Annual Project Performance Report

1. State: California

Grant number: F-137-R

Grant name: California Inland and Anadromous Sport Fish Management and Research

Project number and name: Project 67: Humboldt Bay Juvenile Salmonid Investigations

2. Report Period: July 1, 2010 through June 30, 2011
Report due date: September 30, 2011
Date prepared: August-September 2011

3. Location of work: Humboldt Bay, Humboldt County California, State Congressional District 1

4. Objectives:

1. To monitor the effects of marsh restoration projects in Wood and Salmon Creeks on juvenile salmonid use and basic water quality conditions, specifically in the newly created off channel ponds (contingent on successful grant application to FRGP).
2. Better describe use of entire Freshwater Creek stream-estuary ecotone by monitoring juvenile salmonid entry timing, movement, and use of Freshwater Creek Slough, Wood Creek, and Ryan Creek/Slough (contingent on successful grant application to FRGP).
3. To describe the use of the tidal portion of smaller Humboldt Bay tributaries such as Martin Slough, Jacoby Creek/Gannon Slough, and Rocky Gulch by juvenile salmonids.

5. Part of Larger Project: This work is being augmented by California Fisheries Restoration Grant Program to pay for Pacific States Marine Fisheries Commission fishery technicians to conduct the field sampling and a small portion of O&E. Aid in Sport Fish Restoration funds are being used to pay for project biologist, O&E, and a small portion of temporary help for project field work.

This project is also collecting juvenile salmonid emigration timing and relative abundance data to document existing conditions prior to marsh restoration projects already ongoing or planned in the tidal portion of Freshwater Creek Slough, Ryan Creek, Wood Creek, and Salmon Creek estuary by other government agencies and private and non-profit groups. This project concluded work in the tidal portions of Jacoby Creek, Gannon Slough, Rocky Gulch, and Martin Slough.

6. Describe how the objectives were met:

Introduction

Estuaries are important habitat for juvenile salmonids and other popular sport fish species. Numerous studies have documented extended estuarine residence by juvenile Chinook salmon (Reimers 1971; Healey 1982; Kjelson et al.1982; Healey 1991), coho salmon (Koski 2009; Wallace and Allen 2009; Miller and Sadro 2003; Nielsen 1994; Tschaplinski 1982), steelhead trout (Bond 2006), and sea-run coastal cutthroat trout (Trotter 1997; Northcote 1997). For

salmonids other than coho salmon, faster growth in the estuary and larger size at ocean entrance has been shown to account for higher marine survival (Northcote 1997; Pearcy 1997; Trotter 1997). These survival benefits to coho salmon have largely been inferred from these studies, but coho salmon have substantially different life histories and estuary use patterns. Relatively few studies have identified the importance of the greater transition zone, or ecotone (Odum 1971), between fresh and brackish water to juvenile salmonids (Koski 2009; Wallace and Allen 2009; Wallace and Allen 2007; Miller and Sadro 2003; Tschaplinski 1982). Miller and Sadro (2003) defined this stream-estuary ecotone, and we adapt their definitions, to include the area of low gradient stream extending from stream entrance to the wide valley floor, through the upper limit of tidal influence downstream to the area where the channel becomes bordered by tidal mudflats. This definition of the ecotone includes all side channels, off channel ponds, tidal channels, and fringing marsh habitats that are accessible to fish for at least some portion of the tidal cycle.

Recent studies conducted by CA Dept. of Fish and Game (CDFG) Natural Stocks Assessment Project (NSA) in the tidal portions of Humboldt Bay tributaries have shown that juvenile salmonids heavily utilize stream-estuary ecotone habitat and routinely rear there for months (CDFG 2010; CDFG 2009; Wallace and Allen 2009; Wallace and Allen 2007). CDFG's Anadromous Fisheries Research and Monitoring Program (AFRAMP) and NSA projects estimated that about 40% of coho salmon smolts and 80 to 90% of large steelhead smolts originated from the stream-estuary ecotone of Freshwater Creek in 2007 and 2008 (Ricker and Anderson 2011). These studies also showed that juvenile salmonids using this habitat grew faster, obtained a larger size, and likely experienced increased marine survival over juvenile salmonids rearing in stream habitat (Ricker and Anderson 2011; Wallace and Allen 2009; Wallace and Allen 2007; CDFG 2007; Wallace 2006; CDFG 2006; CDFG unpublished data).

California salmonid populations have declined considerably from historic levels (Brown et al. 1994, Weitkamp et al. 1995; Busby et al. 1996; Myers et al. 1998; CDFG 2002). Humboldt Bay tributaries support some of the last significant populations of wild coho salmon remaining in California (Brown et al. 1994), as well as Chinook salmon, steelhead trout, and coastal cutthroat trout. Humboldt Bay tributary populations of coho salmon, Chinook salmon, and steelhead trout have been listed as threatened by NOAA Fisheries and coho salmon have been listed as threatened by the State of California. NOAA considers Humboldt Bay tributaries a core population within the southern coastal basin diversity strata of the SONCC and coho populations will need to meet recovery thresholds before they will be considered for de-listing.

The majority of tidal wetlands around Humboldt Bay have been diked and converted to pasture land during the past 150 years (HBWAC 2005). Most, if not all, Humboldt Bay sloughs are now contained between levees and their adjacent marshes converted to pasture land which isolates them from the productive adjacent marshland, and the connectivity between watersheds that these marshes historically provided has been lost. Currently, historic pieces of marshland habitat around Humboldt Bay are being acquired by various public agencies with an eye towards habitat restoration, and willing private landowners are partnering with local land trusts and other non-profit groups to restore wetlands. The result is that numerous estuarine restoration projects are being planned and implemented in Humboldt Bay tributaries and sloughs. However, at present, there are no written criteria to assess estuarine habitat suitability for juvenile coho salmon making it difficult for estuarine habitat restoration projects to target specific habitat goals.

Salmonid recovery plans encouraged numerous estuary and marsh habitat restoration projects around Humboldt Bay and the Eel River estuary (HBWAC 2005; CDFG 2004). Implementation of habitat restoration projects on Wood and Salmon Creeks have already begun. Both projects have been at least partially funded by the State of California's Fisheries Restoration Grant Program (FRGP). Restoring estuarine habitat in these areas will likely benefit coho salmon and steelhead trout as well as juvenile Chinook salmon, coastal cutthroat trout, and other estuarine

fishes. However, very little project evaluation has taken place in estuary restoration projects to determine how they benefit salmonids or to measure the response of water quality and juvenile salmonids to specific restoration techniques. Additional years of monitoring are needed to determine if coho salmon populations in these watersheds will respond to these projects. By 2013 adult coho from cohorts rearing in the restored habitat in Wood Creek should be returning to Freshwater Creek and depending on the start of project implementation maybe to Salmon Creek as well. Ongoing AFRAMP monitoring will determine if adult populations increase in Freshwater Creek, and planned CMP redd surveys may also be able to detect salmonid population response in Salmon Creek. By using PIT tags and PIT tag antennas we can confirm our initial findings that juveniles rearing in the newly restored stream-estuary ecotone habitat have higher marine survival than those rearing in stream habitat.

NSA, by describing life history traits and habitat needs of juvenile salmonids in the stream-estuary ecotone of Humboldt Bay, has already played an important role by providing needed data to help in the design local estuarine habitat restoration projects. However, few if any of these projects have measured the response of salmonid use or water quality to their restoration measures. Specifically, ongoing restoration projects in Wood Creek and Salmon Creek, Humboldt Bay, CA have proposed to improve habitat by in part, constructing off channel ponds to increase the number, size, and survival of juvenile salmonids, especially during the winter months. Therefore in addition to the Aid in Sport Fish Restoration funding received by NSA, Pacific States Marine Fisheries Commission in cooperation with NSA has received a grant from FRGP to monitor the effects of marsh restoration projects in Wood and Salmon Creeks on juvenile salmonid use and basic water quality conditions, specifically in the newly created off channel ponds. We will submit our findings and recommendations to resource managers and the restoration community to assist in their planning, prioritization, and implementation of future estuary restoration projects.

During the duration of this contract period (2009-20011) NSA continued to sample the tidal portion of upper Freshwater Creek Slough, Wood Creek, and Salmon Creek estuary to document their use by juvenile salmonids. NSA completed sampling in lower Freshwater Creek Slough, Elk River Slough, Hookton Slough, Jacoby Creek/Gannon Slough, Martin Slough, and Rocky Gulch. NSA initiated sampling in Ryan Creek Slough to determine how juvenile salmonids use the Freshwater-Ryan stream-estuary ecotone as a rearing area. Finally, NSA installed PIT tag antennas in Wood Creek to assess the performance of a newly constructed off channel pond as over winter habitat for juvenile coho salmon. By describing life history traits and habitat needs of juvenile coho salmon, Chinook salmon, steelhead trout, and sea-run coastal cutthroat trout and by assessing the performance of newly constructed off channel ponds this project hopes to provide important data to the restoration community to help restoration planning projects succeed. This project will provide “snapshots” of juvenile salmonid use of these areas before and after restoration projects.

