

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, 2013 through June 30, 2014

Report due date: September 30, 2014

Date prepared: August 2014

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

4. Objectives:

1. Monitor and evaluate the effects of ongoing estuarine habitat 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, Freshwater Creek, 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.

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, Jacoby Creek, and Salmon Creek estuary by other government agencies and private and non-profit groups. Project biologist also participates in

technical review teams to develop project criteria and review restoration project designs.

6. Describe how the objectives were met:

During the past year CA Dept of Fish and Wildlife's (CDFW) Natural Stocks Assessment Project (NSA) continued to sample the tidal portion of upper Freshwater Creek Slough, Wood Creek, Ryan Creek, Jacoby Creek, and Salmon/Cattail Creek estuary to document their use by juvenile salmonids. NSA also assessed estuarine habitat restoration projects in Wood and Salmon Creeks and collected data to describe pre-project conditions in Jacoby Creek. Salmonid recovery plans encouraged numerous estuary and marsh habitat restoration projects around Humboldt Bay (NMFS 2012; 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 and installed a PIT tag antenna in Ryan Creek to better describe the use of the stream-estuary ecotone by juvenile salmonids. NSA continued pre-project monitoring of an off channel habitat restoration project in Jacoby Creek that will connect an existing isolated pond to Jacoby Creek. NSA also participated on technical review teams to develop project criteria and review restoration project designs for planned projects in Freshwater Creek, Wood Creek, Jacoby Creek, and continuing projects on Salmon/Cattail Creeks. 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 in Martin Slough so we will begin to collect pre-project data there in 2014-15.

Methods

When stream and weather conditions allowed, NSA conducted bi-weekly sampling for juvenile salmonids in Freshwater Creek Slough, Ryan Creek Slough, Salmon Creek estuary, and the off channel pond in Wood Creek. We conducted monthly sampling in Wood Creek, Cattail Creek, and Jacoby Creek restoration site (Figure 1). We used a 30 ft X 4 ft seine net to capture fish in Freshwater Creek Slough and Cattail Creek, 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, Jacoby Creek, and sections of Salmon and Cattail Creeks where we were unable to seine (Figure 1). 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

