Tualatin River

Rapid Bio-Assessment 2013 & 2014 Final Report

September 2015

Prepared for: Tualatin River Watershed Council
Prepared By: Bio-Surveys, LLC
Funded By: Clean Water Services

EF Dairy Cr, Side Channel A

Introduction

The 2014 Rapid Bio-Assessment inventory of the upper Tualatin basin covered 91 miles of stream habitat. The effort encompassed all of the mainstem and tributary habitats exhibiting the potential for providing functional summer habitat for anadromous salmonids in five sub-basins: Gales Cr, EF Dairy Cr, Rock Cr, McFee Cr, and Chicken Cr. There have been consecutive Rapid Bio-Assessment (RBA) Inventories conducted in two of these sub-basins: Gales Cr and EF Dairy Cr. The following final report document includes the combined results of those two inventories so that inter annual comparisons can be made that assist in revealing how current conditions in the basin play a role in the distribution and abundance of both anadromous and resident salmonid species.

The intent of this project was to quantify the distribution and relative abundance of all juvenile salmonid species during pinch period summer low flow regimes. The distribution of salmonid juveniles can be truncated and influenced by abiotic factors such as elevated summer temperatures. The inventory consisted of snorkel surveys that began at select locations in each mainstem and at the mouth of each tributary. Surveys continued to at least the end of the current distribution of coho and steelhead and therefore describe the full extent of distribution for steelhead and coho for 2013 and 2014. The surveys did not extend to the end of cutthroat distribution because insufficient funding was available to encompass the full range of cutthroat distribution above the extent of anadromy. The surveys are intended to establish base-line distribution and abundance metrics, provide a foundation for long term trend analysis, identify anchor habitats and guide future restoration and management actions.

The juvenile census is a 20% sub-sample of pool rearing habitats only (no riffles or rapids were sampled) using a Rapid Assay technique designed to cover large distances and succeed in describing the distribution patterns and the relative abundance of multiple species of salmonids. Beaver dam abundance, road crossing information, GPS coordinates and temperature data were also collected. The juvenile salmonid abundance data presented tabularly in this document has been expanded from the 20% sample to represent an estimate of abundance for all pool habitats within a stream segment. Although estimates of abundance have been produced for all existing pool habitats this still does not represent a complete population estimate for each species because steelhead and cutthroat both utilize fast water habitats for summer rearing. Coho expansions from the pool inventory can be used as a surrogate for a population estimate because coho summer rear almost exclusively in pool habitats. Because juvenile distribution within side channel habitats is not evenly distributed, most side channels were sampled at a 100% rate (every pool). Sampling rates for side channels are indicated within the comment field of the Access database that accompanies this report.

The abundance estimates for steelhead and cutthroat in this document should only be utilized for inter annual trend analysis and do not represent an estimate of total abundance.

The juvenile abundances documented in the Tualatin basin during the summer of 2013 were the result of an adult escapement of 12,941 wild coho (6,571 adults / 6,370 jacks) and 7,616 winter steelhead (Willamette Falls Fish Count) into the Willamette River for the 2012 brood year. The juvenile abundances documented in 2014 were the result of an adult escapement of 22,738 wild coho (18,627 adults / 4,111 jacks) and 4,944 winter steelhead (Willamette Falls Fish Count).

Several significant observations were made during the field work and subsequent data analysis phase of this assessment that are worth highlighting to set the stage for your review of this 2 year comparative analysis;

1) The current range of anadromous fish distribution repeatedly fell substantially short of the range of stream miles exhibiting high quality anadromous potential. Essentially there are

many miles of underutilized high quality habitat accessible to anadromous populations that are currently not being seeded by adult escapement.

2) When steelhead were present they were predominantly observed in low densities. Steelhead were not observed in the subbasins of McFee Cr, Chicken Cr, or Rock Cr.

3) Deep channel entrenchment and riparian buffers providing limited stream shading were consistently documented in lower mainstems and tributary habitats.

4) Coho are by far the most abundant salmonid species and have succeeded in capitalizing on habitat niches not well utilized by other salmonid species.

5) Low abundances of sub-yearling chinook were observed in the Gales Cr mainstem and Iler Cr in 2014.

The average rearing density for a stream segment is utilized in this document as a metric for comparing productivity between streams and stream reaches. The average has been calculated by dividing the sum of the pool averages by the total number of sampled pools. This is not a weighted average that would divide the total metric surface area of the sampled pools by the total number of fish observed.

The average rearing density for a surveyed reach (fish/sqm. of pool surface area) is also an excellent metric that can be monitored from year to year to establish trends. However, it tends to portray only a general description of the current status within a reach. Understanding how each reach is functioning is more accurately interpreted in a review of how the rearing density changes within the reach. The pivot table graphics provided in electronic format with this summary are essential for the proper interpretation of this review. This more refined analysis of distribution patterns allows us to get a sense of what the true rearing potential is for the highest quality individual pool habitats. We can then identify the key anchor habitats existing within a stream segment. Identifying these key zones of high production potential aids in understanding the unique biological and morphological characteristics that create and maintain exceptional ecosystem function. Anchor habitats may be capable of rearing salmonid juveniles at disproportionately higher densities than non-anchor reaches. In many cases, these unique habitats require special conservation measures to be applied to their management and restoration in order to maintain and enhance their current level of productivity.

It's important to clarify that two different metrics for location are utilized in this assessment for describing specific fish distributions in the Gales Cr mainstem. This was necessary because the inventories began at points above their actual river mouth. Fish distribution graphics that accompany this document have been described in lineal feet above the survey start points. For management actions, we have frequently transposed this measurement into USGS River Mile locations. The USGS mapped mileage will be noted as USGS RM XX. The use of USGS RM estimates was not required to georefference any of the tributary inventories because all the tributary surveys began at RM 0.0.

Mainstem surveys required start points above their mouths because in some cases the visibility in these lower mainstems was not appropriate for the snorkel methodology.

Methods

Snorkel survey crews conducted RBA surveys between July 23 and September 18 of 2013 and August 15 and September 26 of 2014. Land owner contacts were made for all of the small private, industrial and public ownerships that existed on both sides of every stream reach surveyed. These contacts were conducted by Bio Surveys, LLC. The effort involved personal contacts to describe the survey and request permission for access. The land owner information was recorded (name, contact #, tax lot # and location) and is available from the TRWC as a byproduct of this effort.

Stream surveys were initiated by selecting the first pool encountered at the beginning of a mainstem or tributary. By not randomly selecting the first sample pool the method was able to identify minor upstream temperature dependent migrations that may not have extended more than a few hundred feet. Temperature differentials were measured between the tributary mouth and the mainstem directly above the tributary confluence to assess the potential for a thermal relationship that initiated migration. The identification of this type of summer migration pattern for juvenile salmonids is critical for understanding potential limiting factors within the basin (temperature, passage, etc.).

The survey continued sampling at a 20% frequency (every fifth pool) until at least two units without coho or steelhead were observed (the survey does not describe the upper limits of native cutthroat distribution). In addition, pools that were perceived by the surveyor as having good rearing potential (beaver ponds, complex pools and tributary junctions) were selected as supplemental sample units to insure that the best habitat was not excluded with the random 20 percent sample (comparisons were then made in the analysis phase of relative densities by species to determine if anomalies could have existed in the distribution of habitats that would not be captured in the 20% random sample). This method suggests that the data existing in the database could tend to overestimate average rearing density if these non-random units were not removed prior to a data query (the selected units are flagged as non-random in the database).

In sub-basins with low rearing densities, there were situations where coho and steelhead were not detected for more than two sampled units. These situations were left to the surveyor's discretion, whether to continue or terminate the survey. There is a possibility that very minor, isolated populations of juvenile steelhead could be overlooked in head water reaches of small 2nd order tributaries.

Pools had to meet the minimum criteria of being at least as long as the average stream width. They also had to exhibit a scour element (this factor eliminates most glide habitats) and a hydraulic control at the downstream end. There were no minimum criteria established for depth. Only main channel and select side channel pools in the mainstem were sampled. Back waters and alcoves existing on the floodplain and exhibiting limited potential for a hyporehic linkage were not incorporated into the surveyed pool habitats. The primary reason for not including these off channel pool types is that they compromise the consistency of measuring, summarizing and reporting lineal stream distances.

Distances reported in the Access database are from the beginning of one sampled unit to the beginning of the next sampled unit. The length of the sampled pool is an independent quantity, which was also measured and not estimated. Total distances represented in the database are consistently greater than distances generated utilizing a GIS measuring tool on a GIS stream layer (regardless of projection). This is related to the level of sinuosity within the floodplain that is not projected in GIS base map layers. If you are attempting to overlay this database on existing stream layer information there would be a need to justify lineal distances with known tributary junctions (these can be found in

the comments column of the Access database). Comparisons of lineal distance have not been made between the RBA field data and a LIDAR base layer. We would expect the differences to be less significant between these two platforms.

Pool widths were generally estimated. Because pool widths vary significantly within a single unit, a visual estimate of the average width was considered adequate. Pool widths were typically measured at intervals throughout the survey to calibrate the surveyor's ability to estimate distance.

The snorkeler entered the pool from the downstream end and proceeded to the transition from pool to riffle at the head of the pool. In pools with large numbers of juveniles of different species, multiple passes were completed to enumerate by species. (coho first pass, 0+ trout second pass, etc. No specific order of species observation was relevant to this multiple pass effort). This allowed the surveyor to concentrate on a single species and is important to the collection of an accurate value. In addition, older age class steelhead and cutthroat were often easier to enumerate on the second pass because they were concentrating on locating food items stirred up during the surveyor's first pass and appeared to exhibit less of their initial avoidance behavior.

In large order stream corridors (i.e., lower EF Dairy and Gales Cr mainstem) two snorkelers surveyed parallel to each other, splitting the difference to the center from each bank.

A cover/complexity rating was attributed to each pool sampled. This rating was an attempt to qualify the habitat sampled within the reach. The 1 - 5 rating is based on the abundance of multiple cover components within a sampled unit (wood, large substrate, undercut bank, overhanging vegetation). Excessive depth (>3 ft) was not considered a significant cover component.

The following criteria were utilized:

1 0 cover present
2 1-25 % of the pool surface area is associated with cover
3 26-50 % of the pool surface area is associated with cover
4 51-75 % of the pool surface area is associated with cover
5 > 75 % of the pool surface area is associated with cover

A point to consider here is that the frequency of higher complexity pools increases with a decrease in stream order. This inverse relationship is primarily a function of average channel width and the resultant ability of narrow channels to retain higher densities of migratory wood. Channel morphology begins to play a much more significant role in this relationship during winter flow regimes where increases in floodplain interaction and the abundance of low velocity habitat may become as significant as wood complexity.

A numerical rating was given to each sampled unit for the surveyor's estimate of visibility. The following criteria were utilized:

<u>Visibility</u>
1 excellent
2 moderate
3 poor

This variable delivers a measure of confidence to the collected data. Survey segments with a visibility ranking of 1 can assume normal probabilities of detection (the observed abundance is within 20 percent of the actual abundance of coho). Segments with a visibility of 2 suggest that less

confidence can be applied to the observed number (uncalibrated) and segments with a visibility rating of 3 suggest that the observation can probably be used to determine presence or absence only.

Beaver dam presence was also recorded during this inventory. Beaver dams were simply counted along the survey and given a sum total at the end of each stream. Only intact full spanning dams were counted. This variable may then be sorted in the database for presence, absence and inter annual trends within each basin.

There was also commentary recorded within each of the surveyed reaches that included information on temperature, tributary junctions, culvert function, the abundance of other species and adjacent land use. This commentary is included in only the raw Access database under the "comments" field and not in the Excel Pivot Table Summary of distribution graphics.

Distribution profiles

The distribution of juveniles and their observed rearing densities for each surveyed reach provide a basis for understanding how each reach is functioning in relation to the remainder of the basin or sub-basin. These profiles can help identify adult spawning locations, identify potential barriers to upstream adult and juvenile migration, identify the end point of anadromous distribution and they may also indicate how juvenile salmonid populations are responding to environmental variables such as increased temperature. You will find a review of these distribution profiles within this document for each of the streams surveyed.

Average Pool Densities and Seeding Levels

The average densities generated in this report represent the average value for a tributary or unique stream reach. They represent a snapshot in time of the current condition that can be compared to known levels of abundance that exist in fully seeded and fully functional habitats. These densities also provide a method for quantifying and comparing changes in rearing densities by reach or sub-basin over time. Average densities utilized as a metric in this analysis are calculated for pool surface areas only. Lower levels of juvenile coho abundance and higher levels of juvenile steelhead abundance exist in fast water (riffle/rapid) habitats. Replicate surveys conducted in these same reaches in subsequent years will function as an indicator of response to future restoration and enhancement strategies, potential changes in land use and changes in adult abundance.

To understand how any particular stream reach is functioning in relation to its potential, it is desirable to compare the observed densities of salmonid species to some known standard. The term full seeding is utilized to represent a density of juvenile salmonids that are rearing near the habitats capacity. The carrying capacity of habitats varies seasonally in relation to food abundance, adjacent pool / riffle ratios, flow, temperature and the species tolerance to interspecific competition. The interaction of this multitude of values is highly complex and unquantifiable at the level of this RBA inventory. Therefore, we can only comment on seeding levels as they relate to standards observed from a combination of many other stream systems in many geographically unique locations. This renders all discussions of carrying capacity in this document subjective. Any discussion of carrying capacity in the following text is an attempt to highlight the lows and highs within a range of observed values and to use a modicum of professional judgment to help steer comparative analyses in a direction that facilitates the decision making and prioritization necessary to guide restoration.

Within the Tualatin basin cutthroat densities between the range of 0.8 and 1.0 fish / sqm meter were documented as the top end of the observed range (this is a robust and healthy level when

compared to other west side Willamette watersheds). Steelhead densities were consistently low with peaks at the 0.29 fish / sqm level in 2013 and 0.52 fish/sqm level in 2014 (well below the 0.7 fish/ sqm level observed in well seeded sthd systems lacking interspecific competition, see Molalla River RBA Final Report 2012). Because the habitats ability to rear older age class salmonids is heavily influenced by fish size, available pool surface area and food availability, we assume that in zones of cohabitation by steelhead and cutthroat that the combined densities of these similar sized species would not exceed the 0.8 -1.0 fish /sqm observed in other high quality habitats. Observations in many thousands of miles of both Willamette Valley and Coastal streams suggest that densities above 0.7 fish / sqm for older age class steelhead or cutthroat without competition from the other are rare.

For the 0+ age class, there was a dramatic decrease in abundance from 2013 to 2014. Gales Cr sub-basin estimates exhibited a 67.28% drop in abundance and in the EF Dairy sub-basin a similar 59.32% drop. Within the 2013 Gales and EF Dairy sub-basin inventories that contained young of the year fry (combined steelhead / cutthroat), 10 pools exhibited densities between 2 – 3 fish / sqm. Only 2 pools exhibited densities between 3 – 3.23 fish / sqm. Within the 2014 comparative inventory only 2 pools exhibited densities above 2 fish / sqm and there were no pool densities above 3 fish / sqm. The highest densities observed in thousands of miles of Willamette basin and coastal stream inventories for the 0+ age class nearly always hover around 3 fish / sqm. The similarities observed in the Tualatin basin to many other watersheds suggests that a value near 3 fish / sqm is probably a good indicator that the reach is somewhere near its capacity for the 0+ age class and that spawning locations existed nearby.

For coho, an extensive body of data exists that suggests that extremely high quality habitats can maintain average summer rearing densities in the range of 3.5 fish / sqm. The Nickelson / Lawson Coho Production Model that averaged summer rearing densities across the full geographical range of the coastal coho ESU utilizes 1.7 fish/ sqm meter of pool surface area as a value that represents habitats seeded to their summer carrying capacity. In 2013 the average pool densities observed in the Tualatin system by unique stream segment ranged between 0.001 and 7.0 fish / sqm with the lowest value documented in the mainstem of Gales Cr and the highest value observed in Side Channel B of EF Dairy Cr. In 2014 the average pool densities ranged between 0.001 and 6.2 fish/sqm with the lowest value again documented in the mainstem of Gales Cr and the highest value observed in Denny Cr (trib to EF Dairy).

Spawning Location

The approximate location of coho or steelhead spawning events can often be observed by noting the presence of a distinct spike in rearing density of the 0+ age class that trails off rapidly just upstream. The physical location of a spawning destination has a range of variance plus or minus 4 pools due to the 20 percent sample methodology. Because the quality or quantity of spawning gravel can be a seasonal habitat limitation for salmonids (especially coho and steelhead), it is informative to describe not only the range of distribution of the 0+ age class but the peak zones of abundance which are indicating the presence of functional spawning beds. This information assists in guiding restoration prescriptions designed to accumulate spawning gravel to the zone where success is most likely to be achieved.

Adult and Juvenile Barriers

Adult migration barriers for anadromous salmonid species are verified by determining that no juvenile production is occurring above a given obstruction (culvert, falls, debris jam, beaver dam, etc.). There are many barriers, both natural and manmade, that impact the migration of salmonids. Some are definitive barriers that are obvious obstructions (such as bedrock falls). Many barriers however, only impede adult salmonid migrations during low flow regimes. Summer juvenile inventories allow us to definitively quantify whether passage was obtained at any point during the season of adult migration.

Juvenile salmonids typically migrate upstream for a variety of reasons (temperature, winter hydraulic refuge, food resources). Hydraulic refuge and food resources are typically fall, winter and spring migrations that would not be detectable during summer population inventories. Temperature however, is probably the most significant driver of upstream juvenile salmonid migrations during summer flow regimes. Juvenile barriers are subjective to the eye of the observer. The trend in juvenile density can be a method of detecting either partial or full barriers to upstream migration. Each of the surveyed reaches contains a comments section in the Access database to note the presence of culverts, jams and other physical factors that may influence the ability of salmonid populations to make full use of aquatic corridors and there linkages to thermal refugia during summer flow regimes.

Temperature Dependent Migrations

Potential temperature dependent migrations can be observed in the database by looking for densities that decrease significantly as the lineal distance increases from the mouth of the stream or tributary. This pattern is more likely to be observed in low abundance years where tributary habitats that are seeded to capacity are the exception. During years of high abundance there is a more significant potential for density dependent upstream migrations that would be indistinguishable from the distribution pattern mentioned above. The recognition of this migration pattern allows us, during years of low escapement, to identify important sources of high water quality within the basin that may be traditionally overlooked because of some other morphological condition that suggests to us that there is no significant potential for rearing salmonids (i.e. lack of spawning gravel). These stream reaches typically exhibit declining densities with increased distance from the mouth and no indication of a spawning peak (a point near the upper distribution of the population with significantly higher rearing densities of the 0+ age class). These tributaries may be functioning as important summer refugia for salmonid juveniles threatened by increasing temperatures in the mainstems. Several significant temperature dependent juvenile migrations were observed in the Tualatin basin in 2013 and 2014. These migrations will be discussed within the document in each stream where the behavior is occurring.

Precautions

The specific location of spawning sites does not infer that the highest quality spawning gravels were targeted by adult salmonids or that there is any relationship between the location of a redd and the quality of the summer rearing habitat that exists adjacent to these locations.

The average densities that can be generated as an end product for each stream reach are the result of a 20 percent sample. Consequently, they probably vary significantly around the true average density. There are many sources of potential variation, start point, number of units sampled within the reach, surveyor variability, etc. The range of variability for at least one of these variables (start point), was documented in the final review of the 1998 Rapid Bio-Assessment conducted by Bio-Surveys for the Midcoast Watershed Council. To facilitate the proper utilization of the data included in this inventory, the 1998 results are included below. The true average density of a stream reach was retrieved by querying the database from an ODFW survey on East Fk. Lobster Cr in the Alsea Basin, where every pool was sampled (indicated as 100% sample frequency in table 1). Comparisons could then be made between the true average density and a randomly selected 20 percent sub sample (every 5th pool). Only mainstem pools were utilized within the range of coho distribution to match the protocol for the Rapid Bio-Assessment.

