Block nets were used to isolate the work areas and prevent fish from re-colonizing the area before placement of coffer dams. The upstream net was placed immediately downstream of the 6th Street culvert apron. The downstream net was secured just upstream of the pool formed by undercutting at the upstream opening of the 5th Street culvert. Obstructions and some instream cover objects were removed before electrofishing to increase fish capture efficiency.

Fish were removed by electrofishing beginning at approximately 10:00 am. Voltage was initially set to 300 but ultimately increased to 400 volts at a frequency of 30 hz and pulse width of 4 ms. The water temperature was 15°C. The work area was fished in three passes, starting downstream and moving upstream. A pool formed by a mass of woody debris just downstream of the 6th Street culvert provided significant cover for fish and made capture challenging. The only fish encountered were threespine stickleback and steelhead/rainbow trout (*O. mykiss*). Twenty *O. mykiss* were removed by electrofishing (Table1). The largest trout was 276 mm fork length (almost 11 inches). All live steelhead were in excellent condition. There were no mortalities. All live fish were relocated to the main creek channel upstream at locations just below 10th Street. Electrofishing was concluded at approximately 1:30pm and the block nets were left in place.

Table 1. Fish removed during electrofishing in Codornices Creek between 5th Street and 6th Street on August 21, 2006

Common Name	Scientific Name	Pass 1	Pass 2	Pass 3	Total
Threespine stickleback	<i>Gasterosteus aculeatus</i>	87	103	49	239
Steelhead/rainbow trout, young-of-year (<60 mm)	<i>Oncorhynchus mykiss</i>	0	0	0	0
Steelhead/rainbow trout, juv. (>60 mm)	<i>Oncorhynchus mykiss</i>	15	5	0	20

The population estimate for *O. mykiss* between the block nets was 20 trout based on removal method population estimation with 3 removals (Zippen 1958), the same as the number captured. This did not include trout in the 5th Street culvert and pool complex downstream of the lower block net. The depletion pattern appeared relatively consistent for the three passes, however, at least one trout eluded capture in a small pool formed by woody debris just downstream of 6th Street. The upper 95% confidence interval for the total population estimate in the area between the block nets was 22 trout.

August 30, 2006

Installation of the upstream coffer dam was begun around 9:00 am on August 30. The water temperature was 15°C. The lower block net had been cut and re-attached sometime between this date and the time the initial removal was completed on August 21. To facilitate fish capture in and around the 5th Street culvert, water was pumped out to reduce water levels. A large hoop net was pulled through the culvert. Five *O. mykiss* were captured using this method, the largest was 340mm (13 1/3 inches). Two passes through the culvert and within the pool upstream of the culvert were made with the electrofisher and a total of 24 *O. mykiss* were captured (Table 2). Multiple seine hauls were completed through the small pool downstream of the culvert resulting in the capture of 12 *O. mykiss*. Approximately one hour after the removals were completed, two mortalities were found, one 115mm fish and one 87mm fish. These were found in the isolated shallow pool downstream of the 5th Street culvert well after the electrofishing and netting were completed. The pool had become relatively warm during the day and had high turbidity and possibly, low levels of dissolved oxygen. The fish were retained, labeled, and frozen. The surviving *O. mykiss* were relocated to pools upstream of the work area near 10th Street.

HES remained on-site the evening of August 30 to monitor the de-watering of the section of creek above the 5th Street culvert. Water levels dropped slowly and channels were dug to facilitate drainage of the deeper pool with woody debris near the 6th Street culvert. Four *O. mykiss* were dip-netted out of the pool as water levels dropped and were taken to pools near 10th Street. Fish removals were concluded at 7:15 pm.

