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, 2011 through June 30, 2012
Report due date: September 30, 2012
Date prepared: August-September 2012

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.
2. Gather pre-project fish and water quality data for planned estuarine habitat restoration projects in Martin Slough, Ryan Creek, and Jacoby Creek designed to increase the amount and quality of juvenile salmonid rearing habitat.
3. 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.
4. To determine the proportion of the population of coho salmon smolts originating from the stream/estuary ecotone of Freshwater Creek
5. 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.

6. Describe how the objectives were met:

During the past year CA Dept of Fish and Game's (DFG) Natural Stocks Assessment Project (NSA) continued to sample the tidal portion of upper Freshwater Creek Slough, Wood Creek, Ryan Creek, and Salmon Creek estuary to document their use by juvenile salmonids and to assess estuarine habitat restoration projects in Wood and Salmon Creeks. Salmonid recovery plans encouraged numerous estuary and marsh habitat restoration projects around Humboldt Bay (HBWAC 2005; CDFG 2004). This project, 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. NSA monitored 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. NSA installed PIT tag antennas in Wood and Salmon Creeks to assess the performance of a newly constructed off channel pond as over winter habitat for juvenile salmonids. 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. Planned habitat restoration projects were delayed until late summer 2013 in Martin Slough so we will begin to collect pre-project data there in 2013. We plan to begin pre-project sampling in Jacoby Creek October 2012.

Methods

When stream and weather conditions allowed, NSA conducted bi-weekly sampling for juvenile salmonids in Freshwater Creek Slough, Ryan Creek, Salmon Creek estuary, and the off channel pond in Wood Creek. We conducted monthly sampling in Wood Creek (Figure 1). We used a 30 ft X 4 ft seine net to capture fish in Freshwater Creek Slough, a 100 ft X 5 ft seine net to capture fish in the Salmon and Wood Creek ponds, and minnow traps baited with frozen salmon roe in Ryan Creek, Wood Creek, and sections of Salmon Creek where we were unable to seine (Figure 1). In September 2011 we completed 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 mouth of the creek. In the winter of 2011 we installed PIT tag antennas at the opening of the most upstream pond in Salmon 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 2012 NSA also assisted DFG's Anadromous Fisheries Research and Monitoring Program (AFRAMP) with the operation of a juvenile fish weir set up at the