(Table 1)

SAMPLE FREQUENCY	AVG. COHO DENSITY	AVG. SH DENSITY	AVG. CUT DENSITY	AVG. 0+ DENSITY
100 %	1.07	.03	.04	.13
50 %	1.10	.04	.03	.14
20 % Start Pool 1	0.87	.04	.03	.13
20 % Start Pool 3	1.01	.03	.03	.13
20 % Start Pool 5	1.13	.05	.04	.12

General Observations

Tualatin Basin

During the summer of 2013 and 2014 juvenile coho were the most abundant anadromous fish species rearing in pool habitats throughout the inventoried reaches of the Tualatin basin when all mainstem and tributary habitats are combined. For the combined inventories of Gales Cr and EF Dairy Cr sub-basins the total estimated pool abundance of juvenile coho was 63,930 for 2013 and 61,362 for 2014. Their distribution was wide spread across most of the major subbasins inventoried. Utilizing the season to season survival rates developed for coho by the Nickelson / Lawson Coho model, a back calculated estimate of 581 (+/- 90) adult coho utilized the inventoried reaches of Gales and EF Dairy sub-basins to spawn in 2012 and 558 (+/- 90) adult coho in 2013. For 2012 this was an estimated 8.84% of the total adult escapement of coho (6,571 not including jacks) over Willamette falls. The estimates assume that the 6,370 jacks observed at Willamette falls were males. For 2013 this was an estimated 3% of the total adult escapement of coho (18,627 with 4,111 jacks). In addition the sub-basins of Chicken and McFee were documented rearing a combined expanded estimated total of 2019 juvenile coho in 2014. For these sub-basins, the back calculated estimate of 18 adult coho comprises 0.1% of the total adult escapement over Willamette falls. No coho were documented in Rock Cr. These estimates are presented as a minimum metric of adult abundance, they are not meant to be a definitive accounting of escapement. For both years this is an unknown percentage of the total escapement to the Tualatin basin because not all stream reaches were inventoried in the Tualatin basin. As a relative metric of productivity for coho, the highest densities of summer parr in the most functional ½ mile

segment of EF Dairy Cr was rearing 8,109 fish/mile in 2013 and 8,653 fish/mile in 2014; and for Gales Cr 1,494 fish/mile in 2013 and 5,758 fish/mile in 2014.

Steelhead abundance was low in both years with an expanded estimate of only 2,615 in 2013 and 2,717 in 2014. This enumerates only the 1+ age class and older individuals observed in pool habitats for just the sub sample of inventoried sub-basins. In 2013, 74.6% of all steelhead observed were rearing in the mainstem habitats of EF Dairy Cr and 83.4% in 2014. As a relative metric of productivity for steelhead, the highest densities of the 1+ and older age class in the most functional ½ mile segment of EF Dairy Cr was rearing 630 fish/mile in 2013 and 742 fish/mile in 2014. For Gales Cr the highest densities in the best ½ mile stream segment contained 166 fish/mile in 2013 and 134 fish/mile in 2014 (pool only).

Cutthroat were abundant in most of the inventoried subbasins with an expanded estimate documented for the Gales and EF Dairy sub-basins of 7,831 in 2013 and 7,562 in 2014. It is important to reiterate that unlike coho parr, steelhead and cutthroat are capable of rearing in fast water habitat types (rapids, riffles and cascades). Because these fast water habitat types were not sampled during this inventory, the observed numbers of steelhead and cutthroat do not represent any type of population estimate. These numbers can be used however as a very effective tool for inter annual variation and trend analysis. In general, cutthroat numbers and densities during both inventoried years increased above the distribution of steelhead and coho presumably due to the lack of inter specific competition for food and rearing surface area. The highest densities of Cutthroat were observed rearing in headwater reaches without steelhead or coho in densities that ranged between 0.8 – 2.6 fish / sqm.

Water quality issues within the Tualatin basin may also be limiting anadromous salmonid abundance and/or adversely affecting resident fish and aquatic food web relationships. The DEQ conducts assessments of water quality in Oregon to meet the federal Clean Water Act Sections 305(b) and 303(d) requirements and report on conditions in Oregon's surface waters. Water bodies where standards are not met are identified as water quality limited in their Integrated Annual Report and are assigned a status of either Category 4 or Category 5. Several listings were made for various reaches of the inventoried sub-basins. These sub-basin listings will be further discussed in the Site Specific Observations. The listing of “Biological Criteria” is not a measurement of any pollutant but quantifies numerical values or narrative expressions that describe the biological integrity of aquatic communities inhabiting waters of a given designated aquatic life use (Oregon DEQ, Tualatin River Subbasin TMDL: Appendix H (Biological Criteria). The narrative criteria is: waters of the state must be sufficient to support aquatic species without detrimental changes in the resident biological communities (Oregon DEQ 2012 Integrated Report).

It’s important to note that poor visibility was a consistent issue in the lower mainstem of all of the primary subbasins. Heavy tannins limited visibility in deep mainstem pools where slow moving water facilitates the development of a thermocline. The presence of this deep thermocline suggests that estimates of abundance for cutthroat and coho in these reaches likely underestimates the actual number present. The raw data stored in the Access database that accompanies this final report document will

indicate the zones where compromised visibility may influence observed abundance (visibility ranking of 2 or 3).

(Table 2) Expanded Number Estimates for 2013

Stream	Coho	%	0+	%	Sthd	%	Cut	%	Chin	%
EF Dairy	**35,175**	**55**	**8,180**	**26.5**	**1,950**	**74.6**	**2,635**	**33.6**		
Side Channels	593		39				6			
Big Canyon	163		65				30			
Campbell	388		1,280	4.2			280	3.6		
Denny	419		1,205	3.9	5		285	3.6		
Murtaugh	150		125		10		180	2.3		
Panther			130				20			
Plentywater	6		135				40			
Rock	219		1,095	3.6			265	3.4		
Roundy	6		195				35			
Trib A	6		40							
Gales	2,275	3.6	**8,205**	**26.6**	**430**	**16.4**	**1,585**	**20.2**		
Bateman	175		250				115	1.5		
Beaver	**12,700**	**19.9**	425	1.4			360	4.6		
Clear	**5,705**	**8.9**	3,025	9.8	**140**	**5.4**	605	7.7		
Coffee			325	1.1			45			
Finger	156		45				30			
Iler	2,662	4.2	**3,770**	**12.2**	25		**735**	**9.4**		
Low Divide			110							
NF Gales	1,013	1.6	935	3	50	1.9	220	2.8		
Prickett			70				55			
Roderick			40				5			
SF Gales	656	1	1,040	3.4			210	2.7		
Trib A			25		5					
White	1,463	2.3	75				90	1.1		
Inventory Total	**63,930**		**30,829**		**2,615**		**7,831**			

* Highlighted estimates represent the top 3 producers by species.

- Percent contributions are indicated for only those sub-basins that contributed greater than 1% of the total.

- 20% visual bias included for coho expansions

(Table 3) Expanded Number Estimates for 2014

Stream	Coho	%	0+	%	Sthd	%	Cut	%	Chin	%
EF Dairy	**26,188**	**42.7**	**3,595**	**32.4**	**2,265**	**83.4**	**2,680**	**35.5**		
Side Channels	1,583	2.6	36		11		77	1		
Campbell			415	3.7			225	3		
Denny	813	1.3	340	3.1			200	2.7		
Murtaugh	88		55				30			
Panther			65				60			
Plentywater	88		70				35			
Rock	19		440	4			120	1.6		
Roundy			65				10			
Gales	4,319	7	**3,000**	**27.1**	**270**	**9.9**	**1,005**	**13.3**	**5**	**50**
Side Channels	1,141	1.9	1		1		10			
Bateman	38		65		20		30			
Beaver	**10,343**	**16.9**	100				620	8.2		
Clear	**7,628**	**12.4**	**710**	**6.4**	**135**	**5**	665	8.8		
Coffee			195	1.8			60			
Finger			30				30			
Iler	7,188	11.7	675	6.1	5		**885**	**11.7**	**5**	**50**
Low Divide			40				15			
NF Gales	138		510	4.6			295	3.9		
Prickett	31		20				15			
SF Gales	438		630	5.7	10		325	4.3		
White	1,319	2.1	25				155	2		
Inventory Total	**61,362**		**11,082**		**2717**		**7,547**		**10**	

* Highlighted estimates represent the top 3 producers by species.

- Percent contributions are indicated for only those sub-basins that contributed greater than 1% of the total.

- 20% visual bias included for coho expansions

(Table 4) Expanded Number Estimates for 2014

Stream	Coho	%	0+	%	Cut	%	Sthd	%	Chin	%
Chicken	**13**		25	9						
Cedar			20	7.3	10	2				
West Fork Chicken										
McFee	**1181**	**58.5**	10	3.6	**150**	**29.4**				
Gulf Canyon			25	9	25	4.9				
Trib A			**55**	**20**	15	2.9				
Heaton	**819**	**40.6**	**60**	**21.8**	**180**	**35.3**				
Baker										
Fir Clearing			5	1.8						
Trib A	6		**55**	**20**	25	4.9				
Rock			20	7.3	**105**	**20.6**				
Inventory total	**2019**		**275**		**510**					

* Highlighted estimates represent the top 3 producers by species.

- Percent contributions are indicated for only those sub-basins that contributed greater than 1% of the total.

- 20% visual bias included for coho expansions

SITE SPECIFIC OBSERVATIONS

Site specific observations within this document have been combined into the primary subbasins represented in table 3&4. Following each major sub-basin heading, tributaries to that sub-basin are reviewed in alphabetical order. After each review is a summary table that lists that streams contribution to the subbasin by species.

These production estimates are based on an expansion of the 20% snorkel sample in pools only and therefore do not constitute an entire production estimate for the basin. These estimates greatly under-estimate the standing crop of 0+, steelhead, and cutthroat because a significant component of their summer population is rearing in riffle/rapid and glide habitats that were not inventoried. In addition, there is also production for cutthroat that extends upstream beyond the end-point of most surveys. The information below can be utilized to establish a baseline for trend monitoring for subsequent survey years on the basin scale and by tributary. It also provides a comparison of the relative production potential between tributaries that can be utilized as a foundation for prioritizing restoration actions (some streams play a more significant production role and some streams may be ranked differentially for their ability to provide thermal refugia).

(Table 5) Expanded Subbasin Number Estimates for 2013

Subbasin	Coho	%	0+	%	Sthd	%	Cut	%	Chin	%
EF Dairy	37,125		12,489		1,965		3,776			
Gales	26,805		18,340		650		4,055			
Inventory Total	**63,930**		**30,829**		**2,615**		**7,831**			

- 20% visual bias included for coho expansions

(Table 6) Expanded Sub-basin Number Estimates for 2014

Subbasin	Coho	%	0+	%	Sthd	%	Cut	%	Chin	%
EF Dairy	28,779		5,081		2,276		3,437			
Gales	32,583		6001		441		4,110		10	
Inventory Total	**61,362**		**11,082**		**2717**		**7,547**		**10**	

- 20% visual bias included for coho expansions

(Table 7) Expanded Sub-basin Number Estimates for 2014

Subbasin	Coho	%	0+	%	Sthd	%	Cut	%	Chin	%
Chicken	13		45				10			
McFee	2006		210				395			
Rock			20				105			
Inventory Total	**2019**		**275**				**510**			

- 20% visual bias included for coho expansions

Gales Creek Subbasin

In 2013 the Gales Creek subbasin contained 49.4 miles of inventoried stream habitat that exhibited anadromous potential. This total included 13 significant tributaries. The 2014 inventory contained 45.9 mile of stream habitat that included 11 tributaries. Roderick Cr was not sampled in 2014 due to complete lack of water in the lower ½ mile of stream habitat. Trib A was not sampled due to its limited potential. The tributaries of this palmated drainage were observed rearing 91.5% of all coho observed in 2013 and 82.7% in 2014 while contributing around 55% of the total stream miles within the subbasin. The opposite was true for Steelhead where in 2013 only 33.8% and in 2014, 38.8% of the subbasin totals were observed rearing in the tributaries. Each of the tributaries will be reviewed separately below.

Salmonid distribution profiles and abundances varied significantly between the 2013 and 2014 inventoried years (no assessment of variation in adjacent west side sub basins of the Tualatin River are available for comparison). Steelhead abundance exhibited a 32.2% basin wide decline while distribution profiles remained similar, with the only exception being the observed absence of steelhead in NF Gales in 2014. 0+ trout abundance exhibited a dramatic 67.3% basin wide decline between inventoried years. The explanation for this is unclear, but is likely the result of a hydrologic event adversely affecting trout spawning and/or egg to fry survival. Given the low abundance of steelhead in the basin, a large majority of the documented 0+ trout parr are likely the progeny of resident cutthroat trout. Though basin wide cutthroat trout abundance was similar between the two inventoried years, distribution profiles varied. In 2014 14.6% more of the total estimated cutthroat population was observed rearing within the tributary habitats. This was a consistent trend observed in every tributary. Coho distribution and abundance exhibited an interesting year to year differentiation as well. Though total basin wide coho production increased by 21.6% from 2013 to 2014, mainstem and tributary habitats above Balm Grove dam exhibited a 28% decline in coho production. In 2014 Coho distribution above the dam terminated lower in a majority of inventoried reaches including the Gales Cr mainstem, Beaver Cr, and NF Gales. Unlike Clear and Iler Cr these tributaries have no definitive barriers to passage. Year to year differences in peak flow events likely had a considerable impact on adult coho distribution in all Willamette tributaries. In years of late or limited fall rain events, stream levels remain low in the upper reaches of the watershed restricting access for adult coho to potential spawning grounds for the duration of the peak spawning period (discussed further in Gales mainstem section).

Gales Cr enters the Tualatin River from the North West at USGS RM 56.8 just south of Forest Grove. The drainage covers 77.9 sqm and is the 2nd largest subbasin within the Tualatin. The pool production estimates contained in tables 8 and 9 are meant to reveal a relative estimate of production potential and not to make a qualitative comparison of habitat. Differences in habitat quality are discussed within the site specific review of each subbasin where average rearing density provides an opportunity for qualitative comparison.

(Table 8) Expanded Gales Cr Subbasin Number Estimates 2013

Stream	Coho	%	0+	%	Sthd	%	Cut	%	Chin	%
Gales	2,275	8.5	8,205	44.7	430	66.1	1,585	39		
Bateman	175		250	1.4			115	2.8		
Beaver	12,700	47.4	425	2.3			360	8.9		
Clear	5,705	21.3	3,025	16.5	140	21.5	605	14.9		
Coffee			325	1.8			45	1.1		
Finger	156		45				30			
Iler	2,662	9.9	3,770	20.6	25	3.8	735	18.1		
Low Divide			110							

NF Gales	1,013	3.8	935	5.1	50	7.7	220	5.4		
Prickett			70				55	1.4		
Roderick			40				5			
SF Gales	656	2.4	1,040	5.7			210	5.2		
Trib A			25		5					
White	1,463	5.5	75				90	2.2		
Inventory total	**26,805**		**18,340**		**650**		**4,055**			

- Percent contributions are indicated for only those sub-basins that contributed greater than 1% of the total.
- 20% visual bias included for coho expansion

(Table 9) Expanded Gales Cr Subbasin Number Estimates 2014

Stream	**Coho**	**%**	**0+**	**%**	**Sthd**	**%**	**Cut**	**%**	**Chin**	**%**
Gales	4,319	13.3	3,000	50	270	61.2	1,005	24.5	5	50
Side Channels	1,141	3.5	1		1		10			
Bateman	38		65	1.1	20	4.5	30			
Beaver	10,343	31.7	100	1.7			620	15.1		
Clear	7,628	23.4	710	11.8	135	30.6	665	16.2		
Coffee			195	3.2			60	1.5		
Finger			30				30			
Iler	7,188	22.1	675	11.2	5	1.1	885	21.5	5	50
Low Divide			40				15			
NF Gales	138		510	8.5			295	7.2		
Prickett	31		20				15			
SF Gales	438	1.3	630	10.5	10	2.3	325	7.9		
White	1,319	4	25				155	3.8		
Inventory total	**32,583**		**6001**		**441**		**4,110**		**10**	

- Percent contributions are indicated for only those sub-basins that contributed greater than 1% of the total.
- 20% visual bias included for coho expansion

Gales Cr Mainstem

In 2013 the Gales Cr mainstem inventory included 22.9 miles of stream habitat. The survey began at USGS RM 3.6 or the crossing of SW Ritchey Rd. In 2014 the inventory began at USGS RM 7 or the crossing of Stringtown Rd. The lower portion extending to the confluence with the Tualatin was not surveyed due to lack of summer rearing potential and poor visibility. In both 2013 and 2014 the mainstem survey terminated at an 8ft bedrock falls at USGS RM 26.5 functioning as a permanent anadromous barrier.

The Gales Cr mainstem was cited with several water quality limitations including five Category 5 303(d) listings for: dissolved oxygen (10/15-5/15, RM 0-23); chromium (year round, RM 4.5-27.7); lead (year round, RM 0-27.7); and iron (year round, RM 0-27.7). In addition, two Category 4A listings were made for: phosphorus (6/1-9/30, RM 0-11) and temperature (summer, RM 0-11). These pollutants are known to affect resident fish, aquatic life, anadromous fish passage, and fish spawning (DEQ Water Quality Oregon's 2012 Integrated Report).

The Gales Cr mainstem intersects an unusually broad range of geological formations along its reach of anadromous distribution. The deep alluvial deposits and fluvial terraces of the lower mainstem comprise most of the lineal stream miles, these are the floodplains currently exhibiting the majority of the subbasins agricultural interests. The upper forested reaches pass through a combination (moving upstream) of: tuffaceous siltstone/sandstone, a mafic intrusion of igneous basalt, Columbia River basalts, Yamhill formation siltstone/sandstone, and Tillamook volcanics.

Coho and steelhead distribution exhibited a strong preference for the siltstone/sandstone of the Yamhill formation in 2013. The 3 mile stream segment that interfaces with this formation reared 56% of all coho and 55.8% of all steelhead documented in the mainstem. Cutthroat and 0+ trout densities both exhibited an increase in abundance within the Yamhill formation but peaked in the Tillamook volcanics observed in the headwaters. In 2014, coho distribution varied with density peaks and abundance concentrated lower in the basin.

Steelhead distribution extended to USGS RM 24 in 2013 and USGS RM 25 in 2014 with no adult barriers observed blocking access to the additional miles of habitat available to anadromous migrants.

Coho distribution extended to USGS RM 22.5 in 2013 and USGS RM 21.9 leaving some of the highest quality fish habitat in the basin unutilized with no barriers to passage observed. This is an unusual distribution pattern when both coho and steelhead are known to push high in the basin to access spawning habitats. It is likely that during higher abundance years of adult escapement over Willamette Falls and/or favorable river level flow patterns during peak spawning periods, these headwater habitats would be more completely utilized for spawning and rearing.

The first three miles of the mainstem was characterized by: low gradient (0.2%); warm water (20.6 – 22.7 deg C); entrenched banks; deep, silty alluvial deposits; and large debris jams. No salmonids were observed in the lower 3 miles. Pike minnow, red sided shiners, dace and suckers were all abundant in the lower reaches of mainstem Gales. Notes indicated that the few sorted gravel tailouts present in the lower 3 miles were covered in algae and deeply embedded with silt and fines. Numerous irrigation pumps were observed as well as a visible decrease in flow and pool depth as the inventory progressed downstream. Summer temperature limitations in the lower mainstem likely related to irrigation withdrawal limits the distribution and production potential of salmonids. Mean daily temperatures at Stringtown Rd (USGS RM 7) exceeded 17.8 deg for almost all of July and August in 2012 and peaked at 23.7 deg on August 17, 2012. The distribution of salmonids was described by surveys conducted between July 24 and 27 for 2013 and. In 2014 the inventory did not extend downstream of Stringtown Rd.