Methods

When stream and weather conditions allowed NSA conducted bi-weekly sampling for juvenile salmonids in Freshwater Creek Slough and Salmon Creek (Figure 1). NSA used a 30 ft X 4 ft seine net to capture fish in Freshwater Creek and Salmon Creek Sloughs. NSA also continued monthly sampling in numerous smaller Humboldt Bay tributaries started in 2006 and 2007. We used a 100 ft X 5 ft seine net to capture fish in Martin Slough pond; a 30 ft X 4 ft seine to capture fish in sections of Jacoby Creek/Gannon Slough, Martin Slough and Rocky Gulch; and minnow traps baited with frozen salmon roe in sections of Gannon Slough, Martin Slough, Rocky Gulch, and Wood Creek where we were unable to seine (Figure 1). In December 2009 NSA initiated sampling in Cattail Creek and Long Pond on the USFWS Humboldt Bay Refuge property to assess pre-project conditions prior to habitat restoration work on Salmon Creek estuary. In the winter of 2010 NSA installed two passive integrated transponder (PIT) tag antenna arrays in Wood Creek; one in a newly constructed off channel pond and one at the

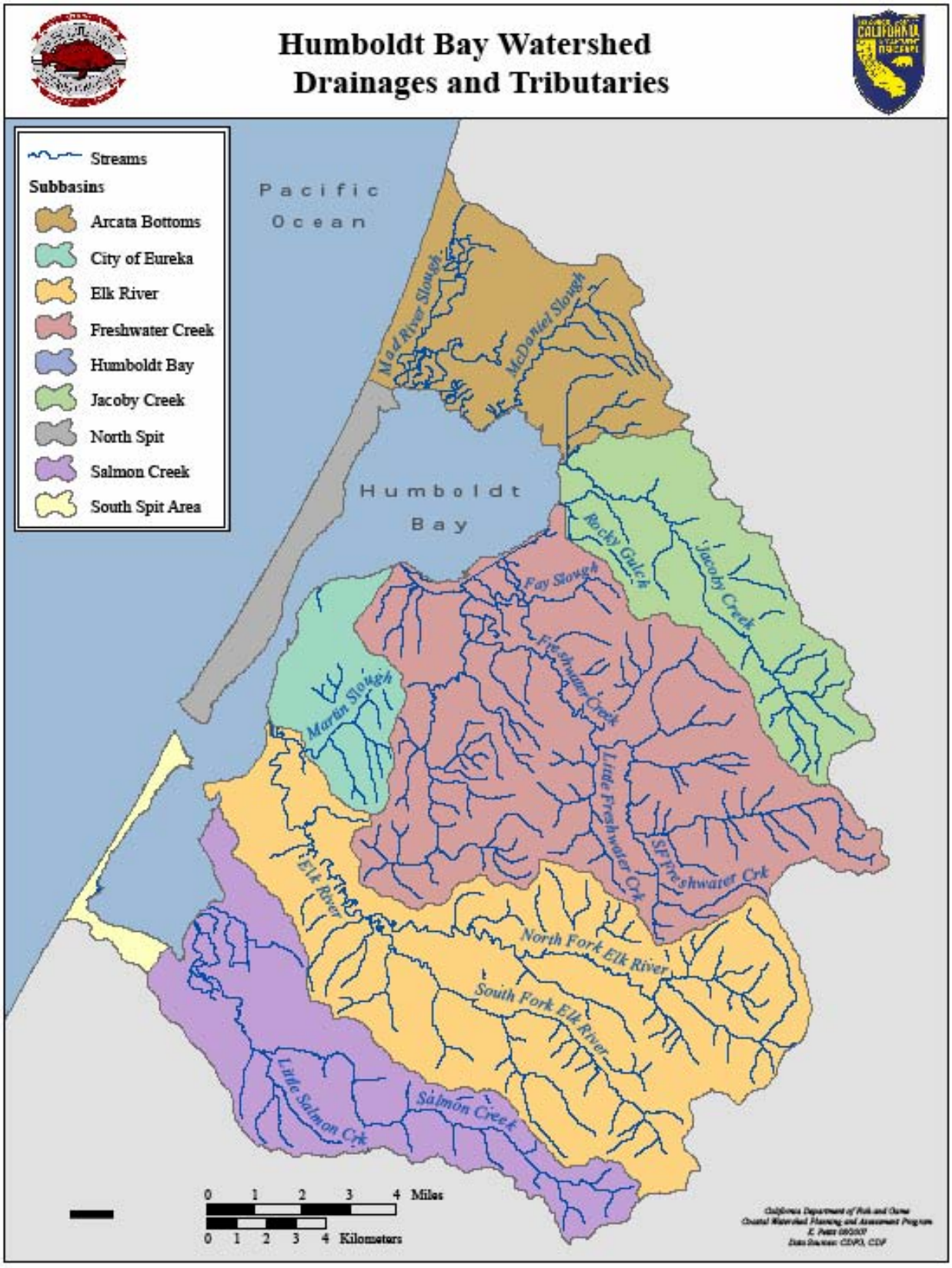

Figure 1. Map of Humboldt Bay tributaries.

mouth of the creek. PIT tag detections were automatically stored on a data logger and NSA crew members downloaded this data every one to two weeks. This data was copied into Excel spreadsheets for future analysis back at the office. In the spring of 2011 NSA also assisted AFRAMP with the operation of a juvenile fish weir set up at the Humboldt Fish Action Council (HFAC) weir site in upper Freshwater Creek Slough to capture juvenile salmonid smolts emigrating from Freshwater Creek. This weir was supposed to be run in conjunction with another AFRAMP weir located about 3 km upstream in order to generate coho salmon and steelhead smolt production estimates passing each weir. Unfortunately a series of fiscal constraints conspired to make it impossible to run the upstream weir. NSA applied PIT tags to all healthy juvenile salmonids ≥55 mm FL to gather residency, movement, and growth information while they were in the stream-estuary ecotone.

Results

Freshwater Creek Slough

Freshwater Creek Slough 2010 and 2011

Our June catches of yoy coho in 2010 were very low compared to past years (Table 1), but unlike 2008, we did see a modest increase of yoy coho later in the summer. NSA captured yoy coho salmon from June to October and their peak monthly catch of 1.35 fish/set occurred in August (Table 2). Their monthly mean FL increased from 66 to 101 mm from June to October (Table 2). High stream flows during the spring greatly curtailed our sampling effort in Freshwater Creek Slough in 2010; therefore, we captured very few salmonids in upper Freshwater Creek Slough in 2010 prior to June (Table 2). In 2010 NSA captured yearling coho salmon from February to August and their peak monthly catch occurred in June at 1.00 fish/set (Table 2). Their peak monthly catch usually occurs in May. Their monthly mean FL increased from 97 mm in February to 115 mm in August (Table 2). NSA captured three yoy Chinook salmon in June with a mean FL of 77 mm (Table 2). NSA captured juvenile steelhead in January and then again from June to October (Table 2). Their peak monthly catch was 0.55 fish/set in August and their FL's ranged from 55 to 205 mm (Table 2). NSA captured cutthroat trout in August and September and their FL's ranged from 153 to 192 mm (Table 2).

Table 1. Effort, number captured, and catch-per-unit-effort of young-of-the-year coho salmon in upper Freshwater Creek Slough during June, 2003-2010.

Year	# Seine Hauls	# Caught	CPUE (fish/set)
2003	48	478	9.96
2004	60	335	5.58
2005	59	447	7.58
2006	48	161	3.35
2007	48	64	1.33
2008	44	4	0.09
2009	34	106	3.12
2010	10	2	0.20
2011	24	33	1.38

Table 2. Monthly catch-per-unit-effort (CPUE) and fork length (FL) in millimeters of young-of-the-year (yoy) Chinook salmon, yoy coho salmon, yearling and older coho salmon, juvenile steelhead trout, and cutthroat trout in upper Freshwater Creek Slough, January 2010-June 2011. CPUE is number of fish per seine haul.

		YOY Chinook			YOY Coho			Yearling Coho			Steelhead			Cutthroat		
	No.	Mean			Mean			Mean			Mean			Mean		
Month	Sets	CPUE	FL	Range	CPUE	FL	Range	CPUE	FL	Range	CPUE	FL	Range	CPUE	FL	Range
Jan	8	0	-	-	0	-	-	0	-	-	0.25	156	141-171	0	-	-
Feb	20	0	-	-	0	-	-	0.10	97	94-99	0	-	-	0	-	-
Mar	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apr	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
June	10	0.30	77	71-81	0.20	66	65-67	1.00	102	73-121	0.40	130	110-156	0	-	-
July	22	0	-	-	0.77	82	73-89	0.14	103	87-115	0.36	100	55-126	0	-	-
Aug	31	0	-	-	1.35	89	77-100	0.06	115	107-123	0.55	88	65-161	0.39	173	158-192
Sept	24	0	-	-	0.50	98	91-105	0	-	-	0.50	137	76-205	0.04	153	153
Oct	22	0	-	-	0.23	101	94-112	0	-	-	0.18	105	91-112	0	-	-
Nov	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dec	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan	24	0	-	-	-	-	-	-	-	-	0.08	176	151-200	0	-	-
Feb	12	0	-	-	-	-	-	0.17	109	106-111	0.17	145	128-161	0.08	183	183
Mar	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apr	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May	20	0.90	46	41-56	1.50	48	36-80	1.10	113	93-167	0.70	117	79-158	0.15	206	191-215
June	24	0.67	55	43-71	1.38	55	39-76	0.04	97	97	0.58	115	83-165	0	-	-

Table 3. Summary of residence times of young-of-the-year (yoy) coho salmon, yearling and older coho salmon, juvenile steelhead trout, and cutthroat trout based on Passive Integrated Transponder (PIT) tag data in Freshwater Creek Slough in 2009 and 2010. Mean days at liberty (DAL) were not calculated for fish species/life stage with sample sizes less than 10 individuals. Growth rates are millimeters per day and mean growth rates were calculated for fish at large $\geq$12 days except where noted.

Species	Number Tagged	Number Recaptured	Percent Recaptured	Mean DAL	Range DAL	Percent Recap at Same Site	Number With DAL >12 Days	Mean Growth Rate	Range Growth Rate
Yoy Coho	60	12	20.0	41	16-113	91.6	12	0.23	0.12-0.48
1+ Coho	14	0	-	-	-	-	-	-	-
Steelhead	31	7	22.6	-	14-124	100	7	-	0.24-0.50
Cutthroat	3	1	33.3	-	14	100	1	-	0.21

In 2011 a peak catch of 3.25 fish/set occurred in July which was the highest monthly CPUE of yoy coho since 2006 (Table 1). Yoy coho monthly mean FL increased from 48 mm in May to 55 mm in June and ranged from 36 to 80 mm (Table 2). The second consecutive year of high stream flows during the spring greatly curtailed our sampling effort in Freshwater Creek Slough in 2011; therefore, we captured very few salmonids in upper Freshwater Creek Slough in 2011 prior to May (Table 2). In 2011 NSA captured yearling coho salmon in February, May, and June. Their peak monthly catch occurred in May at 1.10 fish/set (Table 2). Their monthly mean FL was 109 mm in February and 113 mm in May and ranged from 93 to 167 mm (Table 2). NSA captured relatively large numbers of yoy Chinook salmon in 2011 (Table 2). Their mean FL increased from 46 mm in May to 55 mm in June and ranged from 41 to 71 mm (Table 2). NSA captured juvenile steelhead in January, February, May and June with a peak CPUE of 0.70 fish/set in May (Table 2). Their FL's ranged from 79 to 200 mm (Table 2). NSA captured cutthroat trout in February and May and their FL's ranged from 183 to 215 mm (Table 2).

