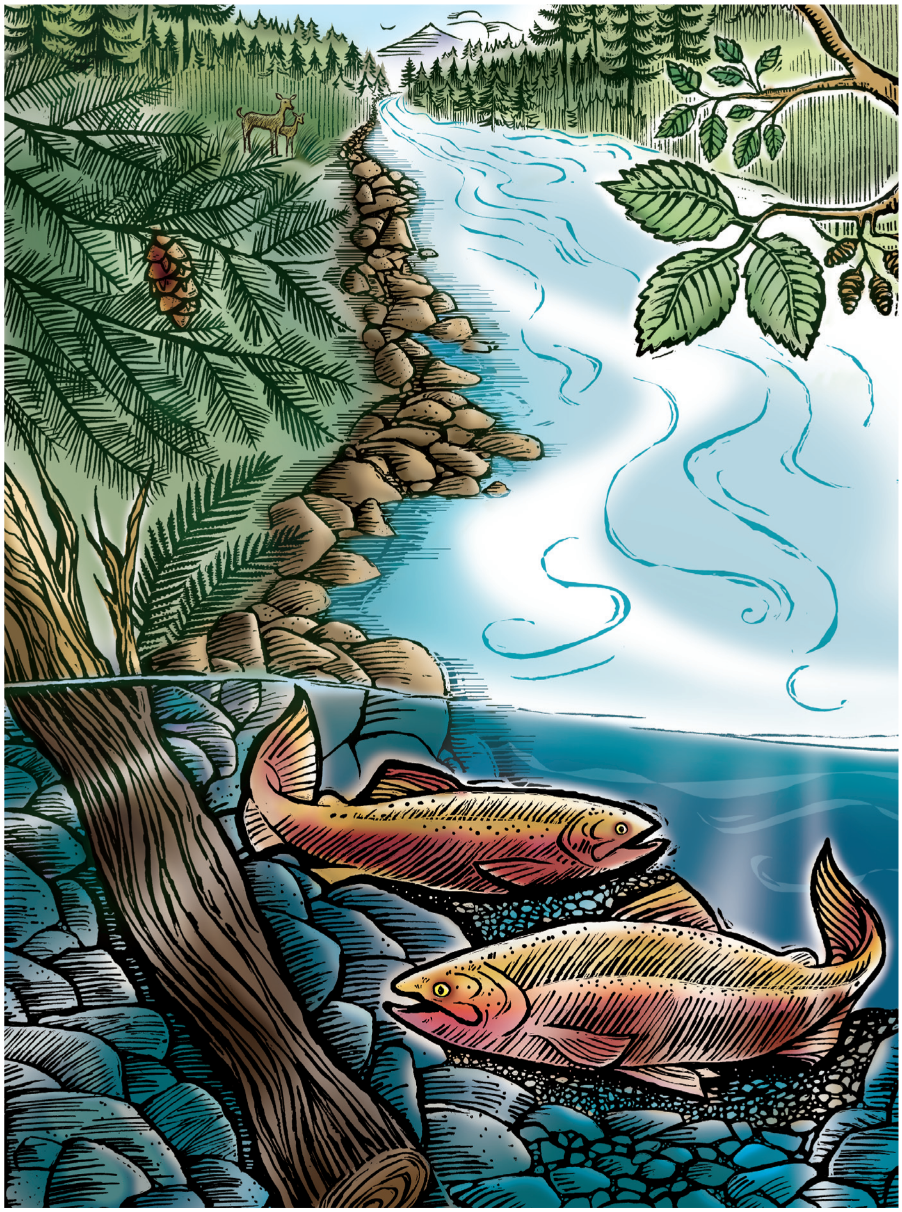
Bull Run Water Supply
Habitat Conservation Plan

Annual Compliance Report 2011 – Year 2



Final · April 2012

Portland Water Bureau

From Forest to Faucet

City of Portland, Oregon 1851

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Acronyms and Abbreviations

cfs	cubic feet per second
EDT	Ecosystem Diagnosis and Treatment
ESA	Endangered Species Act
HCP	Habitat Conservation Plan
JOM	juvenile outmigrants
LCR	Lower Columbia River
MEPS	Middle of Eye to Posterior Scale
MSL	mean sea level
NMFS	National Marine Fisheries Service
O&M	operations and maintenance
ODFW	Oregon Department of Fish and Wildlife
PGE	Portland General Electric
PHP	Portland Hydroelectric Project
PWB	Portland Water Bureau
RM	river mile
TDG	total dissolved gas
USGS	U.S. Geological Survey

1. Executive Summary

The Bull Run Water Supply Habitat Conservation Plan (HCP) is a 50-year plan to protect and improve aquatic habitat while continuing to manage the Bull Run River watershed as a water supply for the City of Portland (City), Oregon. The City created the HCP, with technical assistance from the Sandy River Basin Partners, to minimize and mitigate the effects of covered activities associated with the Bull Run water supply operations on listed and unlisted Endangered Species Act species and their associated habitat. The primary focus of the HCP is protection for ESA-listed anadromous fish under the jurisdiction of the National Marine Fisheries Service (NMFS), but it also includes other species. In 2009, NMFS issued an Incidental Take Permit to the City pursuant to Section 10(a)(1)(B) of the Endangered Species Act and signed an Implementing Agreement with the City. The HCP and each of its provisions are incorporated into those agreements.

In addition, in 2008, the Oregon Department of Environmental Quality's (ODEQ) approved the City's Temperature Management Plan for the Lower Bull Run River. The City's Temperature Management Plan is Appendix G of the HCP. The City's plan addresses temperature requirements for the lower Bull Run River that are articulated in the Sandy River Basin Total Maximum Daily Load (TMDL) report.

The HCP includes 49 conservation measures to protect and improve habitat and to avoid or minimize the impacts of the Bull Run water supply system. Annual reports are required from the City to document compliance with the conservation measures, monitoring requirements, research efforts, and adaptive management actions that are implemented.

The second year of the HCP was 2011, referred to as Year 2 throughout this document. This is the second Annual Compliance Report.

Changing circumstances and conditions have required modifications to some of the original HCP measures. The changed measures were implemented with target amounts or locations that accounted for other measures that could not be implemented (for example, cancelling a large wood project in one location and increasing the amount of large wood pieces in a second location). These changes are noted in this report and documented with an appendix of key correspondence with NMFS.

For 2011, the City was in full compliance with the terms and conditions of the HCP. The City was also in full compliance with the TMDL implementation reporting requirements.

2. Introduction

2.1 Habitat Conservation Plan Background

In April 2009, the National Marine Fisheries Service (NMFS) signed a Permit for Incidental Take of Threatened Species number 13812, granting the City of Portland (City) authorization to operate its Bull Run water supply subject to the provisions of the implementing agreement for the Bull Run Water Supply Habitat Conservation Plan (HCP). The Incidental Take Permit covers four anadromous fish species listed under the Endangered Species Act (ESA) of 1974—Lower Columbia River (LCR) Chinook salmon *(Oncorhynchus tshawytscha)*, Columbia River chum salmon *(O. keta)*, LCR coho salmon *(O. kisutch)*, LCR steelhead *(O. mykiss)*—and Pacific eulachon *(Thaleichthys pacificus)*.

The Bull Run HCP includes 49 habitat conservation measures that are expected to minimize and mitigate, to the maximum extent practicable, the effects of take on the covered fish. The measures are designed to improve habitat conditions for the fish and 18 additional wildlife species in the Bull Run subbasin and the Sandy River Basin, watersheds that are part of the lower Columbia River Basin in northwest Oregon. The Sandy River Basin was included in the plan in order to fully address the Incidental Take Permit requirements.

Measures in the Bull Run include modifying water supply infrastructure, implementing seasonal flow regimes and downramping rates, placing gravel and large wood, establishing fish passage in certain streams, removing invasive species, and defining operational standards to avoid or minimize the effects of operations on the covered species. The measures in the Sandy River Basin, called offsite measures, include large wood and log jam placement, channel redesign and reconstruction, establishing fish passage in certain streams, establishing easements and making improvements in riparian zones, and acquiring land parcels and water rights.

The HCP measures are being implemented and monitored over the course of 50 years. Measures in some reaches are being implemented early in the term of the HCP to provide the greatest improvements over time. Not every measure was implemented in the first year, however. Other measures slated to be implemented later in the HCP time frame are mentioned by name in this report but are not extensively discussed.

A key element of the HCP involves improving water temperature conditions for spawning and rearing salmonid fish. Compliance with this objective also fulfills the temperature objectives for the lower Bull Run River that are articulated in the Oregon Department of Environmental Quality's (ODEQ's) Sandy River Basin Total Maximum Daily Load (TMDL) report (ODEQ 2005). The City's Temperature Management Plan for the Lower Bull Run River, approved by ODEQ in 2008, is Appendix G of the City's HCP.

The HCP outlines a specific program of monitoring, research, and adaptive management to evaluate habitat improvements resulting from the measures. The monitoring component includes both compliance and effectiveness monitoring. This second yearly report of accomplishments includes compliance monitoring information in Section 4.1, effectiveness monitoring information in Section 4.2, and a summary of the planned research in Section 4.3. Reports describing the research and results in detail are available as Appendixes A–E. Appendix F contains key correspondence between PWB and NMFS on obtaining authorization for changes to measures.

2.2 Annual Report Organization

This report is organized to provide the status of work and planned accomplishments for HCP monitoring, the research efforts, and the Portland Water Bureau's adaptive management program. The monitoring section is divided into compliance and effectiveness monitoring. Within each of these monitoring subsections, information is provided for the Bull Run watershed measures and for the offsite measures in the Sandy River Basin, respectively. Measures that share similar objectives (such as large wood placement or obtaining riparian easements) are grouped together. The introductory subsections titled Measure Commitments are taken directly from the HCP and are characterized by a different font than the rest of the report text.

Table 8, beginning on page 52, provides summary information and a snapshot of the status of each measure. The table outlines the measurable habitat objective, the method of compliance monitoring described in the HCP, the years in which the measure is planned to be implemented, and a description of the status. Table 8 also indicates where the effectiveness monitoring report, Appendix A, and the research reports, Appendixes B through D, are located in this annual report. The table includes all of the HCP measures. Measures that are not relevant to the 2011 reporting year are shown with a gray background. Measures that are due to be started in future years are blank in the "Status" column. Measures that are complete are gray and noted as complete in the "Status" column.

3. HCP Monitoring, Research, and Adaptive Management Programs

3.1 Monitoring Program

The monitoring program for the HCP is designed to document compliance and verify progress toward meeting the goals and objectives outlined in Chapter 6 of the HCP. The monitoring program comprises both compliance and effectiveness monitoring. Compliance monitoring tracks progress implementing the HCP measures. Effectiveness monitoring is provided for those measures for which the habitat outcomes are somewhat uncertain.

Compliance monitoring reports focus on the work completed and planned for the following calendar year. Effectiveness monitoring reports focus on the measurable habitat objectives identified for each relevant measure in the HCP. The effectiveness monitoring data will enable an assessment of whether the measurable habitat objectives have been met.

3.2 Research Program

The research program for the HCP focuses on four components in the Bull Run River watershed and one component in the larger Sandy River Basin. In the Bull Run watershed, the City will study the placement of spawning gravel, the degree of gravel scour in spawning beds suitable for Chinook spawning, the concentrations of total dissolved gases at certain locations, and the abundance of spawning Chinook adults. For the Sandy River Basin, the City will collaborate with other organizations doing research to measure the number of juvenile salmonid outmigrants at the reach and basin levels.

3.3 Adaptive Management Program

Adaptive management is an approach that involves monitoring the outcomes of a project and, on the basis of the monitoring, improving the way the project is managed. The City anticipates that, over the course of its 50-year HCP, scientific understanding of the issues relating to salmonid habitat will improve and some conditions will change to the degree that some reconsideration and adaptation of its approach will be appropriate. The adaptive management program provides for ongoing evaluation of individual measures as well as milestones for evaluating the HCP as a whole. A key measure for adaptive management is the Habitat Fund, described in Section 4.4.

4. Monitoring Measures Status and Accomplishments

4.1 Compliance Monitoring

Most of the HCP measures pose very little uncertainty as to whether implementing the measures will meet the objectives. For these measures, the City is conducting compliance monitoring to track implementation and document completion.

4.1.1 Bull Run Measures

The City will use established United States Geological Survey (USGS) sites on the lower Bull Run and Little Sandy rivers to monitor river flow and water temperature. River flow compliance will be measured at USGS Gage No. 14140000 (at river mile [RM] 4.7 on the Bull Run River). This gage will also be used to determine compliance with the downramping rate. Compliance with temperature measures will be based on the temperature data recorded at USGS Gage No. 14140020 on the lower Bull Run River (at RM 3.8, the Larson's Bridge site) and at USGS Gage No. 14141500 on the Little Sandy River (at RM 1.95, the Little Sandy Dam site), as shown in Figure 1.

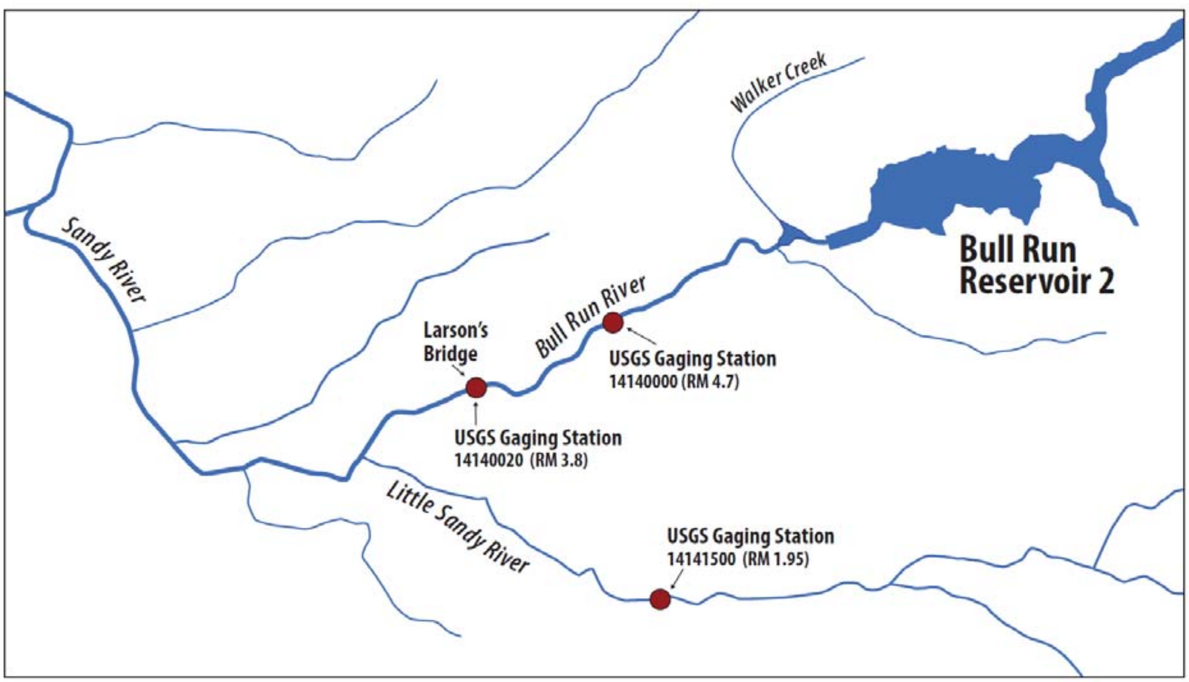

Figure 1. USGS Gaging Stations for Compliance Monitoring

Measure F-1—Minimum Instream Flow, Normal Water Years

Location: Bull Run watershed

Benefits: Bull Run River flow

Contact: Doug Bloem, Environmental Specialist, PWB Resource Protection

Primary Objective

Measure F-1 describes minimum instream flows to improve fish habitat conditions in the lower Bull Run River during normal water years. The measure includes guaranteed minimum flow amounts and other criteria that will maintain flow levels for spawning, rearing, and migrating salmonids and other aquatic species.

Measure Commitments

Measure F-1—Minimum Instream Flows, Normal Water Years: For HCP Years 1-50, the Bull Run water supply will be operated during normal water years to achieve the guaranteed flows in the lower Bull Run River specified in Table 1 (expressed in mean daily flows in cubic feet per second, cfs).

Table 1. Flow Commitments for the Lower Bull Run River During Normal Water Years, Measured at USGS Gage No. 14140000, RM 4.7

Time Period	Guaranteed Minimum Flow (cfs)	Required Percent of Inflow	Maximum Required Flow (cfs)
January 1–June 15	120	n/a[a]	n/a
June 16–June 30	Gradually decrease flows over 15 days from minimum of 120 cfs to a minimum of 35 cfs. If reservoir drawdown begins before June 30, decrease flows at no more than 2”/hour to reach the 20–40 cfs operating range, see below.		
July 1–September 30	Vary flow from 20 cfs to 40 cfs to manage downstream water temperature[b]		
October 1–October 31	70	50%	400
November 1–November 30	150	40%	400
December 1–December 31	120	n/a	n/a

[a]n/a = not applicable
[b]See Measure T-1.

For the period from June 16 to June 30, the guaranteed minimum flow of 120 cfs will be decreased by 5 cfs per day until the minimum of 35 cfs is achieved at Gage No. 14140000.

Variable flows will be implemented in summer (July through September) of normal water years. Water temperature is a key management concern during this season, and the reservoirs will be operated to take advantage of the limited amount of cold water that can be stored. Releases from the reservoirs will vary with weather conditions to better manage use of the available cold water. During mild weather, when temperatures in the river are naturally lower, less cold water will be released from the reservoirs. During warm weather, when cold water from the reservoirs is needed to moderate river temperatures, more cold water will be released. The resulting average summer flow in normal water years is expected to be 35 cfs.

Flow releases in October and November are defined as a percentage of reservoir inflow, with both upper and lower bounds as shown in Table 1. The City will provide a "floor" or minimum flow levels for the lower Bull Run River. The City will also cap the maximum flow level in October and November to allow the reservoir to refill to reduce the potential for unacceptable turbidity. The percentage of inflow released is higher in October than in November, but the total amount of water released will be higher in November because (1) the floor for the November minimum flow is higher than the floor for October and (2) inflow is generally higher in November than October.

Basing water release on a percentage of inflow will ensure that fall flow in the lower river is determined by flow into the reservoirs, not by the amount of water stored in the reservoirs or the amount diverted for municipal supply. Reservoir storage and diversions are both affected by water demand. Inflow is not affected by water demand.

The City will control streamflow releases below Dam 2 at Headworks (RM 6.0 on the Bull Run River) and the lower Bull Run River flow will be measured at USGS Gage No. 14140000 (RM 4.7). For purposes of determining streamflow releases in October and November, reservoir inflow will be measured and totaled for four USGS Gages (No. 14138850, Bull Run River at RM 14.8; No. 14138870, Fir Creek at RM 0.6; No. 14138900, North Fork Bull Run River at approximately RM 0.2; and No. 14139800, South Fork Bull Run River at RM 0.6). The daily mean flows of the four gages will be added and then multiplied by 1.2 to account for the ungaged area of reservoir inflows in the Bull Run watershed.

City staff will determine the week's reservoir inflows once a week and determine the following week's flow target based upon the inflow data. The first determination of reservoir inflow levels will occur prior to October 1. The flow releases to meet the targets will be implemented starting on October 1. Flow release targets will be set each week through the end of November.

Through the term of the HCP, the flow releases in the lower Bull Run River may exceed the guaranteed minimum flows in Table 1 if the reservoir inflows exceed demands for drinking water and the guaranteed minimum flows for fish.

The minimum flow requirements may not be met during the days that the Chinook surveys occur. Flows will be held to less than 150 cfs, as measured at USGS Gage No. 14140000, to allow safe surveying. The surveys are expected to occur approximately once per week from August through November. See Appendix F of the HCP for more details on the Chinook survey procedures.

Status of Work for Calendar Year 2011

The City met the minimum instream flow requirements of HCP Measure F-1. Guaranteed minimum flows for normal water years were met in 2011. Lower Bull Run flows at USGS Gage No. 14140000 are depicted in Figure 2.

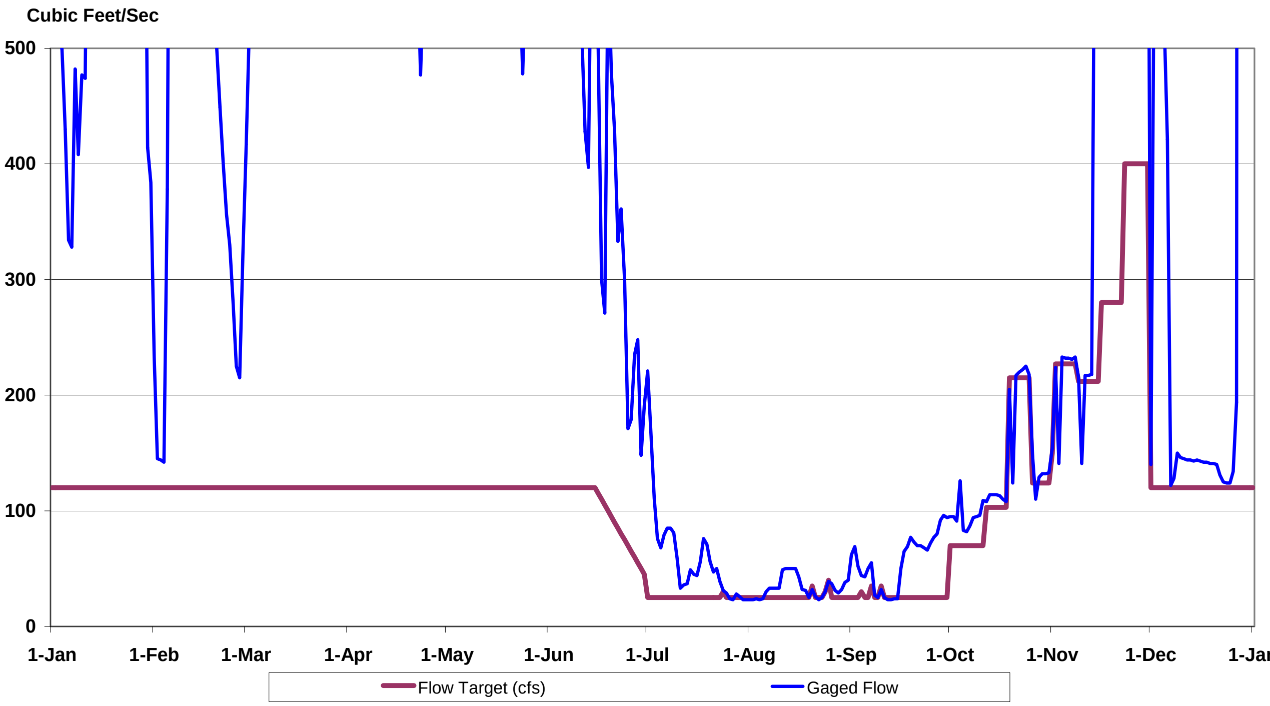

Figure 2. Lower Bull Run River Minimum Flows and Actual Flows[a] in 2011
[a]Flows exceeding 500 cfs are not shown.

There were six days during October and November 2011 when the mean daily flow at the gage was less than the guaranteed minimum levels because releases from Bull Run Reservoir 2 were reduced for part of the day in order to permit Portland Water Bureau (PWB) fish biologists to safely conduct spawning surveys in the lower Bull Run. The reductions in stream flow were allowed under the terms of the HCP measure.

During October and November, guaranteed minimum flows were based on a percentage of total inflow to the Bull Run reservoirs during the previous week. Table 2 summarizes the dates and flows used to derive these calculations.

Table 2. Dates, Inflows, and Flow Targets for October and November 2011

Flow Target Period		Index Period		Average Inflow (cfs) During Index Period	Flow Target (cfs)
From	To	From	To		
1-Oct	4-Oct	20-Sep	26-Sep	93	70
5-Oct	11-Oct	27-Sep	3-Oct	115	70
12-Oct	18-Oct	4-Oct	10-Oct	206	103
19-Oct	25-Oct	11-Oct	17-Oct	431	215
26-Oct	31-Oct	18-Oct	24-Oct	249	124
1-Nov	1-Nov	18-Oct	24-Oct	249	150
2-Nov	8-Nov	25-Oct	31-Oct	567	227
10-Nov	15-Nov	1-Nov	7-Nov	530	212
16-Nov	22-Nov	8-Nov	14-Nov	701	280
23-Nov	30-Nov	15-Nov	21-Nov	1,655	400

Planned Accomplishments for Calendar Year 2012

Flow levels will be monitored in 2012 and compared to the guaranteed minimum flows. Normal-year or critical-year flow criteria will be applied as appropriate.

Measure F-2—Minimum Instream Flows, Water Years with Critical Seasons

Location: Bull Run watershed

Benefits: Bull Run River flow

Contact: Doug Bloem, Environmental Specialist, PWB Resource Protection

Primary Objective

Measure F-2 describes minimum instream flows that will be used during water years with critical seasons. These minimum flows will be used to achieve the guaranteed flows in the lower Bull Run River.

Measure Commitments

Measure F-2—Minimum Instream Flows, Water Years With Critical Seasons: During HCP Years 1-50, for any years that have a critical spring or fall season, the Bull Run water supply will be operated to achieve the guaranteed flows in the lower Bull Run River specified in Tables 4 and 5 (in mean daily flow in cfs). Fall flows in Table 5 will not be implemented more frequently than two years in a row and will not be implemented 4 years after a previous season of critical fall flows has been implemented (to avoid affecting the same age cohort twice). If a year does not have a critical spring or fall season, all flows will be the normal water year flows described in Measure F-1.

The triggers for a critical spring or fall season are defined in Table 3.

Table 3. Critical Spring and Fall Season Triggers

Critical Season	Trigger
Spring	Drawdown occurs prior to June 15
Fall	August and September inflows within lowest 10% of historical record (1940 to current HCP Year)

The response to a critical spring season is outlined in Table 4.

Table 4. Flow Commitments for the Lower Bull Run River During Water Years with Critical Spring Seasons

Time Period	Guaranteed Minimum Flow[a] (cfs)	
June 1–June 30	30	If critical spring season trigger is met, decrease flow after drawdown begins but no earlier than June 1. Maintain downramping rate described in Measure F-3, from 120 cfs to 30 cfs.

[a] Measured at USGS Gage No. 14140000 (RM 4.7)

In any year of the HCP when a critical spring season has been triggered, there may be additional rain that temporarily raises reservoir inflow levels above outflow levels. The City may elect, in such circumstances, to raise the flow of the Bull Run River higher than the critical-period guaranteed minimums indicated in Table 4. Also, the City may elect to release more flow than the guaranteed minimum to the lower Bull Run River during critical spring seasons to meet water temperature objectives as described in Measure T-1 and T-2.

The trigger for the critical fall season is based on whether the mean daily flow for the August and September inflows to the Bull Run reservoirs are within the lowest 10 percent of historical flows for that time period. Throughout HCP Years 1-50, the 10th-percentile flow level will be updated annually to include new years of record.

The response to a critical fall season is outlined in Table 5.

Table 5. Flow Commitments for the Lower Bull Run River During Water Years with Critical Fall Seasons[a]

Time Period	Guaranteed Minimum Flow[a] (cfs)	Required Percent of Inflow (cfs)	Maximum Required Flow (cfs)
October 1–October 15	20	If critical fall season trigger is met, continue to vary flow from 20–40 cfs to manage downstream water temperature	
October 16–October 31	30	50%	250
November 1–November 15	30	40%	250
November 16–November 30	70	40%	350
December 1–May 31	120	n/a	n/a

[a]Measured at USGS Gage No. 14140000 (RM 4.7)

The percentage of inflow and maximum flow requirements might not be met during the days that the Chinook surveys occur. Flows will be held to less than 150 cfs, as measured at USGS Gage No. 14140000, to allow safe surveying. The surveys are expected to occur approximately once per week from August through November. See Appendix F for more details on the Chinook survey procedures.

The City will control streamflow releases at Headworks (RM 5.9 on the Bull Run River) and the lower Bull Run River flow will be measured at USGS Gage No. 14140000 (RM 4.7). For purposes of determining streamflow releases in October and November, reservoir inflow will be measured and totaled for four USGS Gages (No. 14138850, Bull Run River at RM 14.8; No. 14138870, Fir Creek at RM 0.6; No. 14138900, North Fork Bull Run River at approximately RM 0.2; and No. 14139800, South Fork Bull Run River at RM 0.6). The daily mean flows of the four gages will be added and then multiplied by 1.2 to account for the ungaged area of reservoir inflows in the Bull Run watershed.