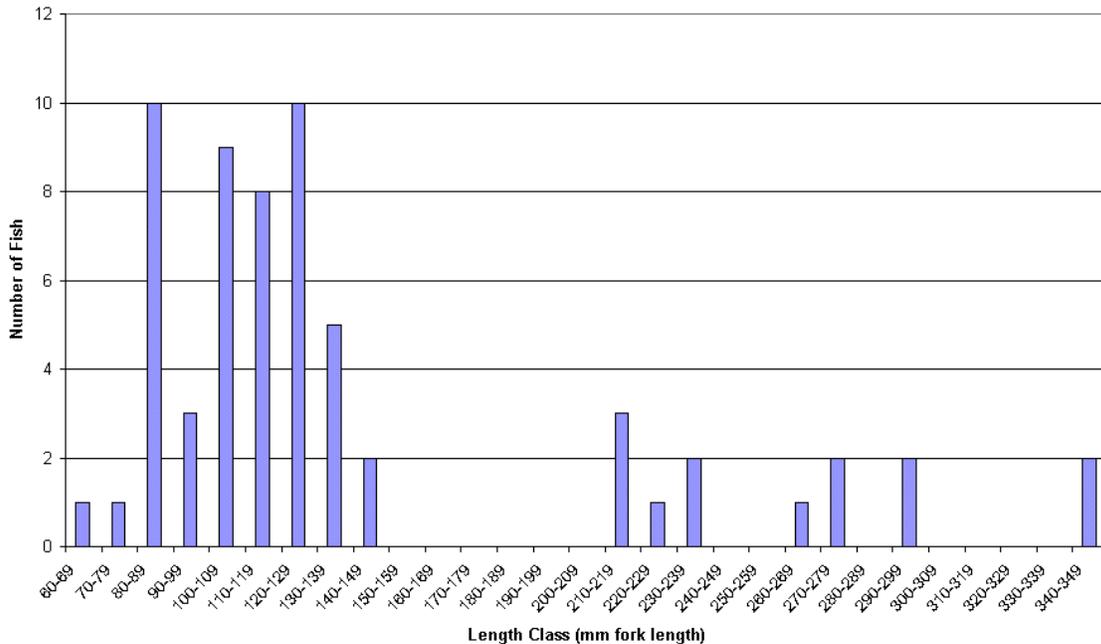
Table 2. Fish removed from Codornices Creek, 5th Street on August 30, 2006

Location, method	Steelhead/ rainbow trout, (<i>Oncorhynchus mykiss</i>)	Threespine stickleback (<i>Gasterosteus aculeatus</i>)
Culvert, hoop net	5	
Culvert, Efish pass 1	15	>100
Culvert, Efish pass 2	9	>2000
Downstream Pool, Efish pass 1	0	
Downstream Pool, Seine haul 1	0	
Downstream Pool, Seine haul 2	2	
Downstream Pool, Efish pass 2	1	
	12	
Downstream Pool, found dead	1	
Upstream Woody Debris pool, dipnet	4	
Downstream Pool, found dead	1	
Total fish removed	50	>2100

A total of 46 *O. mykiss* were captured by electrofishing and netting in the 5th Street culvert/pool complex. These fish ranged in size from 87mm(3 ½ inches) to 340mm (over 13 inches) fork length. An additional 4 trout were captured in the small pool formed by woody debris just downstream of 6th Street. Together with the 20 trout captured on August 21, the total was 70 trout removed from the work area. There were 2 mortalities accounting for 2.8% of the fish captured. The number of trout potentially remaining after removals from the 5th Street culvert and associated pools could not be determined. NOAA Fisheries authorized incidental take of up to 28 juvenile steelhead during the two-year duration of this project's fish relocation activities. The total take of 12 trout during 2004 together with the 2 mortalities in 2006 is within the expected amount of take.