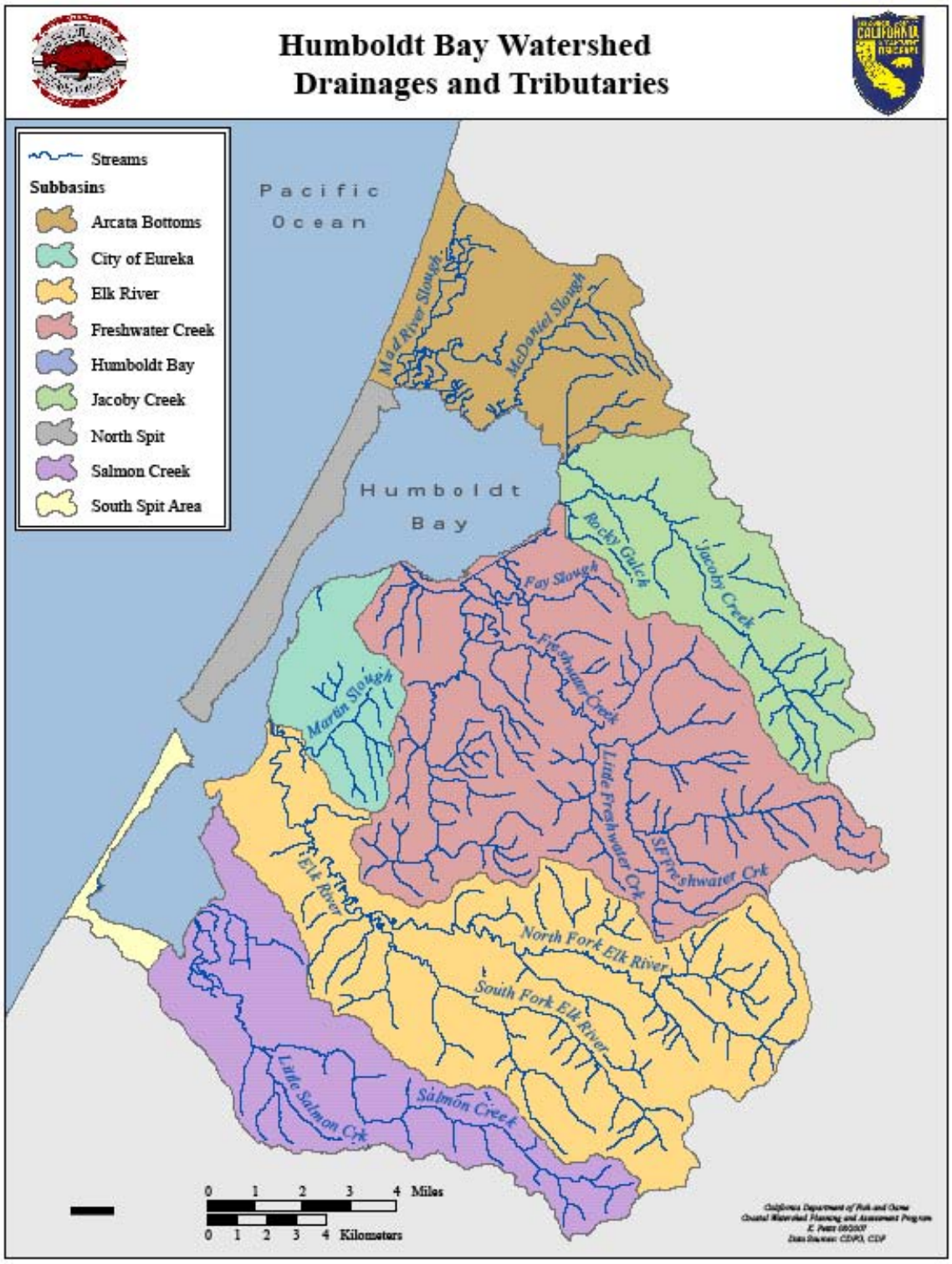

Figure 1. Map of Humboldt Bay tributaries.

Humboldt Fish Action Council (HFAC) weir site in upper Freshwater Creek Slough to capture juvenile salmonid smolts emigrating from Freshwater Creek. 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.

We also conducted water quality sampling bi-weekly at the habitat restoration sites in Wood and Salmon Creeks. We collected temperature, salinity, conductivity, and dissolved oxygen data in the newly constructed ponds and adjacent slough habitat.

Results

Freshwater Creek Slough

Freshwater Creek Slough July 2011 to June 2012

We did not capture yearling coho during July-December 2011. We captured 364 sub yearling coho salmon during July-December 2011. Their monthly catch per unit of effort (CPUE) was 3.55 fish/set in July and then gradually dropped to 1.50 fish/set in November. However, their peak monthly CPUE of 4.55 fish/set occurred in December after the onset of significant rain and increased stream flows. Their monthly mean fork length (FL) increased from 67 to 91 mm from June to November and then dropped to 85 mm in December. We also captured 12 sub yearling Chinook in July and three in August. Their monthly mean FL was 73 mm both months. We captured a total of 35 juvenile steelhead from July through December. We captured them every month and their peak CPUE was 0.54 fish/set in July. Their FL's ranged from 88 to 173 mm. We also captured a total of 19 cutthroat trout. We captured them every month but October and their peak CPUE was 0.25 fish/set in September. Their FL's ranged from 137 to 219 mm.

From January to June 2012 NSA captured 136 yearling coho salmon. We captured some every month and their peak monthly CPUE occurred in January at 3.71 fish/set and May at 1.83 fish/set. Their monthly mean FL increased from 81 mm in January to 105 mm in May and then dropped to 96 mm in June. We captured 237 sub yearling coho in May and June and their peak CPUE occurred in June at 6.64 fish/set. Our June catches of sub yearling coho in 2012 were the highest we've had since 2005 (Table 1). Their monthly mean FL was 40 mm in May and 49 mm in June. NSA captured one sub yearling Chinook salmon in June and it was 42 mm FL. We captured a total of 29 juvenile steelhead. We captured them in every month and their peak CPUE's were 0.45 fish/set in June, 0.44 fish/set in January, and 0.42 fish/set in March. Their FL's ranged from 74 to 188 mm. We also captured six cutthroat trout and their FL's ranged from 141 to 213 mm.