City staff will determine the previous week's reservoir inflows once each week and establish the next week's flow release target based on that inflow data. The first determination of streamflow level will occur prior to October 1. The flow releases to meet the targets will be implemented starting on October 1. Additional flow release targets will be set each week through the end of November.

Status of Work for Calendar Year 2011

The critical spring trigger was not met in 2011; therefore, critical spring flows were not implemented. Drawdown began on July 23, 2011.

The lowest 10 percent of total reservoir inflow during August and September from 1940 through 2010 was 3.704 billion gallons. Total reservoir inflow during August and September 2011 was 6.705 billion gallons.

Planned Accomplishments for Calendar Year 2012

Critical spring and fall triggers will be assessed in 2012. If either of the triggers is met, the City will decide whether to implement the appropriate guaranteed critical year minimum flows per the conditions of the HCP.

Measure F-3—Flow Downramping

Location: Bull Run watershed

Benefits: Bull Run River flow

Contact: Frank Galida, Director, Hydroelectric Project Manager, Portland Bureau of Hydroelectric Power

Primary Objective

The City is committing to a lower downramping rate to reduce effects on covered fish in the lower Bull Run and Sandy rivers.

Measure Commitments

Measure F-3—Flow Downramping: For HCP Years 1-50, the City will release flow into the lower Bull Run River, below Dam 2 as a result of hydropower operation, at a maximum downramping rate of no more than 2"/hour (0.17'/hour), as measured at USGS Gage No. 14140000 (RM 4.7). City staff will monitor recordings at USGS Gage No. 14140000 to ensure that the decreases adhere to this downramping rate.

This maximum downramping rate will not apply to events beyond the control of system operators, such as unexpected power grid interruptions, downed power lines, equipment failures, emergency responses at the Headworks as required to assure compliance with federal Safe Drinking Water standards, the mandatory annual testing of the powerhouse, and other circumstances that preclude the use of the North Tunnel or Diversion Pool at the City's water supply Headworks. The maximum downramping rate will also not apply when naturally occurring high flows, as measured at USGS Gage No. 14138850 (Bull Run RM 14.8), decrease by more than 2"/hour.

Status of Work for Calendar Year 2011

The City was in compliance with Measure F-3. Downward-stage fluctuations in the lower Bull Run River, as measured at USGS Gage No. 14140000, were maintained at or below a rate of 2"/hour (hr) for 99.62 percent of the time in 2011. Downramping exceedences occurred during 33 hours, or 0.38 percent of total operating hours during the monitoring year. The effects analysis outlined in the HCP was based on predicted flow exceedences of 0.4 percent of total operating hours—a level of downramping flow exceedences that was determined to have minimum effects on covered fish species in the plan. The City, at 0.38 percent of total operating hours in 2011, operated within this limit.

Most of the downramping exceedences (28 hours) were attributed to naturally occurring drops in the upstream tributary flows, critical safety inspections or equipment failures, all of which are covered by specific exclusion language in the HCP Measure F-3 description. Accounting for each hour of downramping exceedences follows:

- 23 hours were associated with storm events which generated high flows followed by sharp declines (stage drops greater than 2”/hr) in those flows as measured at USGS Gage No. 141438850.
- 4 hours were associated with a necessary inspection of a critical piece of safety equipment at PHP Powerhouse 1 at a time when excess water was flowing over the spillways of both Bull Run dams (referred to as “spill mode”).
- 1 hour was related to simultaneous equipment failures at PHP Powerhouse 2 and the Water Bureau’s north Howell-Bunger (H-B) valve controls, causing erratic control of downward flow changes at a critical transition of flows from the valves to the powerhouse.

The remaining 5 hours of exceedences occurred during four separate events, all of which are classified as operator error. When taken together, these four operator-caused exceedences represent only 0.06% of the total operating hours for year 2011.

Three of those events occurred as the operator at the Water Supply Headworks was attempting to lower the flow from the H-B valves to the lower Bull Run River. The controls used for that activity are 50 years old and fairly unreliable and inexact. The operators closed the valves too quickly, thereby causing three separate exceedences of the 2”/hr downward stage change limit in the lower river. In response to those three exceedence events, the operators at the Headworks have been given schedules to time the valve closures. The schedules show the operators how long their downramping efforts should take to transition from one flow level down to any lower flow level.

One of the events occurred as one of PGE’s operators incorrectly thought that flows passing Bull Run Dam 1 were high enough to mask the downstream effect of shutting down PHP Powerhouse 1 while the two Bull Run dams were in spill mode. In response to that event, PGE’s project manager has confirmed that when Bull Run Dam 2 is in spill mode, the operators will only shut down PHP Powerhouse 1 when faced with either a critical safety issue or as directed by the City staff to address water quality concerns.

Planned Accomplishments for Calendar Year 2012

Flow downramping will be monitored in 2012. From July 2012 through July 2013, the PWB will be adding a multi-level intake structure to the North Intake Tower at Bull Run Dam 2. (This construction activity is part of HCP Measure T-2 Post-Infrastructure Temperature Management —a critical infrastructure action needed to meet water temperature targets in the lower Bull Run River.) During that construction period, the North Intake Tower and PHP’s Powerhouse 2 will be out of service. The City’s subsequent inability to use those facilities will greatly limit its means to regulate the rate of water flowing past Dam 2. This will lead to a much higher number of exceedences of the 2”/hr downramping rate for part of 2012 and 2013. Measure F-3 contains language that indicates that the 2”/hr maximum downramping limit does not apply when the use of the North Intake Tower and Tunnel is precluded.

Measure F-4—Little Sandy Flow Agreement

Location: Bull Run watershed

Benefits: Little Sandy River flow

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objective

The City will forgo consumptive use of Little Sandy River water under the 1892 claim and the 1909 right for the term of the HCP. When coupled with the conversion of the Portland General Electric (PGE) claim to instream use, the City's action assures natural flows in the Little Sandy for 50 years. In addition, flows in the lower Bull Run River, below the confluence with the Little Sandy and above PGE's Bull Run powerhouse (about 1.5 miles), will be significantly higher than flows that occurred during PGE's Marmot/Little Sandy hydropower operation (when most Little Sandy River flows were diverted to Roslyn Lake).

Measure Commitments

Measure F-4—Little Sandy Flow Agreement: In HCP Years 1-5, the City will create a flow agreement documenting the City's commitment to forgo exercise of the City's water right and claims to the Little Sandy River for the term of the HCP. Flows associated with the City's unexercised water rights will remain instream.

Status of Work for Calendar Year 2011

No work was done on this measure in calendar year 2011.

Planned Accomplishments for Calendar Year 2012

Work on this measure may not occur until calendar year 2013. The City has until 2014 to complete this measure.

Measure T-1—Pre-infrastructure Temperature Management

Location: Bull Run watershed

Benefits: Bull Run water temperature

Contact: Doug Bloem, Environmental Specialist, PWB Resource Protection

Primary Objective

The City will alter its water supply infrastructure and its water supply operations to reduce water temperatures in the lower Bull Run River. The City's strategy relies on sharing the available cold water in the Bull Run reservoirs. The City will store cold water in the reservoirs in early summer when overall temperatures are lower, and will release it in the late summer when river temperatures are warmer. The multilevel intakes already existing at Dam 1 are used for this purpose. The City will maintain the 7-day moving average of the maximum daily water temperature of the lower Bull Run River below 21 °C for salmon/trout rearing. Compliance with this measure fulfills the objectives of the City's Temperature Management Plan (TMP) for the Lower Bull Run River (Appendix G of the HCP).

Measure Commitments

Measure T-1—Pre-infrastructure Temperature Management: Prior to the completion of the infrastructure changes described in Measure T-2, the City will manage flow releases from Headworks to maintain the 7-day moving average water temperature of the daily maximums at equal to or less than 21.0 °C. Stream temperatures will be recorded at Larson's Bridge on the main stem Bull Run River (USGS Gage No. 14140020).

Status of Work for Calendar Year 2011

The daily maximum temperature requirement outlined in HCP Measure T-1 was met. The 7-day moving averages of the daily maximum water temperature at Larson's Bridge are shown in Figure 3. All 7-day averages were less than 21.0 °C. The maximum value for the 7-day moving average was 20.1 °C.

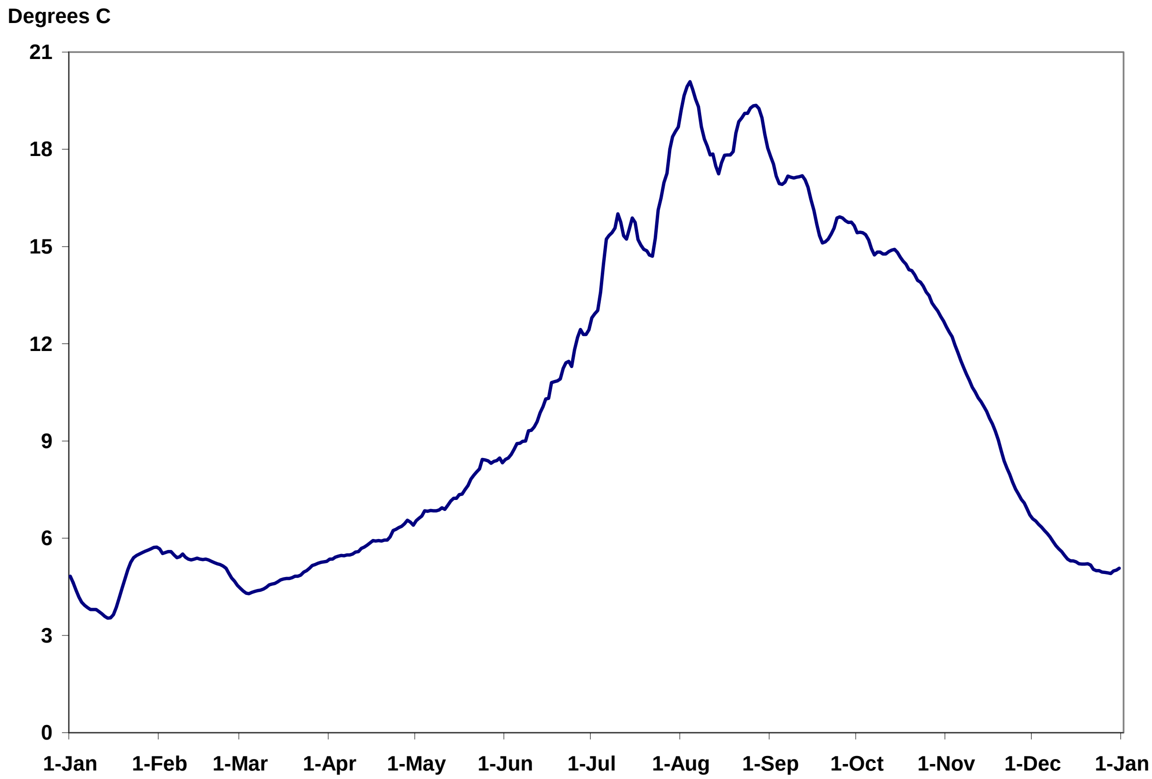

Figure 3. 7-Day Moving Average of Daily Maximum Water Temperature in the Lower Bull Run River at Larson's Bridge (USGS Gage No. 14140020) for 2011

Planned Accomplishments for Calendar Year 2012

The City will manage flow releases from Headworks to maintain the 7-day average of daily maximum temperatures at Larson's Bridge below 21.0 °C.

Measure R-1—Reservoir Operations

Location: Bull Run watershed

Benefits: Avoids or minimizes cutthroat and rainbow trout mortality

Contact: Doug Bloem, Environmental Specialist, PWB Resource Protection

Primary Objective

The City will continue to manage the reservoirs to assure compliance with federal Safe Drinking Water standards and to avoid or minimize mortality of cutthroat and rainbow trout.

Measure Commitments

Measure R-1—Reservoir Operations: For HCP Year 1-50, the City will operate the two Bull Run reservoirs to avoid or minimize mortality of cutthroat and rainbow trout. The operating criteria for the reservoirs will be the following:

1. When the City is operating its hydroelectric powerhouses at the two Bull Run dams during the winter, the reservoir surface elevations will not normally vary outside of the upper two feet of the reservoirs' normal full pool range (except as noted in items 2 and 3 below). For Bull Run Reservoir No. 1, the elevation range is 1,034 to 1,036 feet above MSL. For Reservoir 2, the range is 858 to 860 feet above MSL.

2. The City will lower the surface elevation of the two reservoirs beyond the upper two feet of the normal full pool level only for water supply and/or quality reasons, for downstream fish habitat reasons, for dam safety reasons, or for repairs or maintenance to the dam or hydropower project facilities.

3. The City will operate the two reservoirs as needed to maintain required streamflows and water temperatures in the lower Bull Run River for covered species.

4. During the summer drawdown season, Reservoir 1 may be lowered to approximately elevation 970 feet above MSL and Reservoir 2 may be lowered to approximately 832 feet above MSL as needed for water supply purposes

5. At the end of each drawdown season, the two Bull Run reservoirs will be filled as rainfall, streamflow, and required downstream releases permit.

6. The spillway gates on Bull Run Dam No. 1 will be lowered onto the spillway crest in the spring to store additional water for use in the summer months. After the risk of major flooding has passed, and any habitat maintenance work has been completed in the upper reaches of Bull Run Reservoir No. 1 (see Measure R-3, Reed Canarygrass Removal), the water surface level in that reservoir will be raised to a summer supply full pool level of 1045 feet.

7. The City will use 4-cycle engines on its boats to minimize reservoir water pollution.

Status of Work for Calendar Year 2011

The Bull Run reservoirs were operated to meet the requirements of Measure R-1 in 2011. Graphs of the daily surface elevations of each reservoir are shown in Figures 4 and 5.

Reservoir 1 was operated within 2 feet of the spillway elevation from January 1 through May 21, except during several periods when storm flows surcharged the reservoir. From January 12–18, a series of storms surcharged the reservoir to more than 1,043 feet elevation. These storms delivered a large load of sediment and turbidity to the reservoirs, making it necessary for PWB to take the Bull Run supply out-of-service and switch to the City's groundwater source. From January 24 to January 28, flows out of the reservoir were increased to flush out the turbid water, lowering the elevation to just above 1,025 feet. Reservoir 1 was refilled to the normal winter operating range by January 30. Several smaller storms raised Reservoir 1 elevations to the 1,038–1,039-foot range on March 14–16, March 30–31, and April 15–16.

The spillway gates were lowered (closed) on May 20, and Reservoir 1 was operated about halfway up the gates (1,038–1,040 feet) from May 25–June 1. Once Measure R-3 (Reed Canarygrass Removal) was completed, Reservoir 1 was filled to the top of the spillway gates and held there (1,044–1,045 feet) until reservoir drawdown began on July 23. Reservoir 1 reached its minimum elevation for 2011 of 1,005.5 feet on October 5, then refilled to spillway elevation (1,036 feet) on November 17. Reservoir 1 remained within 2 feet of spillway elevation after November 17 except for the period of December 28–30, when the reservoir was surcharged by a storm to more than 1,042 feet elevation.

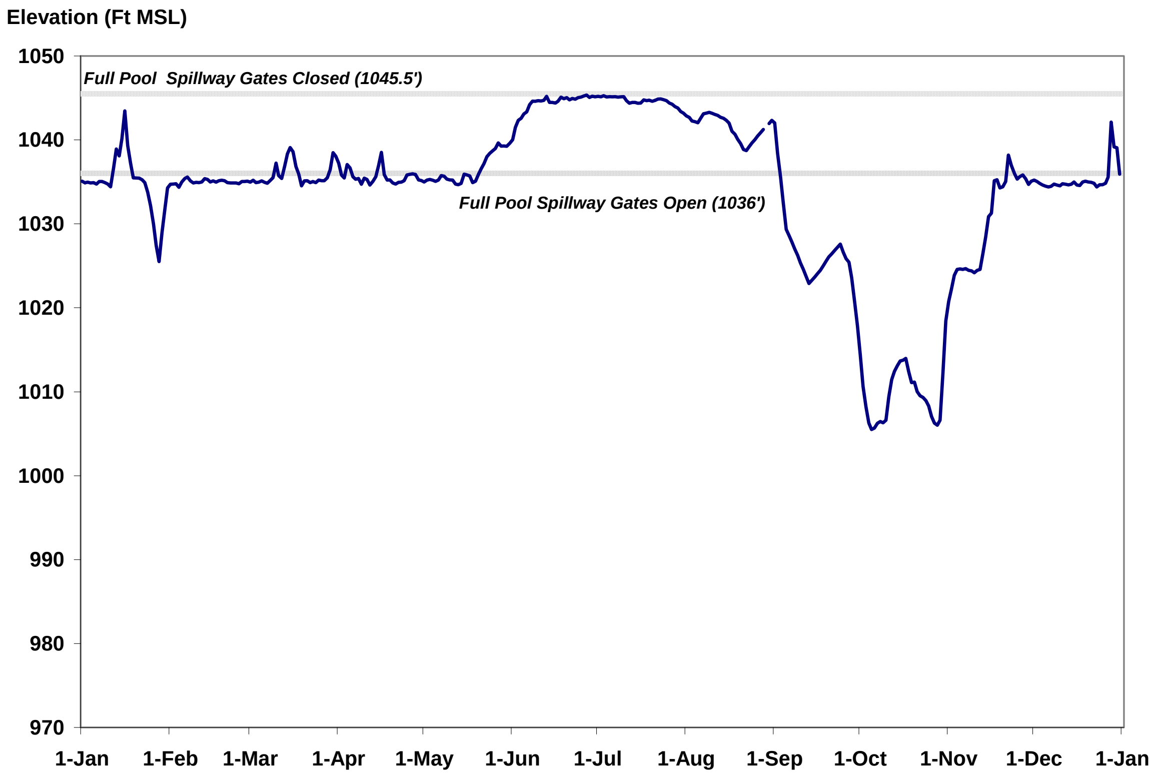

Figure 4. Reservoir 1 Elevations[a] During 2011

[a]Reservoir elevations were recorded at midnight at USGS Gage No. 14139800 in feet above mean sea level (MSL)

Reservoir 2 was operated within 2 feet of spillway elevation from January 1 through July 17, except during periods of storm flows. From January 12—18, storm surcharge raised the reservoir as high as 863.8 feet elevation. From January 29–31, following the flushing from Reservoir 1, flows out of Reservoir 2 were increased to flush it in turn, lowering the elevation to just below 855 feet. Reservoir 2 was refilled to the normal winter operating range by February 3. Several smaller storms raised Reservoir 2 elevations to the 860–862 foot range on March 10–11, March 15–19, March 29–April 6, and April 15–17.

PWB started drafting (drawing down) Reservoir 2 on August 4, reaching its minimum elevation for 2011 of 840.29 feet on September 24. Reservoir 2 refilled to within 2 feet of spillway elevation on November 17. The reservoir was drawn down to the 852–856 foot range on November 15, November 21, and November 29, in order to provide room to hold back water from the lower Bull Run channel to permit PWB fish biologists to safely conduct spawning surveys. It then remained within 2 feet of spillway elevation from December 5 through the end of the year, except for the period of December 28–31, when the reservoir was surcharged by a storm to almost 863 feet elevation.

The City used only 4-cycle engines on all powered boats used on the Bull Run reservoirs.

Figure 5. Reservoir 2 Elevations[a] During 2011

[a] Reservoir elevations were recorded at midnight at USGS Gage No. 14139900 in mean feet above sea level (MSL).

Planned Accomplishments for Calendar Year 2012

Reservoir elevations will be managed in 2012 according to the commitments of this measure. All boats operated on the Bull Run reservoirs will be powered by 4-cycle engines or human power.

Measure R-2—Cutthroat Trout Rescue

Location: Bull Run watershed

Benefits: Prevent mortality of cutthroat trout in spillway canal

Contact: Burke Strobel, Fish Biologist, PWB Resource Protection

Primary Objective

The City will implement Measure R-3 to prevent cutthroat mortality due to elevated summer water temperatures.

Measure Commitments

Measure R-2—Cutthroat Trout Rescue: For HCP Years 1-50, the City will remove cutthroat trout from the Dam 2 spillway approach canal annually to prevent mortality due to elevated summer water temperatures.

The City will use several approaches to implement this measure and will determine which one is most effective.

In HCP Year 1, the City will install a fyke net and place salmon eggs in a basket in the trap box to attract cutthroat trout. The fyke net will be placed in the spillway approach canal in early June when water temperatures are cool and will be checked two to three times per week through the end of the month. After June, and when drawdown first starts to isolate the water in the spillway approach canal, the City will drain the canal to determine whether the fyke net was effective for capturing fish.

If at least two-thirds of the cutthroat found in the approach canal are trapped by the fyke net and successfully returned to Reservoir 2, the City will continue that approach for HCP Years 2-50. If less than two-thirds of the cutthroat trout are successfully returned to Reservoir 2, the City will consider a new orientation and location for the fyke net.

After HCP Year 2, if the City determines that fyke netting does not effectively capture the cutthroat in the canal, the City will drain the canal in Reservoir 2 as soon as reservoir elevations allow.

If the City determines that draining the canal sends warm water down the Bull Run River, and interferes with the objectives for Measures T-1 and T-2, the City will not continue this conservation measure. Funding would be allocated to other habitat conservation measures according to the adaptive management process described in Chapter 9 of the HCP.

If the City's methods for the spillway approach canal fish rescue are ineffective—defined as having more than one-third mortality associated with the trapping of fish or leaving fish in the spillway to experience high water temperatures—the City will not continue the measure. In that case, the funding will be allocated to other habitat conservation measures according to the adaptive management process described in Chapter 9 of the HCP.

Status of Work for Calendar Year 2011

The City met the requirements of Measure R-2. The City successfully captured cutthroat trout from the spillway canal and released them in the main part of Reservoir 2 in 2011.

Protocols for this measure were changed in 2010 from those described above; revised protocols were followed in 2011. Trapping cutthroat trout using a fyke net was attempted in 2009. The technique was ineffective and resulted in no cutthroat trout being captured. Instead, in 2011, the spillway canal was electro-shocked using a boat electro-shocker.

A crew of two Oregon Department of Fish and Wildlife (ODFW) employees electro-shocked the entire surface of the spillway canal on August 18, using a boat electro-shocker, while two City employees transferred captured fish to the main body of Reservoir 2.

The water surface elevation of Reservoir 2 was drawn down below approximately 855 feet above sea level by August 13, isolating the spillway canal. An experienced ODFW boat electro-shocking crew began electrofishing early on August 18 to avoid the heat of the day. Electro-shocker settings were adjusted until the crew was confident that they were capturing fish at the maximum efficiency. The boat was slowly driven back and forth, systematically electro-shocking the entire surface area of the spillway canal. Captured fish were kept in aerated buckets of water maintained at 18 °C. Fish were released in the main part of the reservoir as soon as possible.

Sixteen cutthroat trout were captured. Eleven of these fish were released in the main part of Reservoir 2, and five fish (31 percent) died as a result of injuries sustained from electro-shocking. The fork lengths of captured cutthroat trout ranged from 60 to 285 millimeters, suggesting that the methods used were effective at capturing fish in a range of various sizes.

Electro-shocking was not completely effective at removing all cutthroat trout from the spillway canal. Two City employees snorkeled in the spillway canal on the afternoon of August 18 to investigate whether any trout remained in the spillway canal. Two cutthroat trout, estimated to be greater than 250 millimeters, were observed actively swimming along the south bank of the canal.

After removing cutthroat trout, the water surface elevation of Reservoir 2 was maintained below 855 feet above sea level throughout the summer to prevent cutthroat trout from reentering the spillway canal.

Planned Accomplishments for Calendar Year 2012

The City plans to remove cutthroat trout from the Reservoir 2 spillway canal in the early summer using protocols identical to those used in 2011.

Measure R-3—Reed Canarygrass Removal

Location: Bull Run watershed

Benefits: Improve terrestrial habitat for wildlife

Contact: Angie Kimpo, Invasive Species Coordinator, PWB Resource Protection

Primary Objective

The City has identified three areas along the upper end of Bull Run Reservoir 1 that are important for reproduction and egg incubation for western toads and red-legged frogs to improve breeding and rearing habitat for these species.

Measure Commitments

Measure R-3—Reed Canarygrass Removal: For HCP Years 1-50, the City will cut and rake reed canarygrass away from three areas along the north bank of the upper end of Bull Run Reservoir 1. The City will access the site by boat from the reservoir and by trail. Power tools will be used for cutting the grass. Neither heavy equipment nor additional road access will be needed. The cutting will occur just prior to the summer season lowering of the spillway gates on Dam 1, which will flood the shallow area of the reservoir. The areas to be cut are approximately 10' x 15', 100' x 100', and 100' x 40'; this total area to be cut is approximately one-third acre.

Status of Work for Calendar Year 2011

The City met the requirements of Measure R-3. In the spring of 2011, City staff and wildlife biologist Char Corkran worked at the north bank of the upper end of Bull Run Reservoir 1. All parties participated in cutting reed canarygrass in three areas within the western toad and red-legged frog breeding areas. Once the three areas were cut, the grass was removed from breeding locations with rakes and pitchforks. The three sites were left with grass stubble approximately 2–4 inches in height and exposed mineral soil.

Planned Accomplishments for Calendar Year 2012

City staff will return to the three sites and cut reed canarygrass within the western toad and red-legged frog breeding areas.

Measure H-1—Spawning Gravel Placement

Location: Bull Run watershed

Benefits: Improve instream habitat

Contact: Burke Strobel, Fish Biologist, PWB Resource Protection

Primary Objective

The City will replenish spawning gravel and mimic natural supply and accumulation in the lower Bull Run River. The three selected sites provide the best combinations of access for delivery of gravel to the river and proximity to known spawning areas (CH2M HILL 2000).

Measure Commitments

Measure H-1—Spawning Gravel Placement: The City will augment spawning gravel in the lower Bull Run River and monitor the effects of the gravel placements. A total of 1,200 cubic yards of gravel will be placed in the river annually during HCP Years 1-5; 600 cubic yards will be placed annually for the remainder of the HCP term (HCP Years 6-50). The gravel will consist of a spawning matrix composed of medium to very coarse material (0.5 to 4 inches) that has been washed or sorted to remove fine sediment. The City will purchase gravel from companies with current valid permits for the mining or removal of gravel. The City will only purchase gravel that comes from areas outside of river floodplains.

Gravel will be placed in the river downstream of the City's water supply intakes. Equal amounts will be placed at three locations:

- 1,200 feet downstream of the Plunge Pool at RM 5.7
- 450 feet downstream of USGS Gage No. 1414000 at RM 4.7
- 600 feet downstream of Larson's Bridge at RM 4.0

Spawning gravel placement will occur in December after the primary fall Chinook salmon spawning period, and before steelhead spawning starts in the spring.

Gravel placements will continue as described above unless

- the lower Bull Run River does not experience high enough flows to distribute the gravel at the three placement locations

or

- the gravel placement is determined to be ineffective for creating spawning habitat for the covered species.

If either of these two conditions arises, the City will work with the NMFS to modify implementation of the measure as needed.

Appendix F of the HCP describes how the City will assess the effectiveness of the placed spawning gravel.

Status of Work for Calendar Year 2011

The City met the requirements of the HCP measure. The City successfully placed 1,200 cubic yards of spawning gravel in the lower Bull Run River in January 2011, at the three specified locations specified. Using trucks with conveyor belts, the City placed a total of 400 cubic yards of gravel into the river at each location between January 10 and 14, 2011. The gravel was obtained from a gravel quarry located near Estacada, Oregon, on an old alluvial terrace above the Clackamas River. The material complied with the specifications described in the measure.

Conveyor trucks were able to throw gravel to the middle of the Bull Run River, where it was moved downstream by high flows. River flows during implementation of the project ranged from approximately 477 cfs to approximately 4,300 cfs. No gravel was placed in pools. Gravel placement did not accumulate or hinder the movement of fish at any of the three sites. A large flood (20,200 cfs) on January 16, 2011, completely redistributed the added gravel.

Planned Accomplishments for Calendar Year 2012

Additional spawning gravel will be placed in the lower Bull Run River in January 2012. The placement methods will be similar to those used in 2011.

Measure H-2—Riparian Land Protection

Location: Bull Run watershed

Benefits: Improve riparian and instream habitat

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objective

City-owned lands along the lower Bull Run River are capable of providing riparian habitat at a level comparable to unmanaged late-seral forest. The City will continue managing these lands for the duration of the HCP so that their value to instream habitat will be maintained, and in some cases improved.