The size range of *O. mykiss* captured was similar to those captured during removals downstream of 5th Street in 2004 but the distribution among size classes was completely different. In 2004, the majority of trout were in the 150mm to 250 mm size range (HES 2005) while in 2006, the majority were less than 160 mm (Figure 1). The smaller trout, 100mm fork length and less, are presumed to be young-of-year and show relatively good growth rates with the majority 80mm or greater in length. The size structure in 2006 is consistent with Central California steelhead populations where the transformation from parr to smolt typically occurs after two seasons of rearing at a size of about 150mm (6 inches). The larger trout would have remained in the stream past the typical stage of parr to smolt transformation and are likely following a resident or non-migratory life-history strategy.

Figure 1. Size classes of *O. mykiss* captured in Codornices Creek Fish Removals



Most of the trout were in good condition and showed no external signs of disease or parasites. No trout had any indication of black spot disease (BSD). Black spot disease is indicated by external dark spots attributed to the resting stage of trematodes that encyst under the scales of fish and occurs in trout populations in the Bay Area and elsewhere where warmer water temperatures occur (the trematode requires temperatures above 18°C to complete its life history). One of the trout, 235 mm in length, was very active and had very faint parr marks and moderate silvering indicating that it may have begun the process of smolting.

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Technical Memorandum

Codornices Creek Restoration Phase III: 6th to 8th Street Creek Modifications Fish Relocation Activities, July 2010

Prepared for: **City of Albany**

Prepared by **Hagar Environmental Science**

Phase III of the Codornices Creek Restoration Project requires re-grading and modification of the creek channel between 6th Street and 8th Street. As part of this restoration work, Codornices Creek was dewatered in the project area- between the 6th Street culvert and just upstream of 8th Street- to enable in-stream work. Permitting for the project requires relocation of steelhead/rainbow trout (*Oncorhynchus mykiss*), possibly part of the Central California Coast steelhead ESU, present in the creek. This work was permitted under USACE permit number 28288-1S and NOAA Fisheries permit 151422SWR04SR9261:ES.

The species has a great diversity of life history variation ranging from fully anadromous to non-migratory and estuary migrating strategies are known in other *O. mykiss* populations (Savvaitova et al. 1973, 1997). It is not possible to distinguish juvenile *O. mykiss* with anadromous parents from those that are resident based on external examination so it is unclear whether the trout present were part of an anadromous steelhead population or a resident spawning rainbow trout population. Post-mortem examination of strontium to calcium ratios in the otoliths of four *O. mykiss* captured during fish removals for the Phase I Codornices Creek Restoration project in 2004 indicated that these fish were the progeny of resident rainbow trout (HES 2005).

Hagar Environment Science (HES) completed removal of steelhead/rainbow trout (*Oncorhynchus mykiss*) from the project area in two stages as part of the dewatering activities. The initial fish removal commenced just downstream of the 6th Street culvert on the morning of 13th July, prior to construction of two coffer dams (downstream of the 6th Street culvert and upstream of 8th Street) and dewatering of the work area. Due to the presence of large pools, significant undercut banks and other cover between 6th and 8th Streets, pumping to draw down the water level was necessary. Despite repeated dewatering challenges, removal of fish from the project area was finally completed on 26th July. An electrofisher, a small seine and dip-nets were used in these removals. A total of 494 feet of stream between 6th Street and 8th Street was cleared of fish, as well as approximately 30 feet downstream of the 6th Street culvert and a small reach upstream of the 8th Street culvert. Just downstream of the 8th Street culvert a concrete channel of 86 feet in length was not sampled (less than 1 inch of water trickled at the surface of this reach).

July 13 to 15, 2010

Block nets were used to isolate the work areas and prevent fish from re-colonizing the area before placement of coffer dams. The upper net was placed upstream of the 8th Street culvert. The lower net was secured just downstream of the 6th Street culvert apron. The work area was fished starting downstream and moving upstream. Over three days a total of four passes were made downstream of 8th Street and two passes were made upstream of 8th Street.