PIT Tag Results for 2011- We applied PIT tags to 520 sub yearling coho in 2011 and recaptured 74 (14.2%) of them. Their mean length of residence was 52 days and ranged from 12 to 165 days. Sub yearling coho mean length of residence was 41 days in 2010, 60 days in 2009, 68 days in 2007 and 33 days in 2006. The mean growth rate of recaptured sub yearling coho was 0.25 mm/day and ranged from 0 to 0.93 mm/day. We applied PIT tags to 11 yearling coho in 2011 and recaptured one

Table 1. Effort, number captured, and catch-per-unit-effort of young-of-the-year coho salmon in upper Freshwater Creek Slough during June, 2003-2012.

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
2012	22	146	6.64

of them. It was at large 13 days and during that time it grew 4 mm (0.31 mm/day). We also recaptured six coho that were tagged by AFRAMP in the Freshwater Creek basin; five in the fall of 2011 and one in the fall of 2010. We applied PIT tags to 41 juvenile steelhead in 2011 and recaptured five (12.2%) of them. They were at large for 14 to 124 days and during that time they grew 4 to 13 mm (0.06 to 0.24 mm/day). We also captured another 12 juvenile steelhead that were tagged by other projects and/or in other locations in the Freshwater Creek basin. We applied PIT tags to seven cutthroat trout in 2011 and recaptured none of them. However, we recaptured six cutthroat trout that were tagged by other projects and/or in other locations in the Freshwater Creek basin. 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 2012 and these results will be reported in our project's 2012/13 SFRA Annual Report.

Wood Creek

Wood Creek July 2011 to June 2012

From July to December 2011 we captured 80 sub yearling coho salmon in Wood Creek. Our peak catch of 39 fish occurred in August. Their monthly mean FL increased from 63 in June to 92 mm in December. We did not capture any other salmonid species. In monthly sampling of Wood Creek pond we captured one sub yearling coho and it was 62 mm FL.

From January to June 2012 NSA captured 65 yearling coho salmon in Wood Creek. We captured them every month but April and our peak catch of 30 occurred in February. Their monthly mean FL ranged from 81 mm to 90 mm in with no apparent pattern. We captured one cutthroat trout in May and it was 108 mm FL. In Wood Creek pond we captured 237 yearling coho, 75 sub yearling coho, one steelhead, and one cutthroat trout. We captured yearling coho from January to April and our peak catch of 195 occurred in March. Their monthly mean FL increased from 74 mm

in February to 84 mm in April. We captured sub yearling coho in May and June with a peak catch of 58 in May. Their monthly mean FL was 40 mm in May and 50 mm in June. We captured the steelhead in February and the cutthroat in April and their FL's were 71 mm and 104 mm respectively.

PIT Tag Antenna 2011/2012- Between October 2011 and June 2012 NSA detected 305 coho salmon, one steelhead, and one cutthroat trout at the pond antenna. Individual coho were first detected on 11/20/11 and last detected on 6/11/12, though most had left the pond by the end of April. Of the 305 coho detected in the pond, 199 (65%) were tagged by NSA and released into the pond, 21 were NSA tagged fish from Wood Creek (13 tagged in 2012 and eight tagged in 2011), eight were NSA tagged fish from Freshwater Creek Slough (five tagged in 2012 and three tagged in 2011), seven were Green Diamond Co. tagged fish from Ryan Creek, and 70 were tagged upstream in Freshwater Creek basin by AFRAMP during the fall of 2011 (Table 2). One hundred and twenty eight of the fish were detected in the pond on more than one day. These 128 fish had an average time between first and last detection (a surrogate for residence time) of 11 days (range 1-96 days).

Table 2. 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, October 2010 to October 2011, and October 2011 to July 2012.

Fish Origin	Pond 2010	Pond 10/11	Pond 11/12	Tide Gate 2010	Tide Gate 10/11	Tide Gate 11/12
Stream-Estuary Ecotone	7	1		9	30	
Lower Mainstem	11	6	26	11	49	75
Middle Mainstem		11	16		79	51
Upper Mainstem	7	6	12	10	59	34
Little Freshwater Cr	12			13		
Cloney Gulch	9	4	6	8	45	23
South Fork Freshwater Cr		0	10		13	31
Freshwater Creek (total)	**46**	**28**	**70**	**51**	**275**	**214**
Wood Cr Pond	74	8	199	33	3	138
Wood Cr (tagged 2012)	-	-	13	-	-	42
Wood Cr (tagged 2011)	-	6	8	-	17	25
Wood Cr (tagged 2010)	26	3	0	47	5	0
Wood Cr (tagged 2009)	1	0	0	1	0	0
Ryan Sl/Cr	0	0	7	26	5	24
Freshwater Sl (tagged 2012)	-	-	5	-	-	20
Freshwater Sl (tagged 2011)	-	0	3	-	2	33
Freshwater Sl (tagged 2010)	0	0	0	2	8	0
Freshwater Sl (tagged 2009)	5	0	0	9	0	0
HFAC Weir (tagged 2012)	-	-	*	-	-	*
HFAC Weir (tagged 2011)	-	0	0	-	122	0
HFAC Weir (tagged 2010)	0	0	0	163	1	1**
HFAC Weir (tagged 2009)	1	0	0	2	0	0
Estuary Ecotone (total)	**107**	**17**	**235**	**283**	**163**	**283**
Grand Total	**153**	**45**	**305**	**334**	**438**	**497**