Measure Commitments

Measure H-2—Riparian Land Protection: For HCP Years 1-50, City-owned lands adjacent to the lower Bull Run River will be managed for the conservation of riparian habitat. The City will not cut trees within 200 feet of the river's average high water level on City-owned lands for the term of the HCP. A tree, as defined here, is any coniferous species with a minimum average diameter at breast height of 12 inches. Exceptions will include selective tree cutting to construct, maintain, and operate water supply and treatment facilities, water monitoring facilities, power lines, roads, and bridges. The City will also remove trees if they threaten City facilities, pose a significant risk to human safety, or when the City and NMFS determine selective cutting is desirable for the purpose of maintaining or improving riparian habitat. If trees are removed, the City will assess the site to determine whether an appropriate riparian species could be planted where the tree (or trees) was removed and will replant trees where feasible. The planted trees will be species that do not grow as tall as the removed trees. See also Measures W-1 and W-2.

Status of Work for Calendar Year 2011

The City met the requirements of Measure H-2. The City did not cut trees within 200 feet of Bull Run River's average high-water level on City-owned lands in 2011.

Planned Accomplishments for Calendar Year 2012

The City will continue to monitor activities within 200 feet of the Bull Run River.

Measure O&M-1—Bull Run Infrastructure Operations and Maintenance

Location: Bull Run watershed

Benefits: Avoid or minimize effects of operations and maintenance activities on covered lands

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objective

The City will implement the Bull Run Infrastructure Operations and Maintenance (O&M) measure to address the potential impacts of maintaining and operating its water supply facilities in the watershed.

Measure Commitments

Measure O&M-1—Bull Run Infrastructure Operations and Maintenance: For HCP Years 1-50, the City will take the following actions to avoid or minimize effects on species covered or addressed in the HCP in the Bull Run watershed:

Covered Lands

- The City will prevent paint and debris from falling in the river during bridge and conduit maintenance at all active stream crossings.
- The City will avoid or minimize erosion during repair and maintenance of all water supply infrastructure.
- Water drained from the conduits will be dechlorinated and routed through energy dissipaters prior to releases in the nearest waterway.
- The City will not use insecticides on covered lands. The City will allow BPA to use the herbicide Garlon 3A in a limited manner on the BPA transmission line easement on City land (see Section 8.7 for more information). The City will avoid or minimize use of other herbicides on covered lands except as necessary to control invasive plants. Plans for herbicide use that might affect habitat for covered species will be provided to NMFS for preapproval.
- The City will use fertilizers on lands if necessary to encourage plant establishment and growth after projects that cause ground disturbance (e.g., as part of hydroseeding).
- The City will remove trees in riparian areas if they threaten City facilities or pose a significant risk to human safety. The City will plant replacement trees, in the same approximate locations, if trees of greater than 12 inches diameter at breast height are cut.

Sandy River Station

- Within HCP Years 1-10, the City will evaluate stormwater drainage at Sandy River Station and improve facilities if needed.

Status of Work for Calendar Year 2011

The City followed all of the commitments stated in Measure O&M-1.

Planned Accomplishments for Calendar Year 2012

The City will continue to monitor the commitments stated in Measure O&M-1.

Measure O&M-2—Bull Run Spill Prevention

Location: Bull Run watershed

Benefits: Avoid or minimize effects of operations and maintenance activities on covered lands

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objective

The City will implement the Bull Run Spill Prevention measure to address the potential impacts of maintaining and operating its water supply facilities in the watershed.

Measure Commitments

Measure O&M-2—Bull Run Spill Prevention: For HCP Years 1-50, the City will implement the following actions to avoid or minimize spill effects on the species covered or addressed in the HCP in the Bull Run and Sandy rivers:

Headworks

- Fuel and chlorine deliveries will be escorted by a pilot car via paved roads.
- Secondary containment will be provided for the fuel tanks.
- Containment basins will be inspected and pumped out as needed.

Sandy River Station

- Secondary containment systems will be provided for the fuel tanks and pumps to contain any leaks. Containment basins will be inspected and pumped out as needed.
- Within Years 1-5 of the HCP, the City will evaluate the feasibility of moving existing fuel tanks and pumps out of the Sandy River floodplain. This feasibility analysis will be done in conjunction with a City capital improvement project.

Status of Work for Calendar Year 2011

The City has complied with all of the commitments in Measure O&M-2. In 2010, the City also moved the fuel tanks and pumps out of the Sandy River floodplain.

Planned Accomplishments for Calendar Year 2012

The City will continue to monitor adherence to the commitments in Measure O&M-2.

4.1.2 Offsite Measures

The City will implement conservation measures on land in various locations throughout the Sandy River Basin. The measures are grouped by type: riparian easements and improvements, acquisition of water rights, fish passage, carcass placement, large wood and log jam placement, channel restoration, and terrestrial wildlife habitat conservation.

4.1.2.1 Riparian Easements and Improvements

The City will obtain easements from willing landowners for a total of 373 acres of riparian lands. The original easement targets in the HCP were 151, 99, and 123 acres for the lower, middle, and upper Sandy River watershed, respectively (see Table 6). For

Table 6. Original and Revised Easement Acre Targets for HCP Implementation, Year 2 (2011)[a]

Measure Code	Reaches	HCP Implementation Years	Acre Targets HCP	Acre Targets 2011	Easement Acres
Lower Sandy					
H-11	Sandy 1	2010-2014	11	11	
H-12	Sandy 2	2010-2014	62	62	
H-13	Gordon 1A & 1B[b]	2010-2014	78	93	3
		Subtotal	151	166	
Middle Sandy					
H-14	Sandy 3	2020-2024	7	7	17
H-15	Cedar 2 & 3	2015-2019	49	49	
H-16	Alder 1A & 2	2010-2014	43	43	
		Subtotal	99	99	
Upper Sandy					
H-18	Sandy 8	2020-2024	25	25	2
H-19	Salmon 1	2015-2019	23	23	
H-20	Salmon 2	2020-2024	36	36	
H-21	Salmon 3	2020-2024	12	12	
H-22	Boulder 1[b]	2010-2014	15	0	Measure will not be implemented. Acre target shifted to Gordon Creek.
H-28	Zigzag 1A & 1B	2020-2024	12	12	
		Subtotal	123	108	
	Grand Total		**373**	**373**	**22**

[a]White cells indicate easements targeted for implementation in HCP Years 1–5. Gray shading indicates easements targeted for future HCP years.

[b]Changes to acreage totals in reaches were authorized by NMFS. See Appendix F of this report for supporting documents.

adaptive management reasons, the easement targets have been changed slightly for individual conservation measures. Compliance will be determined by the acres specified, aggregated into the three portions of the basin. The City must obtain the total target acreage by Year 15 of the HCP (2024).

When applicable, the measurable habitat objectives define a number of acres for riparian easements. The intent is for the easements to provide 100-foot-wide buffers from the top of the mean high-water level in the specified reach. The total acres per reach may or may not be contiguous, depending on the opportunities to contact willing sellers.

Five riparian easements and improvement measures are targeted for implementation in HCP Years 1-5 (2010–2014). These are listed in Table 6.

Measures H-11, H-12, H-13, H-16, and H-22–Riparian Easements and Improvements

Location: Lower Sandy River, middle Sandy River, and upper Sandy River watersheds

Benefits: Improve riparian and instream habitat

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objective

The City has identified habitat conservation measures that will improve riparian-zone conditions. The land easements will improve a minimum of 100 feet of riparian forest on either side of the active channel width of the river or creeks. The conservation measures include silvicultural practices (e.g., selective thinning and tree planting) to improve the riparian zones. The acreage totals for the land protection easements will be calculated by multiplying the lineal distance of the stream by the amount of riparian forest protected by the easement.

A general riparian easement and improvement measure description is provided so that duplicate text is not repeated. The specific HCP measures from the three areas of the Sandy River Basin differ only by the total acreage targets.

Measure Commitments

Within HCP Years 1-5, the City will acquire 100-foot-wide land protection easements from willing private landowners for at least XX acres which will comprise the total number of lineal feet x 100 feet of riparian width on either side of the Sandy River in the named reaches. At a minimum, the easements will be maintained for the term of the HCP. The City will also consider, on a voluntary and case-by-case basis, obtaining easements with durations longer than the term of the HCP and greater than 100 feet wide. The HCP funding for purchasing and maintaining each easement will be limited to what is defined in Chapter 11 of the HCP for that measure. The easement areas will be managed to support forest of ≥70 percent conifer trees (by canopy cover) where site conditions are conducive to the growth of conifers. Deciduous trees will be selectively thinned and the easement will be replanted with conifers. If the easement area is not conducive to the growth of conifers, the area will be managed to support the growth of native hardwood species. Management of the easements will also include control of invasive plant species.

Status of Work for Calendar Year 2011

For HCP Measures H-11, H-12, H-13, H-16, and H-22, the City focused its beginning easement efforts in the middle and upper Sandy River watershed. The City also began easement negotiations with willing landowners in the Boulder and Gordon Creek subbasins.

The City was successful in working with willing landowners and finalized three easements in 2011. Easements were finalized for 3, 17, and 2 acres in reaches Gordon 1B, Sandy 3, and Sandy 8, respectively.

Since the creation of the conservation easement measures in the HCP, land ownership in the Sandy River Basin has changed tremendously. Many private land parcels have been purchased and converted to public lands in the target areas for the HCP easements. The City will continue to assess potential easements and communicate with NMFS about potential habitat benefits and acreage totals for various locations in the Sandy River Basin.

The City did not pursue easements with landowners in the Boulder Creek subbasin because much of land has been transferred to public ownership and there were few opportunities. The City will pursue an additional 15 acres of easement area in Gordon Creek to compensate for the acreage that could not be obtained along Boulder Creek. Authorization for this adaptive management change was granted via letter (NMFS letter to Steve Kucas dated May 11, 2011), available in Appendix F, Item 1.

The City also started negotiations to purchase land in the lower Bull Run watershed. If the purchase is completed, the City will count any acquired acreage within a 100-foot buffer towards the overall conservation easement targets expressed in the HCP. Authorization for this adaptive management change was granted via letter (NMFS letter to Steve Kucas dated September 16, 2011), available in Appendix F, Item 3.

Canopy cover will be estimated both prior to work on site and after planting to determine progress towards canopy closure goals. PWB is currently evaluating the use of remote sensing to collect canopy data on larger parcels.

At present, a densiometer is used to evaluate canopy cover on riparian conservation easements. From the edge of the easement boundary, transects run north or south. Permanent plots occur each 25 paces, beginning 25 paces into the easement. At each plot, densiometer readings are taken in cardinal directions. Each plot location is recorded using a global positioning system (GPS) unit. Readings are averaged per plot and then again per site to calculate the average site canopy cover.

Table 7 summarizes the location, acreage total, and condition of the canopy cover for the three easements that the City has obtained to-date.

Table 7. Location, Amount, and Condition of Canopy Cover for Easements, HCP Year 2 (2011)

Reach	Easement	Acres	Canopy Cover[a] Initial	Canopy Cover[a] 2011
Gordon 1A & 1B	1	3	47%	47%
Sandy 3	1	17	28%	28%
Sandy 8	1	2	92%	92%

[a]Canopy cover estimates are provided for each easement.

The City is obligated to treat all easement area so that the canopy cover exceeds 70 percent conifers trees, or native hardwood species as the site conditions dictate, over the term of the HCP. The canopy cover for easement 1 in Sandy 8 is 92 percent conifer trees and exceeds the $\geq$70 percent criterion stated in the HCP. The City will continue to track the canopy cover for all easements.

Planned Accomplishments for Calendar Year 2012

The City anticipates finalizing two easements in 2012. The City will also be negotiating easements with other willing landowners.

4.1.2.2 Water Rights

Measure F-5—Cedar Creek Purchase Water Right

Location: Cedar Creek in Sandy River Basin

Benefits: Improve instream habitat

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objective

Cedar Creek is a populated watershed with numerous privately owned parcels and associated water rights for rural residential and agricultural purposes. The creek has elevated water temperatures in late summer, partially due to water withdrawals. The City will acquire water rights to improve water quality and base flows in Cedar Creek for steelhead, coho, and cutthroat trout.

Measure Commitments

Measure F–5—Cedar Creek Purchase Water Rights: Within the first 10 years of the HCP term, the City will acquire approximately 50 percent of the current certificated surface water rights that affect summer flows on Cedar Creek. These water rights will be acquired from willing sellers and will be converted to instream use for at least the term of the HCP.

Status of Work for Calendar Year 2011

The City did no work on Measure F-5 in 2011. The City can pursue acquiring water rights on Cedar Creek through 2019.

Planned Accomplishments for Calendar Year 2012

The City plans to do no work on Measure F-5 in 2012. However, if opportunities arise with landowners, the City will approach them about purchasing their water rights.

4.1.2.3 Fish Passage

Measures P-2, P-3, and P-4—Alder and Cedar Creek Fish Passage

Location: Alder and Cedar creeks in the Sandy River Basin

Benefits: Provide fish passage

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objective

Alder Creek, one of the larger tributaries to the middle Sandy River, currently supports steelhead and coho. The two fish passage conservation measures will provide access to 5.5 miles of good quality steelhead and coho habitat in reaches 1 and 1A.

Cedar Creek is one of the largest, low-gradient tributaries to the Sandy River. Fish access to Cedar Creek has been blocked since the Sandy River Hatchery was constructed in the 1950s. The City's conservation measure, in conjunction with Oregon Department of Fish and Wildlife's commitments to fish passage on Cedar Creek, will provide passage to approximately 12–14 miles of stream habitat on Cedar Creek reach 1 for coho, steelhead, and anadromous cutthroat trout.

Measure Commitments

Measure P–2—Alder 1 Fish Passage: Within HCP Years 1–5, the City will modify the fish ladder under the Highway 26 bridge in reach Alder 1 to provide upstream and downstream volitional passage for steelhead and coho salmon. Passage design will be reviewed and approved in advance by NMFS.

Measure P–3—Alder 1A Fish Passage: Within HCP Years 1–5, the City will modify the City of Sandy water diversion weir at RM 1.7 of reach Alder 1A to provide upstream and downstream volitional passage for steelhead and coho. Passage design will be reviewed and approved in advance by NMFS.

Measure P–4—Cedar Creek 1 Fish Passage: Within HCP Years 1–5, the City will provide up to a maximum of $3.7 million dollars to fund three components of fish passage improvements on Cedar Creek. The City will provide the money to ODFW to fund the following:

1. Upgrades to the Sandy Fish Hatchery water intake screens and associated features to conform to NMFS criteria

2. Passage improvements at the adult diversion ladder, downstream passage pipeline, and downstream plunge pool

3. Upgrades at the discharge channel to the plunge pool, the sluice gates, the diversion dam, and safety improvements for daily maintenance

The City will not provide money to fund the necessary water treatment improvements and any operations and maintenance costs that may be necessary for fish passage on Cedar Creek.

If ODFW cannot secure money for the other components necessary to implement this passage project, the City will redirect the $3.7 million to the Habitat Fund to finance other capital projects in the Sandy River Basin. This reallocation will occur in consultation with NMFS and the Sandy River Basin Partners. The $3.7 million will be reallocated in a manner (e.g., time frame) that will not adversely affect the City's water rate payers, as determined by the City.

The City will not be responsible for monitoring fish passage on Cedar Creek after the improvements have been made. The City assumes that ODFW will be responsible for monitoring, treatment, and operation and maintenance.

Status of Work for Calendar Year 2011

The City has complied with fish passage measures P-2, P-3, and P-4.

The City hired an engineering contractor to develop preliminary fish passage designs for Measures P-2 and P-3. For Measure P-2, improving fish passage at a waterfall on Alder Creek, the preliminary design focused on the construction of concrete jump pools. The conceptual design was reviewed by ODFW and NMFS and more detailed designs were developed in 2011. For Measure P-3, the contractor developed a side-channel construction design that the City did not accept because of the difficulties of constructing and maintaining such a structure.

For Measure P-4, the City provided $2,337,500 to ODFW to fund fish passage improvements on Cedar Creek.

Planned Accomplishments for Calendar Year 2012

The City plans to further develop plans and specifications for the construction of the fish passage measures on Alder Creek. The City anticipates refining the fish passage design for Measure P-2 and developing a new design for Measure P-3. The City anticipates the construction for Measure P-2 to occur in 2012. Starting in 2012 or 2013, the City will develop a different construction design for Measure P-3, with construction starting in 2013 or 2014.

For Measure P-4, the City anticipates paying ODFW the remaining funds to enact fish passage improvements on Cedar Creek.

4.1.2.4 Large Wood Placement

Measures H-5, H-6, H-7, and H-26—Large Wood Placement

Location: Gordon, Trout, and Boulder creeks

Benefits: Improve instream habitat

Contact: Burke Strobel, Fish Biologist, PWB Resource Protection

Primary Objective

The City's large wood measures are being implemented to help restore key habitat for fish. The large wood additions will increase habitat complexity, providing benefits such as pools and cover for migrating, spawning, and rearing fish in Gordon Creek, reaches 1A and 1B; and in Trout Creek, reaches 1A and 2A. Benefits were also anticipated in Boulder Creek, reaches 0 and 1, but this measure was cancelled in 2011 due to insufficient landowner permissions. Instead, the large wood intended for Boulder Creek will be placed in Gordon Creek. Section 4.2.1 of this report describes the effectiveness monitoring methods for these measures.

A general large wood measure description is provided in the following subsection so that duplicate text is not repeated. The specific measures for the Sandy River Basin reaches differ only by the number of logs to be placed. In future HCP compliance reports, the specific measure commitments will be included to track City compliance.

Measure Commitments

Within HCP Years 1-5, the City will work with willing landowners to place a minimum of 410 key logs into Gordon Creek and Trout Creek, avoiding federal land, land without landowner permission, and land where the preexisting large wood quantity is already adequate. Large wood quantities were chosen to achieve placement densities of approximately 75 pieces per mile on average for the originally planned treatment reaches, Gordon 1A and 1B, Trout 1A and 2A, and Boulder 0 and 1. Individual LW pieces will be sound conifer logs with a small-end diameter of at least 12 inches and a length of at least 30 feet. The key pieces will be placed to collect other additional woody debris. If available, large root wads will also be selected for placement. Artificial anchoring of the wood will only be used when wood movement cannot be tolerated. Anchoring will only be used if the large wood might move downstream and damage road culverts, bridges, private property or other streamside improvements. It is desirable for the stream to redistribute the placed large wood to some extent, as long as damage is avoided. Methods and timing for LW placement will be determined in consultation with NMFS and the ODFW.

The LW placements is maintained for 15 years. Year 1 of the maintenance will be the calendar year following the wood placement.

Effectiveness monitoring is described in Section 4.2.1 of this report.

Status of Work for Calendar Year 2011

H-5 Gordon 1A and 1B LW Placement

Preparations continued for Measure H-5 in 2011. The City will use a helicopter to place large wood in Gordon Creek because of the inaccessible nature of the location. Two large wood staging areas —one of which can also serve as a helicopter landing zone—were identified and their use arranged. All of the necessary large wood pieces have been acquired and stored. Hydrologic and hydraulic modeling for Gordon Creek was completed. Large wood structure designs for all of the planned sites were created and were being refined as of the end of 2011. All affected landowners have been engaged to seek permission to place wood on their land.

H-6 Trout 1A LW Placement

Preparations were begun for Measure H-6 in 2011. The City will use a helicopter to place large wood in Trout Creek because of the inaccessible nature of the location. The City intends to implement this project in conjunction with the implementation of Gordon 1A and 1B LW Placement. Two large wood staging areas—one of which can also serve as a helicopter landing zone—were identified and their use arranged. All of the necessary large wood pieces have been acquired and stored. Hydrologic and hydraulic modeling for Trout Creek was completed. Large wood structure designs for all of the planned sites were created and were being refined as of the end of 2011. All affected landowners have been engaged to seek permission to place wood on their land.

H-7 Trout 2A

Preparations for Measure H-7 in 2011 were begun. The City will use a helicopter to place large wood in Trout Creek because of the inaccessible nature of the location. The City intends to implement this project in conjunction with the implementation of Gordon 1A and 1B LW Placement. Two large wood staging areas—one of which can also serve as a helicopter landing zone—were identified and their use arranged. All of the necessary large wood pieces have been acquired and stored. Hydrologic and hydraulic modeling for Trout Creek was completed. Large wood structure designs for all of the planned sites were created and were being refined as of the end of 2011. All affected landowners were engaged to seek permission to place wood on their land.

H-26 Boulder 0 and 1

Implementation of Measure H-26 was cancelled in 2011 due to insufficient landowner permissions. Land parcels key to the City's large wood placement plan in Boulder Creek became unavailable for placements in 2011, either because landowners would not give final permission or because properties' ownership status changed so that permissions could not be secured. The City has received authorization from NMFS to place the 65 key pieces of large wood intended for Boulder 0 and 1 into Gordon 1A and 1B, instead (see Appendix F, Item 2). These pieces will be in addition to the 300 pieces already planned for Gordon 1A and 1B.

Planned Accomplishments for Calendar Year 2012

H-5 Gordon 1A and 1B LW Placement

In 2012, the City plans to complete a stability analysis on the planned structures, obtain the necessary permits to implement the project, secure permissions for the placements and future monitoring, and select a contractor. The City intends to implement this measure in the summer of 2012.

H-6 Trout 1A LW Placement

In 2012, the City plans to complete a stability analysis on the planned structures, obtain the necessary permits to implement the project, secure permissions for the placements and future monitoring, and select a contractor. The City intends to implement this measure in the summer of 2012.

H-7 Trout 2A

In 2012, the City plans to complete a stability analysis on the planned structures, obtain the necessary permits to implement the project, secure permissions for the placements and future monitoring, and select a contractor. The City intends to implement this measure in the summer of 2012.

H-26 Boulder 0 and 1

This project will not be implemented. The large wood pieces intended for placement in Boulder Creek will be placed in Gordon Creek instead.

4.1.2.5 Channel Restoration

Measure H-8— Sandy 1 Reestablishment of River Mouth

Location: Sandy River Basin

Benefits: Increase and enhance species habitat

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objectives

The objective for Measure H-8 is to re-establish the historic mouth of the Sandy River. Approximately one mile of channel habitat will be opened that will improve habitat diversity, provide cover, and increase refuge areas for migrating fish.

Measure H-8 Commitments

Measure H–8—Sandy 1 Reestablishment of River Mouth: Within HCP Years 6–10, the City will contribute up to a maximum of $1.1 million for the removal of a 1930s–era dike in the Sandy River delta area in coordination with the Columbia River Gorge National Scenic Area. All project designs will be submitted to USFS and NMFS for review.

Status of Work for Calendar Year 2011

For Measure H-8, the City worked with the U.S. Army Corps of Engineers (Corps) and the U.S. Forest Service on the development of an environmental assessment (EA) for the removal of the Sandy River delta dam. The City commented on the EA and supported full removal of the dam.

The City anticipates providing money to the Corps to fund the removal of the dam. The City was committed to providing funding for dam removal but under the terms of the HCP, it was not committed to providing funds until 2015-2019. The City has redirected budget funds to allow for contributing to the dam removal in 2012. However, the City will not be able to fund Habitat Fund commitments because of limited resources. See the discussion of Measure H-30 that begins on page 47.

Planned Accomplishments for Calendar Year 2012

Pending successful completion of the EA by the Corps and resolution of landowner issues, the City plans to partially fund the removal of the Sandy River delta dam in 2012.

Measure H-10 Sandy 1 Turtle Survey and Relocation

Location: Sandy River Basin

Benefits: Avoid impacts to species

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objectives

The objective for Measure H-10 is avoid impacts to western painted or northwestern pond turtles that may be in the Sandy River delta.

Measure H-10 Commitments

Measure H–10—Turtle Survey and Relocation: The City will survey areas downstream of the I–84 bridge in the Sandy River delta for the presence of western painted and northwestern pond turtles if there will be any ground disturbance associated with implementation of the City's habitat conservation measures in the Sandy River delta (e.g., H–8 and H–9). Any of the two species of turtles that would be directly affected will be relocated. Relocations will be coordinated with ODFW.

Status of Work for Calendar Year 2011

There was no work on Measure H-10 in 2011 because there was no ground disturbance associated with implementation of the City's habitat conservation measures in the Sandy River delta.

Planned Accomplishments for Calendar Year 2012

The City is planning to coordinate with the U.S. Forest Service to complete turtle surveys in association with the removal of the Sandy River delta dam. Turtle relocations would be coordinated with the Forest Service and ODFW.

4.1.2.6 Terrestrial Wildlife Habitat Conservation

Measures W-1, W-2, and W-3—Minimum Impacts to Spotted Owls, Bald Eagles, and Fishers

Location: Sandy River Basin

Benefits: Avoid disturbance of species' habitat

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

Primary Objectives

The objective for Measures W-1 and W-2 is to avoid or minimize the periodic, temporary disturbance of habitat that might otherwise result from the routine operation, maintenance, and repair of water supply facility from implementation of HCP measures.

Although fishers have not been found in the Sandy River Basin, the City developed Measure W-3 as a contingency habitat measure to avoid or minimize impacts to fishers during the performance of covered activities in the basin.

Measure W-1 Commitments

Measure W–1—Minimize Impacts to Nesting Spotted Owls: For the term of the HCP, the City will take steps to avoid or minimize impacts to nesting spotted owls on all covered lands. The terms of the measure are described on page 7–66–7–69 of the HCP.

Measure W-2 Commitments

Measure W–2—Minimize Impacts to Bald Eagles: For the term of the HCP, the City will take steps to avoid or minimize impacts to bald eagles on all covered lands. The terms of the measure are described on page 7–69–7–74 of the HCP.

Measure W-3 Commitment

Measure W–3—Minimize Impacts to Fishers: If the fisher is found to occur within 30 miles of the Bull Run watershed, or the locations of any unfinished HCP measures, the City will meet with USFWS to discuss whether any steps need to be taken to avoid or minimize impacts to fishers during the performance of the covered activities.

Status of Work for Calendar Year 2011

For Measures W-1, W-2, and W-3, the City avoided or minimized impacts to spotted owls and bald eagles for all City projects in 2011.

Fishers have not been found to occur anywhere near the Bull Run watershed, and therefore no avoidance or minimization actions were necessary.

Planned Accomplishments for Calendar Year 2012

The City will continue to evaluate potential impacts to spotted owls and eagles when considering City projects. The City will continue to be vigilant about any information related to fishers and will consider such information during the performance of covered activities.

4.2 Effectiveness Monitoring

The City will conduct effectiveness monitoring for some of the HCP conservation measures. Those measures include large wood placement/log jam creation, side-channel development, river mouth reestablishment, and floodplain reconnection. For these measures, there is some degree of uncertainty about the biological effectiveness.[1] All effectiveness monitoring will be conducted to test the hypothesis that at least 80 percent of the projected changes in the key habitat variables will occur in each stream reach. The City will use the habitat variable ratings from the Ecosystem Diagnosis and Treatment (EDT) model and has provided estimated improvements from HCP measures in Appendix E of the HCP. For a detailed description of effectiveness monitoring for offsite in-channel conservation measures, including sampling methods and assessment procedures, see Appendix F of the HCP.

For the first monitoring year, the City is conducting baseline monitoring to serve as a benchmark for effectiveness monitoring of large wood and log jam placement.

4.2.1 Large Wood and Log Jam Placement

Measures H-5, H-6, H-7, and H-26—Large Wood Placement

Location: Gordon, Trout, and Boulder creeks in the Sandy River Basin

Benefits: Instream habitat

Contact: Burke Strobel, Fish Biologist, PWB Resource Protection

Primary Objective

The City's large wood measures are being implemented to help restore key habitat for fish. The large wood additions will increase habitat complexity, providing benefits such as pools and cover for migrating, spawning, and rearing fish in Gordon Creek, reaches 1A and 1B and in Trout Creek, reaches 1A and 2A. A large wood measure was also planned for Boulder Creek reaches 0 and 1, but was cancelled in 2011 because the City was unable to secure sufficient landowner permissions. See measure description starting on page 37 for more information.

Measure Commitments

The measure commitments for HCP Measures H-5, H-6, H-7, and H-26 are described in Section 4.1.2.4, which starts on page 37 of this report.

[1] In some cases, the City does not plan to conduct effectiveness monitoring because the outcomes are already known and are well-supported by the available scientific literature.