On July 13th, fish were removed by electrofishing beginning at approximately 9:00 am. The water temperature was 17.5°C. Electrofishing downstream of the 6th Street culvert found no *O. mykiss*. The only fish encountered were threespine stickleback. From 9:45 am to 1:12 pm, obstructions and a considerable amount of instream cover vegetation were removed before continuing electrofishing, upstream of the 6th Street culvert, to increase fish capture efficiency. Air and water temperatures were monitored regularly to ensure compliance with permit requirements for fish removal at this site.

The reach between 6th Street and 8th Street contained three significant pools: A deep pool just upstream of the 6th Street culvert, another formed by a mass of woody debris further upstream, and a third below a dense tussock of pampas grass (*Cortaderia selloana*) with deep bank undercuts. These pools provided significant cover for fish and made capture challenging. The only fish encountered were threespine stickleback and steelhead/rainbow trout (*O. mykiss*).

Ninety-four *O. mykiss* were removed by electrofishing (Table 1). The largest trout was 305mm fork length (just over 12 inches). All live steelhead were in excellent condition. On July 15th there was one *O. mykiss* mortality (fork length 126 mm). This fish had been accidentally retained in a dip-net while electrofishing. The fish was retained, labeled, and frozen. All live fish were relocated to the main creek channel downstream at locations below 5th Street. Electrofishing was concluded at approximately 10:40 am on July 15th and the block nets were left in place.

Table 1. Fish removed during electrofishing in Codornices Creek between 6th Street and 8th Street (Passes 1 to 4) and just upstream of 8th Street (Passes A and B), July 13th to 15th, 2010

Common Name	Scientific Name	Pass 1	Pass 2	Pass 3	Pass 4	Pass A	Pass B	Total
Threespine stickleback	<i>Gasterosteus aculeatus</i>	63	86	93	94	5	2	343
Steelhead/rainbow trout	<i>Oncorhynchus mykiss</i>	43	18	11	14	6	2	94

Since more *O. mykiss* were captured on the fourth pass than on the third pass, population estimation for the reach between 6th Street and 8th Street was invalid using the removal method (Zippen 1958). Based on the first three removals only, the population estimate would have been 81 *O. mykiss* with an upper 95% confidence limit of 94 fish which is consistent with the electrofishing capture total below 8th Street of 86. However, another 42 *O. mykiss* were subsequently removed by seining and dip-net during the dewatering phase (see below). Apparently, there were a number of *O. mykiss* in the project area that were not susceptible to capture by electrofishing. This was likely a result of the large amount of cover including deep pools with deep undercut banks and overhanging vegetation. The population estimate for the reach upstream of 8th Street was 7 *O. mykiss* which was the number actually captured. The upper 95% confidence limit for *O. mykiss* in this reach was 8 fish.

July 22nd to 26th, 2010

Installation of the upstream coffer dam was complete around 9:00 am on July 22nd, with testing of dewatering pumps beginning at 8:00 am. The block nets were still in place, but the lower net needed to be reinforced due to accumulated debris. To facilitate fish capture in and around the 6th Street culvert, water was pumped out to reduce water levels. Just after 11:00 am, one *O. mykiss* was caught (fork length 198 mm) in the pool upstream of the 6th Street culvert.

Dewatering continued to be sluggish due to suspected groundwater and bank saturation. Two passes with dip-nets were made through the 6th Street culvert and within the pool upstream of the culvert, capturing thirty-four threespine stickleback. No further *O. mykiss* were captured on this day, but at least two large *O. mykiss* individuals were seen in pools. By the end of work day all three major pools were still full, water conditions were turbid due to bankside work and crew moving in the channel with pumps.

By the morning of the 23rd it was clear that pumping would have to be accelerated to achieve dewatering. The channel had refilled overnight to pre-pumping levels. On the first morning creek walk no *O. mykiss* were detected during visual surveys. The downstream block net again needed to be cleared of debris and crew began sandbagging to create a stronger downstream coffer dam, while addressing pumping issues at the upstream dam. Debris was cleared several times this day at the lower block net. Several pumping strategies were attempted.