PIT Tag Results for 2010- We captured far fewer coho salmon in 2010, especially yoy coho, so therefore tagged and recaptured fewer coho this year compared to past years. We applied PIT tags to 60 yoy coho in 2010 and recaptured 12 (20.0%) of them (Table 3). Their mean length of residence was 41 days and ranged from 16 to 113 days. Yoy coho mean length of residence was 60 days in 2009, 68 days in 2007 and 33 days in 2006 (CDFG 2010). The mean growth rate of recaptured yoy coho was 0.23 mm/day and ranged from 0.12 to 0.48 mm/day (Table 3). We applied PIT tags to 14 yearling coho in 2010 and recaptured none of them (Table 3). However, we did capture two yearling coho that were tagged by AFRAMP at the HFAC weir. One of these fish was recaptured in the pool just downstream of the weir and it was at large from 5/23 to 8/5/10 (74 days) and grew 22 mm (0.30 mm/day). We applied PIT tags to 31 juvenile steelhead in 2010 and recaptured seven (22.6%) of them (Table 3). They were at large for 14 to 124 days. All seven of the project marked steelhead were recaptured at the same site where they were marked. The growth rates of the seven recaptured juvenile steelhead at large for at least 12 days ranged from 0.24 to 0.50 mm/day. We also captured another four juvenile steelhead that were tagged by AFRAMP at the HFAC weir. They were at large for 76 to 147 days and during this time they grew 15 to 36 mm (0.10 to 0.40 mm/day). We applied PIT tags to three cutthroat trout in 2010 and recaptured one (33.3%) of them (Table 3). It was at large for 14 days and grew 0.21 mm/day (Table 4). We also captured one cutthroat trout that NSA tagged in 2009. It was at large from 7/14/09 until 8/17/10 (399 days). We did not measure its FL in 2010 so were unable to determine a growth rate for this fish. We also captured one cutthroat trout tagged by AFRAMP at the HFAC weir. It was at large from 5/8/10 until 9/28/10 (143 days) and during this time it grew 30 mm (0.21 mm/day). It is likely that some of the cutthroat trout captured by our project were resident adult fish.

We are still analyzing PIT tag information for 2011 and these results will be reported in our project's 2011/12 SFRA Annual Report.

Downstream Migrant Weir- Due to lack of funds AFRAMP and NSA were not able to construct and fish the downstream migrant trap at Howard Heights in the spring of 2011. However, NSA did assist AFRAMP in running the HFAC downstream migrant trap in order to PIT tag fish to determine their marine survival. Without operating both traps we were unable to estimate the portion of Freshwater Creek coho salmon and steelhead trout smolts originating from the stream estuary ecotone.

Martin Slough and Rocky Gulch

June 2010 was the last of our planned surveys for Martin Slough and Rocky Gulch. We are ending these surveys to devote more time and resources to evaluating the success of estuarine habitat restoration projects in Wood Creek and Salmon Creek. The information learned at these areas, especially the heavy use of pond habitat by juvenile coho in Martin Slough, is being incorporated into multiple estuarine restoration projects around Humboldt Bay. However, we did

not present 2010 PIT tag information for these locations in last year's annual report, so we report them here.

Martin Slough PIT Tag Results for 2010- We applied PIT tags to 253 yearling and older coho salmon and recaptured 17 (6.7%) of them. They were at large for an average of 50 days (range 27-119). We recaptured seven of the 17 (41%) coho at different sites from where we originally marked them. This is a much higher rate of movement compared to our observations of yoy coho in Freshwater Creek and Elk River Sloughs. We also captured one tagged coho that was originally tagged by NSA in upper Elk River Slough. This fish was marked in June 2009 and was at large 302 days and grew 43 mm (0.14 mm/day). The mean growth rate of the coho tagged and recaptured in Martin Slough was 0.41 mm/day (n=17; range 0.21 to 0.76 mm/day). Their weight increased on average 0.16 g/day (n=13; range 0.02 to 0.29 g/day), and we observed increases in their initial body weight ranging from 0.11 to 5.32% per day. We also captured two coho marked by NSA in Martin Slough in 2009. They were at large for 64 and 310 days and grew 16 (0.25 mm/day) and 66 mm (0.21 mm/day) respectively.

We did not apply PIT tags to any other fish. However, we did recapture one cutthroat trout that NSA tagged July 9, 2009. It was at large 341 days and was recaptured in the same location where we originally tagged it. The recaptured fish 186 mm FL when tagged and was about 12 inches long when recaptured (we did not measure the fish when recaptured).

Rocky Gulch PIT Tag Results for 2010- We applied PIT tags to 97 yearling coho salmon and recaptured 13 (13.4%) of them. The recaptured yearling coho were at large 28-94 (mean=43 days). They grew 4-42 mm and their mean growth rate was 0.33 mm/day (range 0.12 to 0.45 mm/day). One of the fish was recaptured at a different site than where we originally tagged it. We also recaptured one tagged juvenile coho in Rocky Gulch in March 2010 that NSA originally tagged in the Jacoby Creek estuary in December 2009. It was at large 90 days and grew 19 mm (0.21 mm/day). We also applied PIT tags to six cutthroat trout and did not recapture any of them. We did recapture one cutthroat trout in February 2010 that NSA marked in July 2009. It was at large 216 days and grew 32 mm (0.15 mm/day). We also applied a PIT tag to one juvenile steelhead and did not recapture it.

Wood Creek

Wood Creek 2010

Juvenile coho salmon were the most abundant salmonids captured in Wood Creek and they were most abundant in winter and spring (Table 4). We captured a total of 228 juvenile coho salmon in Wood Creek and in the newly constructed off channel pond (Table 5). Their monthly mean FL increased from 72-74 mm in January and February to 103-105 mm in April and May and individual fish ranged from 53-119 mm FL (Table 4). By June most over-winter rearing coho had left Wood Creek and a small number of yoy coho had moved in to take their place (Table 4). We also captured two cutthroat trout and their sizes ranged from 127-133 mm FL (Table 4).

Wood Creek 2011

Juvenile coho salmon were the most abundant salmonids captured in Wood Creek and they were most abundant in winter and spring (Table 4). We captured a total of 95 juvenile coho salmon in Wood Creek and in the newly constructed off channel pond (Table 5). Their monthly mean FL varied from 92 to 115 mm between January and March and individual fish ranged from 84-125 mm FL (Table 4). Yoy coho began to arrive in Wood Cr in April and by June most over-winter rearing coho had left Wood Creek (Table 4). We also captured one juvenile steelhead in January and two cutthroat trout in June (Table 4).

PIT Tag Antenna 2010- NSA installed a PIT tag antenna array at the mouth of the newly constructed off channel pond on January 29, 2010 and at the mouth of Wood Creek in the tide gate structure on February 22, 2010. We installed two antennas at each site in an attempt to

Table 4. Summary of the number of fish captured and fork length (FL) information of juvenile salmonids captured in Wood Creek January 2010-June 2011.

Wood Creek

Date	Coho Salmon			Steelhead/RT			Cutthroat Trout		
	No.	FL	Range	No.	FL	Range	No.	FL	Range
1-08-10	44	74	53-112	0	-	-	0	-	-
2-03-10	37	72	53-112	0	-	-	0	-	-
3-03-10	59	90	65-119	0	-	-	0	-	-
4-01-10	9	105	80-115	0	-	-	0	-	-
5-03-10	8	103	85-115	0	-	-	0	-	-
6-02-10	5*	78	62-108	0	-	-	0	-	-
7-01-10	2*	80	71-89	0	-	-	1	127	127
8-02-10	0	-	-	0	-	-	0	-	-
9-08-10	0	-	-	0	-	-	1	133	133
10-05-10	0	-	-	0	-	-	0	-	-
11-02-10	1*	87	87	0	-	-	0	-	-
12-01-10	4*	108	91-118	0	-	-	0	-	-
1-04-11	0	-	-	0	-	-	0	-	-
1-20-11	4	115	112-118	1	165	165	0	-	-
2-01-11	4	92	84-107	0	-	-	0	-	-
3-02-11	12	108	100-125	0	-	-	0	-	-
4-04-11	14*	80	39-121	0	-	-	0	-	-
5-02-11	15*	45	40-50	0	-	-	0	-	-
6-01-11	8*	53	49-59	0	-	-	2	129	126-131

* includes yoy coho

Table 5. Comparison of the number of juvenile coho salmon captured by site in Wood Creek, February 2007 to June 2011.

	Sample Sites							
Date	**1**	**2**	**3**	**4**	**5**	**6**	**Pond**	**Total**
Feb-Mar 07	1	3	27	16	15	22		84
May-Jun 07	6	1	7	2	3	10		29
Jul-Sep 07	0	4	7	0	-	6		17
Oct-Dec 07	1	0	1	7	1	7		17
Jan-Mar 08	0	5	5	15	44	56		125
Apr-Jun 08	4	4	4	9	5	24		50
Jul-Sep 08	0	0	0	1	0	0		1
Oct-Dec 08	0	0	0	2	0	3		5
Jan-Mar 09	1	2	5	1	11	26		46
Apr-Jun 09	5	0	0	3	2	12		22
Jul-Sep 09	0	0	0	0	0	4		4
Oct-Dec 09	0	0	0	0	1	3		4
Jan-Mar 10	0	6	8	10	45	28	102	199
Apr-Jun 10	0	1	3	2	4	10	2	22
Jul-Sep 10	0	0	0	0	0	2	0	2
Oct-Dec 10	0	0	0	0	0	5	0	5
Jan-Mar 11	0	0	0	0	4	16	12	32
Apr-Jun 11	0	5	0	0	2	9	47	63
Total	**18**	**31**	**67**	**68**	**137**	**243**	**163**	**727**

discern directional movement in and out of the pond and creek. However, due to the voluminous amount of data recorded I will only present a general summary for this report. Also, since the fish were detected remotely by the antenna array we never actually handled and measured the fish. We tagged and released 93 coho salmon in the newly constructed pond in 2010 and eventually detected 80 (86%) of these coho at either or both of the antennas (74 at pond; 34 at tide gate; 28 at both). We tagged and released 102 coho salmon into the mainstem Wood Creek and eventually detected 60 (59%) of these coho at either or both of the antennas (27 at pond; 49 at tide gate; 16 at both). The pond antenna eventually detected 80% of the pond tagged coho and 26% of the creek tagged coho. The tide gate antenna eventually detected 37% of the tagged pond fish and 48% of the tagged creek fish. Detection rates were almost certainly lower at the tide gate antenna than the pond antenna due to the larger area of the tide gate antennas and the more frequent occurrence of brackish water at the tide gate. NSA tests showed that water salinity as low as 3 to 5 ppt drastically reduced the read range of our PIT tag antennas.