The next several miles exhibit an increase in gradient to 0.45% as well as higher flows and improved pool / riffle ratios as the channel rises out of the alluvial deposits and into a siltstone/sandstone dominated substrate. Notes indicated clean sorted gravel in tailouts and long cobble riffles in between pools. Coho, steelhead, and cutthroat are first observed in significant numbers around USGS RM 8. In 2014 a secondary coho density peak of 0.32 fish/sqm and a high pool count of 517 was documented at USGS RM 10.25 (below the Cox Rd bridge). This same reach exhibited very low abundance of coho in 2013. In 2014, Sub-yearling chinook (photo 1) were first observed at USGS RM 9.9 and again at USGS RM 11.8 in a non-random pool that exhibited high wood complexity, deep scour, side channel habitat and cold water seeps of hyporheic flows both upstream and downstream of the observed wood complexity (no specific temperature data was collected because the cool ground water influence felt by the immersed surveyor was easily mixed by disturbance).

Photo 1 Chinook and Coho parr

There were 4 significant tributaries offering potential cold water refugia in the temperature transition zone between USGS RM 6 and USGS RM 13: Pricket Cr enters at USGS RM 6.5, 2.2˚C cooler (in 2014) than the mainstem with a seasonal irrigation dam just above the first pool blocking any upstream temperature dependent migration of salmonids; Roderick Cr enters at USGS RM 7.7 through a broad solar exposed wetland exhibiting extensive solar exposure (no thermal refugia currently present) and completely dry at confluence in 2014 (Photo 2), evaporation in the broad wetland development is the likely vector for loss of connectivity at its confluence with the mainstem of Gales Cr; Clear Cr enters at USGS RM 10.66, 2.8˚C cooler (in 2014) than the mainstem above with the first pool exhibiting coho and cutthroat densities among the highest observed in the entire Tualatin basin (distribution suggests the existence of upstream migration from the mainstem to seek thermal refugia); and Iler Cr enters at USGS RM 11.4, 1.3˚C cooler (in 2014) than the mainstem. A series of concrete steps (see Iler Cr discussion) impedes upstream migration from the mainstem for thermal refuge 580ft above its confluence with Gales Cr.

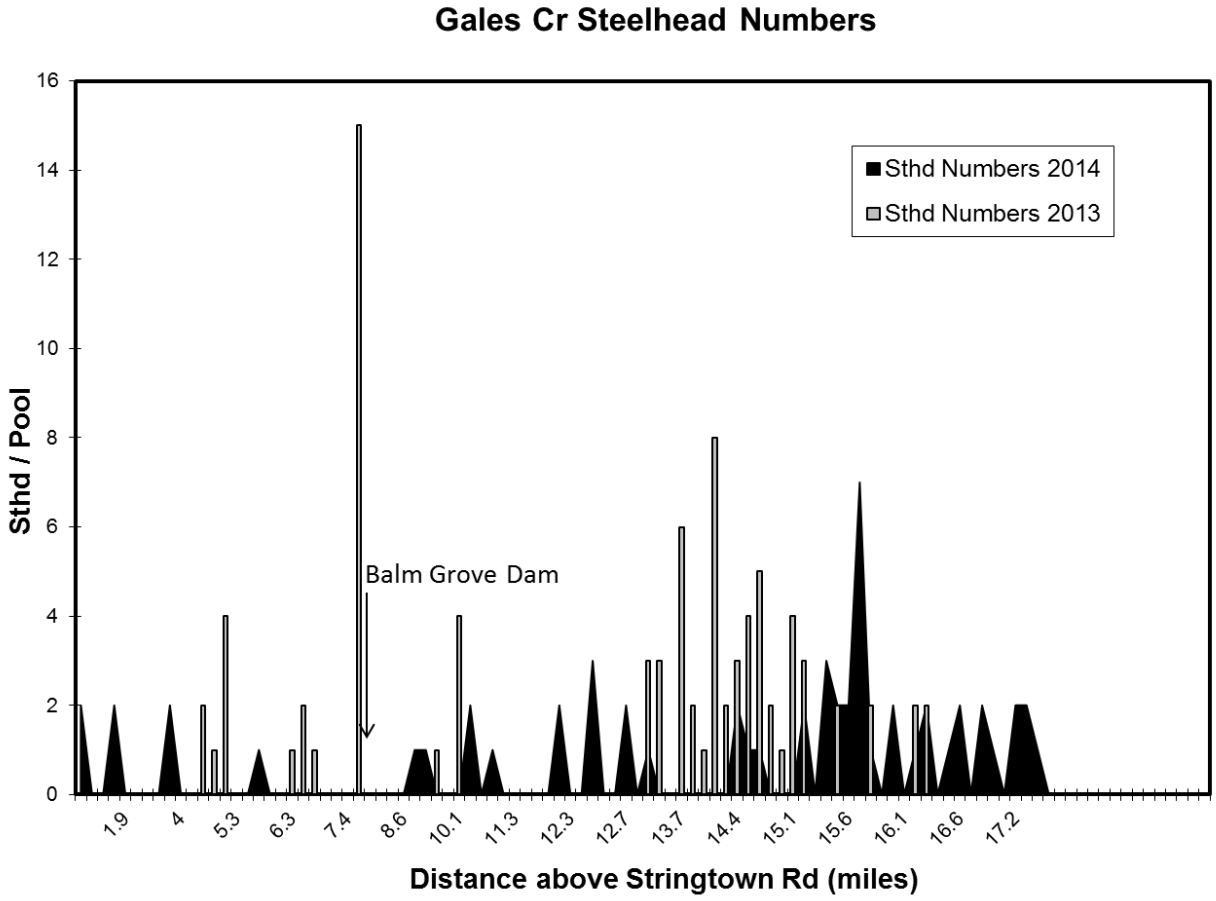
Photo 2 Roderick Cr 2014

Upstream temperature dependent migrations within the mainstem of Gales Cr are terminated just below Parsons Rd at USGS RM 12.7 at the 3ft high Balm Grove dam (Photo 3). A density spike of steelhead and cutthroat trout were observed at the base of the falls in 2013 (figure 3). This is an indicator of both the existence of a temperature limitation in the mainstem at this milepost and unsuccessful attempts to migrate past the vertical obstruction. With a good jump pool below this is not a winter barrier for large adult salmonids but it likely truncates access to the upper basin for late spawning fluvial Cutthroat because of their smaller size that limits their vertical range (spawning period extends from December – May). The barrier may also complicate passage for adult coho arriving before significant fall rain events. Coho distribution profiles in 2014 suggest that in years of inadequate fall rains the Balm Grove dam limits adult access to the upper basin and its tributaries. Though coho abundance in mainstem Gales exhibited an 89.9% increase in abundance from 2013-2014, there was a 60% decline in coho parr observed rearing in mainstem habitats above the dam. In addition, the

tributaries entering above the dam (Bateman, Beaver, NF, SF, and White) all exhibited declines in abundance while tributaries below the dam (Clear, Iler, and Pricket) all exhibited increases in abundance. The month long period from mid-September to mid-October encompassed the peak coho escapement over Willamette falls for 2012 and 2013 accounting for approximately 86% of the total escapement over the falls in both years. Review of USGS gage height and discharge data for EF Dairy Cr (a comparable system) show a clear difference in flow patterns between the two years. In the fall of 2012 there were several significant flow events between October and late November that raised baseline discharge to over 100 cfs, more than ten times that of summer discharge (around 10 cfs). These events exhibited peaks between 600 – 1000 cfs. These levels continued throughout the three month period following peak escapement over the Willamette falls. This encompassed the critical migration and spawning period for Willamette coho. In 2013, only a few isolated flow events occurred within this same three month period that raised the baseline discharge to just 35 cfs with peaks between 140 – 180 cfs. This pattern continued until mid- February of 2014. The inter annual comparison of coho distribution suggests that the Balm Grove dam exists in the zone of documented active upstream juvenile migrations to escape temperature limitations in the lower mainstem of Gales Cr and terminates that migration. In addition, during low fall flow regimes the Balm Grove dam also appears to limits passage for adult coho.

Photo 3 Balm Grove Dam

Figure 1

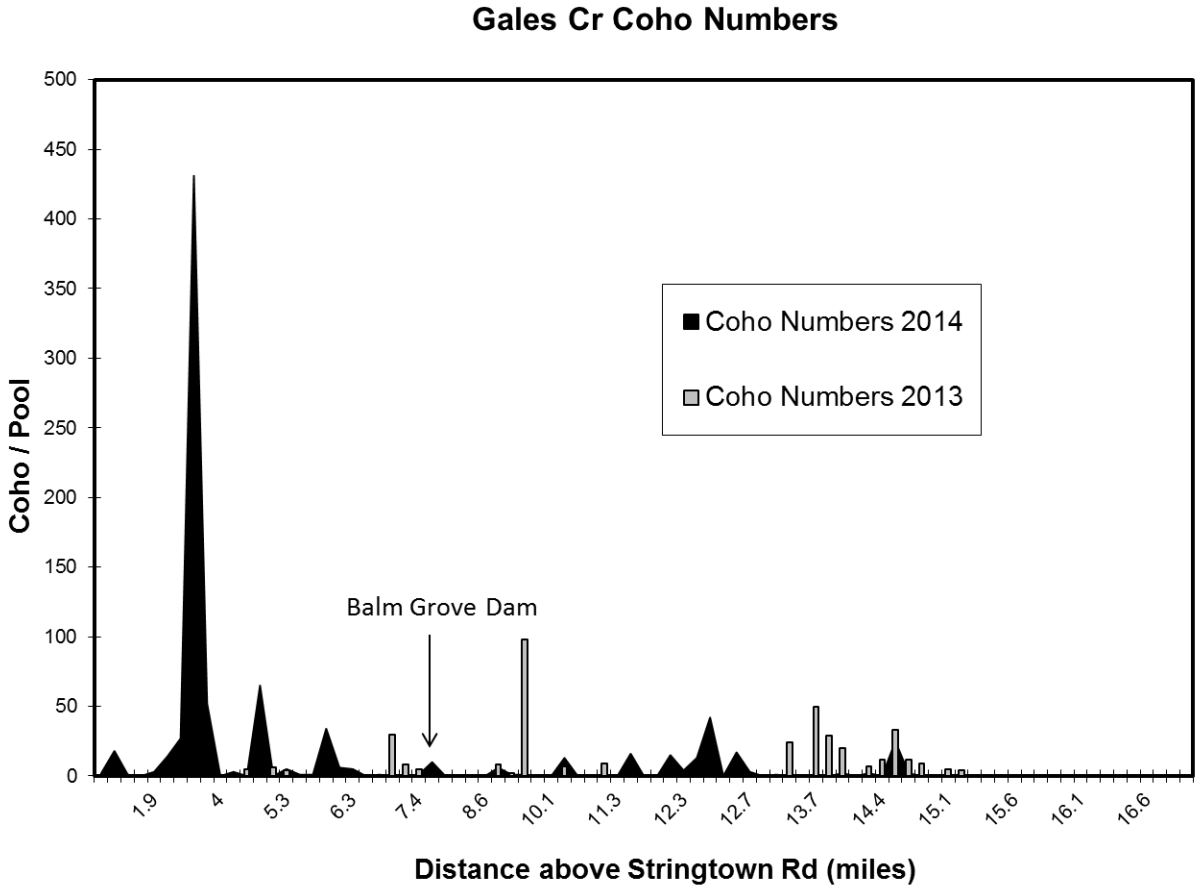


Above the dam the channel morphology transitions to siltstone/sandstone, exposed bedrock and deep basalt trench pools. At USGS RM 14.3 Side Channel A provided 9 pools of high complexity off-channel habitat that extended 520 ft. Though connectivity with the mainstem was maintained within the side channel (not preferred) with a minimal temperature differential between the Gales Cr mainstem and the side channel, four beaver dammed pools were documented establishing thermoclines of cold stratified water that effectively provided thermal refugia to juvenile salmonids. Most undisturbed juvenile salmonids observed in temperature limited stream reaches are observed utilizing the colder water settling below and established thermocline. High coho densities averaging 1.3 fish/sqm were observed in the side channel along with an abundance of 1,084 coho (visual bias included). One steelhead and nine cutthroat were also documented in the 100% pool sample. This 520 ft of stream habitat was by far the most productive (for coho) within the Gales sub-basin. Very few salmonids were

documented in the adjacent mainstem habitat. Due to year to year differences in landowner access, Side Channel A was not sampled in 2013. It is clear that even the smallest pockets of thermal refugia are highly utilized by juvenile salmonids and that the preservation and augmentation of these micro habitats is critical for pinch period survival.

White Cr enters at USGS RM 14.4 as a cold water contribution 2˚C cooler (in 2014) than the mainstem above. A 1ft perch created by a concrete sill on the Highway 8 culvert that crosses White Cr was terminating upstream temperature dependent migrations into White Cr from the mainstem of Gales Cr.

Figure 2



Bateman Cr enters at USGS RM 16.25 as a cold water contribution 2.4˚C (in 2014) cooler than the mainstem above. Coho appear to also be utilizing Bateman Cr as a source of cold water refugia from the mainstem of Gales Cr. A series of 3-4ft bedrock falls was encountered approximately 1,100 ft above the confluence of Bateman Cr in the mainstem of Gales Cr that represent the end of upstream migrations of juvenile salmonids for thermal refugia. The spatial relationship between this natural juvenile barrier and any cold water tributaries directly downstream is important in understanding how to prioritize restoration actions. Because mainstem Gales Cr is temperature limited for salmonids during summer flow regimes, providing unimpeded access to any cold water refugia (regardless of its size) in the tributaries nearest this terminus (Bateman Cr, White Cr) directly addresses a primary limiting factor for multiple salmonid species. CWS temperature monitoring at Clapshaw Hill Rd

(USGS RM 12.4) in 2012 documented a max temp of 21.8 C on August 17 and the mean daily temperature exceeded DEQ standards 14 days in July and 18 days in August. Summer temperature limitations probably continue significantly further upstream than USGS RM 12.4, however the actual transition to a functional summer reach for salmonids is not well bracketed with temperature data.

Beaver Cr enters within the reach accessible to temperature dependent upstream migrants at USGS RM 18. However, Beaver Cr enters Gales Cr with a similar summer temperature profile as the mainstem of Gales Cr rendering it an unlikely destination for upstream temperature dependent migrations. Salmonid distribution profiles in lower Beaver Cr support this conclusion (see Beaver Cr discussion). Beaver Cr and its tributaries were the largest producers of coho in the Gales Cr basin (over 5 times greater than the mainstem of Gales Cr).

Channels scoured to bedrock and deep basalt trench pools continue to another 4 ft. bedrock falls at USGS RM 19.75 (just below Coffee Cr). The low salmonid abundance observed in all of mainstem Gales Cr continues to persist to the confluence of Coffee Cr. Juvenile salmonids rearing between Bateman and Coffee Cr become isolated from thermal refugia because there are no cold water tributaries entering within the reach and multiple natural barriers deny them an escape route to the upper basin. The lack of cover in the form of wood or substrate complexity exacerbates the thermal limitations and likely reduces survival in the reach.

The next few miles encompass the most productive mainstem fish habitats as Gales Cr transitions out of the scoured bedrock of the Columbia River Basalts into the siltstone/sandstone of the Yamhill Formation. Significant increases in coho, steelhead, and cutthroat abundance were observed in this stretch between years. Coffee Cr and Finger Cr enter just above the juvenile barrier documented above. Both exhibited steep confluences and no evidence of upstream temperature dependent juvenile migrations. Landowners restricted access to a few thousand feet of Gales Cr above the confluence of Finger Cr. Surveyors returned to a channel braided across a wide floodplain just below the confluence of SF Gales. SF Gales enters at USGS RM 20.7 and was receiving upstream migrant juvenile coho from the mainstem of Gales Cr (thermal refugia).

Just above the confluence of the SF Gales Cr at USGS RM 20.8 the highest mainstem coho density for 2103 was observed at 0.7 fish/sqm. This density was still well below full seeding levels (1.7 fish/sqm, ODFW). In very close proximity (USGS RM 21.3) the highest steelhead density for 2013 was observed at 0.25 fish/sqm. In 2014 this reach exhibited a marked decrease in coho abundance with lower densities and intermittent pool presence. The primary coho density peak in 2014 was documented at 0.33 fish/sqm near the confluence of NF Gales Cr (USGS RM 21.7). Coho distribution in 2014 ended shortly above this density peak at USGS RM 21.9. Cutthroat numbers begin to climb in this reach and a noticeable increase in the abundance of older age class cutthroat was observed. The gradient throughout this peak production reach averaged 1.5%.

At the confluence of NF Gales Cr at USGS RM 21.7 a 0.8 mile reach treated with LWD begins in the mainstem of Gales Cr. A broad and interactive gravel floodplain with treatment logs was developing excellent channel complexity (braiding) and bedload aggradation was occurring. The structures were a good mix of high and low profiles for engaging and interacting with both summer and winter flow regimes. Treatment logs were associated with several sampled pools. At USGS RM 22.5, just above the treatment reach, a log jam forming a significant deposition plain storing large quantities of migratory bedload. This jam was the end of coho distribution in 2013. The channel above the jam is braided through a historical alder flat (dead and still standing, photo 4). In 2013, Steelhead distribution continued above the jam but became sporadic above the treatment reach and ended at USGS RM 24. In 2014 Steelhead distribution extended an additional mile to USGS RM 25 terminating at the base of a

two foot sill log. In this uppermost pool the highest steelhead density was documented at 0.1 fish/sqm. No barriers to steelhead passage were observed near the end of their distribution.

Photo 4 High quality habitat above the current end of coho distribution

The inventory extended several miles above the current end of anadromous distribution through what was the highest quality summer rearing habitat in the basin. A decrease in gradient to1% was noted around the confluence of Low Divide Cr (within the Gales Cr campground). Extensive channel braiding, high wood complexity, and a mature riparian canopy were all noted throughout the next 2 miles with a final increase in gradient to 2.2%. Trib A enters at USGS RM 23.6 with high flow, cold water and very low numbers of steelhead parr in 2013. In 2014 steelhead were not observed in Trib A.

In the last 1.5 stream miles, mainstem flows rapidly diminish with each tributary contribution. Pools become isolated from each other and are summer linked only hyporehicly. Cutthroat and 0+ trout densities climbed throughout this stretch with a peak cutthroat density in 2013 of 1fish/sqm at USGS RM 25.8 and a peak 0+trout density of 2.9 at USGS RM 25.4. In 2014 a peak cutthroat density of 2.6 fish/sqm and high count of 72 was documented at USGS RM 26 in a deep, highly complex, non-random plunge pool. In 2014 a peak 0+ trout density of 1.94 fish/sqm was documented at USGS RM 25.7. Though these values represent fully seeded pool capacities the lack of riffle habitat (photo 5) has concentrated the fish populations in pool habitats boosting summer density profiles. These density values were among the top 4 highest densities recorded in the entire Tualatin basin.

Gradients continue to increase to an average of 3.7% near the end of the surveyed stream reach. There was also a decrease in pool complexity and an increase in the d50 for the dominant cobble

substrates. In both years the survey terminated at an 8 ft. bedrock falls above a canyon pinch at USGS RM 26.5.