Between 7:00 am and 12:00 pm approximately 453 threespine sticklebacks had been dip-netted between 6th Street and 8th Street. No *O. mykiss* were caught due to continuing high water levels in pools and existing cover. By midday, dewatering in the 6th Street culvert and the pool just upstream had improved. Eight *O. mykiss* (fork lengths ranging from 86mm to 300mm) were dip-netted in the culvert at the remaining large pool on the extreme downstream end. Fish were at surface breathing, due to turbid conditions and suspected low dissolved oxygen. The trout appeared healthy and were released into clear water downstream.

Multiple seine hauls were completed through the pool upstream of the 6th Street culvert resulting in the capture of 13 *O. mykiss*. The *O. mykiss* were relocated to pools downstream of 5th Street. The 6th Street culvert was also seined resulting in the capture of one *O. mykiss* (fork length 86mm).

The site was closed for the weekend of the 24th and 25th July. On Monday morning, the crews recommenced dewatering with renewed vigor. The pools had again refilled. Water levels dropped slowly as additional pipes and pumps were put in place to facilitate drainage of the deeper pools. Water was noted streaming from the saturated banks at various points between 6th and 8th Streets. This along with turbid waters resulting from crew working in and around the channel continued to make fish removal challenging.

On Monday the 26th, several seine hauls were completed in the major pools upstream of 6th Street. Water levels were finally pumped down sufficiently to verify that few if any *O. mykiss* remained in the project area. A total of nineteen *O. mykiss* were netted out of pools as water levels dropped and were taken to pools near 5th Street. Fish removals were concluded at 3:00 pm.

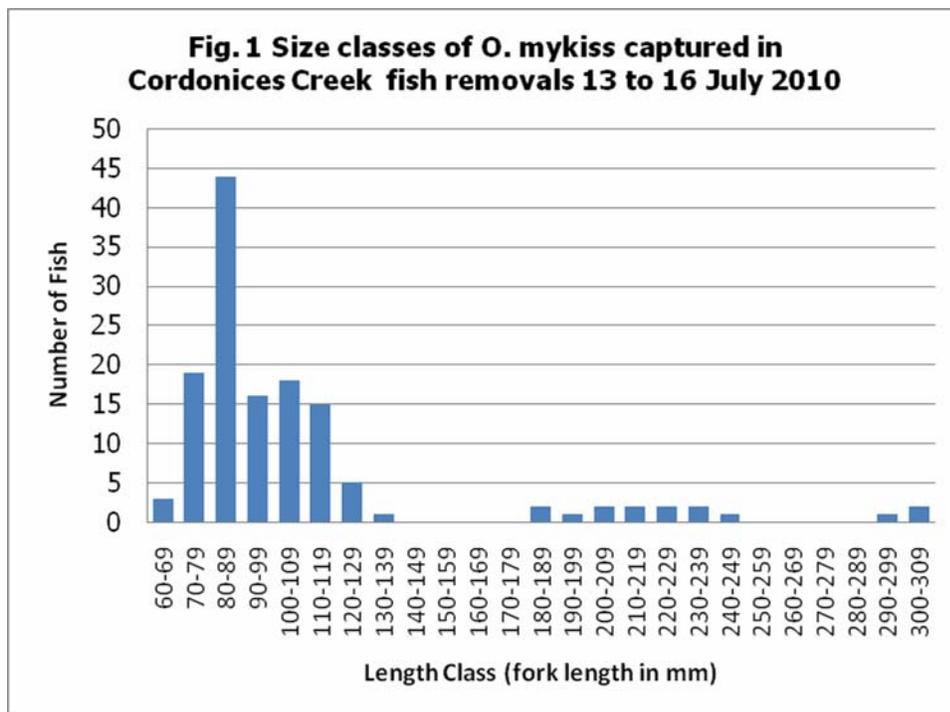
Table 2. Fish removed from Codornices Creek downstream of 6th Street to 8th Street culvert July 13th to 26th, 2010