* We still have 241 unidentified PIT tags collected during 2011/12. We anticipate many of the tags will be comprised of coho tagged at HFAC Weir and in Ryan Creek during the spring of 2012.
** This was likely an adult coho returning to Freshwater Creek basin.

At the tidegate antenna we detected 497 coho salmon, 15 juvenile steelhead, 20 cutthroat trout, and 238 PIT tags waiting to be identified (most of the unidentified tags will likely be from fish marked at the HFAC weir site in the spring of 2012). Individual coho were first detected on 9/2/11 and last detected on 6/27/12. Most coho were first detected from November 2011 to January 2012 (49%) and another 38% were first detected in March and April 2012 illustrating that a large redistribution of juvenile coho occurs in the fall after the first rains followed by the traditional spring out migration. Of the 497 coho detected at the tide gate, 214 (43%) were tagged by AFRAMP upstream in Freshwater Creek basin during the fall of 2011, 138 fish were tagged by NSA and released into the newly constructed off channel pond at Wood Creek, 67 were tagged by NSA and released into Wood Creek (42 tagged in 2012 and 25 tagged in 2011), 53 were tagged by NSA in Freshwater Creek Slough (20 tagged in 2012 and 33 tagged in 2011), 24 were tagged by NSA or Green Diamond Co. in Ryan Creek, and one was tagged at the HFAC weir in 2010 and was returning to Freshwater Creek as an adult (Table 2).

Ryan Creek July 2011 to June 2012

In Ryan Creek we captured 208 sub yearling coho, 65 juvenile steelhead, and 45 cutthroat trout from July to December 2011. We captured sub yearling coho in every month and our peak catch of 55 occurred in November. Their monthly mean FL increased from 71 to 89 mm from July to November and dropped slightly to 85 mm in December. We captured juvenile steelhead in every month and our peak catch of 30 occurred in July. Their monthly mean FL ranged from 111 mm to 124 mm with no apparent pattern. We captured cutthroat trout every month and their peak catches of 12 and 11 occurred in July and August respectively. Their monthly mean FL ranged from 119 mm to 134 mm with no apparent pattern.

In the wetlands adjacent to Ryan Creek we captured one sub yearling coho salmon in December and it was 61 mm FL.

From January to June 2012 we captured 108 yearling coho, two sub yearling coho, 28 juvenile steelhead, and 41 cutthroat trout in Ryan Creek. We captured yearling coho every month and our peak catches of 33 and 31 occurred in February and May respectively. Their monthly mean FL increased from 88 to 104 mm from January to May and dropped slightly to 98 mm in June. We captured two sub yearling coho in June and they were 48 and 59 mm FL. We captured juvenile steelhead in every month and their peak catch of 15 occurred in June. Their FL's ranged from 68 to 150 mm. We captured cutthroat trout every month and their peak catches of 17 and 15 occurred in May and June respectively. Their FL's ranged from 98 to 163 mm.

In the wetlands adjacent to Ryan Creek we captured 51 yearling coho salmon and their peak catches of 22 and 20 occurred in March and January respectively. Their monthly mean FL increased from 80 to 100 mm from January to June.

PIT Tag Results for 2011- We applied PIT tags to 182 juvenile coho salmon and recaptured 36 (19.8%) of them. The recaptured coho were at large 14 to 225 days and their mean residence time was 75 days. They grew 1 to 36 mm and their mean

growth rate was 0.13 mm/day (range 0.04 to 0.31 mm/day). We applied PIT tags to 100 juvenile steelhead and recaptured 17 (17.0%) of them. The recaptured steelhead were at large 14 to 158 days and their average residence time was 54 days. They grew 0 to 29 mm and their mean growth rate was 0.21 mm/day (range 0 to 0.64 mm/day). We applied PIT tags to 40 cutthroat trout and recaptured 17 (42.5%) of them. The recaptured cutthroat were at large 14 to 113 days and their average residence time was 58 days. They grew 1 to 29 mm and their mean growth rate was 0.17 mm/day (range 0.04 to 0.38 mm/day).