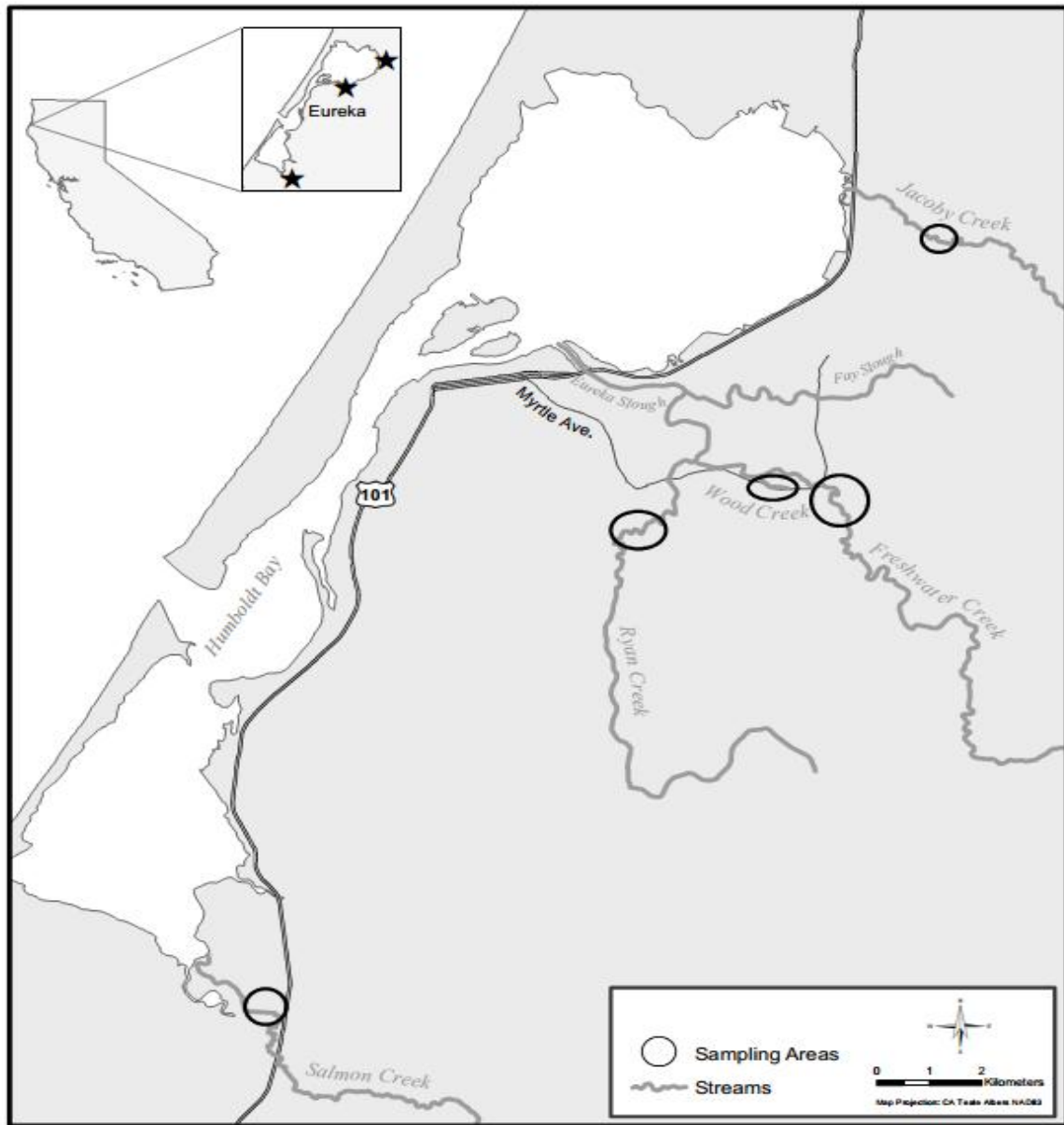


Figure 1. Map of Humboldt Bay tributaries.

PIT tag antennas at the opening of the most upstream pond in Salmon Creek. In the winter of 2012 we installed PIT tag antennas in Ryan 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. NSA applied PIT tags to all captured healthy juvenile

salmonids ≥ 55 mm FL to gather residency, movement, distribution, 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, Salmon, and Cattail Creeks and monthly in Jacoby Creek. 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 2013 to June 2014

We captured 396 sub yearling coho salmon during July-December 2013. Their monthly catch-per-unit-effort (CPUE) was 2.97 fish/set in July, peaked at 4.12 fish/set in October, and then gradually dropped to 1.05 fish/set by December. Their monthly mean fork length (FL) increased from 68 to 79 mm from July to September, but then dropped to between 64 to 71 mm FL during October to December. We captured 18 yearling coho from July through November 2013. Their highest catch occurred in July (n=11) when their CPUE was 0.31 fish/set. Their FL's ranged from 97 to 126 mm. We captured 45 juvenile steelhead from July through November. We captured them every month but December and their peak CPUE was 0.54 fish/set in November. Their FL's ranged from 53 to 192 mm. We also captured 41 cutthroat trout July to December. We captured them every month but November and their peak CPUE was 0.47 fish/set in August. Their FL's ranged from 155 to 278 mm. We did not capture sub-yearling Chinook salmon during July-December 2013.