Between late January and the end of June 2010 we detected 153 coho salmon, one steelhead, and two cutthroat trout at the Pond antenna. Individual coho were first detected on 1/29/10 and last detected on 6/15/10, though most had left the pond by the end of April. Most fish were last detected in March suggesting that March was the time of peak emigration of coho out of the pond. Of the 153 coho detected in the pond, 74 were tagged and released into the pond by NSA, 27 were NSA tagged fish from Wood Creek, 46 were tagged upstream in Freshwater Creek basin during the fall of 2009 by AFRAMP, five were from Freshwater Creek Slough tagged by NSA in the summer and fall of 2009, and one was tagged at the HFAC weir site in 2009 (Table 6). One hundred twenty two of the fish were detected in the pond on more than one day. These 122 fish had an average time between first and last detection (a surrogate for residence time) of 23 days (range 1-87 days).

The one steelhead detected in the pond occurred on May 16, 2010. This fish was tagged by AFRAMP and NSA at the HFAC weir site on May 9, 2010. The two cutthroat trout detected in the pond were also both marked at the HFAC weir in 2010. One fish was tagged on April 18 and then detected at the tide gate on April 18 and in the pond on April 19. The other fish was tagged on March 29 and then detected at the tide gate on April 1 and in the pond on April 6.

On February 22, 2010 NSA installed a PIT tag antenna array at the mouth of Wood Creek in the tidegate structure. Between then and the end of September we detected 331 coho salmon, 31 juvenile steelhead, and 58 cutthroat trout at the tidegate antenna. Individual coho were first detected on 2/22/10 and last detected on 7/6/10, though most (>80%) were detected by the end of May. Most coho were last detected in May suggesting that was the time of peak emigration of coho out of Freshwater Creek. Of the 331 coho detected at the tide gate, 33 were tagged by NSA and released into the newly constructed off channel pond and 47 were tagged by NSA and released into Wood Creek in 2010 (Table 6). The remaining coho were comprised of one fish tagged by NSA and released into Wood Creek in 2009, 161 fish tagged by AFRAMP and NSA at the HFAC weir site in 2010, one fish tagged by AFRAMP and NSA at the HFAC weir site in 2009, 51 tagged by AFRAMP upstream in Freshwater Creek basin during the fall of 2009, four fish tagged by NSA in Ryan Slough in the winter of 2010, 22 fish tagged by Green Diamond Resources biologists in Ryan Creek in 2010, nine fish tagged by NSA in Freshwater Creek Slough the summer and fall of 2009, and two tagged by NSA in Freshwater Creek Slough in 2010 (Table 6). One hundred eight of the 331 coho were detected at the tide gate on more than one day. These 108 fish had an average time between first and last detection (a surrogate for residence time) of 11 days (range 1-67 days). The average residence time in Wood Creek for coho tagged in the winter of 2009 through the spring of 2010 (from day of tagging and final detection at either antenna) was 40 days (range 0 to 137 days). We also detected one coho salmon marked in Wood Creek by NSA in the summer of 2009 that was at large 373 days.

Table 6. Origin of PIT tagged juvenile coho salmon tagged in Freshwater Creek basin detected at Wood Creek pond and tidegate antennas during January to September 2010 vs. October 2010 to June 2011.

Fish Origin	Pond 2010	Pond 2010/11	Tide Gate 2010	Tide Gate 2010/11
Stream-Estuary Ecotone	7	1	9	30
Lower Mainstem	11	6	11	49
Middle Mainstem		11		79
Upper Mainstem	7	6	10	59
Little Freshwater Cr	12		13	
Cloney Gulch	9	4	8	45
South Fork Freshwater Cr		0		13
Freshwater Creek (total)	**46**	**28**	**51**	**275**
Wood Cr Pond	74	8	33	3
Wood Cr (tagged 2011)	-	6	-	17
Wood Cr (tagged 2010)	26	3	47	5
Wood Cr (tagged 2009)	1	-	1	-
Ryan Sl/Cr	0	0	26	1*
Freshwater Sl (tagged 2011)	-	0	-	2
Freshwater Sl (tagged 2010)	0	0	2	8
Freshwater Sl (tagged 2009)	5	-	9	-
HFAC Weir (tagged 2011)	-	*	-	*
HFAC Weir (tagged 2010)	0	0	161	1
HFAC Weir (tagged 2009)	1	-	1	-
Grand Total	**153**	**45**	**331**	**312**

* We still have 199 unidentified PIT tags collected during 2010/11. We anticipate many of the tags will be comprised of coho tagged at HFAC Weir and in Ryan Creek during the spring of 2011.

NSA detected 161 coho salmon at the tide gate antenna originally tagged at the HFAC weir in 2010. These fish had a mean residence time of 12 days (range 0 to 64 days) between the HFAC weir and Wood Creek. Residence was calculated as the number of days between day of tagging and the last day of detection at Wood Creek. Fifty (31%) of these fish were at large at least 14 days and 32 (20%) were at large at least 21 days. This shows that a significant portion of emigrating coho were rearing in the stream-estuary ecotone of Freshwater Creek Slough between HFAC weir and the mouth of Wood Creek, even though most of this section of Freshwater Creek Slough is contained between levees and the habitat heavily degraded.

The 31 steelhead detected at the tide gate antenna were first detected on March 2, 2010 and last detected on July 28, 2010. March and July were the months with the highest number of steelhead detections. Of the 31 steelhead detected at the tide gate all but one was tagged at the HFAC weir site. Seven of the steelhead tagged at the HFAC weir were tagged in 2009 and 23 were tagged their in 2010. The mean residence time for 2010 tagged steelhead between tagging and final detection at the tide gate was 44 days (range 1-95 days). The residence times of the seven steelhead tagged in 2009 ranged from 323 to 378 days. The remaining steelhead was tagged in the lower mainstem of Freshwater Creek by AFRAMP in 2008. Its residence time between tagging and final detection was 682 days.

The 58 cutthroat trout detected at the tide gate antenna were first detected on February 26, 2010 and last detected on July 29, 2010. May was the month with the highest number (23) of cutthroat trout detections. Of the 58 cutthroat detected at the tide gate 40 were tagged at the HFAC weir site in 2010, 13 at the HFAC weir site in 2009, three in Ryan Creek Slough by NSA (two in 2009 and one in 2010), one by NSA in Wood Creek in 2009, and one in the lower mainstem Freshwater Creek by AFRAMP in 2007. The mean residence time for HFAC 2010

tagged cutthroat trout between tagging and final detection at the tide gate was 28 days (n=40; range 1-100 days). The mean residence time of the 13 cutthroat trout tagged in 2009 was 385 days and ranged from 336 to 448 days. The cutthroat trout originally tagged in Ryan Creek Slough in 2009 were at large 245 to 249 days, and the one tagged in 2010 was at large 45 days. The cutthroat trout tagged in Wood Creek in 2009 was at large 348 days and the cutthroat trout tagged in the lower mainstem Freshwater Creek was at large 1,027 days.

PIT Tag Antenna 2011- Between October 2010 and June 2011 NSA detected 45 coho salmon, two steelhead, and one cutthroat trout at the pond antenna. Individual coho were first detected on 12/3/10 and last detected on 6/1/11, though most had left the pond by the end of April. Of the 45 coho detected in the pond, eight were tagged and released into the pond, nine were NSA tagged fish from Wood Creek (six tagged in 2011 and three tagged in 2010), and 28 were tagged upstream in Freshwater Creek basin by AFRAMP during the fall of 2010 (Table 6). Twenty seven of the fish were detected in the pond on more than one day. These 27 fish had an average time between first and last detection (a surrogate for residence time) of 36 days (range 1-121 days).

The two steelhead detected in the pond both were first detected on November 7, 2010 and last detected on December 5, 2010 (28 days). They were also both detected at the tidegate antenna at the mouth of Wood Creek entering and leaving Wood Creek. One entered Wood Creek on 10/26/10 and left 3/13/11 (138 days) and the other entered 10/25/10 and left 3/14/11 (140 days). The first fish was tagged by NSA in Freshwater Creek Slough on 8/31/10 and the second fish was tagged by AFRAMP and NSA at the HFAC weir site on May 5/8/10 which strongly suggests that these steelhead were rearing in the stream-estuary ecotone for many months. The cutthroat trout detected in the pond was detected on 3/24&25/11 and then detected at the tidegate antenna on 3/28/11. It was originally tagged by NSA in Wood Creek on 7/1/10 suggesting it resided in the tidal portion of Wood Creek for almost nine months. Between October 25, 2010 and July 19, 2011 at the tidegate antenna we detected 312 coho salmon, 13 juvenile steelhead, one adult steelhead, 17 cutthroat trout, and 199 PIT tags waiting to be identified (most of the unidentified tags will likely be from fish marked at the HFAC weir site in 2011). Individual coho were first detected on 10/25/10 and last detected on 7/2/11. Most coho were first detected in November (33%) and December (22%) 2010 and another 22% were first detected in May illustrating that a large redistribution of juvenile coho occurs in the fall after the first rains followed by the traditional spring out migration peaking in May. Most fish were last detected in May (28%) and December (23%) lending additional evidence that late fall and spring were the times of peak movement/emigration of coho out of Freshwater Creek. Of the 312 coho detected at the tide gate, 275 (88%) were tagged by AFRAMP upstream in Freshwater Creek basin during the fall of 2010 (Table 6). Of the 275 coho from Freshwater Creek, 79 were from the middle mainstem, 59 were from the upper mainstem, 49 were from the lower mainstem, 45 were from Cloney Gulch, 30 were from the stream-estuary ecotone, and 13 were from the south fork (Table 6). The remaining coho were comprised of three fish tagged by NSA and released into the newly constructed off channel pond at Wood Creek in 2011, 17 tagged by NSA and released into Wood Creek in 2011, five tagged by NSA and released into Wood Creek in 2010, one tagged by AFRAMP and NSA at the HFAC weir site in 2010, one tagged by NSA in Ryan Slough in 2011, two tagged by NSA in Freshwater Creek Slough in 2011, and eight tagged by NSA in Freshwater Creek Slough the summer and fall of 2010 (Table 6).

One hundred fifty seven of the 312 (50%) coho were detected at the tide gate on more than one day. To estimate estuarine residence time for coho tagged and released by AFRAMP in Freshwater Creek I used the time between first and last detection at the PIT tag antennas (a surrogate for residence time) and for coho tagged and released in the stream-estuary ecotone I used the time between tagging date and last detection at the antenna. These 157 fish had a mean length of estuarine residence of 86 days (range 1-370 days). The mean estuarine residence time for coho tagged in Wood Creek, Freshwater Slough, or Ryan Slough (the

stream-estuary ecotone) in the summer of 2010 through the spring of 2011 (from day of tagging and final detection at either antenna) was 126 days (n=32; range 1 to 370 days).