Measurable Habitat Objectives

The measurable habitat objectives for the large wood measures share the common objective of achieving 80 percent of the predicted increase in pieces of large wood within 15 years of implementation. Additional habitat objectives created for reaches 1A and 1B of Gordon Creek are to achieve 80 percent of the predicted increase in backwater pools, pools, and pool-tail habitat within 15 years of implementation.

Effectiveness Monitoring Method

To test whether the habitat variable ratings in the current EDT database are representative of pre-project conditions, and to determine whether the projected increases in habitat ratings are an accurate representation of post-project conditions, the City is implementing the following monitoring methodology:

- Conduct baseline habitat surveys in both the project reaches and in upstream control reaches, where no habitat enhancement projects are planned.
- Conduct post-project habitat surveys in both the project reaches and in upstream control reaches.
- Compare the baseline and post-project survey results for project and control reaches. Effectiveness will be evaluated by comparing observed changes with the measurable habitat objectives, after adjusting for background changes observed in control reaches.

Status of Work for Calendar Year 2011

The City fully complied with the effectiveness monitoring as required by the HCP for Measures H-5, H-6, H-7, and H-26. The specific monitoring accomplishments are referenced by measure name (e.g., Gordon 1A and 1B LW Placement) in Appendix A of this report. No effectiveness monitoring was conducted in Boulder Creek in 2011 because the large wood placement measure for this creek was cancelled.

Planned Accomplishments for Calendar Year 2012

The collection of baseline data for effectiveness monitoring will be conducted in 2012 in Gordon Creek and Trout Creek. No effectiveness monitoring will be conducted in Boulder Creek in 2012 because the large wood placement measure for this creek has been cancelled. Baseline habitat surveys will follow protocols and geographic extents identical to those used in 2011.

4.3 Research Program

4.3.1 Bull Run Research

4.3.1.1 Spawning Gravel Placement

Under the HCP, the City places spawning gravel in the lower Bull Run River to increase spawning habitat, primarily for Chinook salmon and steelhead. Each year, the City evaluates the gravel placement to determine the amount of resulting surface area covered by gravel suitable for spawning salmon and steelhead.

The City conducted this evaluation of spawning gravel placement as planned in 2011. A detailed account of the gravel placement protocol is available in Appendix F of the HCP. The current status of spawning gravel placement is detailed in Appendix B of this report.

4.3.1.2 Total Dissolved Gas

During 2005-2009, the City evaluated the structures, valves, and turbines in the Bull Run water supply system to determine whether any facilities would exceed the state standard for total dissolved gas (TDG). Additional TDG data were collected on two occasions in 2011. The City has only measured TDG levels once in excess of 110 percent at river flows below the 10-year, 7-day average flood (7Q10) flow at the monitoring sites in the lower Bull Run watershed. On that occasion, the water with high TDG levels had not yet had a chance to mix with the rest of the water in the river. The average TDG for the river was calculated to be less than 110 percent saturation. The detailed account of the TDG evaluation protocol is available in Appendix F of the HCP. The results of the TDG evaluation are in Appendix C of this report.

4.3.1.3 Bull Run Adult Chinook Population

In conjunction with other agencies in the Sandy River Basin, the City has partially funded research of the status of fish listed under the Endangered Species Act. The results of the research will be evaluated along with the results of the City's effectiveness monitoring to determine the City's adaptive management response over time.

The City will collect adult Chinook salmon information for the lower Bull Run River. It will conduct an annual survey of the lower river from RM 0 to RM 6.0 to count adult spring and fall Chinook salmon from August through mid-December. The spatial extent of the survey was extended in 2011 to include RM 5.8 to 6.0 after removal of the rock weir at RM 5.8 in 2011 made an additional 0.2 miles accessible to salmon and steelhead. Surveys will be conducted on a weekly basis, provided instream flows allow for safe navigation of the river channel. Instream flows can be managed, by the City to a certain extent to make these surveys possible. The HCP allows for departure from required minimum flows (Measures F-1 and F-2) for this purpose. Overall, the City anticipates funding 20 years of surveys over the 50-year term of the HCP.

The City conducted this annual survey of the Bull Run Chinook population as planned in 2011. The detailed description of the protocol is available in Appendix F of the HCP. The results of the current year's survey are available in Appendix D of this report.

4.3.2 Sandy River Basin Research

4.3.2.1 Sandy River Basin Juvenile Outmigrants

Although the HCP is habitat-based and not focused on the specific population responses of the species, information about juvenile outmigrants (JOM) is needed to obtain a complete picture of the condition and change in freshwater productivity through time. The results of the JOM research will be evaluated with other monitoring results to determine the City's adaptive management response over time.

The City will provide funds for collecting JOM information in the Sandy River Basin. This money will be leveraged with other funds to create a coordinated monitoring program. Twelve sites in the basin will be monitored and will serve as an index for the entire basin.

The City and its partners monitored JOM production in six streams as planned in 2011. The City's specific commitments and the approach to JOM research are outlined in Appendix F of the HCP. The results of this research are presented in Appendix E of this report.

4.4 Adaptive Management Program

The Bull Run HCP defined adaptive management along two concurrent tracks: adaptive responses for individual measures and decision milestones for addressing the effectiveness of the HCP as a whole. Through monitoring, the City will evaluate its progress on implementation as well as effectiveness of the measures. Should monitoring results indicate, the City will use its adaptive management program to change its approach.

If monitoring results indicate that a measure cannot be implemented, that an instream measure has not met its measurable objective, or that factors outside the City's control have reduced the habitat benefits of a measure by more than 20 percent, then the City will implement adaptive management. The adaptive management response includes several factors: consultation with NMFS, site surveys, and rerunning the EDT model to characterize baseline watershed conditions.

If, after taking these steps, the City and NMFS reach the conclusion that an additional or substitute measure is necessary, the City will follow the guidelines outlined in Chapter 9 (Section 9.4.3) of the HCP in its approach. Costs for implementing additional measures after the original measure has been implemented will be paid from the adaptive management section of the Habitat Fund. See the description of the Habitat Fund measure, below.

Measure H-30—Habitat Fund

Location: Covered lands

Benefits: Assists in meeting HCP objectives

Contact: Steve Kucas, Senior Environmental Program Manager, PWB Resource Protection

The adaptive management portion of the Habitat Fund will be used to implement additional projects if one or more of the offsite measures does not meet its objectives. The Sandy River Basin Partners' portion of the fund will be used to implement additional habitat projects that help compensate for water system impacts not fully addressed by other projects. The details of the Habitat Fund measure are presented in Chapters 7 and 11 of the HCP.

Primary Objective

The Habitat Fund enables adaptive management and allows the City to address water system impacts that may not otherwise be addressed, respond to unknown future opportunities, and contribute to partnership projects.

Measure Commitments

The City will provide money to create a Habitat Fund of $9 million. A $5-million portion of the Habitat Fund is available in four increments prior to HCP Year 20 and is dedicated to partnership projects. The increments are described in Chapters 9 and 11 of the HCP (see also Figure 11-1). The remaining $4 million is dedicated to adaptive management needs but will be used for additional partnership projects if not needed for adaptive management (see Chapters 9 and 11). Projects will be selected in consultation with the HCP Implementation Committee (see Chapter 9) and will be guided by the Sandy River Basin Restoration Strategy. The City and NMFS will make the final project selection decisions.

Of the $5 million, the City will specifically dedicate $1.7 million toward habitat enhancement projects on the Salmon River to be implemented jointly by the Sandy River Basin Partners, and with additional funds from the Partners and/or from grants. If partnership funds cannot be obtained to implement these projects, the City funds will be used for other projects in the Sandy River Basin.

Based on an informal agreement in October 2004, the City will also work with the Partners to provide resources from the $5-million portion of the Habitat Fund to (1) participate in basin-wide efforts to control invasive plants that threaten riparian habitat, and (2) build the organizational capacity of the Partners to implement the basin-wide Restoration Strategy, including outreach.

Status of Work for Calendar Year 2011

The City has complied with the Habitat Fund Measure 30. The City has committed $175,000 of Habitat Fund dollars through June 2012 to Sandy River Basin Partners projects. Three projects have been funded:

Oregon Trout, $25,000

The City executed a grant agreement (Ordinance Number 182484) with Oregon Trout to build the capacity of the Sandy River Basin Partners in obtaining additional funding to help implement the Partners' restoration strategy. That work has been completed and the funds have been spent.

The Freshwater Trust, $50,000

The City executed a grant agreement (Number 302000260) with The Freshwater Trust to partially fund implementation of the Sandy River Basin Short-Term Restoration Strategy. The money was used to partially fund stream restoration measures in the Salmon River, a tributary to the Sandy River. The funds were used for implementing actions in the Salmon River subbasin. The work was done from July 2009 through June 2010. The funds have been spent.

The Freshwater Trust, $50,000

The City executed a grant agreement (Number 30001899) with The Freshwater Trust to partially fund design and construction of habitat restoration projects to reconnect isolated habitat, restore habitat complexity, and monitor project impacts. The funds were used for implementing actions in the Salmon River subbasin. The work was scheduled from July 2010 through June 2011. The funds have been spent.

Because HCP implementation began in 2010 and few projects have been implemented, the City used the Habitat Fund dollars for funding Sandy River Basin Partners projects only.

The Freshwater Trust, $50,000

The City executed a grant agreement (Number 32000592) with The Freshwater Trust to fund design and construction of habitat restoration projects to reconnect isolated habitat and restore habitat complexity. The funds were used for implementing actions in the Salmon River subbasin. The work was scheduled from July 2011 through June 2012. As of December 31, 2011, a portion of the funds has been spent.

Planned Accomplishments for Calendar Year 2012

The City will not award Habitat Fund money to Sandy River Basin Partners in Fiscal Year 2012-13 (July 1, 2012 through June 30, 2013). The City is planning to use this Habitat Fund money to partially fund the removal of the Sandy River delta dam.

Table 8. Summary of All Measures

This table includes all of the HCP measures. Measures that are not relevant to this reporting year are shaded with a gray background and there is either no information in the Status column or the Status column indicates that the measure has been completed. In some cases, the status description includes a reference to an appendix where more detailed information can be found.

Bull Run Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
F-1	**Minimum Instream Flow, Normal Water Years**	Provide instream flows	Record hourly flows at USGS Gage No. 1414000	2010–59	Measure is in full compliance.
F-2	**Minimum Instream Flows, Water Years with Critical Seasons**	Provide instream flows	Record hourly flows at USGS Gage No. 1414000	2010–59	Measure is in full compliance.
F-3	**Flow Downramping**	Maintain downramping rate at or below 2"/hour	Record hourly flows at USGS Gage No. 14140000	2010–59	Measure is in full compliance.
F-4	**Little Sandy Flow Agreement**	Avoid conflicts with natural instream flows	Document completion of flow agreement	2010–14	Measure is in process—PWB anticipates full compliance by 2014.
T-1	**Pre-infrastructure Temperature Management**	<u>Pre-infrastructure objective:</u> Maintain water temperatures at or below 21 °C at Larson's Bridge	Record water temperatures hourly for the lower Bull Run River and Little Sandy River Document implementation and completion of Dam 2 tower and spillway rock weir improvements (tower improvements will be complete and operational by 2013)	2010–13	Measure is in full compliance.

Bull Run Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
T-2	**Post-infrastructure Temperature Management**	Post-infrastructure objective: Maintain water temperatures at their natural thermal potential	Record water temperatures hourly for the lower Bull Run River and Little Sandy River Document implementation and completion of Dam 2 tower and spillway rock weir improvements (tower improvements will be complete and operational by 2013)	2014–59	
P-1	**Walker Creek Fish Passage**	Provide year-round upstream and downstream passage for steelhead and coho	Document passage conditions compared with NMFS design criteria	2010–14	Measure has been completed.
R-1	**Reservoir Operations**	Avoid or minimize mortality of cutthroat and rainbow trout	Document reservoir surface elevations	2010–59	Measure is in full compliance.
R-2	**Cutthroat Trout Rescue**	Prevent mortality of cutthroat trout in spillway canal	Document any fish mortality that occurs in the canal and/or during handling (prior to release)	2010–59	Measure is in full compliance
R-3	**Reed Canarygrass Removal**	Improve one-third acre of habitat for Western toad, red-legged frog, and northwestern salamander through annual removal of reed canarygrass	Provide photo documentation of sites after reed canarygrass removal	2010–59	Measure is in full compliance.
H-1	**Spawning Gravel Placement**	Supply spawning gravel in amounts equivalent to natural accumulation	Survey the lower Bull Run River (RM 1.5–RM 6.0) in Years 1, 2, 3, 5, 7, and 10 after initial gravel placement and every five years thereafter Document the amount of gravel placed, the placement locations, and amount of gravel usable for spawning by fish in annual report as described in Appendix F of the HCP	2010–59	Measure is in full compliance.

Bull Run Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
H-2	**Riparian Land Protection**	Preserve the riparian forest on City land along the lower Bull Run River	Survey riparian forest condition during annual spawning and gravel surveys; document results in annual report	2010–59	Measure is in full compliance.
O&M-1	**Bull Run Infrastructure Operations and Maintenance**	Avoid or minimize the effects of operations and maintenance activities on covered lands in the Bull Run watershed	Document any releases of sediment or debris to the reservoirs, the lower Bull Run River, or any tributary streams Document changes in stormwater facilities at Sandy River Station, if needed Document tree planting and success of revegetation efforts	2010–59	Measure is in full compliance.
O&M-2	**Bull Run Spill Prevention**	Avoid or minimize effects of spills from water supply operations on covered species in the Bull Run River and the Sandy River below the confluence with the Bull Run	Document any spills to the reservoirs, the lower Bull Run River, or to any tributary streams	2010–59	Measure is in full compliance.

Offsite Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
Riparian Easements and Improvements					
H-11	**Sandy 1 Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 11 acres (with 100-foot buffer widths) within 15 years	Complete an aerial photograph analysis or site survey to determine whether planting is needed Repeat the analysis every five years for the term of the HCP to verify that initial planting has succeeded and/or if replanting is warranted Document date riparian easement is completed and when site potential forest is established	2010–14	Measure is in process—PWB anticipates acquiring conservation easement acreage by 2014.
H-12	**Sandy 2 Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 62 acres (with 100-foot buffer widths) within 15 years	Same as above	2010–14	Measure is in process—PWB anticipates acquiring conservation easement acreage by 2014.
H-13	**Gordon 1A and 1B Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 78 acres within 15 years of establishment of easement Fifteen (15) acres are added to this measure to compensate for the acreage anticipated from Boulder 1 Riparian Easement and Improvement (H-22).	Complete an aerial photograph analysis or site survey to determine whether planting is needed Repeat the analysis every five years for the term of the HCP to verify that initial planting has succeeded and/or if replanting is warranted Document date riparian easement is completed and when site potential forest is established	2010–14	Measure is in process. PWB anticipates acquiring conservation easement acreage by 2014.

Offsite Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
H-14	**Sandy 3 Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 7 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2020–24	
H-15	**Cedar 2 and 3 Riparian Easement and Improvement**	Establish riparian forest of >70% site potential trees (by canopy cover) for approximately 49 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2015–19	
H-16	**Alder 1A and 2 Riparian Easement and Improvement**	Establish riparian forest of >70% site potential trees (by canopy cover) for approximately 43 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2010–14	Measure is in process—PWB anticipates acquiring conservation easement acreage by 2014.
H-18	**Sandy 8 Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 25 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2020–24	
H-19	**Salmon 1 Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 23 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2015–19	

Offsite Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
H-20	**Salmon 2 Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 36 acres (with 100-foot buffer widths) within 15 years. of establishment of easement	Same as above	2020–24	
H-21	**Salmon 3 Riparian Easement and Improvement**	Establish riparian forest of ≥70% site potential trees (by canopy cover) for approximately 12 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2020–24	
H-22	**Boulder 1 Riparian Easement and Improvement**	Establish riparian forest of >70% site potential trees (by canopy cover) for approximately 15 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2010–14	This measure will not be implemented. The City is pursuing easements in Gordon Creek to compensate for the acreage that could not be obtained in Boulder Creek. Change authorized by NMFS in May 11, 2011 letter (see Appendix F, Item 1).
H-28	**Zigzag 1A/1B Riparian Easement and Improvement**	Establish riparian forest of >70% site potential trees (by canopy cover) for approximately 12 acres (with 100-foot buffer widths) within 15 years of establishment of easement	Same as above	2020–24	

Offsite Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
H-24	**Salmon 2 Miller Quarry Acquisition**	Establish riparian forest of >70% site potential trees (by canopy cover) for approximately 40 acres (with 100-foot buffer widths) within 15 years of acquisition	Document purchase of the site in annual report Complete an aerial photograph analysis or site survey to determine whether planting is needed Repeat the analysis every five years for the term of the HCP to verify that initial planting has succeeded and/or if replanting is warranted Document date riparian easement is completed and when site potential forest is established	2015–19	
Water Rights					
F-5	**Cedar Creek Purchase Water Rights**	During HCP Years 1-10, purchase approximately 50% of the current surface water rights that affect summer flows	Document the rights purchased and the estimated amount of additional flow for fish	2010–19	Measure is in process—PWB anticipates full compliance by 2019.
Fish Passage					
P-2	**Alder 1 Fish Passage**	Provide year-round upstream and downstream passage for steelhead	Document passage conditions compared with NMFS design criteria once every three years after project implementation	2010–14	Measure is in process—PWB anticipates full compliance by 2014.
P-3	**Alder 1A Fish Passage**	Provide upstream and downstream passage for native fish during the months of water diversion operation	Same as above	2010–14	Measure is in process—PWB anticipates full compliance by 2014.
P-4	**Cedar Creek 1 Fish Passage**	Provide up to $3.7 million dollars to fund fish passage improvements on Cedar Creek.	Same as above	2010–14	Measure is in full compliance.

Offsite Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
Carcass Placement					
H-25	**Salmon 2 Carcass Placement**	Place 1,800 salmon carcasses in one season	Document number of carcasses, release sites, and year of implementation	2015–19	
H-29	**Zigzag 1A, 1B, and 1C Carcass Placement**	Place 1,800 salmon carcasses in one season	Same as above	2020–24	
Large Wood					
H-3	**Little Sandy 1 and 2 LW Placement**	Place 50 key pieces of LW and achieve 80% of predicted woody debris levels within 15 years of placement	Monitor number of pieces of wood in the stream as described in HCP Appendix F	2015–19	
H-4	**Sandy 1 and 2 Log Jams**	Place 10 engineered log jams in reaches Sandy 1 and 2	Same as above	2015–19	
H-5	**Gordon 1A and 1B LW Placement**	Place 300 key pieces of LW in reaches Gordon 1A and 1B and achieve 80% of predicted woody debris levels within 15 years of placement An additional 65 key pieces of LW will be placed in reaches Gordon 1A and 1B to compensate for the wood that was not placed in Boulder 0 and 1.	Same as above	2010–14	Measure is in process—PWB anticipates full compliance by 2014. Number of pieces has been increased from 300 to 365 with LW from Boulder 0 and 1 LW Placement. Change authorized by NMFS in August 16, 2011 letter (see Appendix F, Item 2).
H-6	**Trout 1A LW Placement**	Place 25 key pieces of LW and achieve 80% of predicted woody debris levels within 15 years of placement	Same as above	2010–14	Measure is in process—PWB anticipates full compliance by 2014.

Offsite Measures–Compliance					
#	**Measure**	**Measurable Habitat Objective**	**Compliance Monitoring**	**HCP Years**	**Status**
H-7	**Trout 2A LW Placement**	Place 20 key pieces of LW in reach Trout 2A and achieve 80% of predicted woody debris levels within 15 years of placement	Same as above	2010–14	Measure is in process—PWB anticipates full compliance by 2014.
H-17	**Cedar 2 and 3 LW Placement**	Place 600 key pieces of LW in reaches Cedar 2 and 3 and achieve 80% of predicted woody debris levels within 15 years of placement	Same as above	2015–19	
H-26	**Boulder 0 and 1 LW Placement**	Place 65 key pieces of LW in reaches Boulder 0 and 1 and achieve 80% of predicted woody debris levels within 15 years of placement	Same as above	2010–14	Measure has been cancelled. Pieces planned for this measure have been added to Gordon 1A and 1B LW Placement instead. Change authorized by NMFS in August 16, 2011 letter (see Appendix F, Item 2).
Channel Restoration					
H-8	**Sandy 1 Reestablishment of River Mouth**	Create one additional mile of stream by reconnecting with original river mouth	Document reestablishment of the historic Sandy River mouth	2015–19	The City is planning to implement this measure in 2012.
H-9	**Sandy 1 Channel Reconstruction**	Open one-third river miles of side-channel habitat Place 25 logs in side channel	Tag all side-channel logs at the time of placement for later identification Once every three years, resurvey the stream to document seasonal flooding of the side-channel habitat and determine how many pieces of LW are still within the side channel	2015–19	

Offsite Measures–Compliance

#	Measure	Measurable Habitat Objective	Compliance Monitoring	HCP Years	Status
H-10	**Sandy 1 Turtle Survey and Relocation**	Avoid direct impacts to western painted turtles and northwestern pond turtles	Document surveys of potential turtle habitat. Document all turtle relocations (species, number, locations, and dates) Note: Measure H-10 is only necessary for projects conducted in the Sandy River delta	2015–19	If Measure H-8 is implemented in 2012, the City will implement this measure.
H-27	**Zigzag 1A Channel Redesign**	Maintain one-third mile of floodplain habitat for steelhead, coho, and spring Chinook Place 25 pieces of LW in reaches Zigzag 1A and 1B	Tag all pieces of LW at the time of placement for later identification Once every three years, resurvey the stream to determine how many pieces of LW are still within the side channel	2020–24	
Terrestrial Wildlife Habitat Conservation					
W-1	**Minimize Impacts to Spotted Owls**	Avoid disturbance of active nesting habitat	Survey protocols for owls, eagles, and fishers have not yet been determined Protocols will be available within six months of the start of the HCP term	2010–59	Measure is in full compliance.
W-2	**Minimize Impacts to Bald Eagles**	Avoid disturbance of active winter night roosts or nests	Survey protocols for owls, eagles, and fishers have not yet been determined Protocols will be available within six months of the start of the HCP term	2010–59	Measure is in full compliance.
W-3	**Minimize Impacts to Fishers**	Avoid disturbance of fisher habitat	Survey protocols for owls, eagles, and fishers have not yet been determined Protocols will be available within six months of the start of the HCP term	2010–60	Measure is in full compliance.

Offsite Measures—Effectiveness					
#	**Measure**	**Measurable Habitat Objective**	**Effectiveness Monitoring**	**HCP Years**	**Status**
H-5	**Gordon 1A and 1B LW Placement**	Achieve 80% of predicted increase in pieces of LW within 15 years of implementation	Conduct habitat surveys per monitoring protocol	2010–14	Measure is in full compliance. Effectiveness monitoring will continue through 2025. See Appendix A.
H-6	**Trout 1A LW Placement**	Achieve 80% of predicted increase in pieces of LW within 15 years of implementation	Conduct habitat surveys per monitoring protocol	2010–14	Measure is in full compliance. Effectiveness monitoring will continue through 2025. See Appendix A.
H-7	**Trout 2A LW Placement**			2010–14	Measure is in full compliance. Effectiveness monitoring will continue through 2025. See Appendix A.
Large Wood and Log Jam Placement					
H-3	**Little Sandy 1 and 2 LW Placement**	Achieve 80% of predicted increase in pieces of LW within 15 years of implementation Achieve 80% of predicted increase in backwater pools, pools, and pool-tail habitat within 15 years of implementation Achieve 80% of predicted increase in percentage of total habitat that is large-cobble riffles, within 15 years of implementation	Conduct habitat surveys per monitoring protocol	2015–19	

Offsite Measures—Effectiveness

#	Measure	Measurable Habitat Objective	Effectiveness Monitoring	HCP Years	Status
H-26	**Boulder 0 and 1 LW Placement**	Achieve 80% of predicted increase in pieces of LW within 15 years of implementation.	Conduct habitat surveys per monitoring protocol	2010–15	Measure and associated effectiveness monitoring have been cancelled.
H-4	**Sandy 1 and 2 Log Jam Placements**	Achieve 80% of predicted increase in pieces of LW within 15 years of implementation	Conduct habitat surveys per monitoring protocol	2015–19	
H-17	**Cedar 2 and 3 LW Placement**	Achieve 80% of predicted increase in pieces of LW within 15 years of implementation Achieve 80% of predicted increase in percentage of off-channel, beaver pond and pool habitat within 15 years of implementation	Conduct habitat surveys per monitoring protocol	2015–19	
Channel Restoration					
H-9	**Sandy 1 Channel Reconstruction**	Achieve 80% of predicted increase in percentage of off-channel habitat within 15 years of implementation	Every three years, resurvey the site to determine whether the gradient control structure is maintaining flow in the side channel and the river	2015–19	
H-24	**Salmon 2 Miller Quarry Acquisition and Restoration**	Achieve 80% of predicted improvements in off-channel habitat within 15 years of implementation	Once every three years after measure implementation, survey opened floodplain area and side channels	2020–24	
H-27	**Zigzag 1A Channel Design**	Achieve 80% of predicted habitat improvements within 15 years of implementation	Conduct habitat surveys per monitoring protocol	2020–24	

Offsite Measures—Effectiveness

#	Measure	Measurable Habitat Objective	Effectiveness Monitoring	HCP Years	Status
H-30	**Habitat Fund**	The City will provide money to create a Habitat Fund of $9 million to contribute to large-scale partnership projects and to implement additional projects for adaptive management, if necessary	Determined through measure effectiveness monitoring	2010–59	Measure is in full compliance.

Research

Topic	Research Protocol & Analysis	Results Reporting	HCP Years	Status and Report Location
Spawning Gravel Placement	Change in gravel from baseline each year, trends over time, using t-tests & linear regression	HCP Years 6 and 12	2010–59	Measure is in full compliance. See Appendix B.
Spawning Gravel Scour	Change in bed elevation, depth of scour, percentage of redds with significant scour	Monitoring starts HCP Year 5; reporting in Year 2016	2015–19	Reporting in Year 2016
Total Dissolved Gas	Exceedence of 110% TDG saturation, rate of TDG dissipation downstream of monitoring. Regression analysis, possibly modeling	Include with annual compliance report	2010–59	Measure is in full compliance. See Appendix C.
BR Adult Chinook Population	Survey, sampling, linear regression	Include with annual compliance report	2010–59	Measure is in full compliance. See Appendix D.
Sandy River Basin JOM	Mark recapture study, various analyses methods	Include with annual compliance report	2010–59	Measure is in full compliance. See Appendix E.

Appendixes

A. Effectiveness Monitoring for Offsite In-Channel Conservation Measures

B. Lower Bull Run River Spawning Gravel Research

C. Total Dissolved Gases in the Bull Run River

D. Lower Bull Run River Adult Chinook Population

E. Sandy River Basin Smolt Monitoring

F. Correspondence on Measure Adjustments

Appendix A

Bull Run HCP Effectiveness Monitoring Report

Effectiveness Monitoring for Offsite In-Channel Conservation Measures

March 2012

City of Portland Water Bureau

Contents

Tables

1. Summary

The City of Portland Water Bureau (PWB) is in full compliance with its Habitat Conservation Plan obligations in 2011 with regard to effectiveness monitoring for offsite in-channel conservation measures. Fish habitat surveys were conducted for three offsite measures— Gordon 1A/1B Large Wood Placement, Trout 1A Large Wood Placement, and Trout 2A Large Wood Placement. No data were collected for the offsite measure Boulder 0/1 Large Wood Placement, because PWB will not implement that HCP measure. The wood that was intended for placement in Boulder Creek will be placed in Gordon Creek instead.

The data collected in each of the three streams in 2011 contribute to the baseline, with which the post-treatment condition of each stream will be compared. This appendix summarizes the results of these surveys.

2. Introduction

PWB committed through its Bull Run Water Supply Habitat Conservation Plan (HCP; Portland Water Bureau 2008) to implement a number of in-channel fish habitat enhancement measures at offsite locations. Offsite locations are those not in the Bull Run watershed, but at other Sandy River Basin streams. These include various tributaries in the basin, portions of the main stem of the Sandy River, and the Little Sandy River. In-channel measures occur actively within the normal high-flow channel of a stream. In-channel measures do not include efforts to improve the riparian zone.

Associated with each offsite in-channel measure are one or more measurable habitat objectives. The effectiveness of PWB's efforts to improve fish habitat at these offsite locations will be evaluated by measuring the habitat attributes associated with these objectives and determining how closely the habitat attributes approach or surpass the value of the respective objective.