From January to June 2014 NSA captured 615 yearling coho salmon. This is the highest number of yearling coho captured since we started sampling in 2005. I suspect this is at least partly due to the relatively dry spring and low winter stream flows which allowed us to sample all sites throughout this time period, compared to most other years when we missed substantial time periods due to high stream flows. We captured fish every month and their peak monthly CPUE occurred in April at 6.95 fish/set. Their monthly mean FL increased from 70 mm in January to 99 mm in June. We captured 15 sub yearling coho, all of them in May and June. Our June catches of sub yearling coho in 2014 was the third lowest since we began sampling in 2005 (Table 1). Their monthly mean FL increased from 44 mm in April to 60 mm in June. We captured a total of 27 juvenile steelhead. We captured them in every month but January and their peak CPUE was 0.36 fish/set in February. Their FL's ranged from 60 to 197 mm. We also captured 34 cutthroat trout, 32 of them from April to June and their FL's ranged from 81 to 246 mm. This year, for the first time since we began sampling in 2003, we did not capture any sub-yearling Chinook salmon in Freshwater Creek Slough during the spring and summer.

PIT Tag Results for 2013- We applied PIT tags to 203 sub-yearling coho in 2013 and recaptured 99 (48.8%) of them. Their mean length of residence was 45 days and ranged from 6 to 140 days and was similar to past years. The mean growth rate of recaptured sub-yearling coho was 0.20 mm/day and ranged from -0.07 to 0.86

Table 1. Effort, number captured, and catch-per-unit-effort of young-of-the-year coho salmon in upper Freshwater Creek Slough during June, 2003-2014.

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
2013	24	80	3.33
2014	24	9	0.38

mm/day. We applied PIT tags to 220 yearling coho in 2013 and recaptured 49 (22.2%) of them. Their mean length of residence was 33 days and ranged from 13-140 days. They grew 0-29 mm and their mean growth rate was 0.32 mm/day (0-0.58 mm/day). We also captured 31 yearling coho that were tagged by AFRAMP at the HFAC weir in the spring of 2013. They resided in the estuary 1 to 65 days. Two of the 31 HFAC fish did not migrate to Humboldt Bay and spent the summer in Freshwater Creek Slough rearing 76 and 173 days, respectively. We also recaptured five coho that were tagged by AFRAMP in the Freshwater Creek basin in the fall of 2012. We applied PIT tags to 62 juvenile steelhead in 2013 and recaptured 15 (24.2%) of them. They were at large for 13 to 238 days and during that time they grew 1 to 33 mm (0.05 to 0.42 mm/day). We applied PIT tags to 36 cutthroat trout in 2013 and recaptured eight (22.2%) of them. They were at large for 13 to 118 days and grew -2 to 14 mm (-0.05 to 0.34 mm/day). We also recaptured one cutthroat trout that was 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.

Wood Creek

Wood Creek July 2013 to June 2014

From July to December 2013 we captured 21 sub yearling coho salmon while minnow trapping in Wood Creek and 10 sub yearling coho while seining the off-channel pond. Our peak monthly catches were 16 fish in the creek in December and six fish in the pond in November. Sub yearling coho mean FL in the creek in December was 76 mm (range 60-109). Coho captured in the pond ranged from 47 to 82 mm FL and tended to be smaller than fish captured in the creek. We did not capture any other salmonid species.

From January to June 2014 NSA captured 194 yearling coho salmon and one cutthroat trout in Wood Creek. We captured the coho every month but June and our peak catch of 142 occurred in March. Their monthly mean FL was 95 mm in January and then dropped to 60 mm in February and gradually increased to 100 mm in May. We captured the cutthroat in May and it was 128 mm FL. In Wood Creek pond we captured only five yearling coho, which is much fewer than past years. We captured four of the coho in April and their FL's ranged from 62 to 113 mm. Due to the dry winter and spring water quality in the pond was unsuitable for salmonids much of this sampling period.