During the entire year we also captured threespine stickleback, prickly sculpin, and Pacific staghorn sculpin.

Wood Creek Habitat Restoration Evaluation

The Northcoast Regional Land Trust (NCRLT) and Redwood Community Action Agency conducted an estuarine habitat restoration project in Wood Creek to increase the tidal prism, increase estuarine function and habitat, and provide over-winter off channel habitat for juvenile coho salmon. The main components of this project were to 1) remove a tidegate flap at the mouth of Wood Creek; 2) replace a road crossing and undersize culvert in Wood Creek; 3) construct an off channel pond; 4) construct tidal channels; 5) move cattle grazing farther from the stream and install cattle exclusion fencing; and, 6) conduct extensive planting of native estuarine plants (NCRLT 2011).

NSA's goal was to assess the performance of estuarine restoration techniques designed to improve juvenile salmonid habitat. NSA tried to determine if 1) water quality in Wood Creek changed after project construction; 2) if juvenile salmonid rearing patterns and distribution changed after project construction, and 3) if juvenile salmonids used the new off channel pond. NSA conducted monthly pre and post project monitoring of juvenile salmon use of Wood Creek and measured water temperature, salinity, and dissolved oxygen before and after the project (Wallace 2010).

NSA established six standard water quality and fish sampling sites along Wood Creek within the project area for pre and post project sampling. Pre-project we measured water quality parameters monthly with a YSI 85 hand held water quality meter and post project we measured water quality twice a month. We assessed the use of the Wood Creek project area by juvenile salmonids by sampling the same six sites with baited minnow traps on a monthly basis and CDFG and Green Diamond Resources biologists applied PIT tags to all healthy untagged juvenile salmonids $\geq$ 55 mm FL throughout the Freshwater Creek basin. After project construction NSA established additional fish and water quality sampling sites in the newly created off channel pond and water quality sampling sites at the upstream end of the newly constructed tidal channels. NSA also installed PIT tag antenna arrays in the tidegate structure at the mouth of Wood Creek and in the newly constructed off channel pond. PIT tagged fish were detected by the antennas and their presence was automatically recorded on a data logger.

Water Quality- NSA found that brackish water became more prevalent in Wood Creek after the tide gate flap was removed and the old road crossing was replaced with a bridge (Table 7). Increased tidal range and flow velocity was evident throughout Wood Creek and the newly constructed tidal channels once the flap gate was removed. The old road crossing and undersized culvert apparently acted as a salt water sill preventing brackish water from moving upstream of Site 4 (Table 7). NSA detected brackish water for the first time in the bottom of a culvert pool at Site 6 after the restoration project was completed confirming that removing the flap gate increased tidal prism in Wood Creek (Table 7). The newly constructed pond also contained brackish water (Table 7) until high winter stream flows flushed the salt water from the pond. The pond remained fresh water during the winter and spring until low stream flows allowed saltwater to once again reach the pond in June 2010. It is likely that the pond will remain brackish and water temperatures too high for salmonids throughout the summer and fall until high stream flows once again flush the salt water from the system. Water salinity was more variable in the tidal channels and Wood Creek downstream of the pond throughout the winter and spring and varied with stream flow and tidal stage. Overall, dissolved oxygen and water temperatures varied little between pre and post project measurements (Wallace 2010).

Table 7. Typical differences in water temperature, salinity, and dissolved oxygen in Wood Creek before (October 10, 2008) and after (November 5, 2009) tide flap removal. Note increased distribution of brackish water in Wood Creek after tide flap removal.

Water Quality Site **October 2008**	**Depth** **(feet)**	**Water Temperature** **(° C)**	**Salinity** **(ppt)**	**Dissolved Oxygen** **(mg/l)**
1- 50 ft upstream of tidegate				
surface	0.5	13.3	16.8	6.53
bottom	2.0	13.0	17.7	4.68
2- ~300 ft upstream of tidegate				
surface	0.5	10.8	0.4	7.82
bottom	2.0	12.3	14.1	6.84
3– ~300 ft downstream of crossing				
bottom	1.0	10.5	0.1	5.22
4- cattle crossing				
bottom	0.5	10.5	0.1	7.97
5- ~200 ft upstream of crossing				
bottom	0.5	9.9	0.1	7.73
6- downstream Myrtle Ave culvert				
surface	0.5	9.7	0.1	4.95
middle	1.3	9.7	0.1	5.56
bottom	2.5	9.5	0.1	5.69
Water Quality Site **November 2009**	**Depth** **(feet)**	**Water Temperature** **(° C)**	**Salinity** **(ppt)**	**Dissolved Oxygen** **(mg/l)**
1- 50 ft upstream of tidegate				
surface	0.5	12.5	23.1	6.43
middle	2.0	12.5	23.3	6.53
bottom	4.0	12.6	23.4	6.31
2- ~300 ft upstream of tidegate				
surface	0.5	12.5	22.0	6.57
middle	1.5	12.5	22.0	6.45
bottom	3.0	12.5	21.9	6.02
3– ~300 ft downstream of crossing				
surface	0.5	12.4	19.6	5.74
bottom	2.0	12.4	19.6	5.88
4- cattle crossing				
surface	0.5	12.2	6.2	5.07
bottom	1.5	12.4	8.0	4.93
5- ~200 ft upstream of crossing				
bottom	0.5	11.7	2.6	4.70
Pond				
surface	0.5	13.2	18.2	5.25
middle	1.5	13.8	22.7	4.97
bottom	3.0	14.1	23.1	3.98
6- downstream Myrtle Ave culvert				
surface	0.5	11.4	0.1	3.69
bottom	2.0	11.5	10.8	2.84

Based on visual observations, between the spring of 2010 and the spring of 2011 it appears that the channel of Wood Creek downcut about 1-2 feet which isolated the pond from the creek during low tide and/or low stream flows. We did not take any survey measurements to determine the depth of the downcut. I believe the downcut is actually a result of brackish water killing dense stands of freshwater obligate bulrush/cattails and eventual erosion of their dense root mats. The increased isolation of the pond from the creek may inhibit movement of coho into the pond and/or decrease water circulation between pond and creek.

Fish Sampling- NSA captured far more juvenile coho salmon in Wood Creek than other salmonids, both before and after project construction (Table 5). NSA found a seasonal pattern of some subyearling coho moving into Wood Creek during the spring and summer followed by a greater number of yearling coho in winter months, suggesting that it was providing important over winter rearing habitat for coho salmon both before and after project construction (Table 5). NSA found that juvenile salmonids began using the newly built off channel pond in January 2010 (Table 5) as soon as high stream flows flushed the brackish water from Wood Creek. The pond supported large numbers of coho throughout the winter and spring. The distribution of our coho catch, especially during the "high catch" months, seemed to be more restricted after project construction than before (Table 5). Pre project, NSA captured coho throughout most of the sample sites but post project the catches were restricted to the most upstream sites. More brackish water was present in Wood Creek in the vicinity of the new tidal channels (between Sites 1-4) after construction. NSA has found that juvenile coho, especially smaller individuals, avoid brackish water while rearing in the tidal portion Humboldt Bay tributaries. However, the new pond appears to be providing additional habitat for coho upstream of the brackish water in Wood Creek (Wallace 2010).

On January 25, 2010 the NSA field crew conducted one seine haul in the pond and captured and tagged 59 coho salmon. From January 29 to June 30, 2010, NSA's PIT tag antenna array detected 153 individually tagged coho in the pond. Only 6 of 103 (6%) coho physically captured in the pond by NSA after antenna installation contained PIT tags, strongly suggesting that the PIT tag antennas were detecting only a small portion of the coho actually rearing in the pond. Based on our high catches of coho in Wood Creek in the winter and spring, Wood Creek appears to provide important over winter habitat for juvenile coho salmon when our coho catches were low in Freshwater Creek Slough. Between October 2010 and June 2011 the pond antenna detected 45 individually tagged coho in the pond. Three of 12 (25%) coho physically captured in the pond by NSA contained PIT tags. Based on the smaller number of coho captured in the pond and the higher tag rate of these fish it appears that many fewer coho utilized the off channel pond in 2010/11 than 2010. Yoy coho densities in Freshwater Creek were much lower in the fall of 2010 than the fall of 2009 (Ricker and Anderson 2011; Seth Ricker personal communication), so subsequent catches of juvenile coho throughout the stream-estuary ecotone were lower in 2011 than 2010. Therefore, it is unclear if the apparent drop in use of the pond in 2011 was due to fewer fish migrating to the stream-estuary ecotone or due to the increased isolation of the pond described in the section above, or both.

Due to the low number of recaptured PIT tagged fish in our catches we weren't able to fully assess the growth of juvenile coho in the pond compared to mainstem Wood Creek or Freshwater Slough. However, the three PIT tagged coho tagged or recaptured in the pond and at large for more than two weeks in 2010 had growth rates of 0.39, 0.51, and 0.78 mm/day. These growth rates are much higher than typical coho growth rates in stream habitat reported in the literature.

The restoration project appears to have met a project goal to increase tidal prism (by removing the tide flap) without net loss of over winter freshwater rearing habitat for coho salmon by constructing the pond. The pond appears to replace freshwater habitat lost by the increased presence of brackish water in Wood Creek between Sites 1 and 4. In addition, other goals likely met by the restoration project such as establishing additional estuarine function and habitat to

support native plants and animals (not assessed by NSA monitoring), also increased the value of this habitat restoration project (Wallace 2010).

Ryan Creek 2010-2011

NSA conducted fish sampling in lower Ryan Creek/Slough on Green Diamond Resources property to investigate the use of the stream-estuary ecotone of Freshwater and Ryan Creeks by juvenile salmonids. CDFG began sampling in October 2009 and sampled nine sites in Ryan Creek and one site in a wetland adjacent to Ryan Creek with minnow traps baited with frozen salmon roe.