In 2011, baseline data were collected in two streams where habitat enhancement measures are planned for the upcoming two years: Gordon Creek and Trout Creek. The three HCP measures associated with this monitoring are H-5, Gordon 1A/1B Large Wood Placement; H-6, Trout 1A Large Wood Placement; and H-7, Trout 2A Large Wood Placement.

A fourth measure had been planned for implementation in 2011, H-26, Boulder 0/1 Large Wood Placement, but was dropped. PWB was unable to obtain enough landowner permissions to implement the measure. PWB has received authorization to place the large wood pieces intended for Boulder Creek into Gordon Creek instead (see Appendix F, Item 2).

This appendix describes the effectiveness monitoring protocols and results to-date for the in-channel measures to be conducted in Gordon and Trout creeks. These measures involve placing large wood and creating log jams to influence stream morphological features such as pools and riffles and to accumulate spawning gravel.

3. Measurable Objectives

The offsite in-channel measures discussed in Chapter 7 of the HCP and their predicted effects on habitat attributes have been evaluated using the Ecosystem Diagnostic and Treatment (EDT) model (City of Portland and Mobrand Biometrics 2004). The anticipated benefits of these measures are summarized by reach and ranked by the predicted net change in the attributes' respective metrics listed in Table 1. The net attribute changes in Table 1 include only those benefits expected to be derived from the proposed in-channel restoration projects. Other measures, such as riparian easements, may occur in, and have benefits for, the same reaches, but these benefits are expected to occur over time scales that are longer than the time scales for the offsite, in-channel measures. The benefits of other measures are not part of the scope of this research.

The net changes predicted in Table 1 represent measurable habitat objectives created for each individual reach. The monitoring objective is to document the effectiveness of the offsite in-channel measures at accomplishing the measurable habitat objectives. PWB's working hypothesis for effectiveness monitoring of these measures is that at least 80 percent of the projected changes in the key habitat attributes (pre-project versus post-project conditions) will occur in each affected stream reach.

PWB has committed to a performance level of 80 percent of projected changes (instead of 100 percent) because there will be a high degree of natural variation from year-to-year and from site-to-site. The natural variation will be further compounded by the error associated with measuring habitat variables in the field. Given this high level of variation, it would not be possible to statistically detect a difference between a 100 percent change in a habitat variable and a much smaller change. PWB chose 80 percent as a minimum performance standard. If that level of habitat response is not met, additional actions will occur, and PWB will follow the adaptive management program described in Chapter 9 of the HCP.

Table 1. Attributes and Measurable Habitat Objectives in Reaches Affected by In-Channel Measures and Surveyed in 2011[a,b]

	Measurable Habitat Objective (80% of Net Change in Metric)		
Attribute	**Metric**	**Net Change**	**Reach**
Large Woody Debris	Number of pieces per channel width	567%	Gordon 1A
Backwater Pools	Percentage of reach (by surface area) that comprises backwater pools	Increase from 0% to 5%	Gordon 1A
Pool Habitat	Percentage of reach (by surface area) that comprises pool habitat	115%	Gordon 1A
Pool-Tail Habitat	Percentage of reach (by surface area) that comprises pool tail-outs	46%	Gordon 1A
Small-Cobble Riffles	Percentage of reach (by surface area) that comprises small cobble riffles	-33%	Gordon 1A
Large-Cobble Riffles	Percentage of reach (by surface area) that comprises large cobble riffles	-17%	Gordon 1A
Fine Sediment	Percentage of gravel patches (by surface area) that is fine sediment	-25%	Gordon 1A
Large Woody Debris	Number of pieces per channel width	567%	Gordon 1B
Backwater Pools	Percentage of reach (by surface area) that comprises backwater pools	Increase from 0% to 5%	Gordon 1B
Pool Habitat	Percentage of reach (by surface area) that comprises pool habitat	212%	Gordon 1B
Pool-Tail Habitat	Percentage of reach (by surface area) that comprises pool tail-outs	326%	Gordon 1B
Small-Cobble Riffles	Percentage of reach (by surface area) that comprises small cobble riffles	-40%	Gordon 1B
Large Woody Debris	Number of pieces per channel width	7%	Trout 1A
Large Woody Debris	Number of pieces per channel width	13%	Trout 2A

[a]Source: EDT model run (10/20/2005) for current and historical status of attributes and expected values after implementation of individual measures.

[b]Appendix E of the HCP, Offsite Habitat Effects Tables, provides the list of all attributes, habitat objectives, and reaches that may be affected by the HCP measures.

4. Key Questions and Hypothesis

One key question and its related null hypothesis (H_o) will be answered by the offsite monitoring protocol:

Did the implementation of the restoration projects result in the changes to the monitored habitat attributes that were predicted by the EDT assessment?

> H_o: The mean of post-treatment values in treatment reaches will not be significantly less than the change from baseline values predicted by the EDT assessment.

In order to make this comparison, the baseline values in the EDT model will be updated by collecting at least two years of pre-treatment data on all the habitat attributes that are predicted to significantly change (summarized in Table 1). If the baseline habitat conditions are the same or worse than those used to develop the measurable habitat objectives summarized in Table 1, PWB will proceed with the in-channel conservation measures as described in the HCP. If the current reach habitat conditions are found to be better than those originally rated in 2003, PWB will follow the framework for adaptive response described in Chapter 9 (Section 9.4.3) of the HCP.

The comparison of the observed changes in monitored habitat attributes to measurable habitat objectives will be analyzed both numerically and statistically (using a 95 percent level of confidence). The numeric test will simply determine whether the mean of post-treatment values is at least 80 percent of the target values. The measurable habitat objective for each offsite, in-channel measure response variable was set at 80 percent of the projected change to account for the fact that each variable is expected to show a large degree of variation. The statistical test will assign a level of confidence to each of the pre-treatment and post-treatment values and determine the power of the statistical test to detect significant shortfalls. Having a level of confidence associated with each value will be helpful during the adaptive management process, should any post-treatment value fall short of the measurable habitat objective.

5. Monitoring Design

5.1 Study Design

PWB will use a Before-After with Control-Impact (BACI) study design to monitor the effects of the HCP offsite, in-stream mitigation projects (Roni et al. 2005). Control reaches upstream of the treated reaches will be surveyed, in addition to the treated reaches, as indicated in Table 2. Control reaches will be entire upstream reaches delineated for EDT or one mile in length, whichever is less, to minimize survey effort, and yet provide a representative length of stream. In cases in which a treated reach is very long (more than five miles) and the treatment is restricted to the lower portion of the reach, the upstream portion of the same reach will serve as a control. This approach is used because the further upstream a control reach is, the less representative it probably is of the habitat in which treatment occurred. PWB will use attribute values for the entire EDT reach (including the control reach segment) as the treatment reach values and just use attribute values from the control reach segment as the respective control reach values.

Table 2. Paired Treatment and Control Reaches in Streams Surveyed in 2011

Watershed	Treated Reaches	Control Reaches
Lower Sandy River	Trout 1A	Trout 3A
	Trout 2A	Trout 3A
	Gordon 1A	Gordon 2A
	Gordon 1B	Gordon 2A

5.2 Spatial Scale

The measureable habitat objectives (in Table 1) are reach-scale objectives. The survey protocols collect data at both the habitat-unit and reach scales, but all the data are used to derive reach-scale assessments of habitat condition. Reaches vary in length, so all attribute values will be normalized by either channel length or surface area.

5.3 Replication/Duration

Most habitat attributes are naturally variable from year to year. For example, there may be no formation of pools resulting from the addition of wood during the first winter, if high flows do not occur. In other years, high flows might fill in some pools and create new ones elsewhere. For this reason, before (pre-treatment) and after (post-treatment) data will be replicated across time.

Surveys will be conducted in the summer or early fall when flows are low and the stream channels are most navigable. Two to three pre-treatment surveys and five post-treatment surveys will be conducted. Pre-treatment surveys will be conducted annually prior to treatment. Post-treatment surveys will be conducted at three-year intervals beginning the year after treatment and continuing for 12 additional years, or a total of five post-treatment surveys.

5.4 Variables

The habitat attributes used by EDT to evaluate restoration alternatives are derived from the data types summarized below. All data types are information collected during stream surveys. However, not all attributes will be used to evaluate the effectiveness of the offsite in-channel measures.

- Reach-scale data
  - Active channel (bankfull)[1] width (feet)
  - Gradient (percent)
  - Total surface area of off-channel habitat (estimated visually, in square feet)
- Habitat unit-scale data
  - Habitat type (pool, backwater pool, beaver pond, glide, small-cobble riffle, large-cobble riffle)
  - Average length (feet)
  - Average width (feet)
  - Amount of pool tail-out habitat (data collected in pools only, percentage of total surface area that is at the downstream end of the pool and flowing with velocities comparable to those of neighboring glides and riffles.)
  - Confinement – Natural (categorical: confined, moderately confined, unconfined)
  - Confinement – Hydrological modifications (percentage of both banks)
  - In-channel wood (number of pieces greater than 1 foot in diameter and greater than 7 feet long in the active channel of the habitat unit)
  - Fine sediment in spawning habitat types (percentage surface area of gravel patches in small-cobble riffles, pool tail-outs, glides)
  - Embeddedness in spawning habitat types (percent of the vertical dimension of surface cobbles and large gravel that is buried in fine sediment in gravel patches in small-cobble riffles, pool tail-outs, glides)

These data will enable PWB to evaluate how well it has met most of the measurable habitat objectives summarized in Table 1. The percentage of fine sediment in spawning gravels may show too much in-reach variability to allow the detection of the anticipated change.

5.5 Sampling Scheme

Habitat attributes in both treatment and control reaches will be monitored using a modified Hankin and Reeves-type stratified systematic inventory of stream channel characteristics (Hankin and Reeves 1988).

Hankin and Reeves-type protocols involve two main sources of error. PWB will adjust its protocols to reduce these sources of error. The first source of error stems from the strategy of estimating habitat dimensions throughout a reach and then using a subset of measurements to correct the estimates. These corrections are associated with a range of variability, which decreases confidence in the final result. To maximize the statistical power of the monitoring data analysis, given the small sample size of pre-treatment data,

[1] The active channel, or bankfull channel, is the portion of the channel where flows occur often enough to prevent the establishment of vegetation, generally corresponding to a break in the slope of the bank.

all habitat unit dimensions will be measured. The second source of error is measurement error, which can accumulate over the length of a reach. PWB will monument survey reaches at specific intervals to allow for standardization of lengths between years.

6. Analysis

6.1 Data Storage

Monitoring data collected during the HCP will be maintained by PWB in a Microsoft® Access database. Summary data will be added to the Sandy River EDT database. It will be made available to the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, or other regulatory agencies (Services) for review at any time and will be extensively discussed during the HCP Year-20 check-in meeting of PWB with the Services. Following quality assurance/quality control procedures and review and approval by PWB and the Services, the data will be made available to the StreamNet Library (through the Columbia River Inter-Tribal Fish Commission [CRITFC] technical reports), Oregon Department of Fish and Wildlife AIP (http://oregonstate.edu/Dept/ODFW/freshwater/inventory/index.htm), and the U.S. Forest Service Natural Resource Information System (NRIS) Water Module databases. Each of these databases was consulted extensively in the Sandy River Basin EDT analysis. Appropriate treatment- and control-reach data that are already in these databases will be used to bolster the sample size of the pre-treatment habitat attributes. Pre-existing data will not be used if the habitat in the respective streams has since been modified by restoration activities other than the planned HCP offsite in-channel measures.

6.2 Hypothesis Testing

Both the numeric and statistical evaluation of the hypothesis for the monitoring plan key question suggest a fundamental comparison between pre-treatment and post-treatment data on a reach-by-reach, attribute-by-attribute basis. Control reaches will be employed to subtract out variation due to large-scale effects outside of PWB's control. An example of how this would occur is given below (T=Treatment reach value, C=Control reach value):

$$\left.\begin{matrix} T_{before1}-C_{before1} \\ T_{before2}-C_{before2} \end{matrix}\right\} \textbf{ mean vs. mean } \left\{\begin{matrix} T_{after1}-C_{after1} \\ T_{after2}-C_{after2} \\ T_{after3}-C_{after3} \\ T_{after4}-C_{after4} \\ T_{after5}-C_{after5} \end{matrix}\right.$$

The numeric comparison of the means of pre-treatment and post-treatment data will determine whether or not the post-treatment mean is equal to or greater than 80 percent of the measurable habitat objective. For statistical comparisons, t-tests will be performed on the differences between treatment reach and control reach habitat attribute values, with a 95 percent level of confidence.

7. Adaptive Management

If data indicate that the effectiveness monitoring protocol hypotheses should be rejected, and if the new EDT results do not indicate that the predicted changes to freshwater productivity would be at least as much as originally described for PWB's offsite in-channel conservation measures, PWB will follow the adaptive management process described in Chapter 9 of the HCP.

8. 2011 Results

Tables 3 and 4 summarize the results for offsite in-stream measure effectiveness monitoring surveys conducted in 2011 in Gordon Creek and Trout Creek, respectively. The tables also compare survey results with the values for the current condition of the same habitat attributes in the EDT database.

Table 3. Comparison of Values for Various Habitat Attributes[a] in Gordon Creek Derived from the EDT Database and 2011 Survey Results

	Treatment Reaches				Control Reach	
	Gordon 1A Reach		Gordon 1B Reach		Gordon 2A Reach	
Attribute	EDT Current	2011 Survey	EDT Current	2011 Survey	EDT Current	2011 Survey
Large Wood (pieces/CW)b	1.5	2.5	1.5	3.7	1.5	4.8
Backwater Pools	0.0%	0.3%	0.0%	0.1%	0.0%	0.2%
Beaver Ponds	0.0%	0.0%	0.0%	5.7%	0.0%	0.0%
Pools	14.0%	46.4%	6.5%	36.4%	3.2%	32.7%
Pool Tails	3.5%	1.4%	1.3%	0.1%	3.2%	0.1%
Small-Cobble Riffles	52.3%	8.8%	58.4%	0.8%	40.6%	2.1%
Large-Cobble Riffles	30.2%	37.5%	33.8%	56.8%	52.9%	65.0%
Glides	0.0%	5.6%	0.0%	0.0%	0.0%	0.0%
Off-Channel Habitat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3. Comparison of Values for Various Habitat Attributes[a] in Gordon Creek Derived from the EDT Database and 2011 Survey Results

	Treatment Reaches				Control Reach	
	Gordon 1A Reach		Gordon 1B Reach		Gordon 2A Reach	
Attribute	**EDT Current**	**2011 Survey**	**EDT Current**	**2011 Survey**	**EDT Current**	**2011 Survey**
Percent Fines	24.0%	6.0%	8.5%	13.3%	8.5%	8.8%
Embeddedness	0.0%	11.7%	0.0%	1.7%	0.0%	13.8%

[a]The selected attributes are expected to respond to HCP in-stream conservation measures.

[b]Large wood is given as a standardized metric (pieces of wood per average high-flow channel width).

Table 4. Comparison of Values for Various Habitat Attributes[a] in Trout Creek Derived from the EDT Database and 2011 Survey Results

	Treatment Reaches				Control Reach	
	Trout 1A Reach		Trout 2A Reach		Trout 3A Reach	
Attribute	**EDT Current**	**2011 Survey**	**EDT Current**	**2011 Survey**	**EDT Current**	**2011 Survey**
Large Wood (pieces/CW)[b]	1.5	0.5	1.5	4.1	1.5	3.0
Backwater Pools	10.3%	0.00%	0.0%	0.00%	0.0%	0.00%
Beaver Ponds	0.0%	0.00%	0.0%	0.00%	0.0%	0.00%
Pools	4.1%	47.66%	0.0%	6.34%	3.9%	21.63%
Pool Tails	1.0%	0.22%	0.0%	0.03%	0.0%	0.00%
Small-Cobble Riffles	41.2%	12.91%	58.0%	8.86%	54.9%	0.00%
Large-Cobble Riffles	43.3%	0.00%	42.0%	84.76%	41.2%	78.37%
Glides	0.0%	39.21%	0.0%	0.00%	0.0%	0.00%
Off-Channel Habitat	0.0%	0.00%	0.0%	0.00%	0.0%	0.00%
Percent Fines	14.5%	36.92%	8.5%	22.00%	8.5%	NA
Embeddedness	0.0%	50.00%	0.0%	33.80%	0.0%	NA

[a]The selected attributes are expected to respond to HCP in-stream conservation measures.

[b]Large wood is given as a standardized metric (pieces of wood per average high-flow channel width).

9. Discussion

The results presented in Tables 3 and 4 of this report contribute to the baseline average of values for the respective monitored habitat attributes, to which post-treatment conditions will be compared. At least one more year of baseline data will be collected in Gordon and Trout creeks. The averages will be calculated and summarized in the 2012 Annual Compliance Report for Year 3. The comparison of baseline values to the current condition values in the EDT database will help determine whether Gordon Creek and Trout Creek require as much or more restoration than was assumed during the creation of the HCP. The eventual comparison of baseline data to post-treatment data will determine whether the PWB met its restoration targets in those streams and whether additional efforts are necessary.

10. Works Cited

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Appendix B

Bull Run HCP Research Report

Lower Bull Run River Spawning Gravel Research

March 2012

City of Portland Water Bureau

Contents

Tables

Figures

1. Summary

The City of Portland Water Bureau (PWB) is in full compliance with its Habitat Conservation Plan obligations in 2011 with regard to lower Bull Run River spawning gravel research. A survey of gravel patches of sufficient area and with adequately sized substrate for Chinook salmon and steelhead spawning was conducted from the Dam 2 spillway plunge pool rock weir (river mile [RM] 5.8) to the mouth of the Bull Run River (RM 0). The addition of spawning gravel in January of 2010 and 2011 was found to have significantly increased (over the baseline average) the combined surface area of adequately sized spawning gravel patches wetted at low river flows. The surface area of spawning gravel in 2011 was similar to what had been observed in 2010, but gravel appears to have been moved downstream and spread out and a larger amount has been moved up the stream margins. This appendix summarizes the results of this study.

2. Introduction

The availability of appropriate gravel patches can limit the productivity of salmonid populations within a given stream. The dams on the Bull Run River block the downstream movement of streambed substrates. These obstructions have contributed over time to a net loss of spawning gravel patches in the lower Bull Run River, as gravel is washed away and then not replaced.[1]

The Bull Run Water Supply Habitat Conservation Plan (HCP; Portland Water Bureau 2008) proposes adding gravel annually to the lower Bull Run River to supplement naturally occurring spawning gravel. A total of 1,200 cubic yards of adequately sized gravel was added to the lower Bull Run River in 2011 to benefit spawning salmonids. This was the second treatment year after the City's adoption of the HCP. This appendix describes the methods and protocols for monitoring the effectiveness of this effort to increase the surface area of spawning gravel in the lower Bull Run River and provides a summary of the resultant findings for 2011.

3. Research Objective

PWB identified a measurable habitat objective for the spawning gravel placement conservation measure detailed in HCP Chapters 7 and 9. PWB will supply spawning gravel in amounts equivalent to, or exceeding, natural supply rates. PWB will augment spawning gravel in the lower Bull Run River with a total of 1,200 cubic yards of gravel

[1] More information on the role of gravel in spawning is available in Chapter 8 and Appendix E of the HCP.

annually for the first five years of the HCP implementation. This roughly doubles the estimated natural recruitment rate of gravel in the absence of reservoirs (calculations and estimates summarized in CH2M HILL 2003) and is intended to accelerate the accumulation of gravel in the lower Bull Run River.

After five years, the rate of gravel supplementation will be decreased to 600 cubic yards annually for the remainder of the HCP, the estimated natural recruitment rate in the absence of upstream reservoirs. PWB, however, cannot predict how the gravel will be distributed or how quickly it will be moved downstream. There is no information on the areal extent of spawning gravel in the lower Bull Run prior to 1929, which is when the first Bull Run dam was constructed.

The objective of the Bull Run River spawning gravel research is to measure the surface area of patches of gravel suitable for spawning steelhead and Chinook salmon in the lower Bull Run River. Effective spawning gravel patches are patches that experience adequate depth and flow throughout the egg and alevin incubation period. Separate estimates will be generated for steelhead and Chinook salmon. PWB will quantify the surface area of all patches with suitable substrate size ranges. (The surface area of the subset of the patches that would be effective for spawning may also be analyzed in the future.)

4. Key Questions and Hypotheses

The key questions and related null hypotheses (H_o) to be answered by the Bull Run River spawning gravel research are described below.

4.1 Area of Spawning Gravel

Question 1: What is the summed surface area of gravel patches suitable for steelhead and Chinook spawning in the lower Bull Run River and has it significantly increased from pre-supplementation values?

> H_o: The summed surface area of spawning gravel patches in each post-supplementation year will not be significantly greater than the mean of pre-supplementation years (one-sample t-test, α=0.05).

The pre-supplementation years that will be used for the analysis are 2007, 2008, and 2009. Gravel data were also collected by PWB in 1997, 1999, and 2001. The data from these surveys were not included in the baseline averages, because they were collected using different protocols, with conclusions based on different flow assumptions. The comparison will only use gravel patches between the Dam 2 spillway plunge pool at RM 5.8 and the Portland General Electric (PGE) Bull Run Powerhouse at RM 1.5, because the 2007 survey data do not cover the river downstream of this point.

4.2 Trend over Time

Question 2: What is the trend in the summed surface area of spawning gravel patches and the effective spawning area for each reach?

> H_o: The summed surface area of spawning gravel patches in post-supplementation years will not show a significant increase over time (α=0.05).
>
> H_o: The summed surface area of effective spawning gravel patches at various flow combinations in post-supplementation years will not show a significant increase over time (α=0.05).

This question was not evaluated in 2011, because a trend requires multiple years of post-treatment data.

4.3 Reach-Level Effective Spawning Gravel

Although the HCP calls for determining the quantity of effective spawning gravel, this objective has proven to be impractical. Determining the effective spawning area for each reach requires information on water surface elevation and water velocity for each gravel patch through time. In 2011, these data were not available because there is no practical method for collecting and summarizing them. Therefore, the following analysis was not attempted.

The following key question and hypothesis were identified in the HCP.

Question 3: What is the effective spawning area of each reach at various combinations of flows and at the flows actually observed during steelhead incubation in the lower Bull Run River?

> H_o: The summed effective spawning area at various flow combinations in each post-supplementation year will not be significantly greater than the mean of pre-supplementation years (one-sample t-test, α =0.05).

The total of the areas of gravel that meet the depth and water velocity criteria for both spawning and incubation of steelhead and salmon (summarized in Appendix F, Table F-5, of the HCP) during the respective time periods are used to determine the “effective spawning area” of each reach (R2 Resource Consultants 1998). These variables, however, will change continuously through time as they are the sum of current and future conditions for each point in space and time.

If a method for accurately estimating depth and water velocity through time for each gravel patch is devised, an analysis of effective spawning gravel may be attempted in the future.

5. Methods

5.1 Gravel Estimates per Seasonal Flow

The design of the lower Bull Run River spawning gravel research involved the use of surveys of spawning gravel surface areas to create a snapshot of the distribution of spawning gravel at a particular point in time. Predicted relationships between stage and flow were developed for multiple points along the lower Bull Run River using Hydrologic Engineer Center's River Analysis System (HEC-RAS).[2] These relationships were then used to estimate the amount of spawning gravel that would be wetted at each flow. Although not all wetted gravel patches would have the proper depth, velocity, or degree of turbulence for spawning, it was assumed throughout the subsequent analyses that the change in overall surface area of gravel can serve as a predictor of the surface area of the subset of that gravel that can be used for spawning.

5.1.1 Steelhead Spawning Gravel

The amount of **steelhead spawning gravel** was estimated for the following flows:

- **1,405 cfs:** 10 percent average exceedence flow for March, April, and May (peak steelhead spawning months)
- **614 cfs:** 50 percent average exceedence flow for March, April, and May
- **120 cfs:** The lowest allowed flow during March, April, and May under the HCP measure for minimum flows (actual flows may be higher)

5.1.2 Spring Chinook Spawning Gravel

The amount of **spring Chinook spawning gravel** was estimated for the following flows:

- **358 cfs:** 10 percent average exceedence flow for September and October (the peak spring Chinook spawning months)
- **77 cfs :** 50 percent average exceedence flow for September and October
- **30 cfs**: The lowest allowed flow during September and October under the HCP measure for minimum flows (actual flows may be higher)

5.1.3 Fall Chinook Spawning Gravel

The amount of **fall Chinook spawning gravel** was estimated for the following flows:

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[2] HEC-RAS is a software package developed by the U.S. Army Corps of Engineers for predicting the behavior of flowing channels using one-dimensional hydraulic modeling.

- **1,480 cfs:** 10 percent average exceedence flow for October and November (the peak fall Chinook spawning months)
- **77 cfs** : 50 percent average exceedence flow for October and November
- **30 cfs**: The lowest allowed flow during October and November under the HCP measure for minimum flows (actual flows may be higher)

Calculating the amount of spawning gravel at the 10 percent and 50 percent exceedence flows, as well as the minimum allowable flow for each species' peak spawning period, allows for comparisons in the amount of spawning gravel across flows and across years. The amount of gravel wetted at the minimum allowable flow represents the minimum amount of gravel that would be available to each species. The amount of gravel wetted at the 10 percent and 50 percent exceedence flows indicates how far up the margins of the channel gravel accumulates and how much gravel remains available for spawning. This combined information can be used to evaluate the effectiveness of the HCP gravel placement effort at increasing the amount of spawning gravel for steelhead and spring and fall Chinook.

5.2 Spatial Scale

Surveys are used to determine the amount and quality of spawning gravel at various flows within the lower Bull Run River from the mouth (RM 0.0 to the Reservoir 2 spillway plunge pool (RM 5.8). Results are applicable only to the lower Bull Run River and have a reach-scale resolution.

5.3 Replication/Duration

Surveys are conducted once per year in the late spring/early summer or early fall in conjunction with adult Chinook surveys. The surveys occur after high flows associated with winter and spring storms have ceased and spawning gravel patches have stabilized, representing the amount available to steelhead and later to Chinook spawners for that year. There is no spatial replication; the entire channel is surveyed.

Three pre-treatment surveys were conducted in 2007, 2008, and 2009. These surveys form the baseline, against which individual post-treatment years will be compared. One post-treatment survey will be conducted each year during HCP Years 2–6, while the maximum amount of gravel supplementation (1,200 cubic yards) occurs. This represents the period of time when gravel is expected to accumulate most rapidly in the lower Bull Run River.

After gravel supplementation is reduced in Year 6 of the HCP (to the maintenance level of 600 cubic yards), gravel surveys will continue once per year for an additional five years, HCP Years 7–11. During this phase, gravel supplementation is primarily intended to maintain gravel deposits in the lower Bull Run River and surveys are designed to allow for an analysis powerful enough to detect negative trends in the surface area of spawning gravel.

Provided that gravel supplementation at maintenance levels does not result in a rapid negative trend during HCP Years 7–11, the frequency of gravel surveys will be reduced to once every five years for the duration of the HCP.

5.4 Variables

The following variables were measured for each gravel patch:

Longitudinal Location. Location relative to the beginning of the reach, measured with a hand-held global positioning system (GPS) device

Lateral Location. Location within the channel—in the center of the channel, in the channel margin, or above the channel margin (outside the wetted area but within the active channel)

Retention Feature. Feature that acts on the current to allow gravel deposition: pool-tail, boulder, bedrock, large wood, and/or slow margins

Patch Size. Surface area of patch (square feet), calculated as total length multiplied by average width

Depth or Elevation. For submerged patches, depth of the center of the patch below the water surface; for gravel patches above the water surface, elevation of the center of the patch above the water surface

Embeddedness. The visually estimated percentage of the vertical dimension of surface substrates between 1.8 inches and 4 inches intermediate axis (roughly golf-ball size to softball size) that is surrounded by silt and sand. Average of 10 particles per patch of varying sizes. The percentage of total embeddedness is calculated as

%Total Embedded=([(%Embeddedlarge particles/100)*(100-% fines)]+[% fines])/100

(Embeddedness procedures are reviewed in Sylte and Fischenich 2002).

Percentage of Fines. Estimated surface area of patch covered by silt and sand (not a thin film over other obvious surface substrates)

Upper and Lower 10th Percentile of Substrate Size. The sizes of particles corresponding to the upper and lower 10th percentile for each gravel patch were visually estimated. Particle size reflects the intermediate axis of the particle, or the axis that controls the particle's passage through a sieve.

5.5 Sampling Scheme

Sampling protocols were slightly altered from those described in Appendix F of the HCP.