PIT Tag Antenna 2013/2014- We did not operate the PIT tag antenna located at the pond from 1/7/14 to 3/30/14 because we used it to replace the antenna stolen from the tide gate location. Between September 2013 and June 2014 NSA detected 21 coho salmon at the pond antenna, which is the lowest number detected since we installed the antennas in 2010 (Table 2). The low number of detections was certainly partially a result of the down time of the pond antenna, but was also partially due to the "late" redistribution of coho to the stream-estuary ecotone due to the lack of rain and low stream flows. Individual coho were first detected on 12/3/13 and last detected on 5/29/14. Of the 21 coho detected in the pond, 11 (52%) were NSA tagged fish from Wood Creek, five (24%) were tagged by NSA and released into the

Table 2. Origin of PIT tagged juvenile coho salmon tagged in Freshwater Creek basin detected at Wood Creek pond antennas during January to September 2010, October 2010 to October 2011, October 2011 to July 2012, October 2012 through June 2013, and September 2013 through June 2014.

Fish Origin	2010	10/11	11/12	12/13	13/14
Stream Estuary Ecotone	7	1	-	1	0
Lower Mainstem Freshwater Creek	11	6	26	2	0
Middle Mainstem Freshwater Creek	-	11	16	1	1
Upper Mainstem Freshwater Creek	7	6	12	4	0
Little Freshwater Creek	12	-	-	-	0
Cloney Gulch	9	4	6	4	0
South Fork Freshwater Creek	-	0	10	2	0
Freshwater Creek (total)	46	28	70	14	1
Wood Creek Pond	74	8	199	42	5
Wood Creek	27	19	20	11	11
Ryan Slough/Creek	0	0	7	2	0
Freshwater Creek Slough	5	0	8	6	0
HFAC Weir	1	0	2	0	4
Estuary Ecotone (total)	107	27	236	61	20
Grand Total	153	55	306	75	21

pond, four (19%) were tagged at the HFAC weir in the spring of 2014, and one (6%) was tagged upstream in Freshwater Creek basin by AFRAMP during the fall of 2013 (Table 2). Twelve of the fish were detected in the pond on more than one day. These 12 fish had an average time between first and last detection (a surrogate for residence time) of 24 days (range 1-122 days).

Numerous components from our tide gate PIT tag antenna were stolen around New Year's Day 2014. Therefore, we do not have any antenna data from 12/18/13 to 1/10/14 for this location. At the tide gate antenna we detected 384 coho salmon, seven juvenile steelhead, 15 cutthroat trout, and 64 PIT tags waiting to be identified. Individual coho were first detected on 10/1/13 and last detected on 6/24/14. The months with the most first detections of individual coho were February (n=151; 39%), April (n=83; 22%), and March (n=80; 21%). Only eight coho were first detected October through January (none in November and December) illustrating that the typical fall redistribution of juvenile coho was delayed until February. This was almost certainly due to the lack of rain and low stream flow prior to February. Of the 384 coho detected at the tide gate, 172 (45%) were tagged by AFRAMP upstream in Freshwater Creek basin during the fall of 2013, 105 (27%) were tagged by AFRAMP at the HFAC weir, 47 (12%) were tagged by NSA in Freshwater Creek Slough (25 tagged in 2014 and 22 tagged in 2013), 44 (11%) were tagged by NSA and released into Wood Creek (38 tagged in 2014 and six tagged in 2013), 11 (3%) were tagged by NSA or Green Diamond Co. in Ryan Creek, and five (1%) were tagged by NSA and released into the constructed off channel pond at Wood Creek (Table 3). The seven steelhead detected at the tide gate antennas were comprised of three fish tagged by NSA in Ryan Slough, two tagged by NSA in Freshwater Slough, and two tagged by AFRAMP at the HFAC weir. Two steelhead were likely adult fish since they were tagged four and two years previous. The 15 cutthroat trout detected at the tide gate were comprised of eight fish tagged by NSA and Green Diamond biologists in Ryan Creek/Slough, four tagged by NSA in Freshwater Slough, one fish each from Wood Creek, HFAC weir, and unknown origin. It is likely that many of the unidentified tagged fish are from Green Diamond's tagging efforts in Ryan Creek.