Photo 5 Isolated pools in treatment reach

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	2,275	.13	8,205	430	1,585	0
2014	4,319	.08	3,000	270	1,005	5

Bateman Cr (tributary of Gales)

Bateman Cr joins mainstem Gales Cr at USGS RM 16.3. The Bateman Cr survey extended 0.6 miles. Coho were observed in low densities for 0.5 miles and ended at a 3ft high sill log pour. This was most likely not a mid-winter barrier for steelhead but may be functioning as a low flow fall barrier for coho adults. Two culverts were observed that definitively terminate upstream temperature dependent juvenile migrations from the mainstem of Gales Cr. The first was observed at RM 0.42 (Photo 6) and was perched 1.5 ft. The second exhibited a 1ft perch and was above the current extent of coho distribution at RM 0.6.

Photo 6 (Turbidity generated by surveyor)

In 2013 pool densities for coho averaged 0.32 coho/sqm with the highest density of 0.8 coho/sqm observed below the perched culvert at RM .42. An expanded estimate of 175 coho parr was observed in Bateman Cr in 2013 and 38 in 2014. Low coho numbers above the juvenile barrier in photo 6 indicate that a single pair of coho spawned in Bateman Cr above this road crossing in 2013. Decreased abundance in 2014 and no coho parr observed above the barrier indicate that the observed coho were the result of an upstream temperature dependent migration from the mainstem of Gales Cr. This suggests no spawning occurred in Bateman Cr in 2014.

0+ trout numbers were low with an average density of 0.5 fish/sqm in 2013 and 0.3 fish/sqm in 2014.

Steelhead were observed in 2014 below the first culvert barrier, an indication of an upstream temperature dependent migration from the mainstem of Gales Cr.

Water temperatures in Bateman were 2.5˚C lower in 2014 than observed in mainstem Gales Cr above its confluence. The presence of a series of natural bedrock sills in the mainstem of Gales Cr just above the confluence of Bateman ramps up the prioritization of this culvert replacement for unimpeded access to cold water refugia for juveniles rearing in mainstem Gales Cr. Substrates were dominated by silt and cobble, no well sorted spawning gravel was observed. Fish distribution patterns indicate that Bateman Cr is serving as cold water refugia for juveniles migrating out of mainstem Gales. The lack of sorted gravels combined with heavy silt loading suggest that it’s not a productive target for adult

spawning. Its greatest significance is its cold water contribution and the spatial relationship to the morphological end of upstream temperature dependent juvenile migrations.

Differences in landowner permission for access between years renders a direct inter annual comparison of production irrelevant.

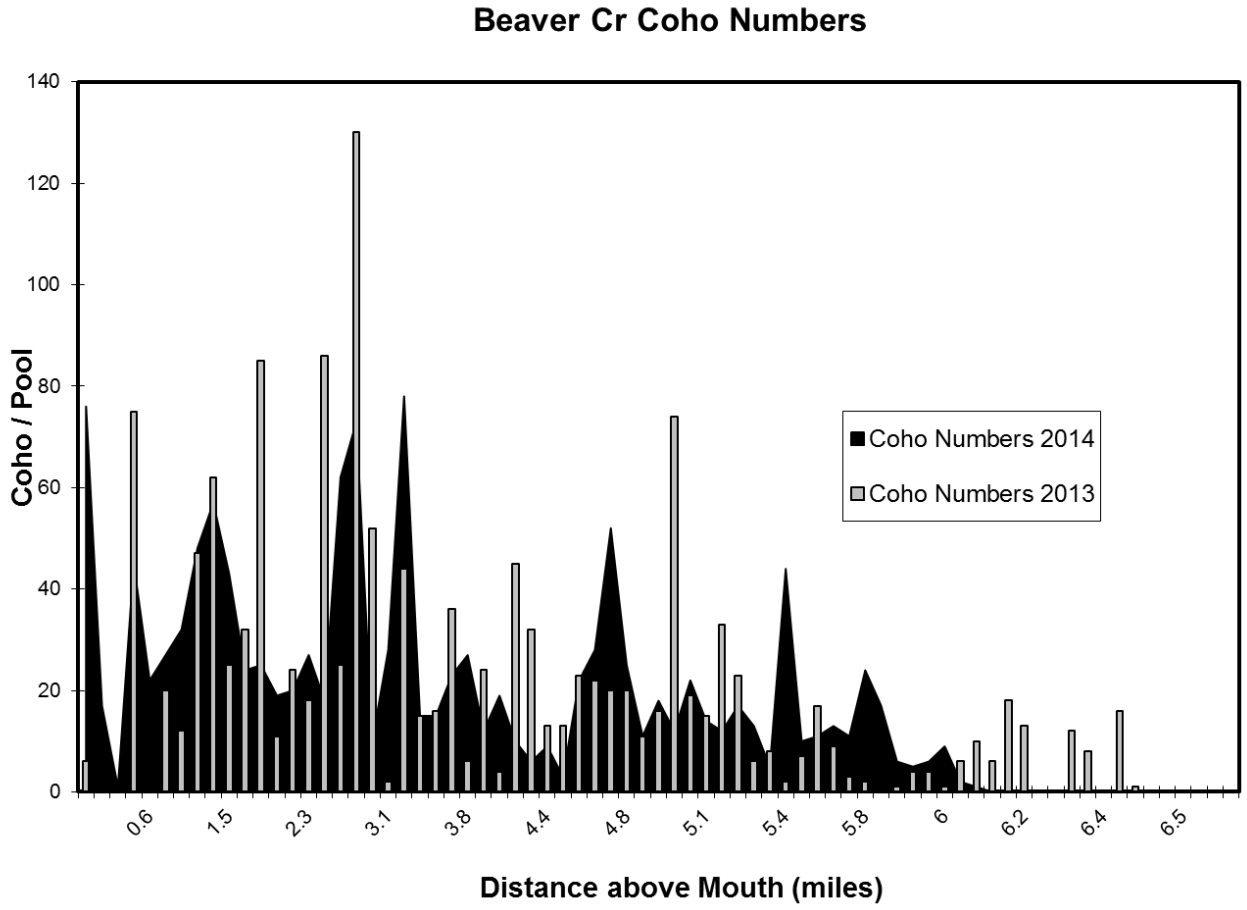
Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	175	0.32	250	0	115	0
2014	38	0.51	65	20	30	0

Beaver Cr (Tributary of Gales)

Beaver Cr enters the mainstem of Gales Cr at USGS RM 18. Beaver Cr is the largest of the Gales Cr tributaries and exhibited an anadromous distribution that extended 6.5 stream miles in 2013 and 5.8 miles in 2014. Coho distribution in 2013 terminated at a series of ephemeral sill log barriers. In 2014 coho distribution terminated below a 1.5ft beaver dam with reduced flows in the stream above the dam observed in 2014. Anadromous potential however, continued above these barriers in both years.

Coho densities peaked at RM 6.2 at 1.9 coho/sqm in 2013 and 0.84 coho/sqm in 2014. In both years, even though peak densities were observed high in the basin (associated with spawning location), the peak production was occurring in the middle half of the distribution with more than twice as many fish/mile observed between RM 1.8 and RM 5.2 (figure 3).

Figure 3



The entire Beaver Cr subbasin contains at least 9.6 miles of stream habitat accessible to anadromous fish. This includes 6 tributaries labeled A – F in the Excel Pivot table workbook (available through TRWC). It should be noted that limited access prevented a full inventory of Tributary A. Tributaries A, B, and C made significant contributions to the total population estimate and will be reviewed separately below. The fish population estimates for Tribs D, E and F are included in the mainstem Beaver Cr totals. Trib D enters at RM 5.5. Low densities of Coho were observed utilizing the first pool of Trib D below a 4ft perched culvert (inaccessible). Trib E enters at RM 5.9 and contributes approximately 40% of the flow at its confluence. In 2013 Coho were only observed in the pool below a rusted out culvert perched 1.5ft above the stream channel just above the confluence (inaccessible). In 2014 coho were not observed in Trib E. Trib F enters at RM 6.4. An expanded estimate of 50 coho parr were utilizing 0.2 miles of stream habitat in Trib F. A juvenile barrier created by a root wad ended their distribution. In 2014 coho were not observed in Trib F.

Beaver Cr was the largest producer of coho in the Gales Cr subbasin. The 2013 expanded estimate of 12,700 coho parr represents 47.4% of all coho observed rearing in the Gales Cr subbasin. Back calculations from the standing crop of summer parr observed in 2013 suggest an escapement of 57 spawning pair of adult coho to Beaver Cr and its tributaries. The 2014 expanded estimate of 10,343 was an 18.6% drop in total coho abundance and comprised 31.7% of total estimated population for the Gales sub-basin. Back calculations for 2014 suggest total adult escapement of 47 pairs of adult coho. The low gradient (averaging 0.6%), siltstone/sandstone dominated channel morphology, high wood

complexity (photo 7) and mature riparian canopy provided favorable conditions for successful coho production in the Beaver Cr drainage.

Photo 7 High Quality Coho / Cutthroat Habitat

0+ trout and cutthroat abundance were low throughout the inventories in both years. 0+ trout and cutthroat distribution trends in 2014 were consistent with those observed throughout the rest of the Gales Cr basin. 0+ trout exhibited a 77.2% drop in abundance while cutthroat exhibited a 72.2% increase in abundance. The Beaver Cr mainstem exhibited the most dramatic change in cutthroat abundance for all of the 2014 inventoried streams of the Tualatin basin with a 97.7% increase documented.

There were no steelhead parr observed rearing in the Beaver Cr system. The habitats here favor the niche exploited most effectively by coho and cutthroat. The large cobbles and higher gradients preferred by steelhead were not present.

Heavy tannins resulted in poor visibility in the lower mainstem, reducing confidence in the observations provided by the snorkel methodology. This suggests that the expanded estimates underestimate the actual population of coho parr as well as the back calculated adult escapement estimates.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	8,750	.38	310	0	225	0
2014	8,137	.35	35	0	435	0

Trib A (Tributary of Beaver)

Tributary A joins the mainstem of Beaver Cr at Rm 0.7. This is just above the beginning of coho distribution in the mainstem. Trib A provides low summer flows and is low gradient.

Eight beaver dams were encountered as the stream channel meanders across a wide and exposed floodplain (legacy beaver flat). Substrates were dominated by silt and Reed Canary grass overwhelms adjacent floodplain terraces here. Above the functional beaver swamp, the habitat is described as transitioning to well sorted gravels, a conifer dominated riparian canopy and a highly sinuous channel form displaying high wood complexity. These are high quality habitats for coho and cutthroat in particular because they provide for each of their seasonal life history needs (spawning and incubation from gravel retention, large summer surface areas with thermocline development for the provision of thermal refugia and low velocity winter refuge related to the impoundment caused by beaver dams).

Coho numbers were high in 2013 throughout the 0.3 mile survey with an average density of 2.75 coho/sqm. In 2013 the peak density of 4.3 coho/sqm was observed at RM 0.3. Coho abundance decreased dramatically in 2014 with a peak density of 0.65 coho/sqm observed 435 ft above the confluence. Trib A had the highest average density observed in the Gales Cr subbasin for 2013. A lack of landowner permission at RM 1.4 prevented the survey from describing the full extent of salmonid distribution. The trend in abundance suggests that the peak production zone may have been above the current survey endpoint. Based on a topographic review (USGS), it is unlikely that coho production persisted for more than an additional 0.5 miles.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	588	2.75	10	0	30	0
2014	50	.4	5	0	30	0

Trib B (Tributary of Beaver)

Tributary B enters mainstem Beaver Cr at RM 3.3. The inventory of Trib B extended 1.2 miles to the end of Coho distribution. With an expanded estimate of 1,681 coho in 2013 Trib B was the largest tributary producer of coho within the Beaver Cr subbasin. In 2014 coho distribution was similar to 2013 but abundances decreased by 46%. A failed culvert perched 4in and rusted through the bottom was observed blocking upstream juvenile migration 290ft above the Beaver Cr confluence.

The channel morphology was described as low gradient and sinuous with a gravel dominated substrate and high wood complexity. In 2013 coho distribution in Trib B exhibited a spawning peak

(3.1 coho/sqm) at RM 0.75. This peak in density overlapped an area with extensive beaver use. In 2014 coho densities peaked at 0.77 coho/sqm at RM 0.2. Coho abundance continued to decline above RM 1 as the gradient increased. The upper end of current distribution transitions to a cobble dominated stream bed and a more hillslope confined channel. No adult barriers were observed.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	1,681	1	65	0	50	0
2014	906	.22	35	0	110	0

Trib C (Tributary of Beaver)

Trib C joins mainstem Beaver at RM 3.5. The inventory extended 0.7 miles to the confluence of Trib C1. Trib C1 continued for 0.5miles contributing the majority of the flow to the system and containing the remainder of stream habitat with anadromous potential. In Trib C no Coho were observed above the C1 confluence as it quickly entered a zone of legacy beaver activity with several large dams in a broad swamp. The abundance data for Trib C and C1 have been combined for consistency in the table below. Coho distribution extended 1.3 miles.

The stream habitat throughout the lower portion of the survey was described as low gradient and sinuous with a solar exposed channel meandering across a wide floodplain with low interactive winter terraces. In 2013 the highest coho density of 3.4 coho/sqm was observed at RM 0.9, 63.2% of the total Coho observed, were rearing it the lower ½ mile. In 2014 the highest coho density of 1.56 coho/sqm was observed at the confluence of C1 at RM 0.7 and fish abundance was more evenly distributed.

Throughout the survey 3 culverts were observed as barriers to upstream juvenile migration. The 1st culvert, just up from the confluence at the crossing of Timber Rd, is perched 4in and rusted out. All of the summer flow was observed passing through the floor of the culvert and not out the end. Adult passage through this culvert was also compromised by steel bars on the inlet end that trap debris and subsequently plug the culvert, denying adult access to spawning habitat. Coho were observed in high concentration in the pool below this culvert, indicating that the culvert also terminates upstream temperature dependent juvenile migrations to thermal refugia.

The 2nd culvert, located at RM 0.23, is perched 1.5ft, undercut and rusted out. The deep plunge pool below this culvert and high tannin levels resulted in low confidence in the abundance estimate for this habitat unit which did not allow verification of the presence or absence of an upstream migration pattern. The 1.5ft perched pipe is however a definitive barrier to upstream juvenile migration.

The 3rd culvert was observed in Trib C1, 185ft above the confluence with Trib C. These two side by side steel culverts were completely rusted out with all flow passing underneath. The inlets were packed with debris along with a 1ft sill log. This culvert is located in the reach of the highest Coho densities.

Visibility was poor for the 1st 0.3 miles of the survey. This was attributed to a zone of extensive beaver use. It is likely that abundance estimates underestimate the actual abundance in this reach.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	1,681	1.08	40	0	55	0
2014	1,250	.48	25	0	30	0

Clear Cr (Tributary of Gales)

Clear Cr joins the mainstem of Gales Cr at USGS RM 10.6. The Clear Cr inventory extended 3.3 miles to just above a steep 10 ft. bedrock cascade that terminates anadromous access (photo 8). Clear Cr was one of the top 3 producers of salmonids within the Gales Cr sub-basin in both inventoried years.

Photo 8

The confluence of Clear Cr exists within the temperature limited reach of the Gales Cr mainstem. The spatial location of the Clear Cr confluence with the mainstem identifies it as an important source of thermal refugia for juvenile salmonids during the summer temperature pinch period. Temperature data collected during the 2014 surveys recorded Clear Cr entering at 15.7˚C with Gales Cr at 18.5˚C above its confluence. In addition, a temperature of 16.6˚C was recorded in the center of the mainstem pool which Clear Cr empties into. In this pool a high count of cutthroat trout was observed with several exceeding one foot in length. This data was collected at 11:00 am on August 20, 2014. The protection, conservation and enhancement of water quality in Clear Cr and the Clear Cr alluvial fan at its

confluence with Gales Cr is critical for the survival and persistence of salmonids in all of the Gales Cr subbasin. The maintenance of its current contribution of cold water and high complexity stream habitat should be ranked highly on basin scale reviews of goals and objectives.

Very high fish densities in the first pool above the confluence of Gales Cr indicate the presence of a definitive upstream migration out of mainstem Gales Cr. As Clear Cr climbs out of the influence of the Gales floodplain, a bedrock intrusion that forms a cascade appears to function as a natural barrier to upstream juvenile migration (photo 9). This raises the importance of the development of a habitat enhancement strategy for those habitats in Clear Cr that exist between the confluence of Gales Cr and the bedrock intrusion 800 ft upstream.

Photo 9

A one mile reach of stream habitat treated with LWD extends from RM 1.3 to 2.3. The restoration completed by the TRWC occurred in 2012. An RBA snorkel inventory was conducted for the treatment reach on 9/10/12 prior to the projects execution. The 2013 inventory was conducted one month earlier on 8/6/13 and the 2014 inventory on 8/29/14. In a comparative review of pre and post treatment affects a few elements stand out.

1) Steelhead were not observed in 2012. Within the treatment reach, there was an expanded estimate of 30 sthd in 2013 and an expanded estimate of 60 sthd in 2014.
2) 0+ trout numbers have exhibited erratic year to year fluctuations in abundance that suggest a larger basin scale impact is driving their abundance.
3) Coho numbers increased dramatically from 2012 to 2013 and 2014. The one mile treatment reach comprised 30.3% of the lineal distance of anadromous distribution and was observed rearing 47% and 40% of the total population estimate for the Clear Cr system in 2013 and 2014. Multiple treatment reach effects may be in play, higher egg to fry survival rates, higher quality summer rearing habitat associated with the increase in wood complexity and a potential increase in the abundance of spawning gravel (spawning gravel abundance was not documented pre project).
4) Cutthroat numbers declined by 33% in the first post treatment inventory (2013) and increased by 131% in the second post treatment inventory (2014). These fluctuations may be related to differences in migration patterns for fluvial components of the Gales Cr Meta population of cutthroat that can vary widely between years as a result of differential flow and temperature. However, the 27.4% increase in relative subbasin scale abundance within the treatment reach between 2013 and 2014 suggests an increase in rearing potential within the treated reach is being expressed.

(Table 10) Expanded Clear Cr Comparison for Treatment Reach

Years	coho	0+	steelhead	cutthroat
2012	631	410	0	195
2013	2,669	1,000	30	130
2014	3,044	225	60	300

- 20% visual bias included for coho expansion

Coho were observed in 2013 at a peak density of 6.25coho/sqm and a high count of 245(visual bias included) in the first pool. This was the 2nd highest density observed in the Tualatin basin. In 2014 the surface area of this high quality habitat expanded into two larger pools and densities of 1.36 coho/sqm and 1.27 coho/sqm were observed with a combined total of 416 coho. The 2013 spawning peak was observed at RM 1.75 with a peak density of 1.7coho/sqm and the 2014 spawning peak at RM 2.2 exhibited a peak density of 2.8 coho/sqm. These spawning peaks both occurred within the LWD treatment reach (Photo 10). Back calculation of expanded population estimates suggests an adult escapement of 26 pairs of coho in 2013 and 34 pairs in 2014.