Yearling coho salmon were the most abundant salmonids captured in Ryan Slough and were most abundant in winter and spring (Table 8). Peak monthly coho catches for 2010 occurred in February but no real peak occurred in 2011 (Table 8). In 2010 their monthly FL increased from 75-79 mm in January to 118-127 mm in May and individual FL's ranged from 63 to 142 mm (Table 9). In 2011 their monthly FL increased from 75-107 mm in January to 112-127 mm in May and individual FL's ranged from 75 to 129 mm (Table 9). By June of both years most over-winter rearing coho had left Ryan Slough (Table 8). We captured 31 yoy coho throughout the survey and our highest catches occurred in June 2011 (Table 8). We captured very few yoy coho in 2010 which followed the same pattern of low yoy coho catches in Freshwater Creek Slough and Wood Creek. This subsequently led to lower catches of yearling coho in Ryan Slough in 2011 compared to 2010 (Table 8). Yoy coho FL's ranged from 46 to 113 mm (Table 9). Our juvenile coho catch was distributed throughout all sampling sites, including the adjacent wetland, but they were most numerous in our three most upstream sites (Table 10). We captured 117 juvenile steelhead throughout the survey and our peak catch occurred in June 2011 (Table 8). Their FL's ranged from 78 to 160 mm (Table 9). Our juvenile steelhead catch was distributed throughout all Ryan Slough sampling sites but they were most numerous in our three middle and three most downstream sites (Table 11).

Table 8. Comparison of the monthly number of juvenile salmonids captured in Ryan Creek/Slough, October 2009 to June 2011.

Date	Yearling Coho	YOY Coho	Steelhead /RT	Cutthroat Trout
Oct 09	0	1	0	3
Nov 09	0	2	0	0
Dec 09	0	2	0	0
Jan 10*	14	0	0	0
Feb 10	67	0	0	0
Mar 10	47	0	0	1
Apr 10	24	0	0	6
May 10	25	0	5	1
Jun 10	3	1	1	0
Jul 10	0	2	0	1
Aug 10	0	1	7	0
Sep 10	0	0	8	1
Oct 10	0	0	9	1
Nov 10*	0	0	11	0
Dec 10*	0	3	11	0
Jan 11	5	0	16	0
Feb 11	0	0	7	1
Mar 11*	4	0	0	0
Apr 11*	0	0	1	2
May 11	3	0	10	2
Jun 11	0	19	21	20

*High stream flows, limited sampling

Table 9. Summary of the number of fish captured and fork length (FL) information of juvenile salmonids captured in Ryan Slough October 2009-June 2011.

Ryan Slough

Date	Coho Salmon			Steelhead/RT			Cutthroat Trout		
	No.	FL	Range	No.	FL	Range	No.	FL	Range
10-15-09	1*	95	95	0	-	-	3	137	131-141
11-18-09	2*	96	93-99	0	-	-	0	-	-
12-16-09	2*	106	98-113	0	-	-	0	-	-
1-19-10	5	79	69-90	0	-	-	0	-	-
1-26-10	9	75	67-84	0	-	-	0	-	-
2-04-10	34	89	70-111	0	-	-	0	-	-
2-22-10	23	92	63-107	0	-	-	0	-	-
3-08-10	19	99	79-126	0	-	-	0	-	-
3-22-10	27	99	79-126	0	-	-	1	141	141
4-06-10	8	92	81-133	0	-	-	2	144	137-151
4-19-10	15	115	92-133	0	-	-	4	127	111-146
5-04-10	3	127	121-131	0	-	-	0	-	-
5-22-10	22	118	99-139	5	120	101-153	1	137	137
6-08-10	3	137	133-142	1	133	133	0	-	-
6-23-10	1*	76	76	0	-	-	0	-	-
7-07-10	1*	80	80	0	-	-	1	143	143
7-21-10	1*	76	76	0	-	-	0	-	-
8-04-10	0	-	-	2	84	82-85	0	-	-
8-18-10	1*	91	91	5	99	79-145	0	-	-
9-01-10	0	-	-	3	94	84-106	1	159	159
9-15-10	0	-	-	0	-	-	0	-	-
9-29-10	0	-	-	5	94	81-108	0	-	-
10-13-10	0	-	-	6	95	83-113	1	139	139
10-27-10	0	-	-	3	106	101-113	0	-	-
11-09-10	0	-	-	11	107	83-133	0	-	-
12-07-10	0	-	-	11	114	87-156	0	-	-
12-28-10**	3*	91	89-96	0	-	-	0	-	-
1-11-11	1	75	75	7	109	80-132	0	-	-
1-25-11	4	107	100-110	9	110	78-125	0	-	-
2-08-11	0	-	-	4	119	83-116	0	-	-
2-22-11	0	-	-	3	116	106-127	1	176	176
3-08-11**	3	102	88-115	0	-	-	0	-	-
3-22-11**	1	98	97	0	-	-	0	-	-
4-06-11	0	-	-	1	104	104	2	119	111-126
5-03-11	2	127	125-129	1	120	120	0	-	-
5-16-11	1	112	112	9	110	88-137	2	130	125-135
6-03-11	2*	49	47-50	6	104	88-135	4	115	92-135
6-13-11	10*	61	46-78	14	111	81-160	5	144	127-167
6-27-11	6*	66	51-77	10	111	93-136	9	125	113-132

* includes yoy coho
** only sampled wetland

Table 10. Comparison of the number of juvenile coho salmon captured by site groupings in Ryan Creek/Slough, October 2009 to June 2011.

	Sample Sites				
Date	**Lower 3 Sites**	**Middle 3 Sites**	**Upper 3 Sites**	**Wetland**	**Total**
10-09	0	0	1	-	1
11-09	0	0	2	-	2
12-09	1	0	1	0	2
01-10*	-	-	0	14	14
02-10	8	23	35	1	67
03-10	14	8	19	6	47
04-10	6	5	9	4	24
05-10	7	11	7	0	25
06-10	0	3	1	0	4
07-10	0	0	2	0	2
08-10	0	1	0	0	1
09-10	0	0	0	0	0
10-10	0	0	0	0	0
11-10*	0	0	0	0	0
12-10*	0	0	0	3	3
01-11	1	1	2	1	5
02-11	0	0	0	0	0
03-11*	-	-	-	4	4
04-11*	0	0	0	0	0
05-11	2	1	0	0	3
06-11	6	4	9	0	19
Total	**45**	**57**	**88**	**33**	**223**

*High stream flows, limited sampling

Table 11. Comparison of the monthly number of juvenile steelhead trout captured by site groupings in Ryan Creek/Slough, October 2009 to June 2011.

	Sample Sites				
Date	**Lower 3 Sites**	**Middle 3 Sites**	**Upper 3 Sites**	**Wetland**	**Total**
10-09	0	0	0	-	0
11-09	0	0	0	-	0
12-09	0	0	0	0	0
01-10*	-	-	0	0	0
02-10	0	0	0	0	0
03-10	0	0	0	0	0
04-10	0	0	0	0	0
05-10	3	2	0	0	5
06-10	0	1	0	0	1
07-10	0	0	0	0	0
08-10	2	3	2	0	7
09-10	4	2	2	0	8
10-10	5	4	0	0	9
11-10*	3	7	1	0	11
12-10*	5	3	3	0	11
01-11	3	5	8	0	16
02-11	3	2	2	0	7
03-11*	-	-	-	0	0
04-11*	1	0	0	0	1
05-11	4	6	0	0	10
06-11	8	9	14	0	31
Total	**41**	**44**	**32**	**0**	**117**

*High stream flows, limited sampling

However unlike coho, we did not capture any steelhead in the adjacent wetland. We caught a total of 39 cutthroat trout throughout the survey and our highest catches occurred in June 2011 (Table 8). Their FL's ranged from 92-176 mm FL (Table 9).

In the fall of 2009 we conducted visual surveys of the wetland adjacent to Ryan Slough and determined that under low flow conditions prior to winter storms the marsh was unlikely to provide salmonid habitat. However, we thought it may provide refugia from high stream flows in the winter for juvenile salmonids. Our suspicions were confirmed as the adjacent wetland was utilized by juvenile coho during the months of December to April and provided over winter habitat for juvenile coho (Table 10). Juvenile coho can readily move into the adjacent wetlands during high stream flow events where they can escape high velocity flows. As flows drop and direct access between the wetland and Ryan Slough is cut off some coho remain and rear in the wetland until the spring. They either return to the stream during a high flow event in the spring or make their way back to Ryan Slough at lower flows through a drainage network consisting of flooded wetlands and/or a buried culverted stream. We have captured coho in Ryan Slough or detected coho at our Wood Creek antennas that were PIT tagged by NSA in the wetland. This shows that once coho move into the wetland at high flows they can return to Ryan Slough.

In 2010 we detected four coho salmon and three cutthroat trout tagged by our project in Ryan Slough at our PIT tag antenna at the mouth of Wood Creek. Two of the coho were originally tagged in the wetland. Also, between mid April and mid June 2010 we detected 18 coho at the mouth of Wood Creek that were tagged by Green Diamond Resource Co. biologists at their screw trap in Ryan Creek in the spring of 2010. We also detected one juvenile coho in April 2010 that was tagged at the Green Diamond screw trap in 2009, and two likely adult coho in December 2010 that were also tagged by Green Diamond in 2009. The mouth of Wood Creek is over one river mile from the wetland in Ryan Creek. This illustrates that juvenile coho can use large portions of the stream-estuary ecotone in the lower portions of Freshwater and Ryan Sloughs and is yet another example of how enhancing connections between adjacent streams will increase juvenile coho rearing habitat.

PIT Tag Results for 2009/2010- We applied PIT tags to 142 yearling coho salmon and recaptured 22 (15.5%) of them. The recaptured yearling coho were at large 14 to 90 days and their average residence time was 49 days. They grew 4 to 38 mm and their mean growth rate was 0.46 mm/day (range 0.20 to 0.75 mm/day). Of these 22 fish, six were originally tagged in the adjacent wetland and recaptured in the wetland (n=3) or in Ryan Slough (n=3). The mean growth rate of the 16 coho tagged and recaptured in Ryan Slough was 0.53 mm/day (range 0.22 to 0.75 mm/day) and the six originally marked in the wetland was 0.27 mm/day (range 0.20 to 0.35 mm/day), suggesting that growth rates of coho rearing in the pond were lower than those rearing in Ryan Slough. Six of the 22 (27.3%) coho were recaptured at a different site than where we originally tagged them, which is a much higher movement rate than NSA observed for yoy coho in Freshwater Creek Slough. We also recaptured one juvenile coho in Ryan Slough in February 2010 that was originally tagged by AFRAMP in Cloney Gulch (tributary to Freshwater Creek) in September 2009. It was at large 143 days and grew 26 mm (0.18 mm/day). We applied PIT tags to 39 juvenile steelhead and recaptured 10 (25.6%) of them. The recaptured steelhead were at large 21 to 92 days and their average residence time was 50 days. They grew 4 to 44 mm and their mean growth rate was 0.26 mm/day (range 0.12 to 0.48 mm/day). We also applied PIT tags to five cutthroat trout but did not recapture any of them.