The lower Bull Run River was divided into a total of 16 segments, each one 2,000 feet in length. The smaller divisions will provide for greater resolution when tracking the dispersal of gravel through time than the original six reaches proposed in the HCP.

Segments were surveyed from upstream to downstream.

The 2011 survey was conducted at a discharge flow of 24 cfs, as measured at U.S. Geological Survey (USGS) Gage No. 14140000.

Patches of gravel suitable for spawning steelhead and/or Chinook were identified along the length of the channel. Patches of spawning gravel were defined as being equal to or greater than 9 square feet, lying within the active channel and composed of substrates between 0.1 and 6.0 inches in diameter along their intermediate axis for Chinook and between 0.1 and 4.0 inches in diameter for steelhead.

A HEC-RAS model was developed for the lower Bull Run River, using cross-sections taken from Light Detection And Ranging (LiDAR)[3] data. The model was calibrated using actual stage-discharge relationships from USGS Gage No. 14140000, as shown in Figure 1. The depth at each gravel patch at various flow levels was determined using stage-discharge relationships developed for each 2,000-foot river segment.

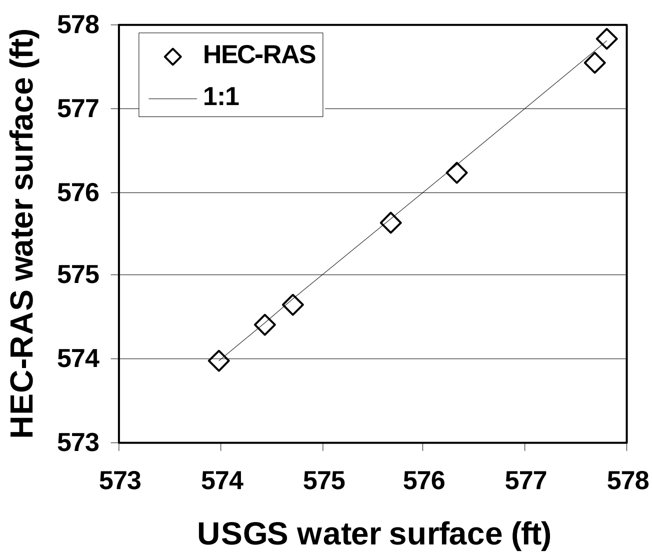

Figure 1. Comparison of HEC-RAS Model River Stage Results with USGS Stage/Discharge Curve Values

[3] LiDAR is a method of determining surface topography using reflected returns from a downward-pointed laser mounted on an aircraft. LiDAR has a resolution of 3 square feet.

6. Analysis

Data Storage. Data are stored in a Microsoft® Access database managed by the City of Portland Water Bureau.

Hypothesis Testing. The hypotheses relating each year's measured surface area of gravel to the mean of pre-gravel supplementation years were evaluated using one-tailed, one-sample t-tests (α=0.05).

7. Results

A total of 624 gravel patches with substrate sizes suitable for spawning Chinook were identified within the active channel in 2011, with a total of 36,775 square feet of combined surface area. Of these, 600 patches also had substrate sizes suitable for spawning steelhead, with a total of 41,542 square feet of combined surface area.

7.1 Area of Spawning Gravel

7.1.1 Steelhead

There was estimated to be significantly more combined surface area of gravel patches with substrate sizes suitable for spawning steelhead in 2011 than the baseline average at flows of 120 cfs, but not at higher flows (one-sample, one-tailed t-test, α=0.95, df=2). The combined surface area, baseline average, standard deviation, and significance for each flow are summarized in Table 1.

Table 1. Combined Surface Area of Steelhead Spawning Gravel Patches in the Lower Bull Run River

	120 cfs	614 cfs	1,405 cfs
2011 Survey Results	13,572 ft^2	18,948 ft^2	22,980 ft^2
Baseline Average	5,159 ft^2	8,373 ft^2	12,532 ft^2
Baseline Standard Deviation	2,396 ft^2	4,723 ft^2	5,708 ft^2
Significantly Greater than Baseline?	Yes	No	No

7.1.2 Spring Chinook

There was estimated to be significantly more combined surface area of gravel patches with substrate sizes suitable for spawning spring Chinook in 2011 than the baseline average at all flows analyzed for spring Chinook (one-sample, one-tailed t-test, α=0.95, df=2). The combined surface area, baseline average, standard deviation, and significance for each flow are summarized in Table 2.

Table 2. Combined Surface Area of Spring Chinook Spawning Gravel Patches in the Lower Bull Run River

	30 cfs	77 cfs	358 cfs
2011 Survey Results	14,469 ft^2	17,429 ft^2	23,193 ft^2
Baseline Average	4,621 ft^2	4,994 ft^2	7,941 ft^2
Baseline Standard Deviation	1,578 ft^2	1,506 ft^2	3,294 ft^2
Significantly Greater than Baseline?	Yes	Yes	Yes

7.1.3 Fall Chinook

There was estimated to be significantly more combined surface area of gravel patches with substrate sizes suitable for spawning fall Chinook in 2011 than the baseline average at all flows analyzed for fall Chinook (one-sample, one-tailed t-test, α=0.95, df=2). The combined surface area, baseline average, standard deviation, and significance for each flow are summarized in Table 3.

Table 3. Combined Surface Area of Fall Chinook Spawning Gravel Patches in the Lower Bull Run River

	30 cfs	77 cfs	1,480 cfs
2011 Survey Results	14,469 ft^2	17,429 ft^2	31,227 ft^2
Baseline Average	4,621 ft^2	4,994 ft^2	13,912 ft^2
Baseline Standard Deviation	1,578 ft^2	1,506 ft^2	5,134 ft^2
Significantly Greater than Baseline?	Yes	Yes	Yes

7.2 Distribution of Spawning Gravel

7.2.1 Steelhead

In 2011, a large amount of steelhead spawning-size gravel had been displaced to stream segments downstream of the gravel placement sites and downstream of the main deposition areas observed. Gravel observed in the low-flow (30 cfs) channel below the

Rock Cut Road site in 2010 appeared to have moved at least 2,000 feet downstream and further up onto the stream margins, where it would be wetted at 1,480 cfs, but not at 30 cfs (Figure 2). Much of the gravel observed below the Southside Bridge site in 2010 apparently moved over 4,000 feet downstream, but was still mostly within the the low-flow channel. A large amount of gravel was found in the vicinity of the Larson's Bridge site, as in 2010, but the location of the gravel—across the channel from where gravel was added—suggested that much of it originated upstream. The surface area of gravel between 4,000 and 12,000 feet downstream of the Larson's Bridge site was greater in 2011 than in 2010, indicating that much gravel had moved at least several thousand feet.

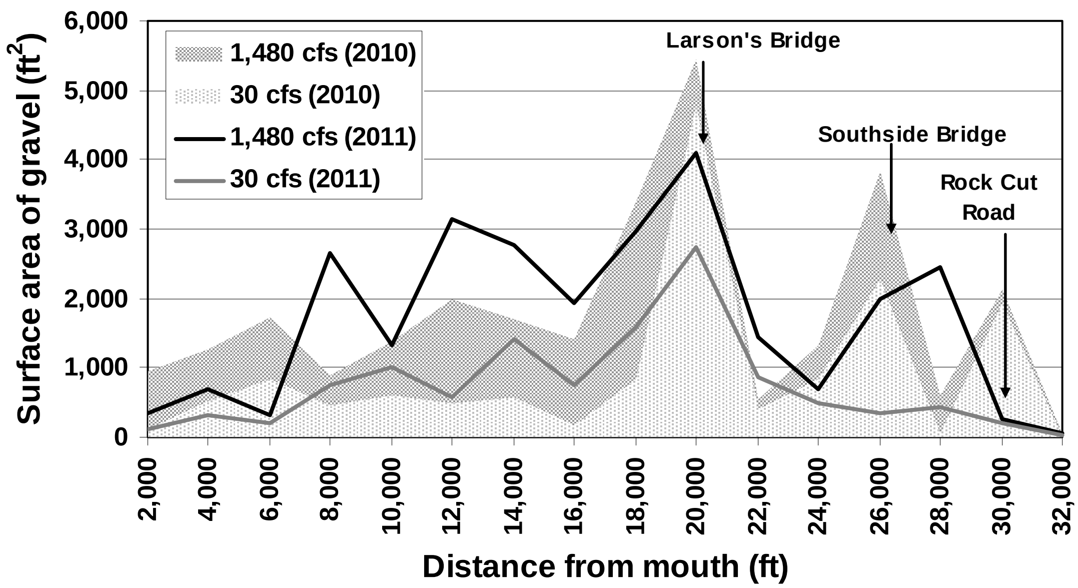

Figure 2. Longitudinal Distribution of Steelhead Spawning-Size Gravel Patches in the Lower Bull Run River in 2011 at 30 cfs and 1,480 cfs compared to 2010

The peaks in gravel surface area observed near the three placement sites in 2010 and 2011 were not present in previous years, as shown in Figures 3 and 4.

The largest observed increases in gravel over the baseline occurred in the portion of the channel wetted at relatively low flows (i.e., 120 cfs and less), as shown in Figure 5. The total surface area of steelhead spawning-size gravel wetted at flows of 77 cfs and greater was nearly unchanged from 2010.

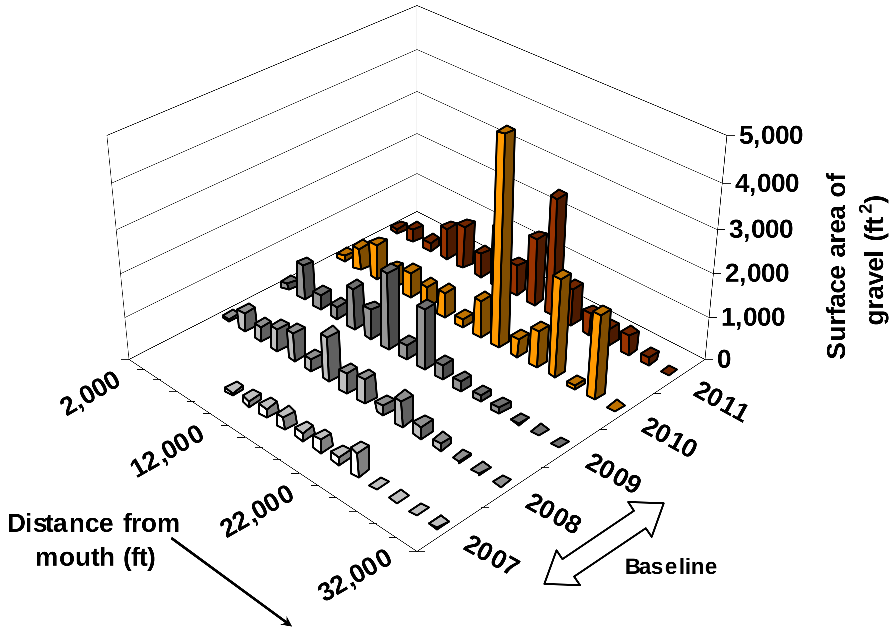

Figure 3. Longitudinal Distribution of Steelhead Spawning-Size Gravel Patches in the Lower Bull Run River in 2007-2011 at 30 cfs

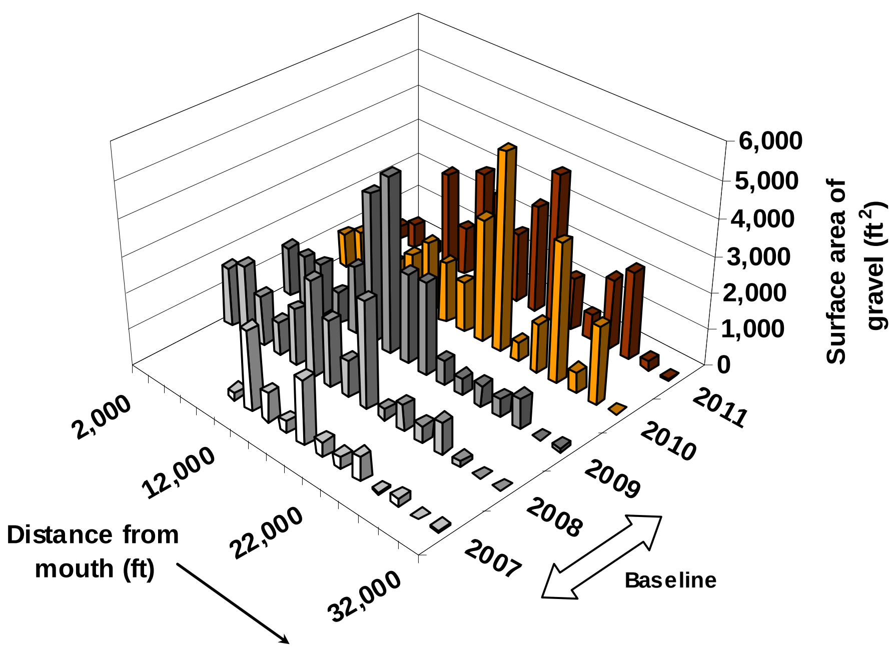

Figure 4. Longitudinal Distribution of Steelhead Spawning-Size Gravel Patches in the Lower Bull Run River in 2007-2011 at 1,480 cfs

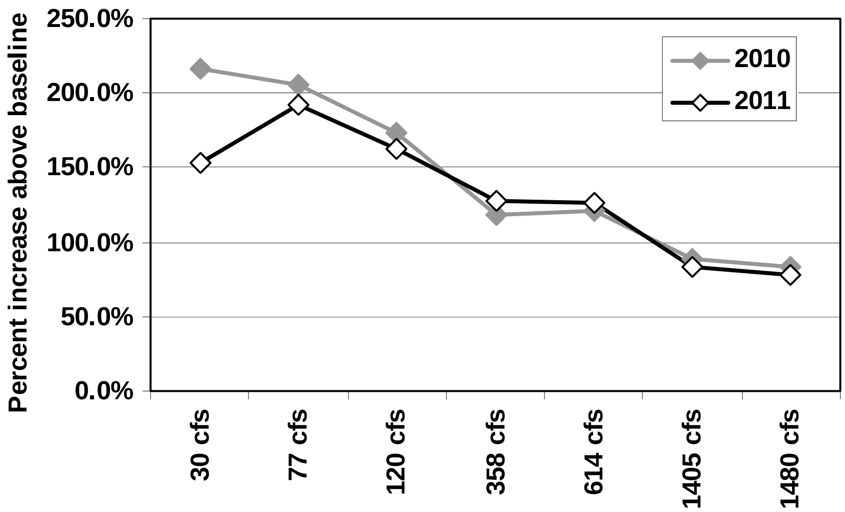

Figure 5. Increase in the Surface Area of Steelhead Spawning-Size Gravel Patches in 2010 and 2011 above the Baseline Average for Various Flows

7.2.2 Chinook

In 2011, a large amount of Chinook spawning-size gravel had been displaced to stream segments downstream of the gravel placement sites and downstream of the main deposition areas observed, as was observed for steelhead. Gravel observed in the low-flow (30 cfs) channel below the Rock Cut Road site in 2010 appeared to have moved at least 2,000 feet downstream and further up onto the stream margins, where it would be wetted at 1,480 cfs, but not at 30 cfs (Figure 6). Much of the gravel observed below the Southside Bridge site in 2010 apparently moved over 4,000 feet downstream, but was still mostly within the low-flow channel. A large amount of gravel was found in the vicinity of the Larson's Bridge site, as in 2010, but its location in the channel, across the channel from where gravel was added, suggested that much of it originated upstream. The highest concentration of gravel in the river was between 6,000 and 8,000 feet downstream of the Larson's Bridge site.

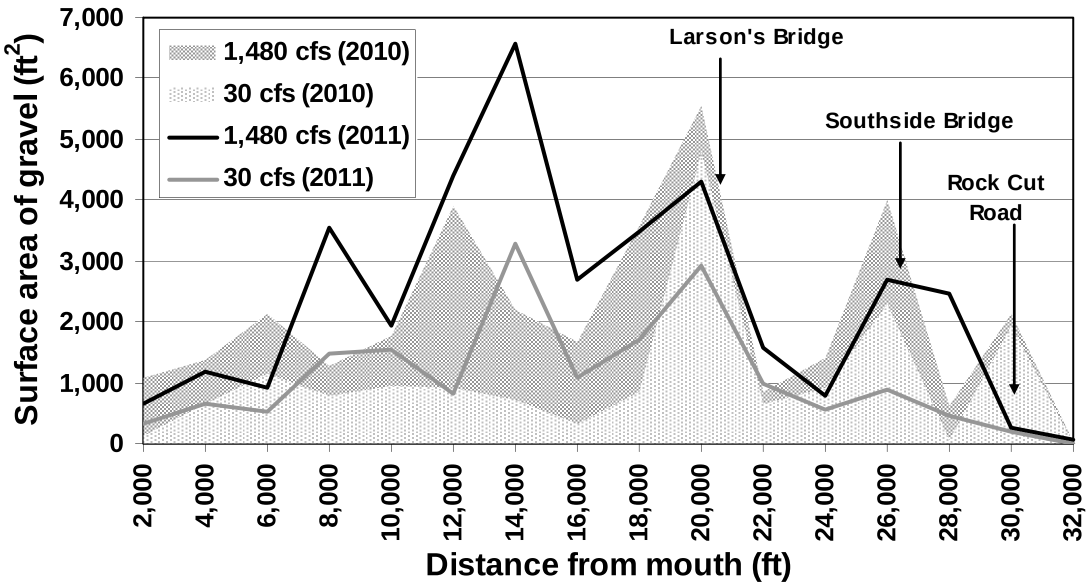

Figure 6. Longitudinal Distribution of Chinook Spawning-Size Gravel Patches in the Lower Bull Run River in 2011 at 30 cfs and 1,480 cfs compared to 2010

The peaks in gravel surface area observed near the three placement sites in 2010 and 2011 were not present in previous years, as shown in Figures 7 and 8.

The largest observed increases in gravel over the baseline occurred in the portion of the channel wetted at relatively low flows (i.e., 120 cfs and less), as shown in Figure 9. The total surface area of Chinook spawning-size gravel increased at all flows above 30 cfs over what was observed in 2010.

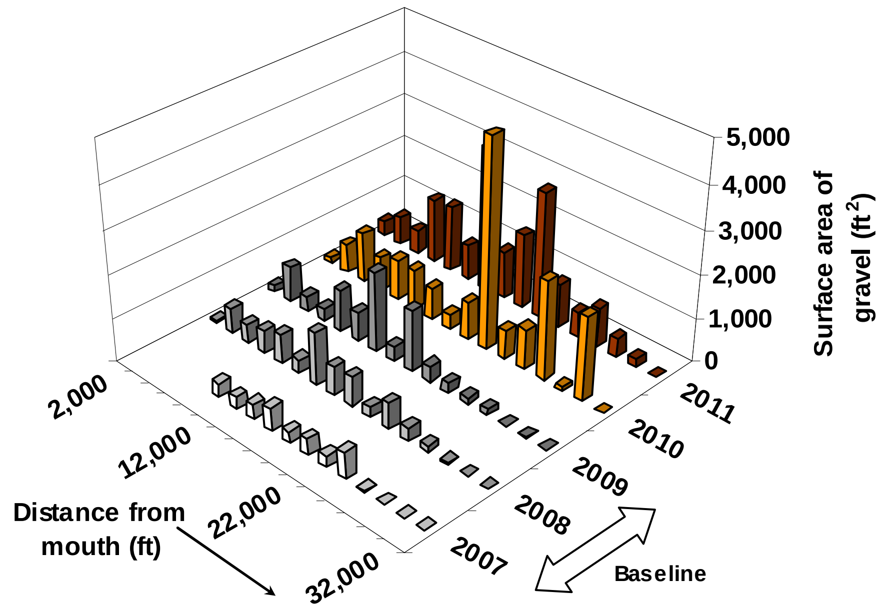

Figure 7. Longitudinal Distribution of Chinook Spawning-Size Gravel Patches in the Lower Bull Run River in 2007-2011 at 30 cfs

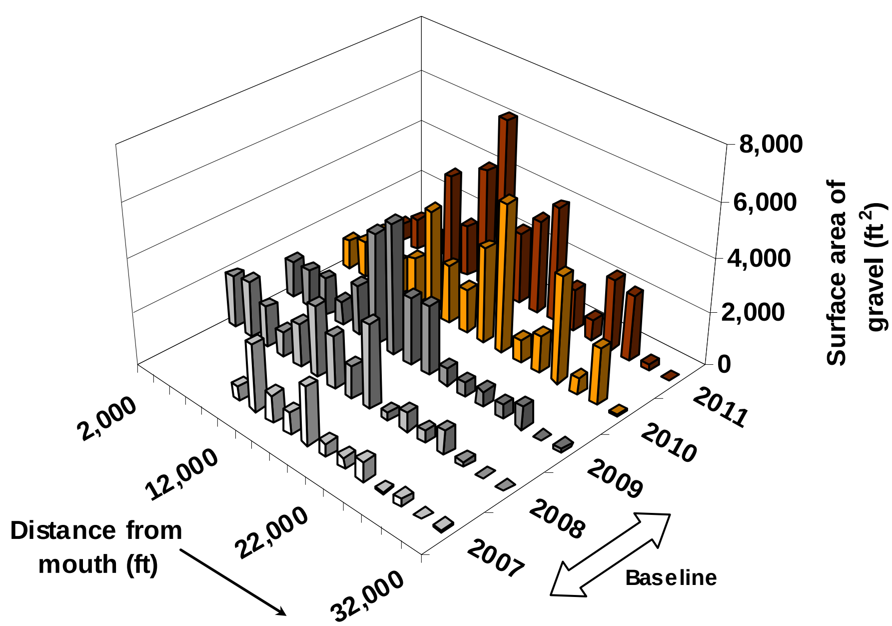

Figure 8. Longitudinal Distribution of Chinook Spawning-Size Gravel Patches in the Lower Bull Run River in 2007-2011 at 1,480 cfs

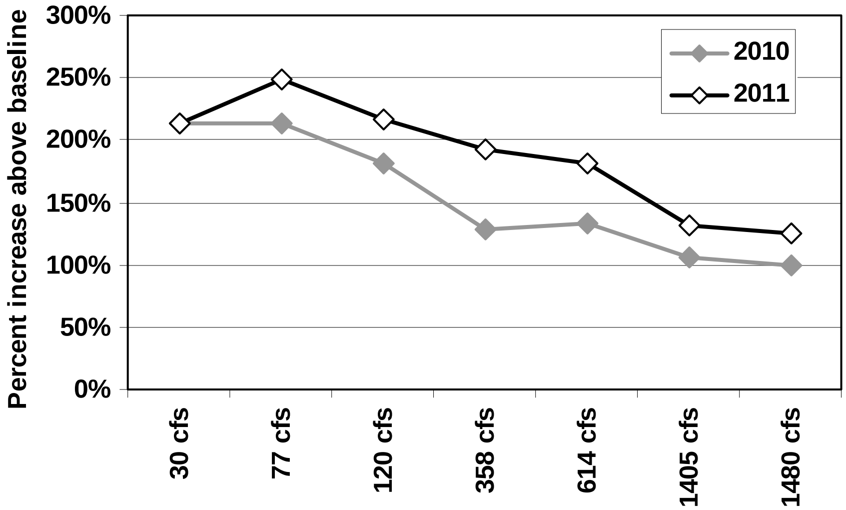

Figure 9. Increase in the Surface Area of Chinook Spawning-Size Gravel Patches in 2010 and 2011 Above the Baseline Average for Various Flows

8. Summary and Discussion

The total surface area of spawning-sized gravel was significantly greater in 2011 than in baseline years for steelhead at low flows and for Chinook at all flows. Gravel appeared to have moved up to several thousand feet downstream and more of it was found higher on the stream margins than in 2010, especially the larger Chinook spawning-sized gravel.

A large flood in the Bull Run River in early 2011 probably accounts for the greater downstream movement of gravel observed in 2011 than in 2010. The Bull Run River experienced a flood event with approximately a 50-year return interval (20,200 cfs) on January 16, 2011. This event occurred after the addition of gravel on January 11-14, 2011, and appeared to be responsible for moving gravel from both 2010 and 2011 downstream and depositing some of it higher on the stream margins than was observed in 2010. The majority of gravel, however, apparently was not washed out of the river and remained low enough in the channel to be used by spawning steelhead and Chinook.

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Appendix C

Bull Run HCP Research Report

Total Dissolved Gases in the Bull Run River

March 2012

City of Portland Water Bureau

Contents

Tables

Figures

1. Summary

The City of Portland Water Bureau (PWB) is in full compliance with its Habitat Conservation Plan (HCP; Portland Water Bureau 2008) obligations with regard to total dissolved gas (TDG) monitoring in the Bull Run River in 2011. TDG data were collected on two occasions in 2011.

PWB has added two new TDG monitoring sites in 2011 to better describe TDG saturation where water with high TDG levels from the dam spillways mixes with water with low TDG levels from the hydroelectric powerhouses. PWB proposes to use these sites in place of sites originally intended to measure TDG levels in the fully mixed water.

On one occasion, PWB has measured TDG levels in excess of 110 percent at river flows below the 10-year, 7-day average flood (7Q10) flow at one of the new sites. The measurement, however, was made in water from a spillway that had not yet had an opportunity to mix with the water from the powerhouse.

PWB's TDG monitoring is taking place under dynamic conditions—modifications of water infrastructure to fulfill the conditions of other HCP measures may have permanently changed TDG levels at certain monitoring sites and will likely change TDG levels at other sites for the duration of modification construction. PWB will continue monitoring to describe these changes.

This appendix summarizes the results to-date of PWB's TDG monitoring in the Bull Run River.

2. Introduction

The level of total dissolved gas is the sum of the partial pressures of all gases, including water vapor, dissolved in a volume of water. Elevated levels of TDG in water can have various negative impacts on fish, such as the formation of gas bubbles in tissues and the vascular system (gas bubble disease) and overinflation of the air bladder. Extremely high levels of TDG or long exposure times can lead to immediate or delayed mortality.

Oregon's Water Quality Standards, as enforced by the Oregon Department of Environmental Quality (ODEQ), state that the concentration of TDG relative to local barometric pressure should not exceed 110 percent of saturation [OAR 340-041-0031]. An exception is made when stream flows at a given sampling site exceed the 10-year, 7-day average flood (7Q10), defined as the yearly peak 7-day rolling average high flow that has an average recurrence interval of 10 years.

In 2005, PWB initiated a monitoring plan to check TDG levels associated with the water facilities in the Bull Run River. The plan, developed in consultation with ODEQ, identified sites at risk of elevated TDG levels and established a sampling regime specific to each sampling site, with a set number of data to be collected. Many of these data had already been collected prior to 2011.

Two modifications to infrastructure underway in the Bull Run watershed will affect TDG and require alterations to the sampling plan developed by PWB. These modifications are to comply with another measure in the PWB's HCP, Measure T-2, Post-Infrastructure Temperature Management and include 1) the removal of a rock weir at river mile (RM) 5.8 in 2011 and 2) the installation of a multiple-level intake on one of the Dam 2 intake towers in 2012.

Removal of the rock weir has altered the usefulness of certain TDG monitoring sites and may have changed TDG levels under certain flows. The rock weir slowed the passage of water through the Dam 2 spillway plunge pool. Its removal will allow cool water to quickly flow downstream with less warming than before, to the benefit of salmon and trout. In the absence of the rock weir, however, spillway water with high TDG levels and Powerhouse 2 water with lower TDG levels, which meet in the plunge pool, will have less opportunity to mix before flowing downstream. As a result, certain TDG sites, selected to monitor fully mixed water, will no longer be useful. In addition, without the rock weir, spillway water will plunge an additional few feet to the lowered pool surface. This could change TDG levels at the base of the spillway from what it would have been in the presence of the rock weir.

Modifications to the intake tower could lead to excessive TDG levels during construction. Water that passes from the intake tower through Powerhouse 2 has relatively low TDG levels. This relatively low-TDG water mixes with water from the spillway, decreasing the higher TDG levels of the spillway water. During modification of the intake tower, however, Powerhouse 2 will be off-line and will not contribute to the dilution of spillway water. TDG levels greater than 110 percent at flows less than the 7Q10 flow could result.

Alterations have been made to the TDG monitoring plan to accommodate these changing conditions in the Bull Run River. This appendix describes updated sampling sites, protocols, and results to-date for monitoring TDG levels in the lower Bull Run River.

3. Research Objectives

The TDG research results will be used to determine whether there are locations in the lower Bull Run River watershed with elevated concentrations of TDG. The sites will be monitored across a range of flows.