Date	Location, method	Steelhead/ rainbow trout, (<i>O. mykiss</i>)	Threespine stickleback (<i>G. aculeatus</i>)
13 July	6 th Street to 8 th Street, Efish Pass 1	43	63
14 July	6 th Street to 8 th Street, Efish Pass 2	18	86
	6 th Street to 8 th Street, Efish Pass 3	11	93
15 July	6 th Street to 8 th Street, Efish Pass 4	14	94
	Upstream of 8 th Street, Efish Pass A	6	5
	Upstream of 8 th Street, Efish Pass B	2	2
22 July	Pool Upstream of 6 th Street culvert, dip-net	1	34
23 July	Downstream of 6 th Street Culvert, dip-net	0	159
	Pool Upstream of 6 th Street Culvert, dip-net	0	79
	Pool Upstream of 6 th Street Culvert, seine net	13	166
	6 th Street Culvert, dip-net	8	
	6 th Street Culvert, seine net	1	41
	6 th Street to 8 th Street various, dip-net	0	216
26 July	Pool Upstream of 6 th Street Culvert/concrete weir, seine net	6	~200
	3 pools between 6 th Street to 8 th Street, seine	1	>50
	Tail of pool just downstream of 8 th Street concrete run, dip-net	1	
	2 nd pool upstream of 6 th Street, seine	8	>50
	Pool under pampas grass, 3 rd pool upstream, dip-net	3	>10
	Pool below school house windmill, seine	0	>50
	Total fish removed	136	~1450

A total of 136 *O. mykiss* were captured by electrofishing and netting in the project area. These fish ranged in size from 66mm (over 2.5 inches) to 305mm (over 12 inches) fork length. Several crayfish of at least two species and dragon fly nymphs were also captured during the fish relocations. There was one *O. mykiss* mortality accounting for less than 1% of the *O. mykiss* captured. The number of trout potentially remaining after removals from the project area could

not be determined based on depletion electrofishing, however, based on visual observations during the final dewatering, it is likely that few if any trout remained.

The size range of *O. mykiss* captured was similar to those captured during removals downstream during Phase II in 2006, but the distribution among size classes was somewhat different. Additionally, the overall numbers caught, in this year's larger project area, are greater with 136 trout captured. In 2004, the majority of trout were in the 150mm to 250mm size range (HES 2005) while in 2006, the majority were less than 160mm. In 2010, the majority of fish are in the 70 to 100mm size classes (Figure 1). The smaller trout, 90mm fork length and less, could be extremely fast growing young-of-year, possibly from spawning early in the season (January or February), or "1+" year-old fish from the previous season. Most of these fish appeared to have high condition factors (high weight to length proportions) and to be well fed. The section of Codornices Creek between 6th and 8th Streets has significant areas lacking tree cover and thus allowing lots of sunlight to reach the stream, making it very productive. This portion of Codornices Creek is relatively cool due to its proximity to San Francisco Bay and lack of full tree cover does not necessarily imply intolerably high stream temperature. Sunlight stimulates growth of aquatic plants and invertebrates and *O. mykiss* grow best at temperatures near their upper tolerance levels as long as abundant food is available. The population size structure in 2010 is consistent with Central California steelhead populations where the transformation from parr to smolt typically occurs after two seasons of rearing at a size of about 150mm (6 inches) and few fish larger than 150mm are found. The larger trout would have remained in the stream past the typical stage of parr to smolt transformation and are likely following a resident or non-migratory life-history strategy.



Most of the trout were in good condition and showed no external signs of disease or parasites. A few trout and several threespine stickleback had indication of black spot disease (BSD). Black spot disease is indicated by external dark spots attributed to the resting stage of trematodes

that encyst under the scales of fish and occurs in trout populations in the Bay Area and elsewhere where warmer water temperatures occur (the trematode requires temperatures above 18°C to complete its life history).

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