Ryan Creek

Ryan Creek July 2013 to June 2014

In Ryan Creek from July to December 2013 we captured six yearling coho, 97 sub yearling coho, 18 juvenile steelhead, and 27 cutthroat trout. We captured sub yearling coho in every month and our peak catch of 46 occurred in November. Their monthly mean FL increased from 76 to 89 mm from July to September and dropped to 77 and 78 mm in October and November with the arrival numerous 55 to 65 mm fish that weren't present July to September. We captured yearling coho July through September and their FL's ranged from 87 to 117 mm. We captured small numbers of juvenile steelhead in every month except December. Their FL ranged from 78 to 174 mm. We captured small numbers of cutthroat trout every month but December. Their FL ranged from 108 to 158 mm.

Table 3. Origin of PIT tagged juvenile coho salmon tagged in Freshwater Creek basin detected at Wood Creek tide gate antennas during January to September 2010, October 2010 to October 2011, October 2011 to July 2012, October 2012 through June 2013, and September 2013 through June 2014.

Fish Origin	2010	10/11	11/12	12/13	13/14
Stream Estuary Ecotone	9	30	-	11	16
Lower Mainstem Freshwater Creek	11	49	75	29	32
Middle Mainstem Freshwater Creek	-	79	51	31	43
Upper Mainstem Freshwater Creek	10	59	34	25	35
Little Freshwater Creek	13	-	-	-	-
Cloney Gulch	8	45	23	32	30
South Fork Freshwater Creek	-	13	31	23	16
Freshwater Creek (total)	51	275	214	151	172
Wood Creek Pond	33	3	138	16	5
Wood Creek	48	35	69	89	44
Ryan Slough/Creek	26	5	71	38	11*
Freshwater Creek Slough	11	10	67	86	47
HFAC Weir	165	123	156**	221	105
Estuary Ecotone (total)	283	176	502	450	212
Grand Total	334	451	716	601	384

* We still have 64 unidentified PIT tags collected during 2013/14. We anticipate many of the tags will be comprised of coho tagged by Green Diamond Resources Co. in Ryan Creek during the fall of 2013 and spring of 2014.

** One of these fish was likely an adult coho returning to Freshwater Creek basin.

From January to June 2014 we captured 306 yearling coho, 12 juvenile steelhead, and 55 cutthroat trout in Ryan Creek. We captured yearling coho every month and our peak catch of 115 occurred in April. Their monthly mean FL increased from 79 to 100 mm from January to June. We captured juvenile steelhead in every month but March and their peak catch of five occurred in June. Their FL's ranged from 91 to 141 mm. We captured cutthroat trout every month and their peak catch of 16 occurred in June. Their FL's ranged from 86 to 166 mm.

In the wetlands adjacent to Ryan Creek we did not capture any coho salmon from July to December 2013. This is the first year since we began sampling Ryan Slough we have not captured juvenile coho in this location during November or December. However, from January to June 2014 we captured 37 yearling coho salmon. We captured them only in March and April and their peak catch of 27 occurred in April. In previous years we found juvenile coho in the wetland throughout the winter and spring (~November to May). This year the dry fall and winter prevented coho from accessing the wetland until at least late February. Their monthly mean FL was 78

mm in March and 77 mm in April. The mean FL of fish captured in the wetland was smaller than those captured in the Ryan Creek channel and this has been the case every year of our study.