We are still analyzing PIT tag information for 2012 and these results will be reported in our project's 2012/13 SFRA Annual Report.

Hookton Slough/Salmon Creek

Salmon Creek July 2011 to June 2012

The Humboldt Bay National Wildlife Refuge completed construction of a new enlarged stream channel and four off channel ponds in the fall of 2011. From July to December 2011 (mostly sampling the old stream channel) we captured five sub yearling coho and 10 juvenile steelhead in the old channel and one steelhead in the new off channel ponds. The coho were caught in July and October and were 76 to 89 mm FL. The old channel steelhead were caught every month but September and November and they were 101 to 144 mm FL. The new pond steelhead was captured in December and was 221 mm FL. We completed sampling in Cattail Creek and Long Pond in September and did not capture any juvenile salmonids.

From January to June 2012 we captured 101 yearling coho and seven juvenile steelhead when seining the new ponds. We captured 87 (86%) of the coho and five (71%) of the steelhead in the upstream most pond where freshwater conditions persisted longer than the other ponds. We captured yearling coho in every month but April and their peak monthly catches of 50 and 38 occurred in March and May. Their monthly mean FL's increased from 73 mm in January to 106 mm in May and then decreased to 100 mm in June. We captured the steelhead in January, March, and May. They ranged in size from 64 to 207 mm FL. We also captured another five yearling coho and eight steelhead trout in the ponds using baited minnow traps. Again, most of the coho and steelhead were captured in the most upstream pond. The coho were 76 to 91 mm FL and the steelhead were 91 to 229 mm FL. We did not capture any juvenile salmonids in the old stream channel.

PIT Tag Results for 2011- We applied PIT tags to four sub yearling coho and recaptured one of them. It was at large 85 days and grew 8 mm (0.09 mm/day) during this time. We applied PIT tags to 96 juvenile steelhead and recaptured 11 (11.5%) of them. This includes fish collected by seining and in minnow traps. The steelhead were at large 13 to 225 days and grew 4-87 mm (0.04-0.46 mm/day). All but one of the steelhead were marked and recaptured in the site where we originally tagged them. The one steelhead that moved was marked in the old channel and recaptured in one of the new off channel ponds in January 2012.

We are still analyzing PIT tag information for 2012 and these results will be reported in our project's 2012/13 SFRA Annual Report.

PIT Tag Antenna 2011/2012- We installed a PIT tag antenna at the opening of the most upstream pond in December of 2011. Between December 2011 and June 2012 NSA detected 80 coho salmon and 16 steelhead at the antenna site. Individual coho were first detected on 1/17/12 and last detected on 7/6/12. Of the 80 coho detected in the pond, 71 were tagged and released into the pond, seven were tagged in the adjacent pond downstream, one was tagged in the second pond downstream, and one was tagged in the old stream channel. Seventy of the coho were detected in the pond on more than one day. These fish had an average time between first and last detection (a surrogate for residence time) of 17 days (range 1-83 days). All of the coho were originally tagged in the estuary so these fish had an average estuarine residence time of 18 days (range 1-104 days).

Individual steelhead were first detected on 12/28/11 and last detected on 5/25/12. Of the 16 steelhead detected in the pond, nine were tagged and released into the pond, one was tagged in the adjacent pond downstream, and six were tagged in the old stream channel. Fourteen of the steelhead were detected in the pond on more than one day. These fish had an average time between first and last detection (a surrogate for residence time) of 36 days (range 1-130 days). All of the steelhead were originally tagged in the estuary so these fish had an average estuarine residence time of 125 days (range 3-315 days).

Off Channel Pond Water Quality

NSA found similar water quality patterns in off channel ponds in Wood and Salmon Creeks (Table 7). The off channel ponds contained brackish water up to 25 ppt until high winter stream flows flushed the salt water from the ponds in the winter. The ponds remained primarily fresh water during the winter and spring until low stream flows allowed saltwater to once again reach the ponds in the late spring and summer. The ponds stratified so that brackish water was found along the bottom while remaining fresh near the surface. Water salinity tended to be higher and more persistent in the more downstream ponds on Salmon Creek. Water temperatures in the ponds also followed a seasonal pattern in that they were cool in the winter and spring but became too warm to support juvenile salmonids in the summer. Dissolved oxygen was often extremely low in the warm brackish layer of the pond during the summer and fall, especially in Wood Creek. The ponds provide good water quality during the winter and spring but become too warm and brackish with low dissolved oxygen during much of the summer and fall.