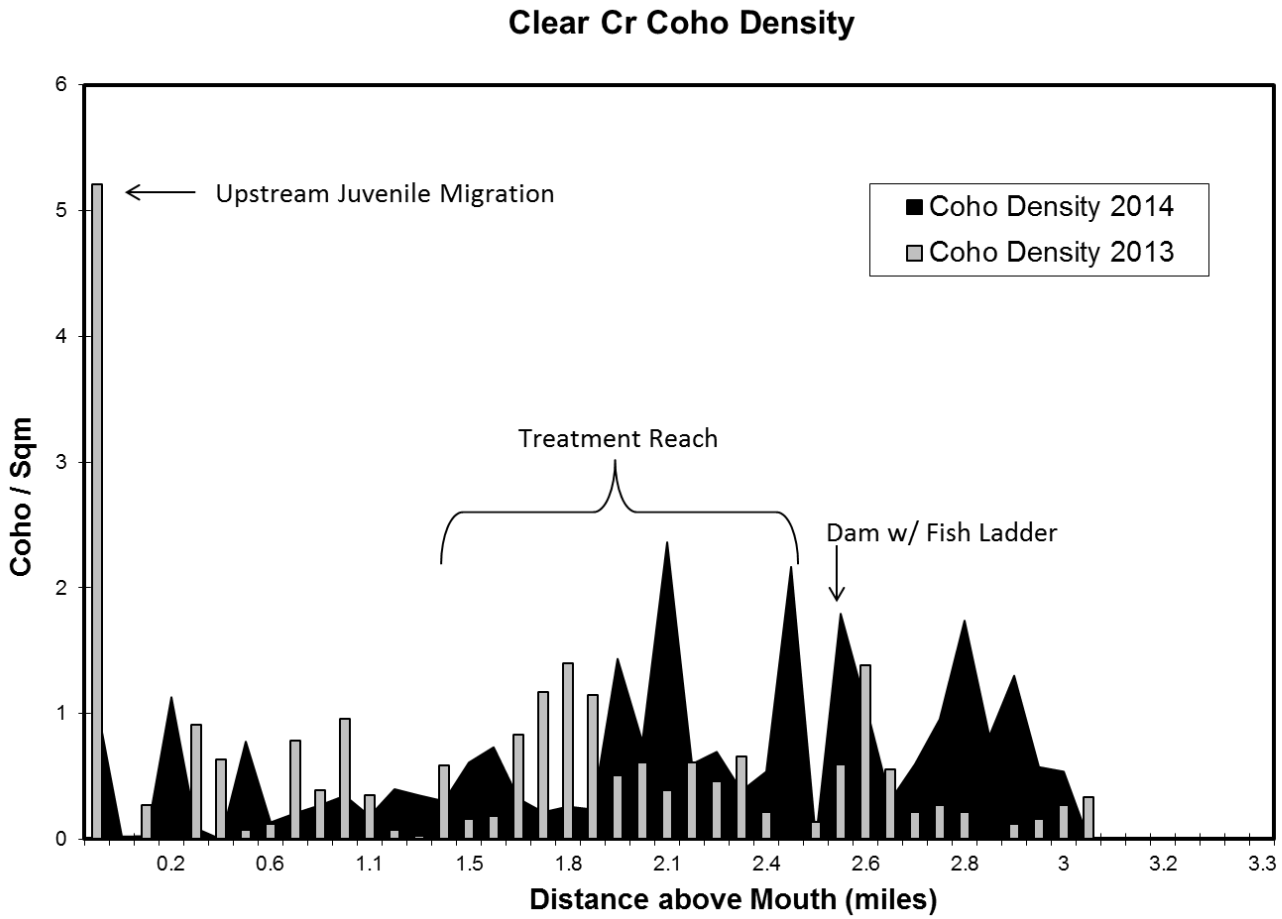
Steelhead were observed in 2013 at a peak density of 0.23 sthd/sqm in the first pool and in 2014 at a peak density of 0.09 sthd/sqm at RM 0.35. Though these values are well below the habitats capacity, they were among the highest values observed in the Gales subbasin for both inventoried years. Steelhead numbers were low and sporadic both years, persisting to the end of anadromous potential in 2013 and ending within the treatment reach in 2014. Clear Cr exhibited the highest abundance of steelhead among all of the tributaries in the Gales subbasin for both inventoried years.

In 2013 cutthroat were observed at a peak density of 1.0 fish/sqm and a very high count of 37 was observed in the first pool (upstream migrants from Gales Cr). In 2014 this pool was relatively vacant of cutthroat. Abundance was low throughout the remainder of the inventory averaging 0.1 fish/sqm (167 fish/mile) in 2013 and 0.13 fish/sqm (184 fish/mile) in 2014.

0+ trout abundance was moderate in 2013 averaging 0.54 fish/sqm (816 fish/mile). In 2014 a 78.6% drop in abundance from the previous year was observed with an average density of 0.16 fish/sqm (177 fish/mile) documented. This drop in abundance is consistent with that observed throughout the other inventoried sub-basins of Gales Cr. In both years the highest pool densities were observed in the upper 0.75 miles of stream habitat.

Photo 10

Figure 4

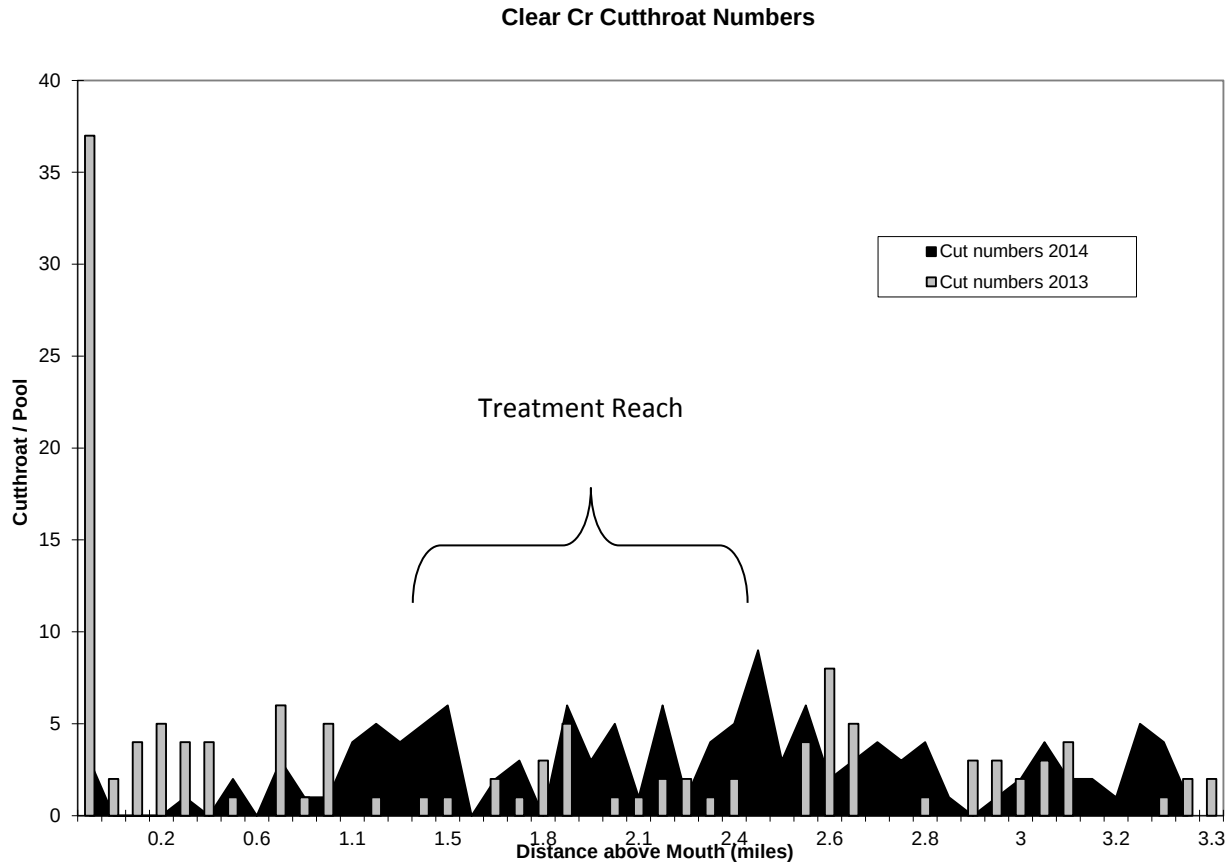


Clear Cr provides a municipal water supply to the city of Forest Grove. The concrete diversion and intake dams on Clear Cr and Roaring Cr exist within the range of anadromous fish distribution. The Clear Cr structure is outfitted with a fish ladder for passing adult salmonids. The progeny of both coho and steelhead were observed rearing above the diversion dam indicating successful adult passage. A significant increase in coho abundance was observed above the dam in 2014, likely due to the observed increase in adult escapement in 2014 (31%). In 2013, 10.2% of the total Clear Cr coho population was observed rearing above the dam, in 2014 this increased to 16.8%. Part of the instream treatment project conducted by the TRWC in 2012 installed a graded riffle below failing sill log structures that was designed to lift the elevation of the active channel and improve adult passage to the Clear Cr dam and fish ladder. Improved utilization of the headwater reaches of Clear Cr for spawning and rearing may be in part related to this modification. The concrete dam on Roaring Cr is not outfitted with a passage structure and terminates both adult and juvenile passage. Above the dam, the high gradient, cobble/boulder dominated stream habitat offers limited anadromous potential and a 20 ft boulder falls at RM 0.5 naturally terminates anadromy.

Due to operational challenges, no water was withdrawn from the Clear Cr intake structure during the summer of 2014. This effectively led to an increase in summer flow volume within the system

during the period of peak thermal load. This appears to have expanded the potential for the upper mainstem of Clear Cr to provide thermal refugia above the alluvial fan that was providing hyporheic cooling at the mouth that exhibited such high densities in 2013. This appears to have triggered fluvial cutthroat to migrate higher in the basin for thermal relief and be responsible for the increase in cutthroat abundance observed in the treatment reach in 2014. This explains the lack of cutthroat observed in the lower pools of Clear Cr in 2014 and the increase in cutthroat abundance observed in the Gales Mainstem pool below the confluence of Clear Cr.

Figure 5



Thomas Cr enters Clear Cr at RM 1.5. The first pool was observed with a coho density of 4.4 fish/sqm in 2013 and 0.7 fish/sqm in 2014. Shortly above this pool a 10ft perched culvert blocks adult and juvenile passage. Above the culvert the gradient quickly increases over boulders and root wads. Very limited anadromous potential exist in Thomas Cr and no recommendations for the provision of passage are appropriate.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	5,705	0.75	3,025	140	605	0
2014	7,628	0.79	710	135	665	0

Coffee Cr (tributary of Gales)

Coffee Cr joins mainstem Gales at USGS RM 19.75. The Coffee Cr inventory extended 1.2 miles ending in a legacy beaver swamp. Coffee Cr enters cold over bedrock steps and boulders through a 2inch perched culvert. Both the gradient and the substrate at the confluence, though not a definitive barrier, complicate upstream juvenile passage.

Above the confluence, the stream exhibits habitat characteristics with anadromous potential to approximately RM 1.0. No coho or steelhead were observed in Coffee Cr. 0+ trout and cutthroat densities were low throughout the inventory. No obvious explanation for the observed low fish abundance was apparent.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	0		325	0	45	0
2014	0		195	0	60	0

Finger Cr (Tributary of Gales)

Finger Cr joins the mainstem at USGS RM 20. Low flows over a low gradient pitch of cobble and small boulders describes the confluence. The survey extended 0.6 miles.

In 2013 coho densities were low with a peak of 0.65 coho/sqm at RM 0.23. The presence of coho above several natural juvenile barriers suggest that a single spawning event occurred with low egg to fry survival. The observed presence of high silt and sediment loading support the conclusion of incubation impacts associated with silt loading. No coho were observed in 2014.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	156	0.4	45	0	30	0
2014	0		35	0	30	0

Iler CR (Tributary of Gales)

Iler Cr enters the mainstem at USGS RM 11.33 just below the Timber Rd bridge. The confluence is described as a cold contribution accessible to juveniles over a medium gradient bedrock riffle. Temperature data collected on 8/20/14 at 12:15 observed Iler Cr entering at 17.9˚C and Gales Cr mainstem above the confluence at 19.2˚C. 580 ft above the confluence, below the first bridge, a series of 1ft concrete steps are a barrier to upstream juvenile migration (photo 11). In the pool below this barrier the peak coho density for 2014 was documented at 3.6 coho/sqm along with a high count of 131 coho parr. Sub-yearling chinook were also documented in this pool. The removal of this artificial barrier is a high priority restoration action because of the spatial relationship of Iler Cr to the temperature limited reach of mainstem Gales Cr and the documentation in both surveys years of a significant upstream temperature dependent migration of juvenile salmonids from the mainstem of Gales Cr.

Photo 11

Coho distribution extended for 2.5 miles at an average gradient of 1.5% and was terminated at a natural log jam. With the log jam classified as an ephemeral barrier, the inventory continued to the end of anadromous potential. An additional 1 mile of stream habitat was described as having: a sinuous channel, an interactive low floodplain, high wood complexity, excellent gravel sorting in pool tailouts, and a mature coniferous riparian corridor. This included two tributaries that contributed short reaches of functional habitat.

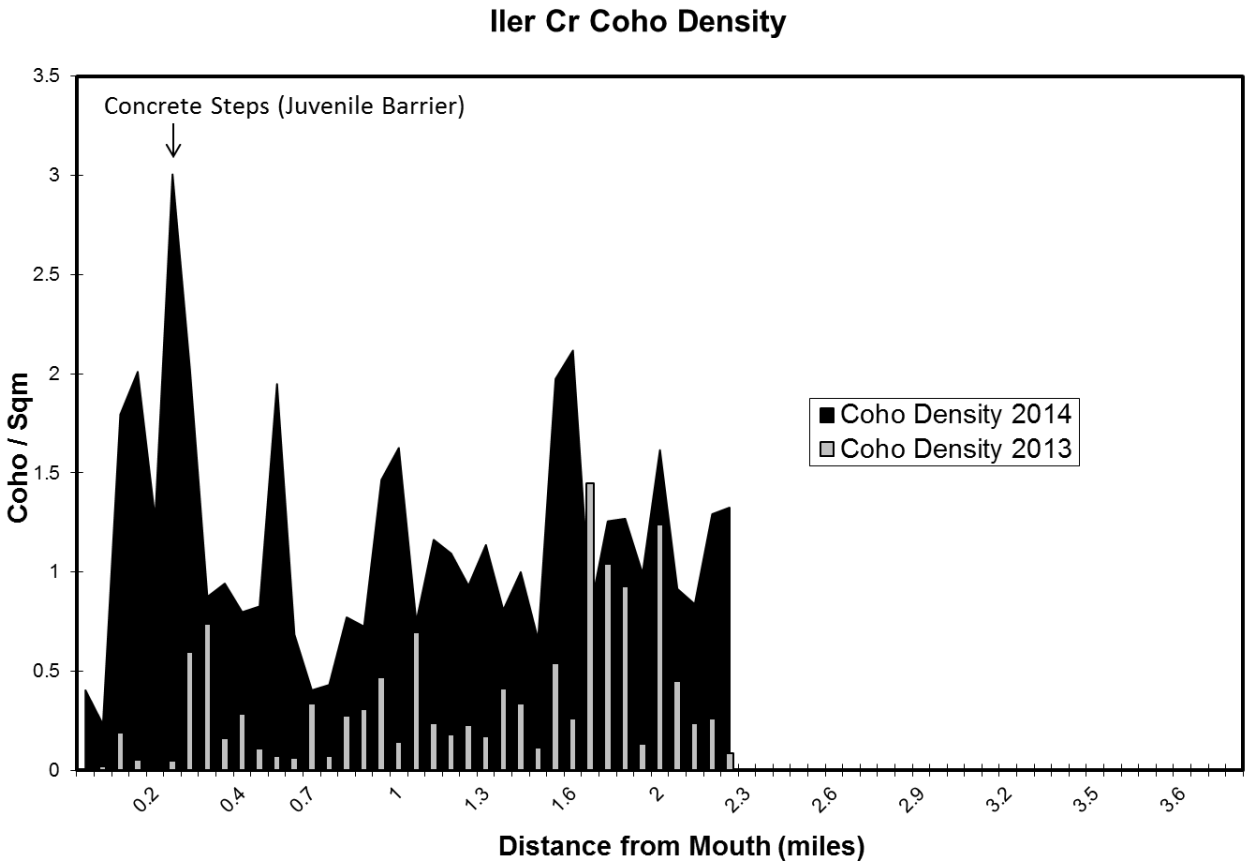
Of all coho observed in the Gales Cr basin, Iler Cr was rearing 10% in 2013 and 22% in 2014. From 2013-2014 a dramatic 167.3% increase in coho abundance was observed (figure 6). At RM 1.9 Coho population estimates for 2013 exhibited a definitive spawning peak with a density spike of 1.73 coho/sqm. In 2014, a spawning peak of 2.54 coho/sqm was observed at RM 1.6. Expanded population estimates suggest an adult escapement of 12 pairs of adult coho for 2013 and 33 pairs in 2014.

Steelhead were distributed sporadically in very low densities for 1.5 miles.

0+ trout densities averaged 0.6 fish/sqm (805 fish/mile) in 2013 and 0.18 fish/sqm (144 fish/mile) in 2014. This value is well under full seeding capacity, but among the top 3 highest averages for all of the primary tributaries of the Gales Cr subbasin. Densities peaked at 2.3 fish/sqm at RM 3 in 2013 and 1 fish/sqm at RM 4 in 2014. Iler Cr was also among the top 3 streams for the Gales sub-basin with 21% of all 0+ age trout fry observed in 2013 and 11% in 2014.

Cutthroat densities were low with an average density of 0.13 fish/sqm (157 fish/mile) in 2013 and 0.18 fish/sqm (180 fish/mile) in 2014. Higher densities were observed in two of its tributaries, Tribs A and B. Trib A exhibited the most potential with excellent gravel sorting that favored cutthroat spawning and beaver documented in the lower reach expanding rearing surface areas. The highest cutthroat density in 2013 was observed in a tributary to Trib A where just above its confluence and below a 2.5 ft. perched culvert, a density of 0.84 fish/sqm (including a few older age-class cutthroat) was observed. In 2014 the highest cutthroat density was observed in Trib A at 0.7 fish/sqm.

Figure 6



Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	2,662	0.43	3,770	25	735	0
2014	7,188	1.4	675	5	885	5

North Fork Gales Cr

NF Gales Cr joins the mainstem at USGS RM 21.7. Temperature data collected on 8/22/14 at 15:30 recorded NF Gales Cr entering at 15˚C and the Gales Cr mainstem above the confluence at 16˚C. The confluence is within an LWD treatment reach on mainstem Gales Cr (photo 12). Treatment extends up the NF Gales Cr from the confluence to RM 0.6. The inventory extended to RM 1.5 where reduced stream flow and coarse substrate diminished anadromous potential (spawning and rearing). No adult barriers to passage were observed.

Coho distribution extended to RM 1.3 in 2013 and was terminated by an ephemeral natural sill log with a 4 ft perch. In 2013, the peak coho density of 2.7 coho/sqm was observed within the treatment reach at RM 0.4. Back calculation of the expanded population estimate suggests an adult escapement of 5 pairs of spawning coho for 2013. In addition, 79% of the total population estimate for Coho in the NF Gales was documented rearing within the treatment reach in 2013. In 2014 coho abundance decreased by 86.4% and distribution terminated within the treatment reach at RM 0.5. The 2014 peak coho density of 0.7 coho/sqm was observed just above the confluence with the Gales Cr mainstem. The distribution profile suggests that the coho population in 2014 was comprised of temperature dependent migrants from the Gales Cr mainstem only and that no coho spawning occurred in NF Gales Cr.

An average gradient of 2.5% was measured for the treatment reach. An average gradient of 4.2% was observed for the remainder of anadromous fish distribution.

Steelhead numbers were low and sporadic in 2013. Steelhead distribution extended to RM 0.8. White fungus was observed on the pectoral fins of several steelhead parr. No steelhead were observed in 2014.

Cutthroat densities increased in the upper reach above coho distribution. A density spike of 1.0 fish/sqm was observed in 2013 in the last pool surveyed, at the base of a sill log pour. In this same pool a density of 3.3 fish/sqm was observed in 2014. This was the 3rd highest cutthroat density observed in the Tualatin basin for 2013 and the highest cutthroat density observed in 2014. This pool was located in a reach where pool habitats lacked connectivity due to isolation resulting from dry intermediate channels (deep bedload accumulation exhibiting high quality floodplain storage and hyporehic linkage).