4. Key Questions and Hypotheses

There are three key questions to be answered by this TDG monitoring plan. Two of the questions have a null hypothesis (H_o) that will be tested with the monitoring protocol; the third question will be addressed by field observation. The questions are as follows:

Question 1: Do any of the monitoring sites exceed the ODEQ standard of 110 percent saturation of TDG?

> H_o: At each monitoring site, the observed TDG concentration will not exceed 110 percent of saturation within any range of flow, as defined in Table F-7 of the HCP, unless the flow exceeds the 7Q10 for the lower Bull Run River.

Question 2: At sites where elevated TDG levels exceeding 110 percent are observed, are there flow ranges associated with excessive TDG levels?

> H_o: At each site with observed TDG levels in excess of 110 percent, there is no relationship between amount of flow and measured levels of TDG.

Question 3: How quickly do elevated levels of TDG dissipate downstream when they are observed?

This key question does not have an associated null hypothesis. It involves the collection of information to assist in the adaptive management process.

5. Monitoring Design

5.1 Sites

PWB, in conjunction with ODEQ staff, identified all watershed structures associated with City operations that could cause elevated levels of TDG. These structures include the spillways, valves, or turbines in which air bubbles could be brought under sufficient pressure to cause their dissolution in water beyond the level of saturation.

Monitoring locations were established to monitor the effects of each specific structure on TDG levels, or to provide information on the persistence of TDG downstream. The monitoring sites, the associated structures that increase the risk of elevated TDG concentrations, and the purposes of measuring each site are summarized in Table 1. Additional sites are also monitored to provide information on the effects of water mixing from various sources and the effects of downstream dissipation on elevated TDG levels. All locations of monitoring sites are shown in Figures 1 and 2.

As a consequence of the removal of the rock weir at the downstream end of the Dam 2 spillway plunge pool in 2011, two monitoring sites were added—TDG-1u and TDG-1L, and two sites will no longer be monitored: TDG-1 and TDG-1a. TDG-1 was intended to monitor the TDG levels of water from the Dam 2 spillway. TDG-1a was intended to monitor fully mixed flows from the spillway and Powerhouse 2 after they had passed over the rock weir. In the absence of the rock weir, however, TDG-1 no longer consistently tracks TDG levels from the spillway, as the relative contributions of the powerhouse flows and the spillway flows vary in complex ways. In addition, in the absence of the rock weir, flows from these two sources are also no longer fully mixed at TDG-1a.

TDG-1u was added to monitor TDG levels of Powerhouse 2 flows entering the spillway plunge pool. TDG-1L was added to monitor TDG levels of water from the Dam 2 spillway without influence from Powerhouse 2 flows. TDG-1u and TDG-1L together allow the calculation of TDG levels of the mixed flow in lieu of an adequate mixed-flow monitoring site. Although TDG-1u and TDG-1L were not a part of the original TDG sampling plan (and so have not been included in previous reports) PWB has additionally collected TDG data at these sites since 2007 in order to better understand results from the established monitoring sites. In 2011, PWB added these sites to the formal monitoring plan and will begin reporting on them.

Table 1. TDG Monitoring Sites, Associated Structure, and Purpose of Measuring

Monitoring Site	Associated Structure	Purpose
TDG-1, TDG-1L, TDG-1u[a]	Dam 2 Spillway	Structure Effects
TDG-1a[a]	Dam 2 Spillway	Downstream Effects
TDG-2	Dam 2 Spillway	Downstream Effects
TDG-3	South Howell-Bunger Valve	Structure Effects
TDG-4	North Howell-Bunger Valve	Structure Effects
TDG-5	Powerhouse 2	Structure Effects
TDG-6	Diversion Dam	Structure Effects (Upstream Value)
	Powerhouse 2	Downstream Effects
TDG-7	Diversion Dam	Structure Effects (Downstream Value)
TDG-8	Lamprey Weir	Structure Effects (Upstream Value)
	Diversion Dam	Downstream Effects
TDG-9	Lamprey Weir	Structure Effects (Downstream Value)
TDG-10	Dam 1 Spillway	Downstream Effects
	Powerhouse 1	Downstream Effects
TDG-11	Dam 1 Spillway	Structure Effects
TDG-12	Powerhouse 1	Structure Effects

[a]TDG-1L and TDG-1u sites were added in 2011; TDG-1 and TDG-1a will no longer be monitored.

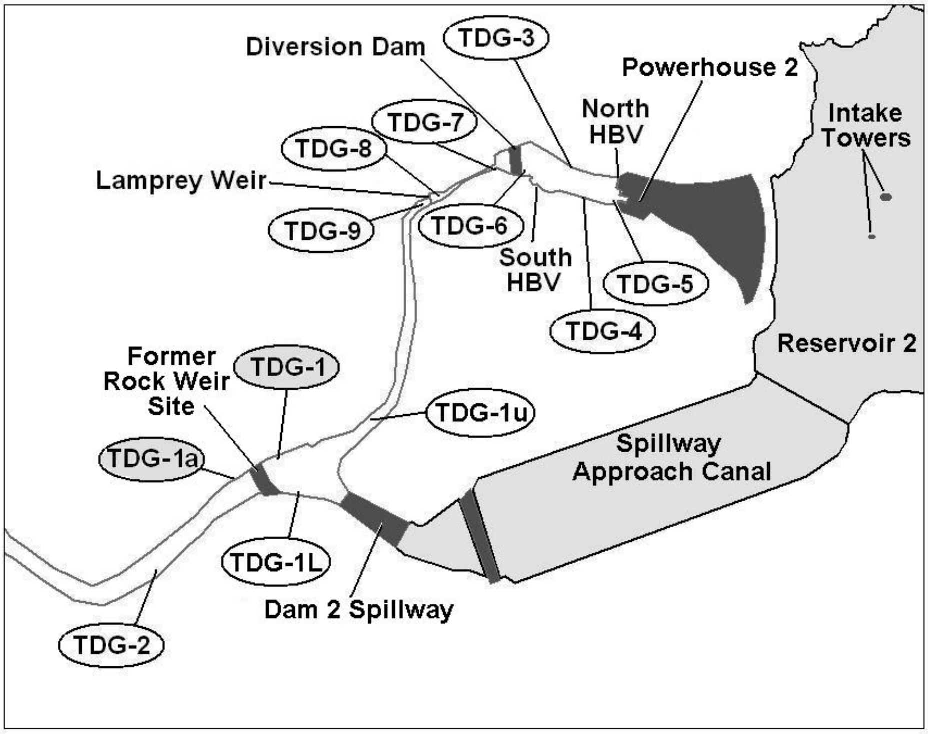

Figure 1. Locations of TDG Monitoring Sites Associated with Dam 2[a], 2011 Update

[a]Monitoring sites TDG-1u and TDG-1L were added in 2011; sites TDG-1 and TDG-1a will no longer be monitored.

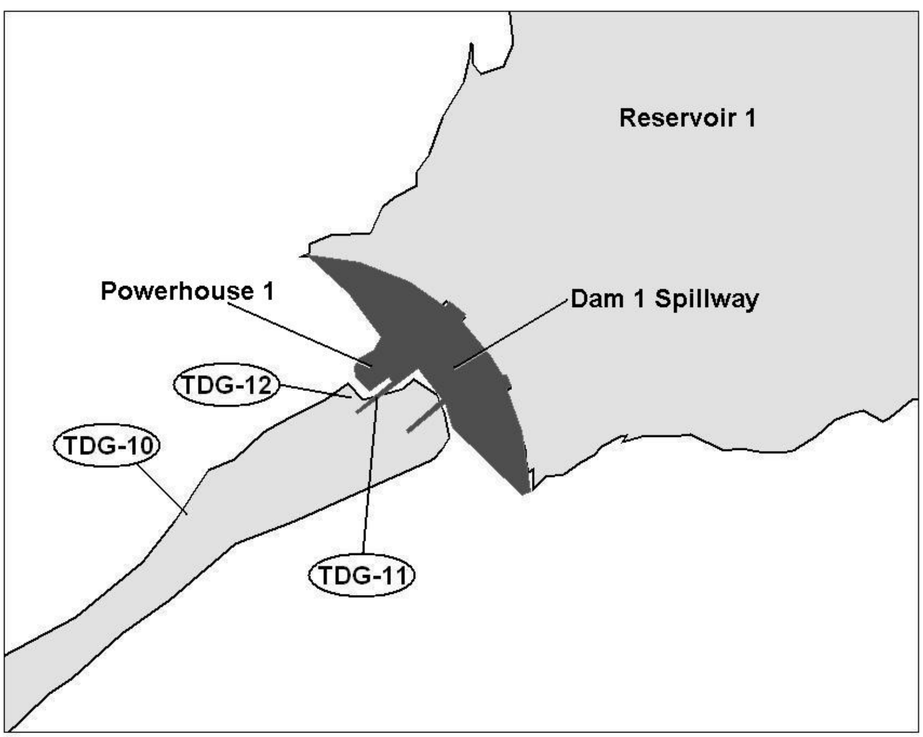

Figure 2. Locations of TDG Monitoring Sites Associated with Dam 1

Each site has a unique span of possible flows, associated with its longitudinal position along the Bull Run River and its function as a part of the City's water and hydroelectric facilities. Flows passing through each of the two powerhouses are measured by flow sensors in the penstocks and are constrained by the minimum flows required to run the turbines and the maximum flows that the turbines can accommodate. Flows passing over each dam's spillway are estimated by employing stage/discharge rating curves established for each spillway. The flows are constrained only by the range of natural variability in the Bull Run River as modified by the water diversions and withdrawals by PWB.

For most of the structures, the historical span of flows was divided into three equal parts or flow ranges. Each flow range will be sampled with replication. The ranges of flows for each structure in cubic feet per second (cfs) and the number of replicates for sampling are identified in Table 2. Sites located downstream of structures are for the purpose of monitoring the persistence of TDG concentrations and will be sampled on the same day as the associated upstream sites (for example, TDG-10 is downstream of TDG-11, the Dam 1 Spillway, and TDG 12, Powerhouse 1).

Table 2. Flow Ranges and Number of Replicates per Flow Range for Sampling TDG

Structure	Flow Ranges (cfs)	Number of Replicates
Dam 2 Spillway	1,700–6,900	5
	6,900–12,000	5
	12,000–17,200	5
Powerhouse 2	210–700	5
	700–1,200	5
	1,200–1,700	5
South HB Valve[a]	While operating	5
North HB Valve[a]	While operating	5
Diversion Dam	Whenever Powerhouse 2 or HB valve readings are taken	15 to 20
Lamprey Weir	Whenever Powerhouse 2 or HB valve readings are taken	15 to 20
Dam 1 Spillway	2,000–5,500	5
	5,500–8,900	5
	8,900–12,400	5
Powerhouse 1	800–1,200	5
	1,200–1,600	5
	1,600–2,000	5

[a]HB =Howell-Bunger

Two Howell-Bunger (HB) valves at Reservoir 2 provide a route for releasing water that bypasses the hydroelectric turbines and the spillway. The HB valves dissipate energy associated with the head pressure behind the dam. Monitoring sites have been located at the outlet of each HB valve. No range of flows has been established for the HB valves. Each site will be sampled several times when the respective valve is in operation.

The 7Q10 for the lower Bull Run River was calculated from historical records from January 1, 1940, to December 31, 2009; it is currently estimated to be 5,702 cfs. The 7Q10 for the Dam 1 spillway was calculated from historical records from January 1, 1976, to December 31, 2009; it is currently estimated to be 4,346 cfs. When flows of these magnitudes occur or are exceeded, sampling will continue; however, the ODEQ standard of 110 percent saturation for TDG will not apply. PWB will update the 7Q10 flow amounts annually for future monitoring purposes.

5.2 Spatial Scale

All data collected on TDG are site-specific. Downstream sites have been included to determine the spatial extent of elevated TDG exposure.

5.3 Replication/Duration

Each site will be monitored until the full set of ranges, as defined in Table 2, has been adequately sampled. Each site will be sampled five times within each flow range; some sampling has already been conducted. The sites associated with the diversion pool dam next to the Headworks facility and the lamprey weir will be sampled as often as possible when the Powerhouse 2 sites are sampled. Downstream sites will be sampled as often as possible when the associated upstream sites are sampled. The HB valve sites will be sampled five times each during valve operation.

Monitoring at all sites associated with the Dam 2 spillway plunge-pool will be reinitiated now that the rock weir has been removed. TDG-1 and TDG-1a will no longer be monitored. Once the relationship of TDG percent saturation for each site and set of variables has been established, further monitoring will rely on tracking the environmental variables, such as water temperature and flow, rather than sampling TDG.

5.4 Parameters

On each sampling occasion, the following information is recorded:

- TDG percent saturation
- Water temperature
- Date and time of day
- Flow at the respective structure (e.g., spillway or powerhouse)

5.5 Sampling

TDG percent saturation and water temperature are measured using a Common Sensing TBO-DL6 dissolved gas and oxygen meter. Flow at the time of measurement will be obtained from data gathered at PWB's water facilities by staff.

6. Analysis

Linear regression is used to explore the relationship between TDG levels and flow at each of the dam spillways and the lamprey weir. In those instances in which the 110 percent TDG criterion is exceeded, a regression model is developed that predicts the conditions under which TDG concentrations might exceed 110 percent at each site. In the future, nonlinear multiple regression may be used to try to use water temperature as a covariate to better model the relationship between flow and TDG concentrations.

The dissipation of elevated TDG concentrations downstream of their sources will be characterized and evaluated across levels of flow using Analysis of Covariance (ANCOVA) of log-transformed data.

7. Results

7.1 Data Collected

TDG data were collected on one occasion in 2011, when the Bull Run River experienced a flood on November 23.

Table 3 summarizes the structures in the lower Bull Run River that are being monitored for TDG and the number of data points that remain to be collected for various flows. The remaining number of replicates for the Dam 2 spillway reflects the fact that monitoring for this structure was reinitiated in 2011 following the removal of the rock weir. All TDG data collected to-date are summarized in Exhibit A at the end of this report.

Table 3. Flow Range for Each Structure and Number of TDG Measurements Yet to be Collected

Structure	Flow Ranges (cfs)	Remaining Number of Replicates
Dam 2 Spillway	1,700–6,900	4
	6,900–12,000	5
	12,000–17,200	5
Powerhouse 2	210–700	4
	700–1,200	5
	1,200–1,700	0
South HB Valve	While operating	2
North HB Valve	While operating	3
Diversion Dam	Whenever Powerhouse 2 or HB valve readings are taken	11
Lamprey Weir	Whenever Powerhouse 2 or HB valve readings are taken	11
Dam 1 Spillway	2,000–5,500	2
	5,500–8,900	5
	8,900–12,400	4
Powerhouse 1	800–1,200	5
	1,200–1,600	5
	1,600–2,000	0

[a]HB=Howell-Bunger

TDG levels greater than 110 percent saturation have only been measured once in the lower Bull Run River when the total river flow was less than the 7Q10 flow. This was at TDG-1L, a site that PWB added in 2011 as a replacement site for TDG-1. The spillway flow at this location had not yet had a chance to mix with water from Powerhouse 2 (see subsection 7.3 below).

TDG levels of greater than 110 percent saturation have been measured at five of the monitoring sites illustrated in Figures 1 and 2, when the total flow of the river was greater than the 7Q10 flow: the Dam 2 spillway on the right bank (TDG-1), the Dam 2 spillway on the left bank (TDG-1L), below the Dam 2 spillway plunge pool rock weir (TDG-1a), downstream of TDG-1a (TDG-2), and the Dam 1 spillway (TDG-11). The highest TDG level observed among these sites was 120 percent saturation at TDG-1L at a spillway flow of 10,611 cfs.

There is the potential for TDG levels to be greater than 110 percent saturation even if the flows are less than the 7Q10 amount. If the total river flow was under the 7Q10 flow for the sites and all flow went over the spillways at either Dam 1 or 2, the levels could be greater than 110 percent. The highest TDG level observed at these sites during *spillway* flows less than the 7Q10 flow has been 113 percent. On all of these occasions, however, a portion of the total flow of the river had passed through the Dam 1 and Dam 2 powerhouses and the combined flows exceeded the 7Q10 flow for the site.

Subsection 7.2 describes the spillway flow at which the 110 percent threshold is predicted to be exceeded in relationship to the 7Q10 flows for each spillway. Subsection 7.3 describes the calculated effects of mixing of spillway flows and powerhouse flows on TDG levels in the Bull Run River.

7.2 TDG/Spillway Flow Relationships

TDG saturation of at least 110 percent has been measured at two of the locations listed in Table 2, the spillways associated with Dam 1 and Dam 2. At the Dam 2 spillway, there was a relationship (R^2=0.98) between flow over the Dam 2 spillway and TDG measurements at the foot of the spillway (TDG-1L) prior to the removal of the rock weir. It was estimated that there was a window of spillway flows in which the threshold of 110 percent TDG saturation could have been exceeded without first exceeding the 7Q10 flow for this site. At the Dam 1 spillway, there is no clear relationship between TDG saturation and spillway flow.

Too few TDG measurements have been made at the Dam 2 spillway since the removal of the rock weir to evaluate the effect of the Dam 2 spillway on TDG levels under current conditions. Prior to the removal of the rock weir, the threshold of 110 percent TDG saturation was predicted to be exceeded at TDG-1L at a spill of approximately 3,740 cfs, as shown in Figure 3. This left a range of flows between 3,740 and 5,702 cfs for which this site had the potential for being in violation of ODEQ's TDG standards if all of the Bull Run flow were to pass over the spillway. The TDG level measured at this site in 2011 was higher than would have been predicted by the old relationship between TDG saturation and spillway flows.

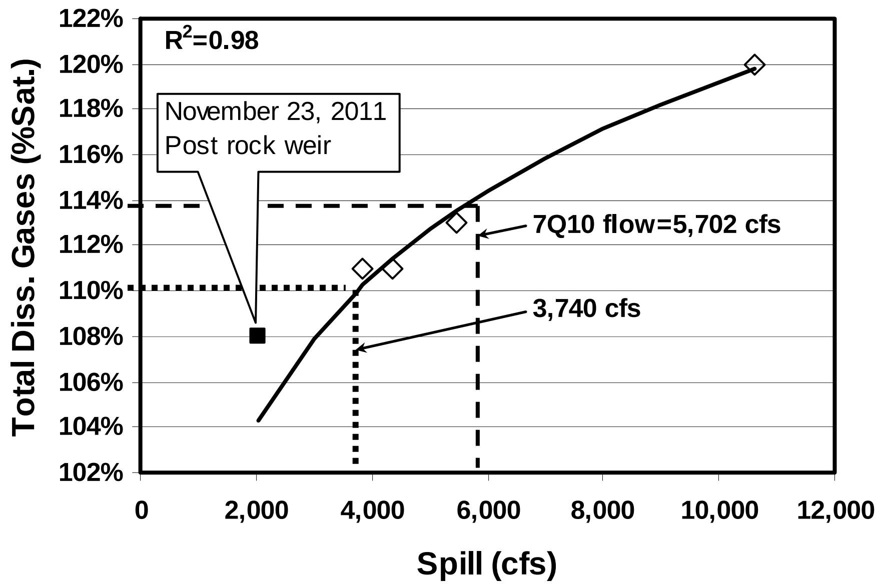

Figure 3. Relationship of TDG Percent Saturation to Flow over the Dam 2 Spillway (TDG-1L) Prior to Rock Weir Removal Compared to Post Rock Weir Removal Datum

There is no apparent relationship between flow over the Dam 1 spillway and TDG measurements, as shown in Figure 4. TDG values in excess of 110 percent saturation were measured twice in the Dam 1 spillway, at spillway flows of 2,177 cfs and 2,804 cfs. Spillway flows much higher than these (e.g., 10,158 cfs), however, resulted in TDG measurements below 110 percent. The large variation in TDG measurements at this site could result from the extreme water turbulence in the Dam 1 spillway, making it difficult to obtain a reliable measurement.

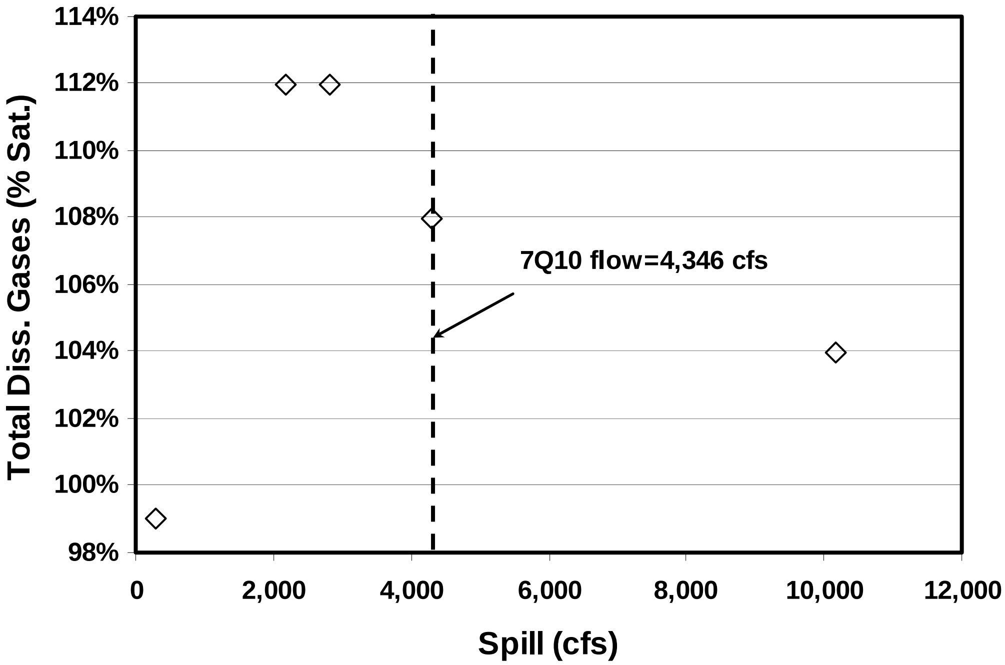

Figure 4. Relationship of TDG Percent Saturation to Flow over the Dam 1 Spillway (TDG-11)

7.3 Effects of Hydropower Water on TDG

The flows from Powerhouse 2, with their lower TDG levels, are expected to have a mitigating dilution effect on Dam 2 spillway flows, similar to what has occurred under previous conditions. Even though TDG levels have exceeded 110 percent at two Bull Run structures, monitoring data indicates that normal water supply operations prior to removal of the rock weir probably has reduced those concentrations through the mixing of powerhouse and spillway water at flows below the 7Q10. The Bull Run Dam 2 powerhouse diverts a maximum of 1,700 cfs for electricity generation. Typically, this powerhouse has operated at close to maximum capacity when flows in the Bull Run River are high enough to allow it. The diverted water downstream of Powerhouse 2 has an average TDG level of 103 percent saturation just before it mixes with water from the Dam 2 spillway. This diverted water has modified the TDG/flow relationships discussed in Section 7.2. Prior to the removal of the rock weir, when Powerhouse 2 was operating at full capacity, such as during high-flow events, the water that it diverted was calculated to decrease the TDG level of the combined flow (powerhouse + spillway) to 108.5 percent saturation at the 7Q10 flow, as shown in Figure 5. The TDG level of the combined flow was predicted to exceed 110 percent saturation above 6,481 cfs.

It is unclear how this relationship might change under current conditions, in the absence of the rock weir. The combined-flow TDG level calculated at this site in 2011 was higher than would have been predicted by the old relationship between TDG saturation and combined spillway and powerhouse flows. The relationship illustrated in Figure 5 will also change if Powerhouse 2 is operated at less than maximum capacity.

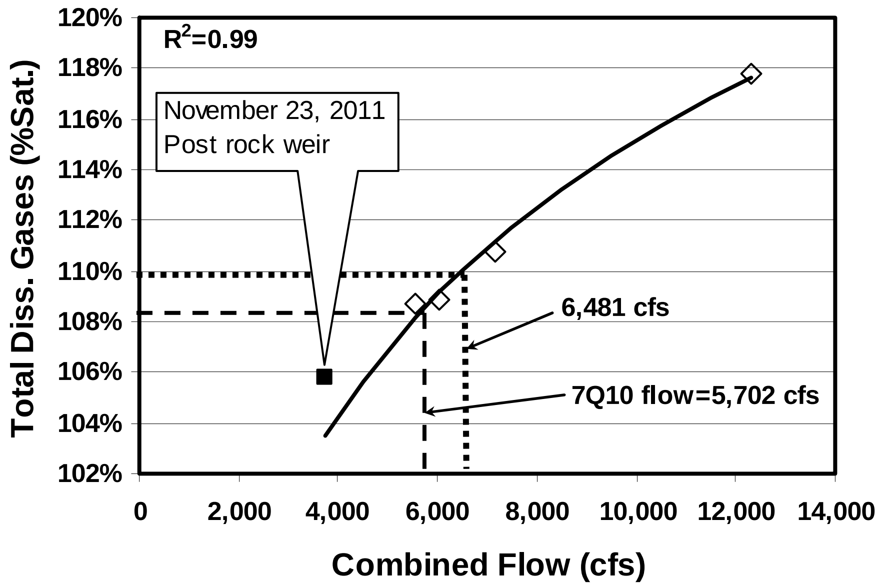

Figure 5. Relationship of TDG Percent Saturation to the Combined Flow of the Dam 2 Spillway and Powerhouse 2 Prior to Rock Weir Removal Compared to Post Rock Weir Removal Datum

The Bull Run Dam 1 powerhouse generally diverts a maximum of 2,300 cfs for electricity generation. Typically, this powerhouse operates at close to maximum capacity when flows in the Bull Run River are high enough to allow it. Diverted water in the tailrace of Powerhouse 1 has an average TDG level of 108 percent saturation. This diverted water modifies the TDG/flow relationships discussed in Section 7.2. When Powerhouse 1 is operating at full capacity, the calculated TDG levels of the combined powerhouse and spillway flows do not show any relationship to amount of flow, but no TDG levels above 110 percent are calculated to have occurred below the 7Q10 flow for the site, as indicated in Figure 6.

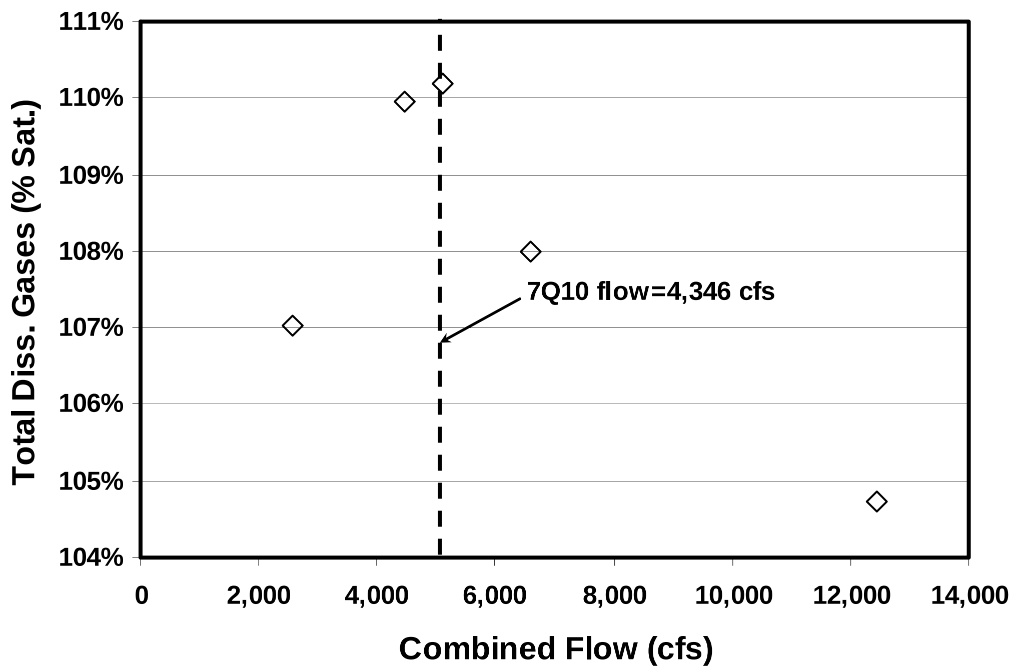

Figure 6. Relationship of TDG Percent Saturation to Combined Flow of the Dam 1 Spillway and Powerhouse 1

PWB does not have a good site to measure the TDG levels of fully mixed water at either the Dam 1 or the Dam 2 spillways, so PWB proposes monitoring both spillways and both powerhouses and calculating the TDG of the combined flows in the future. For Dam 1, the flows from the spillway and Powerhouse 1 do not appear to be fully mixed at TDG-10. An island in the middle of the river channel downstream of the Dam 1 spillway pool allows the flow from Powerhouse 1 and the adjacent spillway to remain separate until significant off-gassing is expected to have occurred. For the Dam 2 spillway, in the absence of the rock weir, flows from Powerhouse 2 and the spillway do not appear to mix fully until they have moved further downstream than TDG-2 and some off-gassing has occurred.