PIT Tag Results for 2013- We applied PIT tags to 75 sub yearling coho salmon in Ryan Creek in 2013 and recaptured 21 (28.0%) of them. The recaptured sub yearling coho were at large 13 to 84 days and their mean residence time was 24 days. They grew 0 to 16 mm and their mean growth rate was 0.19 mm/day (range 0 to 0.36 mm/day). We applied PIT tags to 346 yearling coho salmon in Ryan Creek in 2013 and recaptured 69 (19.9%) of them. The recaptured yearling coho were at large 13 to 112 days and their mean residence time was 45 days. They grew -1 to 29 mm and their mean growth rate was 0.23 mm/day (range -0.08 to 0.57 mm/day). We also captured 20 yearling coho tagged in previous years or from different locations. In the wetland we applied PIT tags to 93 yearling coho salmon and recaptured 40 (43.0%) of them. The recaptured coho were at large 14 to 125 days and their mean residence time was 51 days. They grew 0 to 23 mm and their mean growth rate was 0.16 mm/day (range 0 to 0.36 mm/day). We applied PIT tags to 25 juvenile steelhead and recaptured six (24.0%) of them. The recaptured steelhead were at large 14 to 125 days. They grew 0 to 42 mm and their mean growth rate ranged from 0 to 0.38 mm/day. We also captured nine steelhead tagged in previous years or from different locations. We applied PIT tags to 38 cutthroat trout and recaptured nine (23.7%) of them. The recaptured cutthroat were at large 13 to 182 days and their average residence time was 80 days. They grew -3 to 38 mm and their mean growth rate was 0.18 mm/day (range -0.20 to 0.38 mm/day).

We are still analyzing PIT tag information for 2014 and these results will be reported in our project's 2014/15 SFRA Annual Report.

PIT Tag Antenna 2013/2014- NSA operated a PIT tag antenna array on Ryan Creek Slough near the mid-point of our sampling area from 11/4/13 to 6/30/14 except when it was off line for repairs from 10/12 to 11/4/13 and 2/18 to 3/4/14. NSA detected 198 coho salmon, 13 juvenile steelhead, 35 cutthroat trout, and 491 unknown tag codes at the antenna. Many of the of the unknown tag codes are likely coho salmon tagged by Green Diamond Resource Co. biologists at their screw trap upstream of our sampling area.

Individual coho were first detected on 11/16/13 and last detected on 6/30/14. Of the 198 identified coho detected, 125 (63%) were tagged by NSA and released into Ryan Creek Slough, 34 (17%) were tagged upstream in Freshwater Creek basin by AFRAMP during the fall of 2013, 16 (8%) were tagged by AFRAMP at the HFAC weir in the spring of 2014, 14 (7%) were NSA tagged fish from Freshwater Creek Slough (eight tagged in 2013 and six in 2014), three (2%) were fish tagged and released into the wetland adjacent to Ryan Creek Slough by NSA, and two (1%) were NSA tagged fish from Wood Creek. The 128 coho initially tagged in Ryan Creek Slough and the adjacent wetland and detected at the antenna site had a mean residence time of 81 days (range 1 to 478 days) in the stream-estuary ecotone of Ryan Creek Slough. All

163 coho initially tagged in the Freshwater-Wood-Ryan stream-estuary ecotone had a mean ecotone residence time of 65 days (range 0 to 478 days).

Individual steelhead were first detected on 9/21/13 and last detected on 6/30/14. All the steelhead were originally tagged by NSA in Ryan Creek Slough. They had a mean residence time of 219 days (range 37 to 366 days). Individual cutthroat trout were first detected on 8/15/13 and last detected on 6/25/14. All of the cutthroat trout were originally tagged by NSA in Ryan Creek Slough. They had a mean residence time of 158 days (range 2 to 482 days).