Photo 12

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	1,013	1.04	935	50	220	0
2014	138	0.7	510	0	295	0

South Fork Gales Cr

SF Gales Cr joins the mainstem at USGS RM 20.7. SF Gales Cr is a high flow, cold water tributary with a low gradient confluence. Temperature data collected on 8/22/14 at 14:05 recorded SF Gales entering at 15.1˚C and the Gales mainstem above the confluence at 15.6˚C. Coho distribution extended to only RM 0.3 in 2013 and 0.4 in 2014. The inventory continued to RM 1.6 where a15 ft bedrock falls permanently terminates anadromous migration (photo 13).

Coho densities in 2013 peaked at 2.4 coho/sqm and in 2014 at 2.2 coho/sqm in the middle of this distribution (probable location of spawning in both years).

There were no steelhead observed rearing here in 2013. In 2014 steelhead were observed in one pool. Cutthroat densities were low averaging 0.13 fish/sqm in 2013 and 0.25 fish/sqm in 2014.

Photo 13

Above Coho distribution a gradient increase averaging 4%, an incised stream channel and the lack of sorted spawning gravel limited the capacity of the habitat for significant salmonid production.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	656	1.35	1,040	0	210	0
2014	438	0.9	630	10	325	0

White Cr (Tributary of Gales Cr)

White Cr enters mainstem Gales at USGS RM 14.2. The inventory extended to the end of Coho distribution at RM 0.76. No adult barriers were observed and field notes indicate that an increase in gradient (5.7%) and a lack of spawning gravel limit salmonid production potential above the current documented end of coho distribution.

Defined spawning peaks of 5 coho/sqm were observed at RM 0.3 in 2013 and 4.6 coho/sqm at RM 0.2 in 2014. An average stream gradient of 2.7% was observed throughout the extent of coho distribution.

Temperature data collected on 9/1/14 at 14:00 documented White Cr entering at 16.2˚C and the Gales Cr mainstem above the White Cr confluence at 18.1˚C. White Cr's cool summer temperature profile and spatial location within the temperature limited reach of mainstem Gales Cr suggests that it has the potential to function as thermal refugia during summer flow regimes. The first pool of the inventory was below a 1ft perched culvert. The high counts of Coho in this pool suggest that the culvert is blocking upstream temperature dependent juvenile migrations from mainstem Gales Cr.

The first ½ mile of the inventory observed an exposed stream channel and a thin riparian buffer resulting from a legacy of agricultural impacts.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut	Chin
2013	1,463	1.64	75	0	90	0
2014	1,319	1.8	25	0	155	0

EF Dairy Subbasin

The EF Dairy Cr subbasin of Dairy Cr contained 24.8 miles (mainstem and tributaries combined) of inventoried stream habitats in 2013. The use of more accurate GPS coordinates in 2014 for measuring unsurveyed stream reaches where landowner access was denied resulted in a significant

difference in total inventoried stream distance between years. For reporting consistency, the 2014 distances within this report were recalibrated to match the 2013 RM estimates. This facilitates a consistent year to year comparison of stream attributes and fish distribution.

EF Dairy Cr contained some of the highest quality stream habitat observed in the Tualatin basin and was responsible for a large percentage of all salmonids documented rearing in the inventoried reaches of the Tualatin basin. Although 9 tributaries were included in the EF Dairy Cr inventory, the mainstem was observed rearing the vast majority of all observed salmonids. Many of the tributaries were observed with high gradient confluences which continued to increase with distance as they climbed out of the EF Dairy Cr canyon. Most of them exhibited a decrease in gradient further upstream (headwater flats) once out of the mainstem canyon, but none of the tributary reaches were rearing salmonids to full capacity.

EF Dairy Cr maintains high summer flows and low summer temperature profiles throughout the extent of the survey (both attributes that are foundational for successful salmonid production). These system attributes are responsible for the observation that the summer distribution of coho and cutthroat extends downstream a full 5 miles below the range of functional spawning habitat in the mainstem of EF Dairy Cr. This is an important comparison to the other surveyed subbasins within the scope of this Assay whose mainstem reaches were consistently temperature limited and over allocated for withdrawal well up into the range of available spawning habitat. Despite the increased quality of stream habitat as compared to other Tualatin sub-basins, the EF Dairy Cr mainstem was sited with several water quality limitations including two Category 5 303(d) listings for: dissolved oxygen (10/15-5/15, RM 2.9-20) and biological criteria (year round, RM 0-21.5). In addition, three Category 4A listings were made for: phosphorus (6/1-9/30, RM 0-13.5); temperature (summer, RM 0-13.5); and ph (summer, RM 0-13.5). These pollutants are known to affect resident fish, aquatic life, anadromous fish passage, and fish spawning (DEQ Water Quality Oregon's 2012 Integrated Report).

(Table 11) 2013 Expanded EF Dairy Sub-basin Estimates

Stream	Coho	%	0+	%	Sthd	%	Cut	%
EF Dairy	35,175	94.8	8,180	65.5	1,950	99.2	2635	69.8
Side Channel A	234		9					
Side Channel B	284		25				6	
Side Channel C	75		5					
Big Canyon	163		65				30	
Campbell	388	1	1,280	10.2			280	7.4
Denny	419	1.1	1,205	9.6	5		285	7.5
Murtaugh	150		125	1	10		180	4.8
Panther			130	1			20	
Plentywater	7		135	1.1			40	1.1
Rock	219		1,095	8.8			265	7
Roundy	6.25		195	1.6			35	
Trib A	6.25		40					
Inventory Total	**37,124**		**12,489**		**1,965**		**3,776**	

- Percent contributions are indicated for only those streams that contributed greater than 1% of the total.

- 20% visual bias included for coho expansion

(Table 12) 2014 Expanded EF Dairy Sub-basin Estimates

Stream	Coho	%	0+	%	Sthd	%	Cut	%
EF Dairy	26,188	91	3,595	70.8	2,265	99.5	2,680	78
Side Channel A	602	2.1	3					
Side Channel B	180		22		10		34	1
Side Channel C	123		4				10	
Side Channel D	240		4				27	
Side Channel E	218							
Side Channel F	220		3		1		6	
Campbell			415	8.2			225	6.5
Denny	813	2.8	340	6.7			200	5.8
Murtaugh	88		55	1.1			30	
Panther			65	1.3			60	1.7
Plentywater	88		70	1.4			35	
Rock	19		440	8.7			120	3.5
Roundy			65	1.3			10	
Inventory Total	**28,778**		**5,081**		**2,276**		**3,437**	

- Percent contributions are indicated for only those streams that contributed greater than 1% of the total.
- 20% visual bias included for coho expansion

EF Dairy Mainstem

The EF Dairy Cr inventory began at the Highway 26 crossing and extended 15.5 miles upstream in 2013 at which point reduced flows and natural debris jams limited anadromous potential. In 2014 an additional 0.4 miles of habitat was appended to the inventory. All stream miles in the EF Dairy Cr discussion are referenced from the start point at the Hwy 26 crossing as RM 0. In 2013 coho distribution ended at RM 14.3 and in 2014 at RM 14. Steelhead distribution ended at RM 14.9 in 2013 and RM 14.3 in 2014. No permanent adult barriers to passage were observed. Representing 20% of the total stream miles for the combined Gales and EF Dairy Cr sub-basins, the EF Dairy Cr mainstem was rearing large percentages of all salmonid populations in both inventoried years. In 2013, the EF Dairy Cr mainstem was rearing 55% of all coho observed (basin scale), 25% of all 0+ trout, 75% of all steelhead, and 31% of all cutthroat. In 2014 it was observed rearing: 43% of all coho, 29% of all 0+ trout, 83% of all steelhead and 34% of all cutthroat.

From the start point to RM 5 the stream habitat is characterized by low gradient (0.15% average), entrenched banks, deep silt deposits, and brushy banks with debris jams. Low densities of coho and cutthroat were present and thriving throughout.

Above RM 5 (photo 14), spawning gravel, balanced pool / rifle ratios and the potential for floodplain interaction during winter flow regimes provided fully function anchor habitats. The abundance of all salmonid species increased rapidly above this point and continued to improve for several miles. Peak coho and steelhead production occurred between RM 8-10 in a zone expressing an average gradient of 1.2%. This reach overlaps a geologic unit transition from the alluvial deposits that characterize the lower mainstem to the marine sedimentary and tuffaceous layers that comprise the upper mainstem. In this high production reach, extensive gravel sorting was observed in pool tailouts

and channel sinuosity was exceptional (1.3). Side Channels A, B, C, D, E, and F were all within this reach. A thin riparian canopy and a lack of interactive LWD was commonly noted. A white haze on the entire dermal layer (similar to the symptoms of cold water disease) and pectoral fungus were frequently observed.

Photo 14

Parr distribution trends in both years indicate that two significant coho spawning peaks occurred in the EF Dairy Cr mainstem. In 2013 the first occurred at RM 9.9 (0.45 miles below the confluence of Plentywater Cr) and was observed just upstream of Side Chanel C with the highest pool counts in the basin occurring nearby. In 2014 the first spawning peak was observed at RM 8.8 with the highest pool counts also nearby. Following this first 1 mile zone of peak spawning behavior, the canyon tightens and a series of cobble/boulder riffles dominate the next 2 miles of stream corridor to a 3ft bedrock falls that functions to terminate upstream juvenile migrations.

A rapid decline in coho abundance was observed throughout this 2 mile segment of the mainstem. The second spawning peak in 2013 occurred above this falls near RM 14. Channel characteristics exhibited braiding over a wide interactive flood plain. In 2014, coho distribution ended in this broad floodplain with the dominant spawning peak observed 1.8 miles lower than 2013 near RM

12.2. Shortly above this highly interactive reach, an increase in gradient (averaging 7.5%) over bedrock was observed with a 1 ft bedrock falls that marked the end of coho distribution in 2013 (this is an insignificant barrier for adults and does not describe the permanent end of anadromy, photo 15). Back calculating from summer parr abundance (w/ side channels included) suggests an adult coho escapement for the EF Dairy Cr mainstem of 162 pairs in 2012 and 126 pairs in 2013. This decline in abundance in the Tualatin basins premier habitat was unexpected given that escapement over Willamette falls nearly tripled between 2012 and 2013.

Photo 15

Steelhead exhibited a bimodal distribution similar to coho between RM 6-14, with the highest counts of both species recorded from RM 6-10. The two highest densities observed in 2013 were 0.29 sthd/sqm, below the 3ft falls at RM 11.8 and 0.24 sthd/sqm, below the 1ft falls at RM 14.3 (photo 15). In 2014 higher densities associated with the falls at RM 11.8 were also observed, but a change in pool structure below the falls expanded the surface area of pool habitat lowering the rearing densities. The two highest density peaks in 2014 mirrored those of coho with 0.52 sthd/sqm observed at RM 8.8 and 0.32 sthd/sqm at RM 12.2. Distribution profiles for both years indicate that there may be upstream

movements occurring in the mainstem of EF Dairy Cr. Average steelhead densities for the 9.9 miles of distribution were observed in 2013 at 0.08 sthd/sqm (197 fish/mile) and in 2014 at 0.09 sthd/sqm (229 fish/mile).

Cutthroat and 0+ trout densities exhibited similar relationships to the two barriers described at RM 11.8 and RM 14.3. In 2013 0+ trout were observed at 3.1 fish/sqm and cutthroat at 0.7 fish/sqm below the barrier at RM 14.3. 0+ trout abundance in 2014 was 56% lower than the previous year with the peak density of 0.83 fish/sqm observed at RM 13.5 (just above the confluence of Campbell Cr). This drop in 0+trout abundance is consistent with that observed in the Gales Cr sub-basin. The 2014 Cutthroat density spike of 0.87 fish/sqm was observed at RM 12.4 (confluence of Panther Cr). In both years the distribution profiles of cutthroat and 0+ trout resembled those of coho and steelhead with bimodal increases in abundance occurring near the same locations.

Figure 6

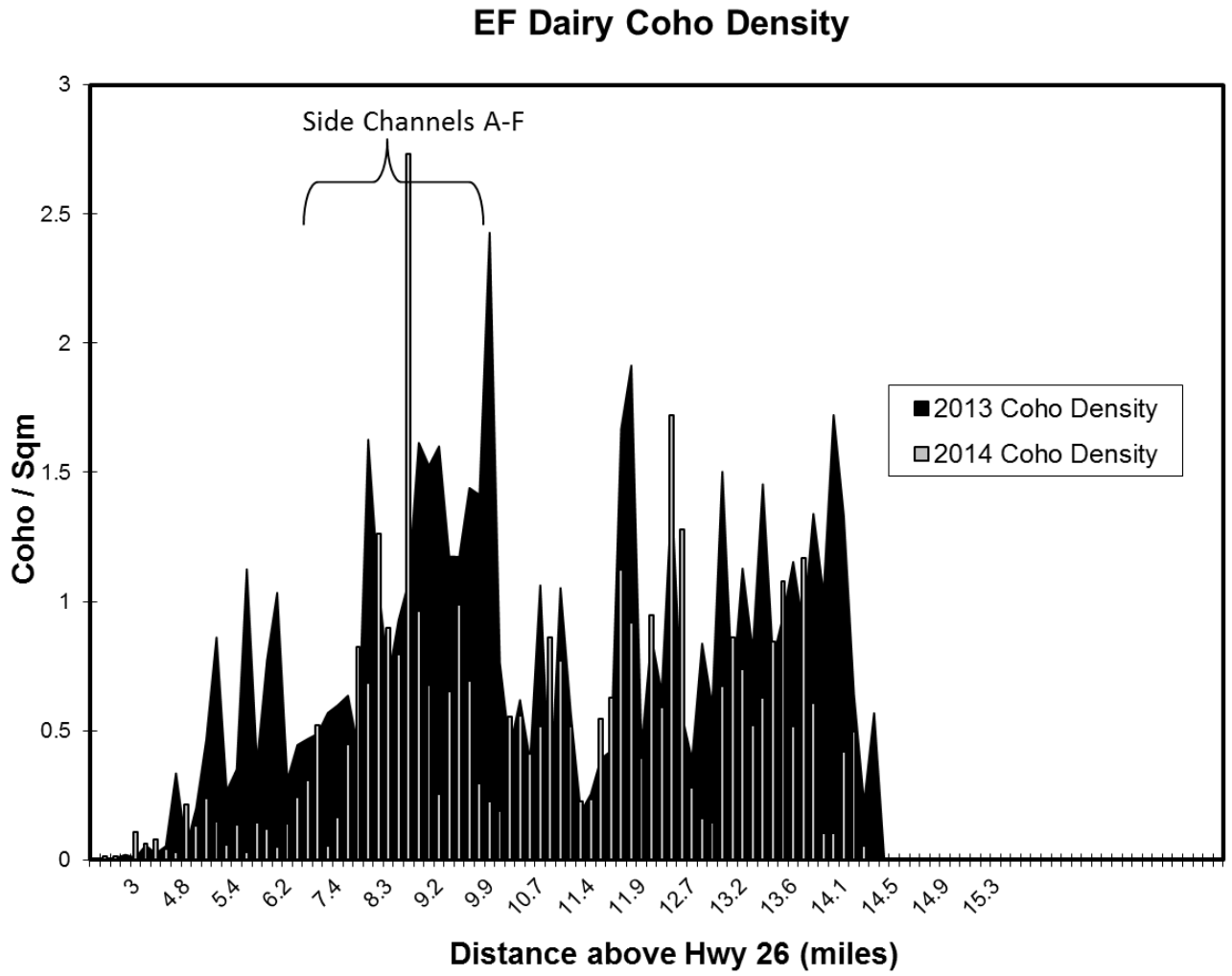
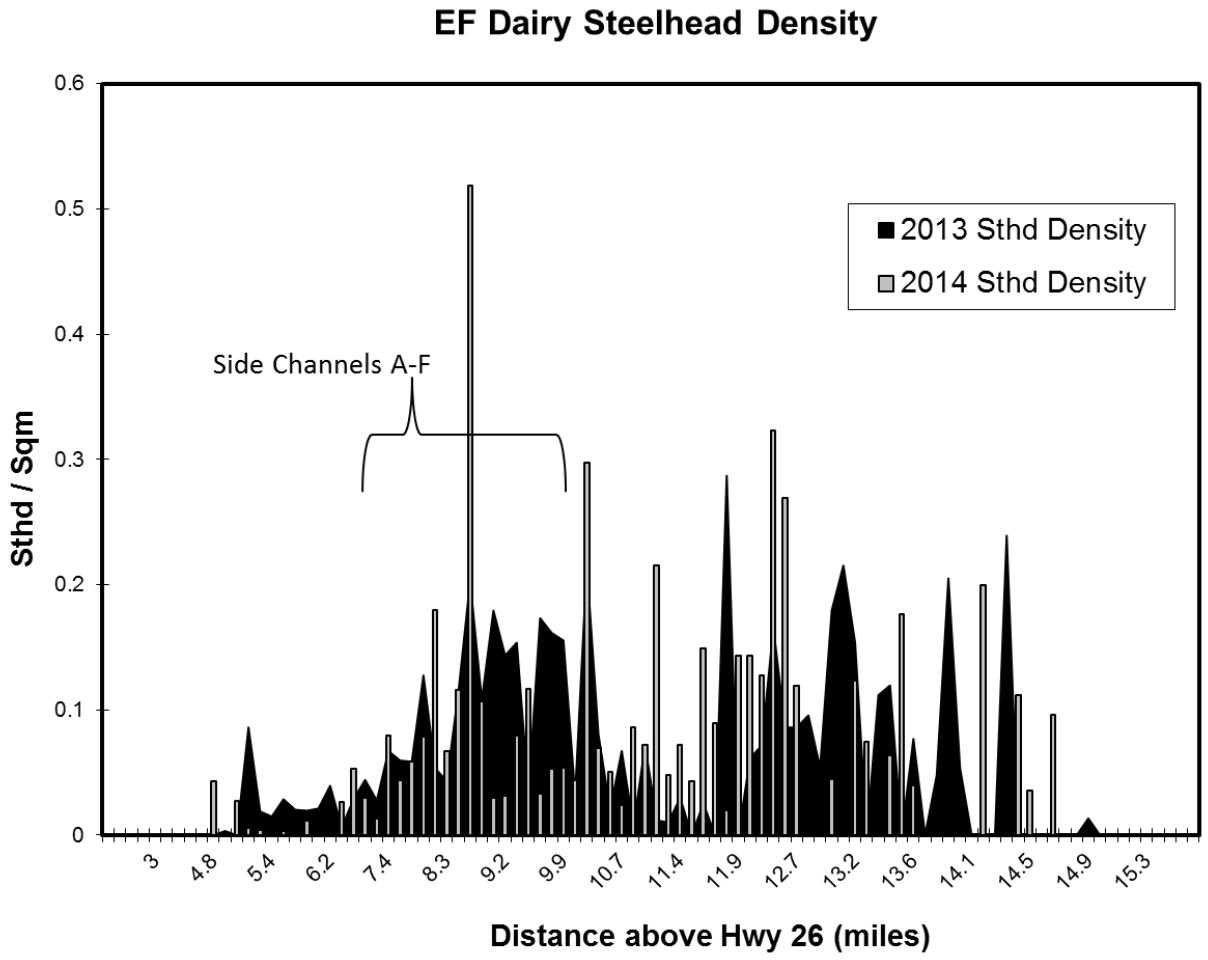


Figure 7



Above the juvenile barrier and gradient increase to 7.5% that ended coho and steelhead distribution, the gradient decreased to an average of 3.7% and high quality stream habitats for salmonid rearing continued for an additional mile. Well sorted gravel, significant channel meander and low interactive floodplain terraces were observed. High wood densities were also noted throughout this upper reach. The quality of the habitat suggests that in years of higher adult escapement (the current primary limiting factor) over Willamette Falls that this habitat would be also be utilized for spawning and rearing. Currently there is more high quality habitat in the subbasin than is being utilized by salmonids.