PIT Tag Results for 2011- Through June 2011 we PIT tagged eight yearling coho salmon and recaptured one of them. We tagged it in the wetland in January and recaptured it at the same site in March. It was at large 70 days and grew 22 mm (0.31 mm/day). We also recaptured two yearling coho that we marked in the wetland in December 2010. One was recaptured in the wetland in March, was at large 70 days, and grew 15 mm (0.21 mm/day). The other was

recaptured in Ryan Slough in May, was at large for 126 days, and grew 36 mm (0.29 mm/day). Through June 2011, we tagged 12 yoy coho and did not recapture any of them. We also tagged 54 juvenile steelhead and recaptured three (5.6%) of them. These three steelhead were at large 14 to 24 days, grew 2 to 8 mm (0.14 to 0.33 mm/day), and were all recaptured at the same site where we originally marked them. We also recaptured four steelhead marked by NSA in Ryan Slough in 2010. These four steelhead were at large 49 to 132 days and grew 12 to 28 mm (0.17 to 0.37 mm/day). Two of these fish were recaptured at different sites from where we originally tagged them. We also applied PIT tags to seven cutthroat trout and did not recapture any of them. However, we did recapture one cutthroat trout we marked in Ryan Slough in April 2010. It was at large 309 days, grew 47 mm (0.15 mm/day), and was recaptured at the same site where we originally tagged it.

Many studies in the Pacific Northwest have documented that juvenile salmonids, especially coho salmon, will move into off-channel habitat or low gradient habitat to escape high stream flows, especially if these habitats have low water velocity and ample cover (Ebersole et al. 2006; Quinn and Petersen 1996; Miller and Sadro 2003). Ryan Creek/Slough and the wetlands appear to meet these requirements. Also, based on coho recaptured in Ryan Creek that were originally tagged in other parts of Freshwater Creek basin (i.e. Cloney Gulch, HFAC weir, mainstem Freshwater Creek) juvenile coho in this section of Ryan Creek/Slough originate from both Ryan Creek and the rest of the Freshwater Creek drainage.

Hookton Slough/Salmon Creek

Salmon Creek 2010 and 2011

Due to high stream flows and habitat restoration construction we attempted fewer seine hauls in Salmon Creek in 2010 and 2011 compared to 2009. We captured nine juvenile steelhead trout in 2010 and their FL's ranged from 55-191 mm (Table 12). In 2011 we seined seven more steelhead and their FL's ranged from 63-127 mm (Table 12). We also captured one yoy trout in July that was 46 mm FL (Table 11). The Humboldt Bay Wildlife Refuge completed construction of one of four planned ponds in the fall of 2010. Even though the pond was isolated from Salmon Creek at low flows it was connected to the stream during high winter flows so NSA sampled the ponds to determine if juvenile salmonids used the pond. In 2010 NSA captured one juvenile steelhead in November that was 120 mm FL and three steelhead in December that ranged from 78-201 mm FL. In 2011 NSA also captured one steelhead in January that was 184 mm FL and six steelhead in March that ranged from 71-183 mm FL. NSA could not effectively seine the pond after early April due to the accumulation of 1-2 feet of fine sediment in the pond that clogged nets and posed a suffocation hazard for fish in the net.

In order to determine if juvenile salmonids were using Salmon Creek estuary during high flows or if they were using other areas of Salmon Creek in the summer we continued qualitative sampling using minnow traps baited with frozen salmon roe in 2010 and 2011. We fished these traps in deeper water or more heavily vegetated habitat near our normal seining sites. In 2010 we captured 29 juvenile steelhead ranging in size from 60-143 mm FL (Table 11). We also captured a total of two yearling coho salmon in May and June 2010 that were 89 and 107 mm FL (Table 11). In 2011 we captured 66 juvenile steelhead, mostly in May and June that ranged in size from 82-153 mm FL. We also minnow trapped the newly constructed pond in May and June 2011 after we could no longer seine the pond and did not capture any salmonids.

In December 2009 we began minnow trapping Cattail Creek and Long Pond just north of Salmon Creek during the same days we sampled Salmon Creek (Figure 2). This was done to determine if juvenile salmonids moved into these areas during high stream flows when Salmon Creek leaves its banks and floods the entire flat land between Salmon and Cattail Creeks. We used minnow traps baited with frozen salmon roe and sampled four locations in Cattail Creek and two locations in Long Pond. We did not capture any juvenile salmonids during our monthly sampling effort in 2010 and 2011. We did capture threespine stickleback in Cattail Creek and Long Pond.

Table 12. Monthly catch-per-unit-effort (CPUE) and fork length (FL) in millimeters of young-of-the-year (yoy) Chinook salmon, yoy coho salmon, yearling and older coho salmon, juvenile steelhead trout, and cutthroat trout in Salmon Creek estuary, January 2010-June 2011. CPUE is number of fish per seine haul.

Seining

		Trout			YOY Coho			Yearling Coho			Steelhead			Cutthroat		
	No.		Mean			Mean			Mean			Mean			Mean	
Month	Sets	CPUE	FL	Range	CPUE	FL	Range	CPUE	FL	Range	CPUE	FL	Range	CPUE	FL	Range
Jan	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
Feb	2	0	-	-	0	-	-	0	-	-	0.50	65	65	0	-	-
Mar	2	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Apr	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May	2	0	-	-	0	-	-	0	-	-	1.00	97	97	0	-	-
June	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
July	2	0.50	46	46	0	-	-	0	-	-	1.00	62	55-68	0	-	-
Aug	4	0	-	-	0	-	-	0	-	-	0.50	64	58-69	-	-	-
Sept	4	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Oct	4	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Nov	4	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Dec	2	0	-	-	0	-	-	0	-	-	1.00	135	79-191	-	-	-
Jan	4	0	-	-	0	-	-	-	-	-	0.25	63	63	0	-	-
Feb	4	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Mar	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apr	2	0	-	-	0	-	-	0	-	-	0.50	76	76	0	-	-
May	6	0	-	-	0	-	-	0	-	-	0.67	111	94-127	0	-	-
June	4	0	-	-	0	-	-	0	-	-	0.25	99	99	-	-	-

Table 12 (con't). Monthly catch-per-unit-effort (CPUE) and fork length (FL) in millimeters of young-of-the-year (yoy) Chinook salmon, yoy coho salmon, yearling and older coho salmon, juvenile steelhead trout, and cutthroat trout in Salmon Creek estuary, January 2010-June 2011. CPUE is number of fish per seine haul.

Minnow Traps

		Trout			YOY Coho			Yearling Coho			Steelhead			Cutthroat		
Month	No. Traps	No. Caught	Mean FL	Range	No. Caught	Mean FL	Range	No. Caught	Mean FL	Range	No. Caught	Mean FL	Range	No. Caught	Mean FL	Range
Jan	3	0	-	-	0	-	-	0	-	-	1	75	75	0	-	-
Feb	4	0	-	-	0	-	-	0	-	-	5	80	60-116	0	-	-
Mar	4	0	-	-	0	-	-	0	-	-	6	94	77-136	0	-	-
Apr	2	0	-	-	0	-	-	0	-	-	1	78	78	0	-	-
May	4	0	-	-	0	-	-	1	89	89	2	106	105-107	0	-	-
June	4	0	-	-	0	-	-	1	107	107	3	108	98-117	0	-	-
July	4	0	-	-	0	-	-	0	-	-	3	116	109-124	0	-	-
Aug	4	0	-	-	0	-	-	0	-	-	3	112	77-143	0	-	-
Sept	4	0	-	-	0	-	-	0	-	-	2	85	82-87	0	-	-
Oct	4	0	-	-	0	-	-	0	-	-	2	82	78-85	0	-	-
Nov	6	0	-	-	0	-	-	0	-	-	1	126	126	0	-	-
Dec	2	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Jan	4	0	-	-	0	-	-	0	-	-	6	103	97-107	0	-	-
Feb	4	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-
Mar	2	0	-	-	0	-	-	0	-	-	6	120	99-144	0	-	-
Apr	4	0	-	-	0	-	-	0	-	-	2	127	105-149	0	-	-
May	6	0	-	-	0	-	-	0	-	-	22	109	82-153	0	-	-
June	4	0	-	-	0	-	-	0	-	-	30	107	87-142	0	-	-