Hookton Slough/Salmon Creek

Salmon Creek July 2013 to June 2014

The Humboldt Bay National Wildlife Refuge completed construction of a new enlarged stream channel and four off channel ponds in the fall of 2011 on Salmon Creek and one additional off channel pond in the fall of 2012. From July to December 2013 we captured one juvenile steelhead. We captured it in Pond 1 in October. It was 185 mm FL and we applied a PIT tag to it. While sampling the constructed ponds from January to June 2014 we captured 17 yearling coho and 41 juvenile steelhead by seine and two yearling coho and eight juvenile steelhead in minnow traps. We captured all the coho and 46 of 49 steelhead in Ponds 1 and 2. While seining we captured yearling coho March through June and their peak monthly catch of nine occurred in March. While minnow trapping we captured both coho in March. While seining we captured steelhead in February, March, and May with a peak catch of 24 fish in March. While minnow trapping we captured seven steelhead in March and one in April. The coho FL's ranged from 78 to 124 mm and the steelhead FL's ranged from 55 to 286 mm. We did not capture any juvenile salmonids in Cattail Creek.

PIT Tag Results for 2013- In 2013 we applied PIT tags to 12 yearling coho and recaptured one (8.3%) of them. This includes fish collected by seining and in minnow traps. The coho was at large 27 days and grew 22 mm (0.81 mm/day). We applied PIT tags to two juvenile steelhead and did not recapture either of them.

We are still analyzing PIT tag information for 2014 and these results will be reported in our project's 2014/15 SFRA Annual Report.

PIT Tag Antenna 2013/14- We installed a PIT tag antenna at the opening of Pond 1, the second most upstream pond, in December of 2011. From September 2013 to June 2014 we detected six coho and 10 steelhead in the pond, all were detected in 2014. All detected fish were tagged by NSA in the Salmon Creek estuary in 2014. Of the six detected coho, four were tagged in Pond 1 and two were tagged in Pond 2. These fish had an average time between tagging and last detection (a surrogate for residence time) of 12 days (range 2-19 days). Of the 10 detected steelhead five were tagged in Pond 2, four were tagged in Pond 1, and one was tagged in Pond 0. These fish had an average time between tagging and last detection (a surrogate for residence time) of 21 days (range 2-60 days).

Jacoby Creek Pond

We sampled Jacoby Creek pond and one site in Jacoby Creek with minnow traps monthly from July 2013 to June 2014. We did not capture any fish in the pond, in fact, due to low water we were only able to sample the pond in July 2013 and February to June 2014. However, we were able to sample Jacoby Creek every month and from July to December 2013 we captured 57 sub yearling coho and 13 juvenile steelhead. The peak catch of 28 sub yearling coho occurred in November and their July to December 2013 mean FL was 74 mm and ranged from 54 to 98 mm. Ten of the 13 steelhead were captured in July and August and their July to December 2013 mean FL was 104 mm and ranged from 86 to 124 mm.

From January to June 2014 we captured 31 yearling coho, eight juvenile steelhead, and one cutthroat trout in Jacoby Creek. We captured yearling coho from January to April and their peak catch of 22 occurred in January. Their January to June 2014 mean FL was 83 mm and ranged from 63-116 mm. We captured steelhead every month but February and May and their peak catch of four occurred in January. The January to June 2014 mean FL of steelhead was 109 mm and ranged from 73-147 mm. We captured one cutthroat trout in April and it was 131 mm FL.

Off Channel Pond Water Quality

NSA found similar water quality patterns in off channel ponds in Wood and Salmon Creeks. The off channel ponds contained brackish water up to 33 ppt in Salmon Creek and 25 ppt in Wood Creek during the summer and fall of 2013. Due to the drought, resulting in little rain and low stream flows, salinities remained elevated in the Wood and Salmon Creek ponds until at least February 2014. During November to January of most years the ponds are often freshwater or at least have a layer of freshwater near the surface. However, this year's November to January salinities ranged from 6 to 26 ppt in Wood Creek Pond and 14 to 31 ppt in the Salmon Creek ponds. Beginning in mid-February modest rain and stream flow events lowered pond surface salinities from February to April to 1 to 11 ppt in Wood Creek and <5ppt in Ponds 0, 1, and 2 in Salmon Creek. By June 2014 pond salinities had risen to 11-14 ppt in Wood Creek and 24 to 38 ppt in Salmon Creek. 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. In most years 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. This past year the ponds provided adequate salmonid rearing habitat only from late February to mid-May.