Six side channels (an additional 3 were sampled in 2014) were observed rearing high densities of coho parr. Some of these side channels were providing high quality thermal refugia but all of them added to the capacity and diversity of habitats observed in the mainstem. Their presence is an indicator of salmonid anchor habitats that are providing the full range of seasonal habitat types required for the retention of salmonids in headwater reaches for their entire fresh water life history. The side channels provide additional spawning and incubation surface area as well as the highest quality winter refuge.

Temperature data collected during the 2014 inventory suggests that only a few of the side channel habitats were currently serving as thermal refugia. In 2013, only Side Channel A (of the 3 side channels documented in 2013) that enters at RM 9, appeared to provide cooler rearing habitat than the mainstem. Side channel A provided connectivity to the mainstem at the bottom and was delinked from the mainstem at the top (photo 16). This allowed hyporehic subsurface flows percolating through bedload to well up in the lower end of the side channel and develop a temperature differential when compared to the mainstem. The provision of these cold pockets attracts large numbers of salmonid juveniles in temperature limited stream corridors (photo 17). The EF Dairy Cr mainstem was not exceeding temperature thresholds during the sample period between September 4 – 13 but the upstream migration patterns observed in both tributaries and side channel A suggest that temperature limitations earlier in the summer were driving the observed upstream migrations. Coho densities in side channel A were exceptional at 4.8 coho/sqm in 2013 and 5.1 coho/sqm in 2014.

Photo 16

Photo 17

Side Channel B enters at RM 9.2 and was observed functioning like an extension of the mainstem with contiguous surface flows and no hyporehic expression. In 2014 Side Channel B exhibited increased flows accounting for approximately 40% of the mainstem flow. High wood complexity and high quality spawning gravels were noted throughout this side channel. Densities above full seeding capacity were observed in every pool of the side channel in 2013 with the peak pool density of 7.3 fish/sqm being the highest documented in all of the inventoried Tualatin basin. In 2014 coho densities and abundance were lower with an average of 1.5 coho/sqm and a peak of 2.3 coho/sqm. With higher flows in 2014 the habitat was more attractive to steelhead and cutthroat which both exhibited increases in abundance.

Side Channel C contains low summer flow (still mainstem linked), is shallow and cobble dominated. Consisting of only a few small pools, its contribution was small but educational. Densities were again high at 6 coho/sqm and 3 coho/sqm in 2014. The existence of this isolated pool life history suggest that maintaining this type of habitat diversity is critical for supporting genetic resilience. Side Channel C was located at RM 9.8 and just below the peak coho densities observed in the EF Dairy Cr mainstem for 2013.

In 2014 an additional 3 side channels were sampled (D, E, and F). Side Channel E (at RM 5.5) and F (at RM 7.25) were both stagnant backwaters associated with historic oxbows observed with shallow thermoclines of cool water. Peak densities were observed at 2.6 coho/sqm in Side Channel E and 1.4 coho/sqm in Side Channel F.

Side Channel D entering from the west at RM 9.2 (across from Side Channel B) provided the highest surface area of aquatic habitat and extended the longest at 0.3 miles. This side channel drains an expansive legacy beaver swamp with large high complexity pools and deep thermoclines of cool water (photo 18). It was not feasible to sample the entirety of the habitat because of the poor visibility resulting from the tannins and turbidity associated with organic decomposition. Fish abundance estimates likely underestimate total fish abundance within this complex of habitat that extends up to 200 ft wide as it braids through the wetland. The highest coho densities were observed in the first few pools with a peak density of 2.7 coho/sqm. Cutthroat were observed in low densities.

Photo 18

Out of the 9 tributaries inventoried in the EF Dairy subbasin, only 2 appeared to have provided spawning habitat for coho; Denny and Campbell. The rest (except Panther Cr) exhibited only upstream temperature dependent migrations of juveniles from the mainstem of EF Dairy. These migrations never

extended more than 1,300 lineal ft (displayed by decreasing densities with increased lineal distance from the mouth and fish distribution ending below the first juvenile barrier). The upstream migration pattern displayed in at least 6 of the 9 tributaries of EF Dairy Cr suggests that summer rearing salmonid juveniles are seeking thermal refugia from the mainstem.

Big Canyon Cr enters EF Dairy Cr at RM 7.6. Coho were observed in 2013 at a peak density of 2.6 coho/sqm in the first pool. Coho distribution extended for 0.3 miles. No coho were observed in 2014. The stream within the surveyed reach displays a mature coniferous riparian canopy and high wood complexity. A lack of sorted spawning gravel and shallow silty pools was also documented (not a concern when the function of the habitat is to provide pinch period thermal refugia).

Murtaugh Cr enters EF Dairy at RM 8.5 (just below the Meacham Rd crossing). Coho were observed at a peak density of 0.82 coho/sqm in 2013 in pool #1 and 0.4 coho/sqm in 2014 in pool #2. A 6ft bedrock falls with a shallow jump pool terminated both adult and juvenile migration access at RM 0.16. A few steelhead were observed with pectoral fungus in the pool below the falls.

Panther, Plentywater, Roundy, and Trib A all exhibited limited anadromous potential. Steep gradient, shallow pools, and the lack of spawning gravel were noted as the primary limitations.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2013	35,175	0.92	8,180	1,950	2,635
2014	26,188	0.6	3,595	2,265	2,680

Campbell Cr (Tributary of EF Dairy)

Campbell Cr joins the EF Dairy mainstem through a 2.5 ft perched, rusted out and undercut culvert at RM 13.3 (just below the gate where Powerline Rd enters). The culvert (photo 19), a definitive juvenile barrier, was passed by adult coho in 2012.

Photo 19

In 2013 a peak coho density of 2.4 coho/sqm was observed 545 ft above the culvert. Coho extended 0.5 miles to where a series of ephemeral log jams associated with a gradient increase in a canyon pinch ended anadromous distribution. Expanded population estimates suggest an adult coho escapement of 2 spawning pairs. No coho were observed in 2014. An average gradient of 3.3% was observed throughout coho distribution.

Anadromous potential continues above the canyon pinch. Field notes describe a slight decrease in gradient to 3.2%, gravel sorting and high wood complexity extending to the confluence of a tributary at RM 0.9. This unnamed tributary of Campbell Cr also exhibited anadromous potential that extended for approximately 0.25 miles. Increased gradient and a series of ephemeral log jam barriers limits access to any additional habitat upstream. Within this tributary, at RM 0.63 a culvert was observed with a 3.5ft perch. A high concentration of cutthroat was observed below this pipe suggesting the presence of upstream migration behavior.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2013	388	0.75	1,280	0	280
2014	0		415	0	225

Denny CR (Tributary of EF Dairy)

Denny Cr enters the EF Dairy Cr mainstem at RM 11 (just below the Dairy Cr bridge crossing where Fern Flat Rd starts). Coho and steelhead distribution extends 0.8 miles to a 2ft sill log spilling onto bedrock. A combined increase in gradient (to 5.2%) and a series of log jams terminates access to habitats further upstream.

Pool densities for coho peaked 500 ft above the confluence with EF Dairy in 2013 at 2.8 coho/sqm and at 1500 ft in 2014 at 6.2 coho/sqm below a 1 ft sill log (probable juv. barrier) suggesting the presence of an upstream juvenile migration out of the mainstem of EF Dairy Cr. Denny Cr was the only stream segment in the EF Dairy sub-basin that exhibited an increase in coho abundance from 2013 - 2014. The expanded population estimate for Denny Cr suggests an adult escapement in 2013 of 1-2 pairs of adult coho and 3-4 pairs in 2014.

Steelhead were observed sporadically and in low numbers in 2013 and not at all in 2014. The presence of steelhead here is most likely the result of an upstream temperature dependent migration and not a spawning event (based on an analysis of distribution). An average gradient of 3% was documented through the range of anadromous distribution.

Cutthroat exhibited two separate density peaks in 2013 representing differences in abundance related to the lack of inter specific competition in the upper reaches above anadromous access. The first spike of 0.6 fish/sqm at RM 0.3 is representative of upstream migration out of the mainstem. The 2nd spike of 0.6 fish/sqm at RM 1.7 probably represents nearly full seeded habitats for an isolated component of the cutthroat population. In 2014 the peak density of 0.5 was observed at RM 1.2.

0+ trout densities peaked in this zone in 2013 at 1.6 fish/sqm (RM 1.5). 0+ trout densities were very low in 2014.

Surveyors noted a lack of sorted spawning gravel throughout the inventory with the average substrate described as cobble and small boulder. Wood complexity increased further upstream with large coniferous logs noted in the active stream channel.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2013	419	0.68	1,205	5	285
2014	813	1.33	340	0	200

Rock Cr (Tributary to EF Dairy)

Rock Cr enters the mainstem at RM 11.7 (just above the Greener Rd crossing). The confluence was described as high gradient, high flow and cold. The inventory extended 2.1 miles in 2013 and 1.9 miles in 2014 with no permanent anadromous barrier observed. This is an especially important tributary for the greater EF Dairy subbasin because of its high volume cold water contribution during pinch period flows. We would recommend taking a closer look at potential conservation measures that would protect and or enhance riparian buffers within Rock Cr for the long term maintenance of mainstem EF Dairy water quality parameters.

Coho extended 0.32 miles in 2013 to just the first juvenile barrier. A peak density of 2 coho/sqm was observed in the first pool. In 2014 coho were observed in only two pools. A review of habitat conditions indicate a lack of spawning gravel, bedrock/boulder dominated substrate, and high gradient (9.5% average) throughout coho distribution. It appears that all of the coho documented were the result of an upstream temperature dependent migration from the mainstem. It is unlikely that adult coho spawned in Rock Cr in 2012.

Cutthroat abundance was moderate with an average density of 0.34 fish/sqm (127 fish/mile) in 2013 and 0.16 fish/sqm (64 fish/mile) in 2014. No steelhead were observed.

0+ trout abundance was moderately high in 2013 with an average density of 1 fish/sqm (526 fish/mile) and a peak density of 2.9fish/sqm at RM 1.9. This value is considered near full seeding in high quality stream habitats. 0+ trout abundance was low in 2014 with an average density of 0.47 fish/sqm (232 fish/mile) and a peak density of 1.88 fish/sqm in pool # 1. The peak density in 2013 was observed in the upper reach where subsurface flows had limited the abundance of riffle habitat for rearing and concentrated fish in isolated pool habitats. In 2013 cutthroat densities also peaked in this reach at 0.9 fish/sqm. In 2014 there was a significant decrease in fish production in this zone.

Steep gradients continued above coho distribution to an ephemeral adult barrier at RM 0.68. Above the log jam, field notes described a gradient decrease, an increase in channel meander, a low interactive floodplain, and the presence of gravel sorting.

Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2013	219	1.19	1,095	0	265
2014	19	0.38	440	0	120

Chehalem Mts Subbasins (Chicken and McFee)

The headwaters of these drainages (Chicken Cr and McFee Cr) originate in the Chehalem Mountains; a series of isolated remnants from Columbia River Basalt flows. This low elevation range rises steeply out of the deep unconsolidated sediments burying the Willamette Valley as a result of numerous inundations of catastrophic floods towards the end of the last ice age. This abrupt interface of geologic units, where low gradient silt dominated valley bottoms meet higher gradient scoured basalt uplands, is providing a limited range for the collection and sorting of mobile gravel and cobble

substrates necessary for successful salmonid spawning within the stream reaches exhibiting adequate gradient and flow. A majority of the drainages palmate once gradient increases, quickly diminishing flow and reducing the quality of habitat necessary for the summer rearing of salmonids. The lower reaches of these drainages predominantly support agricultural, livestock, and residential interests exhibiting a legacy of heavy impact on water quality and stream habitats.

(Table 13) 2014 Expanded Chicken and McFee Subbasin Estimates

Stream	Coho	%	0+	%	Cut	%
Chicken	**13**		25	9.8		
Cedar			20	7.8	10	2.5
West Fork Chicken						
McFee	**1181**	**58.5**	10	3.9	**150**	**37**
Gulf Canyon			25	9.8	**25**	**6.2**
Trib A			**55**	**21.6**	15	3.7
Heaton	**819**	**40.6**	**60**	**23.5**	**180**	**44.4**
Baker						
Fir Clearing			5	2		
Trib A	6		**55**	**21.6**	25	6.2
Inventory total	**2019**		**255**		**405**	

* Highlighted estimates represent the top 3 producers by species.

- Percent contributions are indicated for only those sub-basins that contributed greater than 1% of the total.

- 20% visual bias included for coho expansions

Chicken Cr Sub-basin

The Chicken Cr drainage contained 7 miles of inventoried steam habitats. The inventory included two tributaries: West Fork Chicken and Cedar Cr. Very limited potential for salmonid production was observed in this sub-basin. The Chicken Cr mainstem was sited with several water quality limitations including three Category 5 303(d) listings for: dissolved oxygen (1/1-5/15, RM 0-7); lead (year round, RM 0-7); and iron (year round, RM 0-7). In addition two Category 4A listings were made for: phosphorus (6/1-9/30, RM 0-7) and dissolved oxygen (year round, RM 0-7). These pollutants are known to affect resident fish, aquatic life, anadromous fish passage, and fish spawning (DEQ Water Quality Oregon's 2012 Integrated Report).

Chicken Cr exits the north side of the Chehalem Mountains and enters the Tualatin River from the south within the Tualatin Wildlife Refuge at two points: USGS RM 15.5 and 16.1. The split confluence is created by a series of dams and a diversion (photo 20) that redirects water into a 0.5 mile channel. Most of the summer flow is diverted into this straight, deeply incised channel (photo) with up to 15 ft channel entrenchment observed in the lower end. Numerous sunfish and shiners were observed in the diversion channel. Temperature data collected on 9/25/14 at 11:20 documented Chicken Cr entering at 16.5˚C and the Tualatin River above the confluence at 18.8˚C. The only coho observed in the sub-basin were located in the pool below the first steel dam (1.5 ft). This was the first definitive juvenile barrier observed. This pool was located just above the only gravel tailout observed in the lower 3.8 miles of stream habitat. Tannins and turbidity limited the range of visibility and reduced confidence in population estimates. It's likely that coho abundance is greater than the observed estimate. The 13 observed coho parr may have been the result of a single spawning event with extremely low egg to fry survival rates.

Photo 20

Photo 21

The inventory extended an additional 3.9 miles above the diversion. Average gradient from the diversion to RM 3.7(confluence of a medium sized right tributary) was 0.2%. This reach exhibited very low salmonid potential. The stream habitat was characterized by entrenched brushy banks, silt dominated substrates (no gravel observed), thin deciduous riparian, and high beaver activity (18 dams observed). No salmonids were observed in this reach.

Above RM 3.7, the gradient increases to 1.4%. A more forested riparian zone is observed exhibiting cobble, unsorted gravel and bedrock substrates. These habitat characteristics continue for 0.5 miles. Above that, over the last 0.2 miles of the inventory anadromous potential diminishes as the stream canyon tightens with a more bedrock dominated substrate and a gradient increase to 6.2%. The inventory extended to RM 4.4 (just above Kruger Rd.). Low numbers of 0+ trout were observed in the last 0.7 miles of the inventory. No adult barriers to passage were observed.

Two tributaries were included in the Chicken Cr. inventory: Cedar Cr. entering at RM 1.4 and West Fork Chicken entering at RM 2.25. The inventory of WF Chicken extended 1.6 miles. The stream habitat exhibited low salmonid potential and was characterized by a thin riparian corridor and silt dominated substrates. Beaver activity was observed in the upper half of the inventory with 7 active dams documented. Dace and shiners were present, but no salmonids were observed.

The inventory of Cedar Cr. extended 1.1 miles above the start point at the Rein Rd crossing. There was approximately five miles of stream habitat below the survey start point that exhibited low salmonid potential with an average gradient of 0.26% and low water quality. Poor visibility rendered the snorkel methodology ineffective in this lower reach. Of the 1.1 miles inventoried, only a short reach

of 0.24 miles exhibited adequate substrate, flow, and gradient for salmonid production. Low abundances of 0+ trout and cutthroat were observed in this reach. The inventory ends at a canyon pinch point where the average gradient increases to 6.7%. Above the inventoried reach the confluence of a few tributaries quickly divides and diminishes flow to predominantly dry and gradient decreases to an average of 1.6%. Cedar Cr was sited with four Category 4A water quality limitations: phosphorus (6/1-9/30, RM 0-6.8); dissolved oxygen (year round, RM 0-6.8); biological criteria (year round, RM 0-6.8); and temperature (summer, RM 0-6.8). These pollutants are known to affect resident fish, aquatic life, anadromous fish passage, and fish spawning (DEQ Water Quality Oregon's 2012 Integrated Report).

Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2014	13		45	0	10

McFee Cr Subbasin

The McFee Cr drainage contained 10.5 miles of inventoried steam habitats. The inventory included three tributaries: Gulf Canyon Cr, Heaton Cr, and Trib A. A majority of the inventoried stream habitats exhibited limited salmonid potential. Significant coho production was observed only in McFee Cr and Heaton Cr. The McFee subbasin was sited with several water quality limitations. The McFee mainstem was sited with two Category 5 303(d) listings for: dissolved oxygen (10/15-5/15, RM 0-5.4) and iron (year round, RM 0-8.3) and two Category 4A listings for: phosphorus (6/1-9/30, RM 0-8.3) and dissolved oxygen (year round, RM 0-4.4). Heaton Cr was sited with a Category 4A listing for phosphorus (6/1-9/30, RM 0-5.2). These pollutants are known to affect resident fish, aquatic life, anadromous fish passage, and fish spawning (DEQ Water Quality Oregon's 2012 Integrated Report).

McFee Cr exits the north side of the Chehalem Mountains and joins the Tualatin River at USGS RM 28.2. The inventory began approximately 4.5 miles above the confluence (0.2 miles below Vanderschuere Rd.) and extended 1.75 miles to where an 8 ft. bedrock falls into a shallow pool and terminates anadromous access. The lower 4.5 miles was not inventoried due to poor visibility and slough-like conditions with an average gradient of 0.15%. This section of stream (photo 22) likely provides high quality winter rearing habitat.

Photo 22

For the first mile of the inventory the average gradient remained low at 0.25 %. The stream habitat was characterized by: sinuous channel meander, well sorted gravel in pool tailouts, an entrenched channel with brush lined banks (blackberry and reed canary grass), a thin deciduous riparian facilitating extensive solar exposure and low instream wood complexity. Prolific Western Pearl shell Mussel beds were noted as well as many large crayfish throughout the lower 0.5 miles of the inventory. Dace were also present. The average stream gradient increases to 0.5% above RM 1 with similar habitat characteristics observed. Coho distribution exhibited a spawning peak of 1.5 coho/sqm at RM 1. At RM 1.2 the creek crosses under McCormick Hill Rd. Above this point (photo 23) a well forested coniferous riparian zone extends for the remainder of the inventory and the gradient increases to an average of 1.6% with cobble dominated substrate. This condition continues to just below the falls where gradient increases to 6.4% over boulder and bedrock. Coho distribution continues to the falls (photo 24). Back calculations utilizing summer coho parr abundance suggests an adult escapement of 5 pairs of adult coho that spawned in the McFee Cr mainstem.