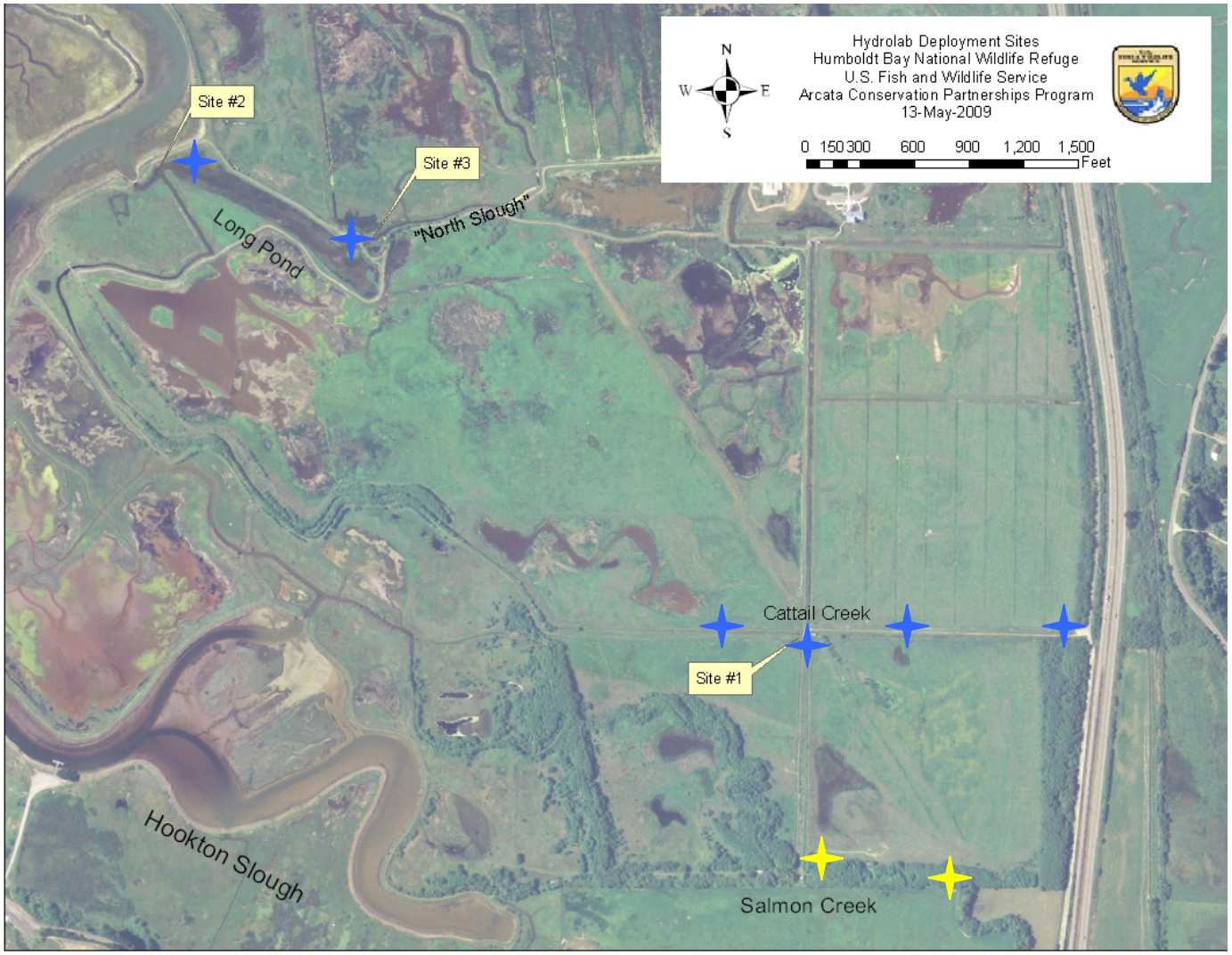

Figure 2. Approximate fish and water quality sampling locations in Salmon Creek (yellow stars), Cattail Creek, and Long Pond (blue stars) on the USFWS Humboldt Bay National Wildlife Refuge.

PIT Tag Results for 2010- We applied PIT tags to 33 juvenile steelhead and recaptured five (15.2%) of them. This includes fish collected by seining and in minnow traps. The steelhead were at large 12 to 260 days and grew 1-85 mm (0.08-0.38 mm/day). All of the steelhead were marked and recaptured in the site where we originally tagged them. We also applied PIT tags to two juvenile coho but did not recapture these fish.

We are still analyzing PIT tag information for 2011 and these results will be reported in our project's 2011/12 SFRA Annual Report.

Summary of Project Results (2003-2011):

- Juvenile salmonids, especially coho salmon, were found rearing in stream-estuary ecotone of most Humboldt Bay tributaries
- Juvenile salmonids, especially coho salmon utilize cool, freshwater tidal portion of stream-estuary ecotone
- Young-of-the-year (yoy) coho salmon rear in ecotone up to eight months
- Yearling coho salmon move into ecotone during fall and winter and rear until smolting the following spring (up to five months)
- Yoy coho salmon from ecotone are typically 15-20 mm FL longer than stream reared fish by the end of summer
- Ecotone reared coho are larger at every life stage compared to their cohorts in stream habitat
- Largest juvenile coho were found in tidal freshwater pond habitat (Martin Slough pond)
- New populations of coho salmon moved into Rocky Gulch and Gannon Slough after impassable tidegates were replaced by fish friendly tidegates
- Juvenile coho salmon moved into the newly constructed off channel pond in Wood Creek immediately after it was built
- Preliminary findings by this project using newly installed PIT tag antenna arrays have documented the long term use of newly constructed off-channel ponds in the stream-estuary ecotone of Wood Creek and that growth rates in the pond are higher than in the sloughs
- These antenna arrays have also documented the fall redistribution of many juvenile coho from Freshwater Creek downstream to the stream-estuary ecotone to over-winter in this low gradient habitat
- From late January to June 2010 the pond antenna detected 152 coho, one steelhead, and two cutthroat trout containing PIT tags in the newly constructed off channel pond in Wood Creek
- In 2010 only 6 of 103 (6%) coho physically captured in the pond by NSA after antenna installation contained PIT tags, strongly suggesting that the PIT tag antennas were detecting only a small portion of the coho actually rearing in the pond
- In 2010, 122 of the tagged coho were detected in the pond on more than one day. These 122 fish had an average time between first and last detection (a surrogate for residence time) of 23 days (range 1-87 days)
- In 2010 the PIT tag antenna detected 46 coho salmon in the pond tagged by AFRAMP the previous fall throughout the Freshwater Creek basin many miles upstream of the estuary. They tagged ~1200 coho which means ~4% of the tagged coho ended up using this one small off channel pond
- Growth rates of the three physically recaptured coho rearing in the pond for at least two weeks in 2010 ranged from 0.39 to 0.78 mm/day
- From November 2010 to June 2011 the pond antenna detected 45 coho salmon, two steelhead, and one cutthroat trout in the constructed off channel pond in Wood Creek
- In 2010/11, only 3 of 12 (25%) coho physically captured in the pond by NSA contained PIT tags, strongly suggesting that the PIT tag antennas were detecting only a small portion of the coho actually rearing in the pond
- In 2010 NSA physically captured 106 (6% contained tags) coho and antenna detected 152 in the off channel pond compared to capturing only 12 coho (25% contained tags) and antenna detecting 45 in 2010/11. This strongly suggests that many fewer coho utilized the off channel pond in 2010/11 than 2010.

- In 2010/11, 27 of the coho were detected in the pond on more than one day. These 27 fish had an average time between first and last detection (a surrogate for residence time) of 36 days (range 1-121 days)
- In 2010/11 the PIT tag antenna detected 28 coho salmon in the pond tagged by AFRAMP the previous fall throughout the Freshwater Creek basin many miles upstream of the estuary. They tagged ~1200 coho which means ~2.5% of the tagged coho ended up using this one small off channel pond
- In 2007, 41% of coho smolts originated from the 3-4 km of ecotone habitat in Freshwater Creek compared to 59% of coho originating from 23 km of stream habitat (in conjunction with AFRAMP)
- In 2008, 39% of coho smolts originated from the 3-4 km of ecotone habitat in Freshwater Creek compared to 61% of coho originating from 23 km of stream habitat (in conjunction with AFRAMP)
- In 2007, about 90% of large steelhead smolts originated from ecotone habitat in Freshwater Creek (in conjunction with AFRAMP)
- In 2008, over 80% of large steelhead smolts originated from ecotone habitat in Freshwater Creek (in conjunction with AFRAMP)
- AFRAMP and NSA data suggests that ecotone reared coho have marine survival rates 2-3 times higher than stream reared coho
- Long term trends in estimates of juvenile salmonid production from river basins are probably inaccurate without considering production originating from stream-estuary ecotone. Therefore, trends in marine survival rates of salmonids are likely inaccurate without considering role of stream-estuary ecotone.

Management Recommendations:
Juvenile salmonids in stream-estuary ecotone of Humboldt Bay should continue to be monitored on a year-round basis to determine seasonal and annual variation in their use of this habitat.

Surveys in Humboldt Bay should be conducted to determine if juvenile salmonids use the bay for rearing, and if so, determine how long do they stay and what habitats (e.g. eel grass beds) do they utilize.

Downstream migrant traps should be established at the upstream and downstream borders of the freshwater/estuary ecotone to conduct a mark-recapture study on coho salmon smolts. This study will determine the number of coho salmon smolts originating from the freshwater/estuary ecotone and the number from the rest of the Freshwater Creek basin upstream.

An inventory of small streams entering the tidal portion of the major Humboldt Bay tributaries should be made to determine if they could provide suitable summer rearing habitat for yoy coho salmon and other estuarine organisms. The establishment of cool freshwater habitat at the mouths of small streams entering the stream-estuary ecotone (presently behind tidegates) could potentially increase the rearing area for yoy coho salmon during the summer and probably more importantly provide refuge from high velocity flows for yearling coho in the winter and early spring.

Habitat adjacent to Humboldt Bay tributaries in the stream-estuary ecotone should be restored as the opportunity arises since juvenile salmonids will use tidal sloughs, off channel

ponds, and very small tributary habitat adjacent to the mainstem streams and sloughs if it is available.

Habitat restoration projects to improve stream-estuary ectone habitat should be monitored to assess their effectiveness and provide feedback to the restoration community to improve future restoration projects.

Habitat restoration projects designed to improve the connectivity of adjacent watersheds, especially between larger streams containing “source” populations of salmonids and smaller adjacent streams should be designed and completed.

Water temperatures in lower Freshwater Creek and Hookton Sloughs become too high to support salmonids by mid summer. This is probably due to the heating of mud flats and shallow water in and adjacent to the sloughs and exasperated by the lack of tidal circulation within the levied sloughs. Therefore management efforts to reduce water temperatures by conducting riparian planting, increasing tidal circulation, and reducing warm water runoff from adjacent agricultural lands should be pursued whenever possible and appropriate.

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Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. NOAA Tech. Memo. NMFS-NWFSC-24, 258 pp.

7. Discuss differences:

The PIT tag antenna at the mouth of Wood Creek was inoperable during part of the survey season due to the presence of saltwater at its location. The read range of the antenna is drastically reduced in salt water. Project personnel are researching other designs to see if we can increase the read range in salt water.

8. List any publications or in-house reports resulting from this work:

Wallace, M. 2006. Juvenile salmonid use of Freshwater Slough and tidal portion of Freshwater Creek, Humboldt Bay, California. 2003 Annual Report. Final Report for contract P0210710 to California Department of Fish and Game Fisheries Restoration Grants Program. March 2006. 32pp.

Wallace, M. 2006. Juvenile salmonid use of Freshwater Slough and tidal portion of Freshwater Creek, Humboldt Bay, California. 2003 Annual Report. California Department of Fish and Game, Inland Fisheries Branch Administrative Report No. 2006-04.

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Wallace, M. and S. Allen. 2007. Juvenile salmonid use of the tidal portions of selected tributaries to Humboldt Bay, California. Final Report for contracts P0310534 and P0410504 to California Department of Fish and Game Fisheries Restoration Grants Program. June 2007. 14pp.

Wallace, M. and S. Allen. 2009. Juvenile salmonid use of the tidal portions of selected tributaries to Humboldt Bay, California 2007-2009. Final Report for contract P0610522 to California Department of Fish and Game Fisheries Restoration Grants Program. August 2009. 32pp.

California Department of Fish and Game. 2009. Humboldt Bay juvenile salmonids investigations. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Grant Number F-122-R. Project No. 67.

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California Department of Fish and Game. 2007. Humboldt Bay juvenile salmonids investigations. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Grant Number F-51-R. Project No. 67.

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