Table 7. Typical differences in water temperature, salinity, and dissolved oxygen in Salmon Creek at high (March 21, 2012) and low (June 13, 2012) stream flows and in Wood Creek at high (March 2, 2012) and low (June 5, 2012) stream flows.

Salmon Creek March 21, 2012 **Water Quality Site**	**Depth** **(feet)**	**Water Temperature** **(° C)**	**Salinity** **(ppt)**	**Dissolved Oxygen** **(mg/l)**
Pond 1 (time 1020 hrs)				
West Transect				
surface	0.5	10.1	0.1	9.92
middle	2.3	10.0	0.1	9.25
bottom	4.5	10.0	0.1	9.74
Pond 2 (time 1145 hrs)				
West Transect				
surface	0.5	10.7	0.1	7.98
middle	2.0	10.5	0.1	9.23
bottom	4.0	10.4	0.1	8.42
Pond 4 (time 1030 hrs)				
Inside Transect				
surface	0.5	10.3	0.1	9.13
middle	2.0	10.2	0.1	9.46
bottom	4.0	10.3	0.1	8.83
Salmon Creek June 13, 2012 **Water Quality Site**	**Depth** **(feet)**	**Water Temperature** **(° C)**	**Salinity** **(ppt)**	**Dissolved Oxygen** **(mg/l)**
Pond 1 (time 0945 hrs)				
West Transect				
surface	0.5	13.7	2.2	8.68
middle	2.0	16.4	12.0	6.03
bottom	4.0	19.8	22.0	6.68
Pond 2 (time 1040 hrs)				
West Transect				
surface	0.5	14.7	1.1	6.13
middle	1.5	15.2	1.1	6.82
bottom	3.0	19.5	13.8	6.54
Pond 4 (time 1245 hrs)				
Inside Transect				
surface	0.5	17.4	2.1	8.63
middle	-	-	-	-
bottom	2.0	25.7	24.5	7.61

Wood Creek **Water Quality Site**	**Depth** **(feet)**	**Water Temperature** **(° C)**	**Salinity** **(ppt)**	**Dissolved Oxygen** **(mg/l)**
March 2, 2012				
surface	0.5	6.9	0.2	6.30
middle	2.0	10.0	4.4	5.79
bottom	4.0	13.4	6.8	0.78
June 5, 2012				
surface	0.5	14.9	2.4	5.46
middle	2.0	18.8	16.5	4.89
bottom	4.0	17.6	16.6	3.32

Summary of Project Results (2011-12):

- Juvenile coho salmon moved into the newly constructed off channel ponds in Salmon Creek immediately after they 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 Salmon Creek by juvenile coho salmon and juvenile steelhead
- These antenna arrays also suggest a fall redistribution of juvenile coho from Salmon Creek downstream to the stream-estuary ecotone to rear during the winter and spring similar to what has been documented in Freshwater Creek
- In 2011/12 NSA physically captured and detected many more juvenile coho in the Wood Creek off channel than in 2010/11, which in turn was down from the number of coho captured or detected in 2009/10. This suggests the annual variation of juvenile coho use of estuarine habitat
- In 2010/11 the Wood Creek pond PIT tag antenna detected 70 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 almost 6% of the tagged coho ended up using this one small off channel pond
- 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.

Fish monitoring stations should be established at the upstream and downstream borders of the freshwater/estuary ecotone to estimate coho salmon abundance (i.e. mark-recapture study) prior to the traditional smolt outmigration from Freshwater Creek. 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 sub yearling 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 sub yearling coho salmon during the summer and probably more importantly provide rearing habitat 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 ecotone 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.

Literature Cited

California Department of Fish and Game. 2004. Recovery Strategy for California Coho Salmon. Report to the California Fish and Game Commission. February 2004.

Humboldt Bay Watershed Advisory Committee. 2005. Humboldt Bay Watershed Salmon and Steelhead Conservation Plan. Prepared for California Department of Fish and Game and the California Coastal Conservancy by the Humboldt Bay Watershed Advisory Committee and the Natural Resources Services Division of Redwood Community Action Agency. 232pp.

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 researched the problem and have made adjustments to increase the read range in salt water.

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

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