Below RM 1.2 (McCormick Hill Rd.) cutthroat, when present, were observed in low abundance at an average density of 0.06 fish/sqm (78 fish/mile). Above RM 1.2 cutthroat abundance increased to 0.27 fish/sqm (189 fish/mile). A cutthroat density spike of 0.7 fish/sqm was observed in the pool below the falls. Very few 0+ trout were observed.

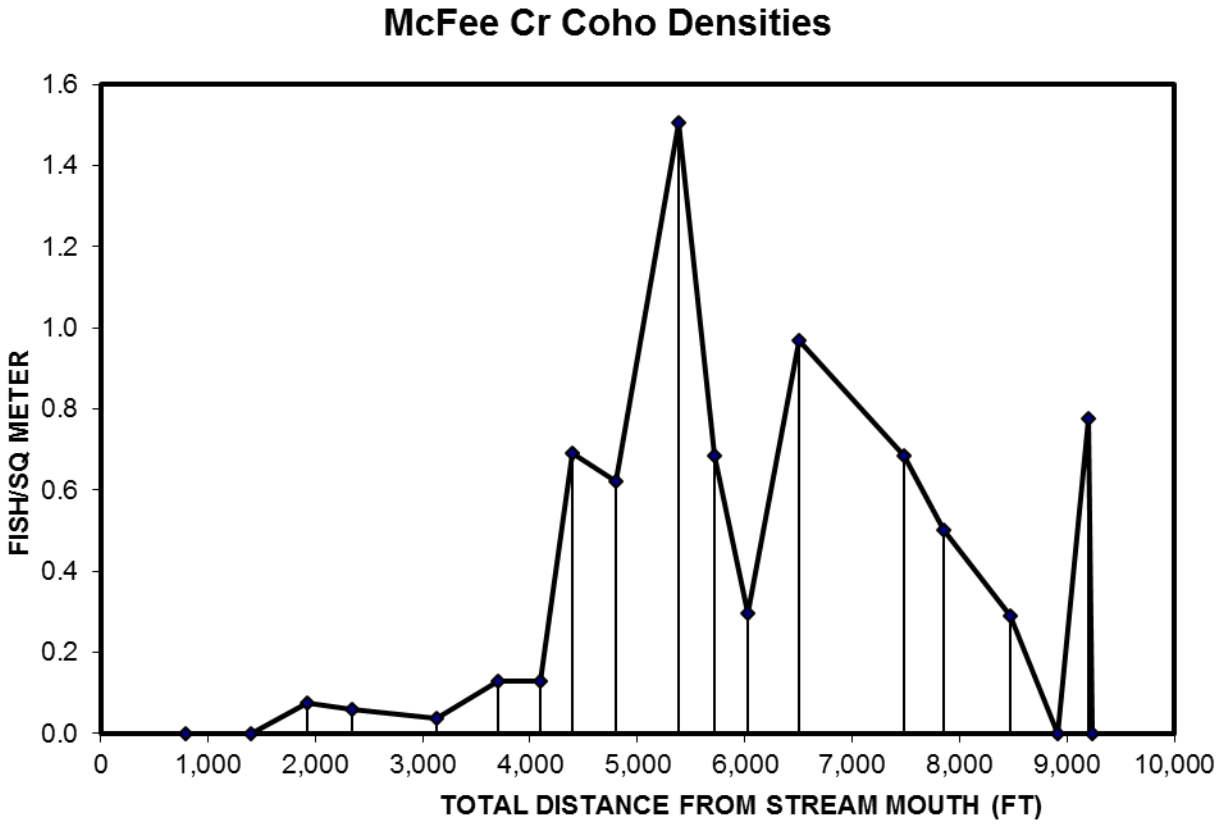
Photo 23

Photo 24

Gulf Canyon Cr enters McFee Cr at RM 0.7. The confluence is described as low gradient entering through an incised stream channel with high solar exposure. Temperature data collected on 9/16/14 at 12:20 recorded Gulf Canyon Cr. entering at 13.9˚C and McFee Cr above the confluence at 14.6˚C. The inventory extended 1.68 miles upstream to a point of diminished flow. No adult barriers to passage were observed. No coho were observed. Cutthroat abundance was very low with intermittent pool presence throughout the inventory. A high count of 38 cutthroat was documented in a non-random beaver dammed pool at RM 1.2. The abundance in this single pool was greater than the expanded total of the entire inventory without this pool. The average gradient was low in the first half of the inventory at 0.5%, increasing in the second half to 2.8%.

Trib A enters McFee Cr at RM 2.8. A complete inventory of Trib A was not possible due to the lack of landowner permission that restricted access to the majority of the stream. A short segment was sampled starting 0.6 miles up from its confluence with McFee where average gradient was 0.4%, visibility was poor, and no salmonids were observed. An additional segment starting At RM 1.3 and extending 0.25 miles was also inventoried. This reach was characterized by an average gradient of 4.4%, a scoured bedrock channel, a cobble/boulder riffle, no sorted spawning gravels and a dense conifer riparian corridor. Moderate numbers of 0+ trout and low numbers of cutthroat were observed.

Figure 8



Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2014	1,181	0.5	10	0	150

Heaton Cr (Tributary of McFee Cr)

Heaton Cr enters McFee Cr at RM 0.34 with a similar temperature profile. The inventory began at the confluence and extended 4.26 miles to a steep bedrock slide/falls terminating anadromous potential. Three tributaries all exhibiting limited anadromous potential were included in the inventory: Baker Cr, Fir Clearing Cr, and Trib A. High beaver activity was observed throughout the inventory with 28 dams documented.

No salmonids were observed in the first mile of the inventory. This reach was characterized by an average gradient of 0.2%, entrenched brushy banks, silt dominated substrates and high beaver activity. Baker Cr enters at RM 1 exhibiting very limited salmonid potential. Coho and Cutthroat are first observed just above the confluence of Baker Cr. Over the next 1.8 miles the gradient increases slightly (0.4%) while other stream habitat characteristics remain the same.

The highest production of coho (76% of the total) and cutthroat (69% of the total) was observed from RM 2.8-3.8. This reach was characterized by an increase in average gradient (1.5%), well sorted spawning gravels in pool tailouts, high channel complexity, sinuous channel meander and channel braiding across a wide low floodplain. A spawning peak for coho of 0.93 coho/sqm was observed in this reach at RM 3.2.

Coho distribution ended at RM 3.8 where the confluence of Trib A divides the flow, the average gradient increased to 6.3% and the stream becomes hillslope confined. Coho were observed in the first pool of Trib A, above which increased gradient, shallow pools and the lack of gravel limit additional anadromous potential. The inventory extended above the observed extent of coho distribution for an additional 0.5 miles to a steep bedrock slide (photo 25) that terminates anadromous potential just above the confluence of Fir Clearing Cr. In Fir Clearing Cr., A 12 ft. bedrock falls just above the confluence functions as a permanent anadromous barrier. Back calculation of coho population estimates suggest an adult escapement of 4 spawning pairs that utilized Heaton Cr in 2014.

Photo 25

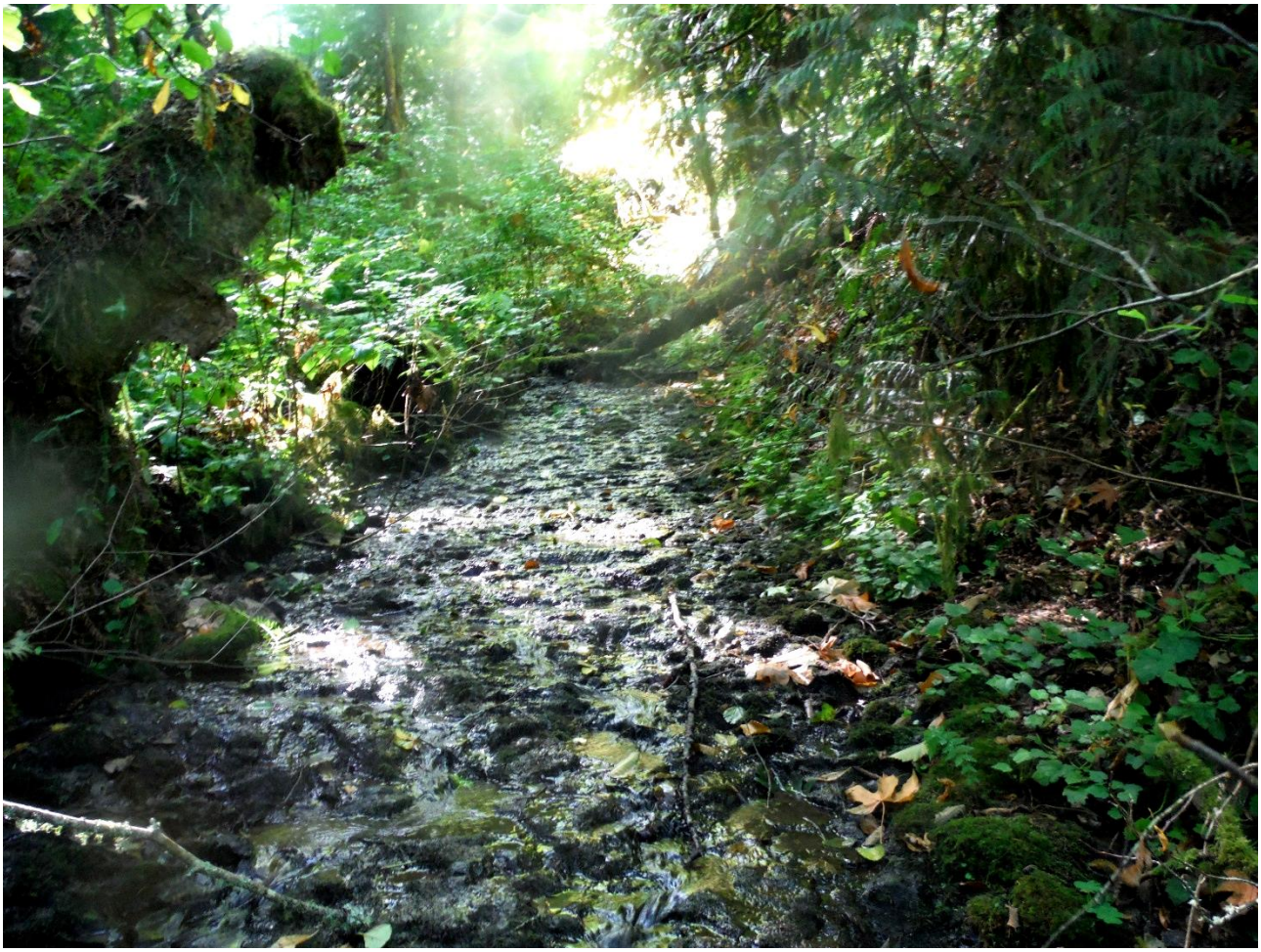
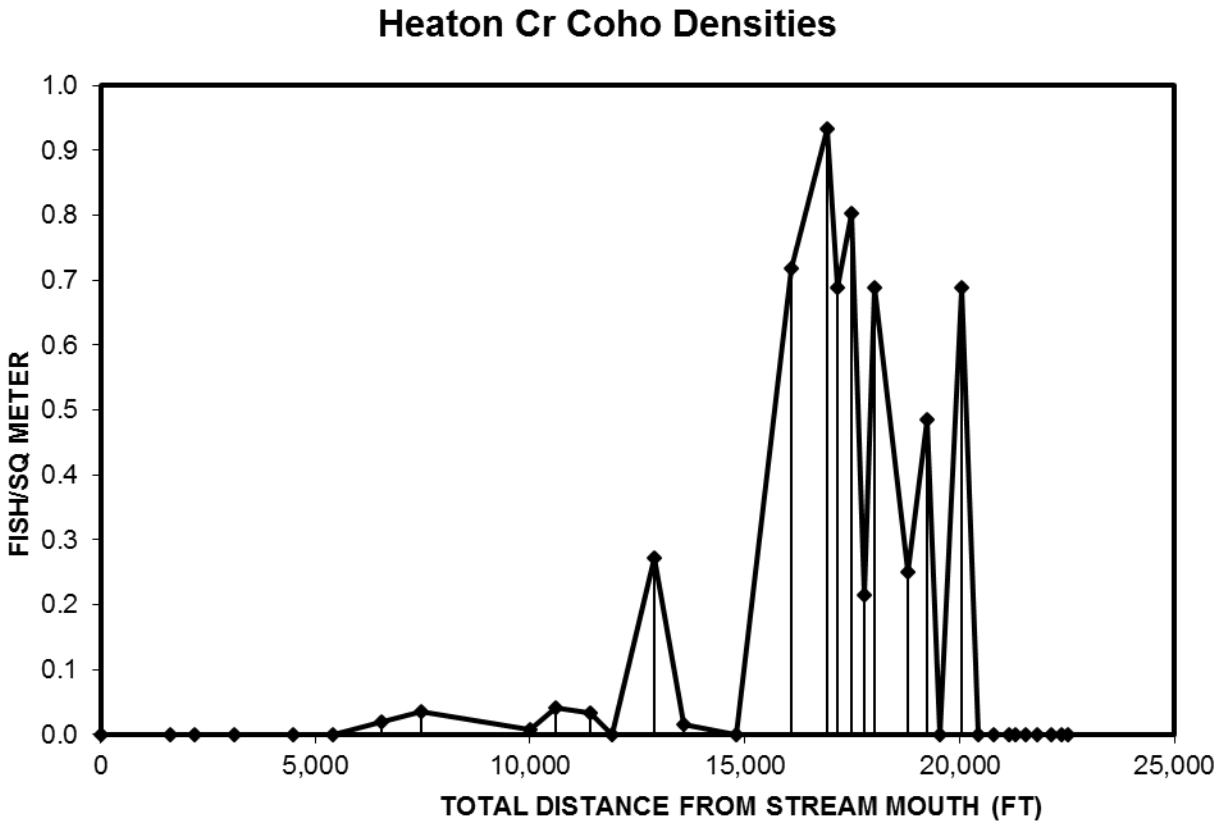


Figure 9



Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2014	819	0.37	60	0	180

Rock Cr (Tributary to Tualatin)

Rock Cr. enters the Tualatin River from the north at USGS RM 38.1 in the town of Hillsboro. The Rock Cr sub-basin drains an area of 75.6 square miles of the Tualatin Mountains and is the third largest sub-basin in the Tualatin. Due to a combination of poor visibility, a lack of summer rearing potential and poor success in acquiring landowner access, only 3.27 miles of the Rock Cr sub-basin was inventoried. The Rock Cr mainstem was sited with several water quality limitations including four Category 5 303(d) listings for: dissolved oxygen (1/1-5/15, RM 0-12.6); lead (year round, RM 0-18.2); iron (year round, RM 0-18.2); and arsenic (year round, RM 0-18.2). In addition four Category 4A listings were made for: phosphorus (6/1-9/30, RM 0-18.2); dissolved oxygen (year round, RM 0-18.3); biological criteria (year round, RM 0-18.2); and temperature (summer, RM 0-18.2). These pollutants are known to affect resident fish, aquatic life, anadromous fish passage, and fish spawning (DEQ Water Quality Oregon's 2012 Integrated Report).

The inventory began at the crossing of the Old Cornelius Pass Rd and ended at the crossing of Rock Cr Rd. No coho or steelhead were observed. Cutthroat and 0+ trout abundance was very low throughout the inventory. Beaver activity was observed in the upper and lower reaches with 15 dams documented. The average gradient throughout the inventory was 1.9%.

The stream habitat in the first half of the inventory exhibited high salmonid potential. It was characterized by well sorted gravel tailouts and high wood complexity. High beaver activity was observed just above the start point. There is no obvious reason for the observed lack of salmonid abundance in this reach.

The stream habitat in the second half of the inventory was characterized by low water flow, a heavily scoured bedrock stream channel, a lack of sorted spawning gravel (photo 26), a well forested riparian corridor and channel meander confined by hillslope and roadbed. A short section of sinuous channel meander with a functional low flood plain and gravel dominated substrate was observed above RM 2.7.

Photo 26

Year	Coho	Avg coho/sqm	0+	Sthd	Cut
2014	0	0	20	0	105

Recommendations

- Replace or remove impassable culverts and irrigation dams, the issues listed below are the highest priority because they block upstream temperature dependent summer migrations of juvenile coho and steelhead that are critical for survival in temperature limited systems. An attempt has been made to list from higher to lower priority. Any of these targets directly addresses the primary habitat limitation for salmonids (access to thermal refugia). This is not a complete list of culvert issues within the inventoried sub-basins. All of the passage issues are discussed in context within the body of this document.
    1) Balm Grove Dam on mainstem Gales just below Parsons Rd (RM 12.7) blocks all juvenile salmonids and adult cutthroat migrations to upstream thermal refugia. In addition, there is evidence that in years of low fall flows, the dam compromises even the passage of large adult salmonids (coho).
    2) Iler Cr - Concrete steps at mouth (just below bridge) block access to all salmonids for thermal refugia during low summer flow regimes.
    3) White Cr - 1ft perched concrete culvert below Highway 8 blocking migration out of a temperature limited reach of mainstem Gales.
    4) Trib C of Beaver Cr – rusted out and perched 4in with a steel trash rack that blocks both adult and juvenile passage above the Timber Rd crossing.
    5) Trib C of Beaver Cr – rusted out and perched 1.5ft at RM 0.23.
    6) Trib C of Beaver Cr – top side of culvert packed with debris and eroding roadbed at during high flows at RM 0.67.
    7) Trib C1 of Beaver Cr – rusted out with all flow draining underneath and packed with debris on top side located just above confluence with Trib C.
    8) Campbell Cr – 2.5 ft perched, undercut and rusted out at confluence with EF Dairy.
    9) Prickett Cr – remove or modify irrigation dam installed above 1st pool that blocks upstream temperature dependent migrations to cold water refugia.
    10) Trib B of Beaver Cr – 4” perched culvert denying access to cooler tributary habitat

- Increase effective shading along all stream reaches that pass through cropland/pastureland with insufficient riparian buffers, but prioritizing those streams with high fish production.
    1) White Cr – lower ½ mile
    2) McFee Cr – lower mile of inventory

- LWD treatment logs in stream reaches that displayed high fish production to: dissipate stream energy and improve fish passage, increase types and sizes of pools, provide overhead cover for fish protection, stabilize spawning areas and build deep accumulations of bedload that can store and protect a hyporehic lens for mitigating elevated summer stream temperatures.

    1) EF Dairy Cr mainstem between RM 8-10 and between RM 13-14. Lack of substantial large wood complexity was noted throughout both of these reaches. Between RM 8-10, EF Dairy Cr repeatedly displays the most productive fish habitat in the Tualatin basin for coho and steelhead. Notes indicate a low terrace and wide floodplain with good potential to increase off channel habitat. The three side channels within this reach would also be good targets for treatment. Between

RM13-14, the secondary spawning peaks of both coho and steelhead were observed. This reach had a gradient of 3.2%. A low wide floodplain was noted closer to RM 14.

- Develop delinked side channel habitats within zones of deep bedload accumulation for the provision of thermal refugia in the form of hyporehicly fed scour pools. This can begin with blocking the inlet end of side channels B and C on the mainstem of EF Dairy Cr with large wood complexes established on point bars. This prescription should also include the creation of scour pools within the side channel to expose the hyporehic strata during summer flow regimes (specific design elements required).

Distribution and Rearing Density Graphics

An Excel Workbook has been developed from the raw Access data that allows the user to preview the distribution, density and abundance graphics by stream, by year and by species that were utilized to conduct this analysis. This pivot table work book allows managers and users to access information for all of the streams surveyed in both 2013 and 2014.

In addition, it is important to note that an extensive amount of supplemental raw data (primarily in the form of surveyor notes, comments and temperature data is also available in the Access database.

Clean Water Services, a partner in this inventory effort, has developed a GIS layer of fish distribution for the inventoried subbasins.