Jacoby Creek pond was essentially dry from August 2013 until the first significant rains of the year occurred in February 2014. Even after rain and high stream flows filled the pond dissolved oxygen levels were too low to support salmonids in 2014.

Summary of Project Results (2012-13):

- The continuing drought resulted in little rain and increased stream flows this winter which delayed the “fall redistribution” of juvenile coho to the stream-estuary ecotone until February.
- Juvenile salmonid rearing habitat conditions in the stream-estuary ecotone remained poor (very brackish and low DO) during much of the fall and winter until modest rains began in February.
- More juvenile coho salmon moved into the constructed off channel ponds in Salmon Creek in 2013/14 compared to 2012/13, but not as many as 2011/12. This suggests the annual variation of juvenile coho use of estuarine habitat.
- Most of the coho salmon captured in the off channel ponds on Salmon Creek were captured in the three upstream most ponds. This continues the pattern of coho using the ponds with the most persistent freshwater habitat.
- We captured substantially more juvenile steelhead in the ponds this year than previous years.
- We found juvenile steelhead reared an average of 21 days, and up to 60 days, in the Salmon Creek off channel ponds. This illustrates that creating off channel habitat provides benefits to steelhead as well as coho salmon.
- 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 in most years similar to what has been documented in Freshwater Creek.
- In 2013/14 NSA physically captured and detected the fewest number of juvenile coho in the Wood Creek off channel pond since it was constructed and we began sampling it in 2010. This was most likely due to lack of rain and stream flow that resulted in delayed downstream distribution and poor water quality conditions in the pond throughout much of the usual winter rearing period. This illustrates the annual variation of juvenile coho use of estuarine habitat.
- Fish tagged in Freshwater and Wood Creeks were detected at the Ryan Creek antenna and fish tagged in Ryan and Freshwater Creeks were detected at the Wood Cr antennas showing that juvenile salmonids use the entire Freshwater-Wood-Ryan stream-estuary ecotone complex for rearing.
- This was the first year since we began sampling the wetland adjacent to Ryan Slough we did not capture juvenile coho in this location during November or December. The continuing drought kept stream flows low and did not provide access to the wetland until February.
- Two years of pre-project fish and water quality sampling of the Jacoby Creek off channel pond show that presently it does not provide rearing habitat for juvenile salmonids. Restoration project designs show the planned project will greatly increase fish access to the pond that will likely result in increased over winter rearing habitat for juvenile salmonids, especially coho salmon.

- 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

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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.

National Marine Fisheries Service. 2012. Public Draft Recovery Plan for Southern Oregon/Northern California Coast Coho Salmon (*Onchorynchus kisutch*). National Marine Fisheries Service. Arcata, CA.

7. Discuss differences:

The PIT tag antennas at Wood, Salmon, and Ryan Creeks were inoperable during parts of the survey season due to various electrical and computer problems. The components were succumbing to effects of water, salt, and inclement weather. Project personnel researched the problem and have replaced worn parts, upgraded electrical connections, and increased weather protection on the units.

PIT tag antenna components at the mouth of Wood Creek were stolen resulting in about a two to three week data gap. We increased the security (installed cameras, purchased better locks etc.) and installed more theft resistant housings for the components.

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. 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.

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Wallace, M. and S. Allen. 2012. Juvenile salmonid use of the tidal portions of selected tributaries to Humboldt Bay, California 2009-2011. Final Report for contract

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California Department of Fish and Game. 2013. Humboldt Bay juvenile salmonids investigations. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Grant Number F-137-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.

California Department of Fish and Game. 2006. Humboldt Bay juvenile salmonids investigations. Annual Performance Report. Federal Aid in Sport Fish Restoration Act. Grant Number F-51-R-16. Project No. 67.

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