Because of these complications, PWB believes that the most meaningful way of estimating the initial TDG of the combined flows at both sites is to calculate TDG using the discharge amount and respective TDG measurements from each powerhouse and each spillway, just before they combine.

In 2012, PWB anticipates that TDG saturation of greater than 110 percent will occur at the Dam 2 spillway at flows below the 7Q10 flow due to construction on the intake tower for Powerhouse 2. All of the river's flow that is not withdrawn for municipal water use will pass over the Dam 2 spillway and into the lower Bull Run River without the moderating effects on flow provided by powerhouse flows. Under these conditions, PWB anticipates exceeding 110 percent TDG saturation at the base of the spillway above flows of 3,740 cfs. The 110 percent TDG threshold could be exceeded at even lower flows in the absence of the rock weir.

7.4 Downstream Dissipation of Elevated TDG

Under the terms of the HCP, PWB monitors the dissipation of TDG levels downstream of the Dam 2 spillway and rock weir structure due to off-gassing. Four flow levels—6,097 cfs (12/3/2007), 6,631 cfs (2/16/2007), 11,315 cfs (11/13/2008), and 15,508 cfs (11/7/2006)—have been monitored. All of the monitored flows were above the 7Q10 flow for the lower Bull Run River.

The natural log of TDG percent saturation above equilibrium (i.e., TDG percent saturation minus 100 percent) initially decreased roughly linearly with distance, as depicted in Figure 8. Table 4 summarizes the average distances downstream at which various elevated TDG levels are predicted to dissipate to 110 percent.

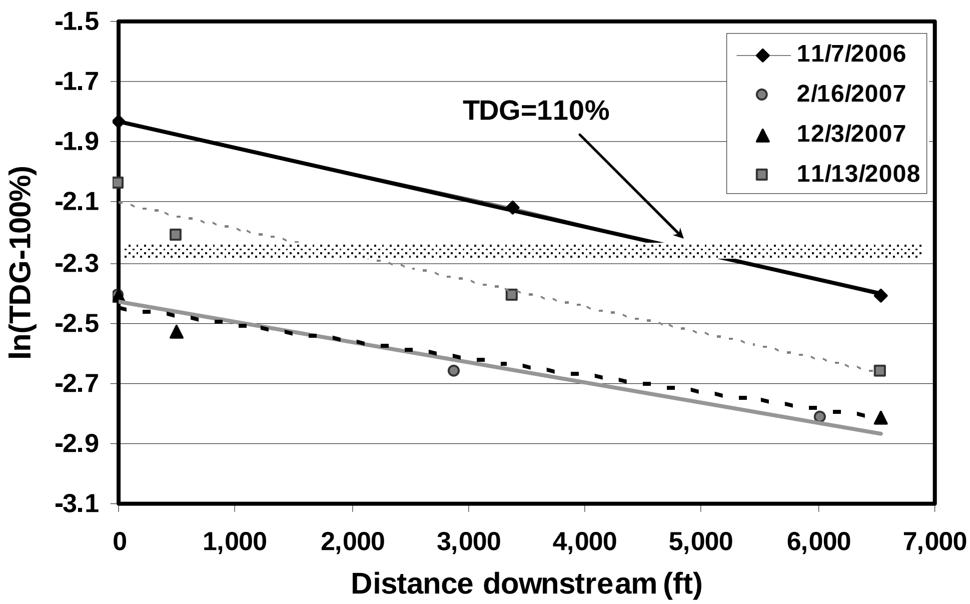

Figure 7. Dissipation of TDG Downstream of the Site of the Rock Weir at the Dam 2 Spillway Plunge Pool on Four Dates

Table 4. Average Distances Downstream at which Various Elevated TDG Levels Are Predicted to Dissipate to 110 Percent

Initial TDG Saturation (%)	Approximate Distance Downstream at which TDG Dissipates to 110%
115	4,800 feet
114	3,874 feet
113	2,880 feet
112	1,805 feet
111	637 feet

PWB will continue to monitor the dissipation of TDG levels downstream of the Dam 2 spillway. Future monitoring will focus on lower Bull Run River flows below the 7Q10 level.

8. Conclusions

The monitoring conclusions are organized based on the key questions presented in Section 4.

1. Do any of the monitoring sites exceed the ODEQ standard of 110 percent saturation of TDG?

There has been one observed exceedence of the ODEQ standard of 110 percent saturation of TDG at a monitoring site when the Bull Run River flows were below the 7Q10 flow for the respective sites. This occurred at a site where water with high TDG levels from the Dam 2 spillway had not yet mixed with water with lower TDG levels from Powerhouse 2. Four monitoring sites (TDG-1, TDG-1a, TDG-2, and TDG-11) have exceeded 110 percent saturation of TDG under higher-flow conditions.

2. At sites where elevated TDG levels exceeding 110 percent are observed, are there flow ranges associated with excessive TDG levels?

PWB is concerned about potential elevated TDG levels at the Dam 1 and 2 spillways under certain flow conditions below the 7Q10. This would occur if the powerhouse flows were cut off and the total river flow went over the spillways.

During normal high-flow conditions in the winter and spring, water is diverted from Reservoirs 1 and 2 and routed through the powerhouses at the base of the dams. If the total river flow is greater than the capacity of the powerhouses, the additional flow goes over the spillways. TDG levels at the Dam 1 and 2 spillway sites are normally reduced by mixing with powerhouse flows downstream of both the Dam 1 and 2 spillways. Powerhouse 2 will be off-line in 2012 for HCP-related modifications. During this period, the potential will exist for exceeding 110% TDG saturation at flows less than the 7Q10 at the base of the Dam 2 spillway.

In the absence of powerhouse flows and prior to the removal of the rock weir, TDG levels were predicted to exceed 110 percent saturation at the base of the Dam 2 spillway at a spillway flow above 3,740 cfs. Too few data exist to evaluate how this threshold flow may have changed since the removal of the rock weir, but the datum collected in 2011 suggests that 110 percent TDG saturation may be exceeded at a slightly lower spillway flow under current conditions.

There is no apparent relationship between spillway flow and TDG levels at the base of the Dam 1 spillway. TDG levels have exceeded 110 percent saturation at the base of the Dam 1 at flows of 2,177 cfs and 2,804 cfs, but higher flows than these have had lower measured levels of TDG.

3. How quickly do elevated levels of TDG dissipate downstream when they are observed?

If the TDG level is 111 to 115 percent of saturation below the site of the Dam 2 spillway plunge pool rock weir, it dissipates to less than 110 percent within 600 to 4,800 feet downstream on the lower Bull Run River. It should be noted that TDG saturation has not exceeded 110 percent below the site of the rock weir (TDG-1a) at total river flows below the 7Q10 flow for the site as of the end of 2011.

9. Work Cited

Portland Water Bureau. 2008. Bull Run Water Supply Habitat Conservation Plan for the Issuance of a Permit to Allow Incidental Take of Threatened and Endangered Species. Portland, Oregon

Exhibit A. TDG Data Associated with Bull Run Dams 1 and 2

Table A-1. Total Dissolved Gases (TDG) Data Associated with Bull Run Dam 2

Date	Monitoring Site	Percent Saturation	Spillway Flow[a] (cfs)	Powerhouse or HBV[b] Flow (cfs)
1/18/2005	TDG-1	107%	1,959	1,695
1/18/2005	TDG-1	108%	2,624	1,695
12/28/2005	TDG-1	111%	4,380	1,690
1/10/2006	TDG-1	116%	7,550	1,690
11/14/2006	TDG-1	103%	1,770	1,714
12/14/2006	TDG-1	107%	2,624	1,700
2/16/2007	TDG-1	112%	4,932	1,699
12/3/2007	TDG-1	111%	4268	1,690
11/13/2008	TDG-1	114%	7,897	1,560
11/13/2008	TDG-1	117%	9,568	1,560
11/23/2011	TDG-1	105%	2,042	1,585
12/29/2011	TDG-1	111%	3,274	1,596
12/14/2006	TDG-1L	111%	4,346	1,700
2/16/2007	TDG-1L	113%	5,464	1,684
12/3/2007	TDG-1L	111%	3,855	1,710
11/13/2008	TDG-1L	120%	10,611	1,560
11/23/2011	TDG-1L	108%	2,042	1,585
12/28/2005	TDG-1a	109%	4,380	1,690
11/7/2006	TDG-1a	116%	14,160	1,645
11/14/2006	TDG-1a	102%	1,717	1,714
12/14/2006	TDG-1a	103%	2,746	1,700
2/16/2007	TDG-1a	107%	4,932	1,699
12/3/2007	TDG-1a	109%	4,397	1,700
11/13/2008	TDG-1a	113%	7,766	1,560
11/13/2008	TDG-1a	114%	9,755	1,560
11/23/2011	TDG-1a	104%	1,959	1,585
12/29/2011	TDG-1a	109%	3,274	1,596
12/14/2006	TDG-1u	102%		1,700

Table A-1. Total Dissolved Gases (TDG) Data Associated with Bull Run Dam 2

Date	Monitoring Site	Percent Saturation	Spillway Flow[a] (cfs)	Powerhouse or HBV[b] Flow (cfs)
2/16/2007	TDG-1u	103%		1,699
12/3/2007	TDG-1u	103%		1,700
11/13/2008	TDG-1u	104%		1,560
11/23/2011	TDG-1u	105%		1,596
1/18/2005	TDG-2	104%	2,444	1,695
11/7/2006	TDG-2	112%	12,155	1,645
11/14/2006	TDG-2	101%	1,797	1,714
12/14/2006	TDG-2	104%	4,046	1,700
2/16/2007	TDG-2	109%	5,464	1,684
12/3/2007	TDG-2	108%	3,924	1,720
11/13/2008	TDG-2	115%	10,323	1,560
11/23/2011	TDG-2	105%	1,932	1,596
2/3/2005	TDG-3	103%		113 (HBV)
3/25/2008	TDG-3	103%		282 (HBV)
7/2/2008	TDG-3	106%		700 (HBV)
2/3/2005	TDG-4	102%		118 (HBV)
7/2/2008	TDG-4	107%		1,300 (HBV)
12/29/2004	TDG-5	102%		409
12/28/2005	TDG-5	102%		1,690
11/14/2006	TDG-5	100%		1,714
2/16/2007	TDG-5	101%		1,681
12/3/2007	TDG-5	100%		1,700
7/2/2008	TDG-5	109%		1,200
7/2/2008	TDG-5	108%		1,300
7/2/2008	TDG-5	108%		1,700
7/2/2008	TDG-5	108%		1,750
5/19/2005	TDG-6	104%		1,725
12/28/2005	TDG-6	102%		1,690
11/14/2006	TDG-6	100%		1,714
2/16/2007	TDG-6	101%		1,681
7/2/2008	TDG-6	107%		2,000 (HBV)

Table A-1. Total Dissolved Gases (TDG) Data Associated with Bull Run Dam 2

Date	Monitoring Site	Percent Saturation	Spillway Flow[a] (cfs)	Powerhouse or HBV[b] Flow (cfs)
7/2/2008	TDG-6	108%		1,820
5/19/2005	TDG-7	104%		1,725
11/14/2006	TDG-7	102%		1,714
7/2/2008	TDG-7	106%		1,820
12/28/2005	TDG-8	103%		1,690
11/14/2006	TDG-8	101%		1,714
2/16/2007	TDG-8	102%		1,681
12/3/2007	TDG-8	102%		1,700
7/2/2008	TDG-8	105%		2,000 (HBV)
11/14/2006	TDG-9	100%		1,714
2/16/2007	TDG-9	103%		1,699
12/3/2007	TDG-9	104%		1,700

[a]Blank space indicates that spillway flows are not applicable to this monitoring site.

[b]HBV: Howell Bunger Valve. If flow refers to HBV flow, then datum is labeled with (HBV).

Table A-2. Total Dissolved Gases (TDG) Data Associated with Bull Run Dam 1

Date	Monitoring Site	Percent Saturation	Spillway Flow (cfs)	Powerhouse Flow (cfs)
1/18/2005	TDG-10	104%	2,000	2,000
12/28/2005	TDG-10	108%	2,340	2,250
1/10/2006	TDG-10	109%	4,801	2,250
11/7/2006	TDG-10	109%	9,851	2,200
2/16/2007	TDG-10	107%	2,042	2,200
12/3/2007	TDG-10	107%	2,834	2,200
11/13/2008	TDG-10	108%	4,111	2,560
11/7/2006	TDG-11	104%	10,158	2,200
11/14/2006	TDG-11	99%	278	2,200
2/16/2007	TDG-11	112%	2,177	2,200
12/3/2007	TDG-11	112%	2,804	2,200
11/13/2008	TDG-11	108%	4,300	2,560
1/4/2005	TDG-12	103%	0	1,385
12/28/2005	TDG-12	108%	2,145	2,250

Table A-2. Total Dissolved Gases (TDG) Data Associated with Bull Run Dam 1

Date	Monitoring Site	Percent Saturation	Spillway Flow (cfs)	Powerhouse Flow (cfs)
11/7/2006	TDG-12	109%	9,667	2,200
11/14/2006	TDG-12	105%	278	2,200
2/16/2007	TDG-12	108%	2,062	2,200
12/3/2007	TDG-12	107%	2,822	2,200
11/13/2008	TDG-12	108%	4,286	2,560

Appendix D

Bull Run HCP Research Report

Lower Bull Run River Adult Chinook Population

March 2012

City of Portland Water Bureau

Contents

Tables

Figures

1. Summary

Regarding lower Bull Run River adult Chinook population research, the City of Portland Water Bureau (PWB) is in full compliance with its Bull Run Water Supply Habitat Conservation Plan (HCP; Portland Water Bureau 2008) obligations in 2011. Weekly surveys of spawning Chinook adults and redds were conducted in the lower Bull Run River from early September through early December. The surveyed portion of the lower Bull Run River was expanded by 0.2 mile in 2011 to include the entire lower river from its mouth to the base of the Bull Run diversion dam at Headworks (river mile [RM] 6.0). The peak adult Chinook count and minimum escapement estimate[1] were larger in 2011 than in any previous year since the removal of Marmot Dam in 2007. The cumulative redd count was also higher than it has been since 2007, despite the cancellation of two surveys in November due to high flows. This report summarizes the results of the 2011 lower Bull Run River adult Chinook population research.

2. Introduction

This section describes the results of surveys of spawning Chinook adults and redds in the lower Bull Run River. Both spring and fall runs of Chinook salmon may spawn in the lower Bull Run River.

The Oregon Department of Fish and Wildlife (ODFW) has conducted surveys of spring Chinook adults and redds in the Sandy River Basin by boat and on foot from 1996 to the present, and surveys on foot of fall Chinook adults and redds in index reaches in the lower Sandy River Basin from 1984 to 2004. These surveys, however, have not included the lower Bull Run River. ODFW conducted weekly surveys of spawning spring and fall Chinook salmon and redds in the lower Bull Run River (RM 0–RM 5.8) in 1997. PWB continued weekly surveys from RM 1.5 to RM 5.8 in 1998 and 1999. An index reach of the lower Bull Run River (RM 1.5–RM 3.7) was surveyed by PWB in 2005 and 2006. This index reach was expanded to include RM 0–RM 3.7 for surveys conducted from 2007 to 2009.

For HCP Years 1–20, PWB will conduct an annual count of spawning Chinook salmon and redds. The lower Bull Run River Chinook population research is designed to provide biologists with meaningful data within a 20-year time frame to evaluate the long-term trend in adult abundance for the Bull Run. The Bull Run data could then be used with information gathered by other agencies to determine the status of listed Sandy River Chinook populations.

[1] Escapement is the number of fish that avoid or escape all harvest and return to spawn at their home stream.

3. Research Objectives

In HCP Year 1 (calendar year 2010), PWB conducted a count of spawning Chinook salmon and redds in the lower Bull Run River from RM 0—RM 5.8. Starting in HCP Year 2 (2011) and continuing through HCP Year 20, PWB will conduct annual counts of spawning Chinook salmon and redds in the lower Bull Run River at RM 0–RM 6.0.

The objectives of the lower Bull Run River Chinook population research are to

- document use of the lower Bull Run River by spring and fall Chinook salmon.
- contribute to ODFW's annual assessment of spring Chinook in the Sandy River Basin.

4. Key Questions and Hypotheses

The key questions to be answered by the research are the following:

- How many Chinook salmon adults enter the Bull Run River to spawn each year? This key question does not have an associated null hypothesis (H_o).
- How many Chinook salmon redds are built in the Bull Run River each year? This key question has been added since PWB's adoption of the HCP and does not have an associated null hypothesis.
- What is the long-term trend (20 years) in spawning Chinook salmon abundance?

  H_o: The abundance of spawning Chinook salmon will not change significantly over the long term (20 years, α=0.05, β=0.20).

- What is the timing (range of dates and peak date) of adult Chinook presence and redd creation in the lower Bull Run River? This key question does not have an associated null hypothesis.
- What proportion of the spawning Chinook salmon are of hatchery origin?[2] This key question does not have an associated null hypothesis.

The City will also collect otolith,[2] tissue, and scale samples from adult carcasses found in the lower Bull Run River. The City will send the samples to ODFW to assist in ODFW's

[2] The protocols followed by PWB will provide the proportion of carcasses found with clipped adipose fins. The proportion of unclipped carcasses that are of hatchery origin will be provided by ODFW analysis of the otoliths. Otoliths are tiny bones that form a portion of a fish's inner ear. A fish lays down new bone material on the ototlith's edge as it grows, forming bands that record a fish growth rate through time. ODFW thermally "marks" otoliths in hatchery Chinook by exposing juvenile fish to varying water temperatures over time. As fish growth increases in warm water or decreases in cold water, characteristic banding patterns are created, which provide an indication of the fish origin (Schroeder et al. 2005).

assessment of spring Chinook in the Sandy River Basin. In return, PWB will receive information from ODFW about the proportion of unclipped Chinook salmon that are of hatchery origin, the relative number of spring and fall Chinook salmon in the lower Bull Run River, and the proportion of Chinook adults showing aspects of various life-history types.[3] The compilation of this information, however, depends on analyses conducted by ODFW and is therefore not reflected in the key questions.

5. Methods

The study design for the lower Bull Run River Chinook population research uses weekly surveys to count live Chinook adults, Chinook salmon carcasses, and newly created redds. The surveys are coordinated with the cooperation of the operators at Headworks and the Portland General Electric (PGE) powerhouses at Bull Run Dam 1 and Dam 2 to maintain flows of 150 cubic feet per second (cfs) or less above the Little Sandy confluence for the duration of each survey. This is the level of flow necessary for safety and for accurate counts. The HCP allows for departures from minimum flow criteria in the lower Bull Run River (Measures F-1 and F-2) to make Chinook spawning surveys possible.

5.1 Spatial Scale

The lower Bull Run River was divided into the following reaches to provide greater spatial resolution of counts than a simple count of the entire river would provide and to reflect the reaches used in previous surveys for comparison:

Reach 1: The confluence of the Bull Run River with the Sandy River to the upstream end of the large pool adjacent to the Bull Run PGE Powerhouse (RM 0–RM 1.5)

Reach 2: The upstream end of the large pool adjacent to the Bull Run PGE Powerhouse to Bowman's Bridge (RM 1.5–RM 2.3)

Reach 3: Bowman's Bridge to the upstream end of the pool at the confluence with the Little Sandy River (RM 2.3–RM 2.8)

Reach 4: The upstream end of the Little Sandy River confluence pool to the upstream end of the pool at Larson's Bridge (RM 2.8–RM 3.7)

Reach 5: The upstream end of the pool at Larson's Bridge to the Road 14 bridge (RM 3.7–RM 4.8)

[3] A Chinook salmon's life history type is defined by when, where, and how it lives over the course of its lifetime. This includes the number of years that it spent in freshwater and in saltwater before returning to freshwater to spawn.

Reach 6: The Road 14 bridge to the Headworks diversion dam (RM 4.8—RM 6.0). In 2010, this reach ended at RM 5.8 at the Reservoir 2 plunge pool rock weir. In 2011, this weir was removed and this reach was expanded to RM 6.0.

These reaches correspond to those used for the HCP Chinook spawning gravel research. Reaches 2, 3, and 4 are also the reaches used in previous Chinook spawning surveys conducted by ODFW and PWB. Reach 4 also corresponds to one of ODFW's probabilistic, randomly selected reaches for the Sandy River Basin steelhead and coho spawning surveys and snorkel surveys. Reaches 5 and 6 were not believed to be used by spawning Chinook salmon prior to 2011. These reaches were surveyed twice in 2010 to confirm whether they were being used; in all, only one spawning coho salmon was observed. Based on this result, in 2011, Reaches 5 and 6 were surveyed every week after October 1. They were not surveyed earlier in the year because low summer flows make it very unlikely that salmon would be able to pass Larson's Falls at RM 3.7. (Flows generally begin increasing with the autumn rains in October, making it possible, though difficult, for salmon to pass Larson's Falls.)

Adult and redd abundance and timing information is summarized at the reach scale. The proportion of hatchery fish is summarized at the scale of the entire lower Bull Run River.

5.2 Replication/Duration

The City is contributing funds for annual surveys of spawning Chinook salmon and redds. These funds will support Chinook population research in the lower Bull Run River for the first 20 years of the HCP.

Weekly surveys in 2011 were conducted from early September through early December. There was no spatial replication, because the entire channel was surveyed.

5.3 Parameters

The following information and samples were collected during each survey.

- Live Adults
  - Number of adults and number of jacks
  - Species
  - Reach
  - Additional behavioral information (e.g., spawning, defending a redd)
- Carcasses
  - Species
  - Reach

  - Length (both total length from the snout-tip to the fork of the tail and the middle of the eye to posterior scale (MEPS) length, in millimeters)
  - Sex
    - If a female, whether it died before spawning
  - Presence of adipose fin
    - If no adipose fin, whether it has coded-wire tags (CWT). If CWT were present, researchers collected the snout.
    - If an adipose fin was present, researchers collected
      - an otolith sample (for ODFW determination of hatchery origin)
      - a tissue sample (for National Marine Fisheries Service distinction of spring from fall Chinook)
      - a scale sample (for ODFW determination of age and life history)
  - Additional information (e.g., whether the individual appeared to be eaten by scavengers or was found in the riparian zone)
- Redds
  - Reach
  - Species (researchers assumed the individual was Chinook unless another species was seen creating or defending it)
  - Size (length x width, in square feet)
  - Substrate size range (visual estimate of the range from approximately the 10th to the 90th percentile of substrate sizes, in inches)[4]
  - Channel feature retaining the gravel patch (e.g., whether the redd is a behind boulder or bedrock, a pool-tail or riffle margin)
  - Evidence of superimposition over a previous redd
- Environmental data
  - Weather (description)
  - Water clarity/visibility
  - Flow (determined from U.S. Geological Survey (USGS) Gage No. 14140000)

[4] Substrate sizes are discussed in the HCP, Appendix F. The HCP is available on the PWB web site at www.portlandonline.com/water/index.cfm?c=46157.

5.4 Sampling

Sampling methods have been altered slightly from those proposed in the HCP. The City intended to conduct spawning surveys by walking the river channel in flows of up to 150 cfs. This was regarded as the maximum flow that would still allow for safe navigation by surveyors on foot, wearing waders. Between flows of 150 and 500 cfs, PWB intended to survey while floating the river with kayaks. An initial trial run with kayaks conducted by PWB before 2010 at 400 cfs, however, convinced PWB that this method would not produce reliable data and was not a safe survey approach.

Instead, surveys were conducted by two observers walking downstream on each side of the channel. Between flows of 150 and 400 cfs (which included contributions from the Little Sandy River) surveyors wore drysuits and life vests. This enabled them to safely swim through otherwise impassable areas. If flows (of the Bull Run River and Little Sandy River combined) could not be maintained below 400 cfs, then surveys were cancelled.

Live adults and jacks were counted and their location recorded. Any carcasses that were found with an intact tail were counted. All carcasses that could be retrieved were measured and their sex was recorded. Females were opened to check for eggs, which would determine whether they died before spawning. All carcasses were checked for the presence of an adipose fin. Carcasses with adipose fins were sampled for otoliths, tissue, and scales before October 15, corresponding to an approximate date used by ODFW to distinguish between spring and fall Chinook. ODFW has an interest only in samples collected from the earlier, spring-run fish. After October 15, only tissue samples were collected from Chinook carcasses with adipose fins.

Redds were counted and their locations recorded. The approximate area of each redd and the size of its substrate were visually estimated. Once these and other data had been collected, each redd was marked with a flag with the date attached to the bank adjacent to the redd. The following week, if there were no signs of adult fish that could still be building the redd, a painted rock comparable in size to those comprising the redd was placed on the redd . The painted rock helped distinguish new redds from old ones. Painted rocks from previous surveys that had been dislodged or buried indicated that further spawning activity had occurred at that location. The flag on the bank aided in confirming the presence of an old redd if the painted rock was missing. If live adults were still observed on or near a redd after two weeks, it was assumed that a new redd was in the process of being built superimposed on the old redd. No rock was placed, but the bank was flagged. If no adults were observed the following week, a rock was placed at that time and a note of it was made.

6. Analysis

Data Storage: Monitoring data collected during the HCP was entered by PWB in a Microsoft® Access database, which also contains data from previous years' surveys.

Hypothesis Testing: The number and timing of Chinook salmon in the lower Bull Run in a given year were compared to the number and timing of Chinook salmon in other years. Individual years were not compared statistically, however, because of the lack of replication.

The trend in peak spawner count (live + dead fish on a given date) and minimum escapement estimate (peak count of live fish on a given date plus cumulative carcass count up to and including that date) was calculated for all surveys to-date using linear regression (α=0.05).

The proportion of hatchery fish in the lower Bull Run in a given year was compared to the proportion of hatchery fish in other years. Individual years were not compared statistically, however, because of the lack of replication.

7. Results and Discussion

7.1 Surveys

A total of 13 weekly surveys were conducted in 2011 between September 1 and December 7. Surveys were cancelled due to high flows during the weeks of November 17 and 24. Figure 1 shows the flows in the lower Bull Run River above and below the Little Sandy River throughout the Chinook spawning season.

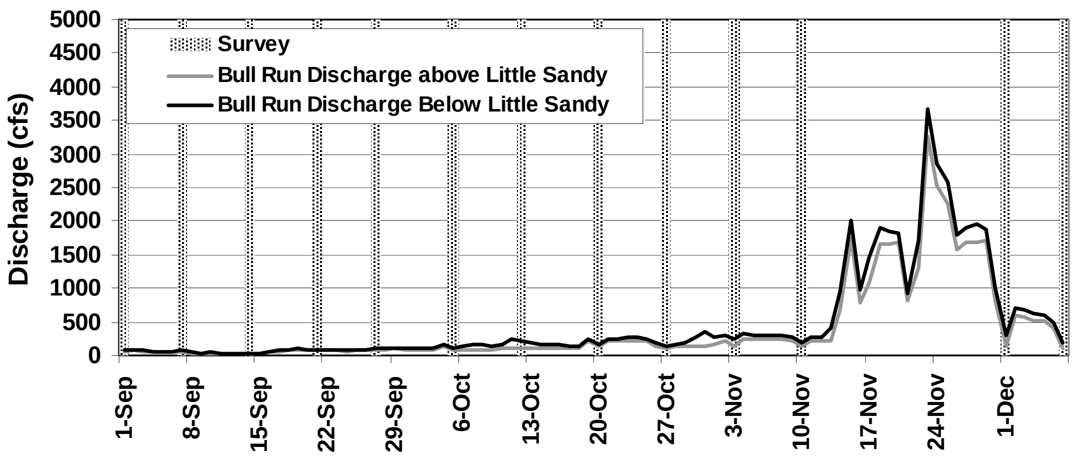

Figure 1. Bull Run River Discharge Above and Below the Little Sandy Confluence and Dates of Chinook Spawning Surveys

7.2 Live Adults

7.2.1 Peak Counts and Minimum Escapement Estimates

Both peak counts and minimum escapement estimates for Chinook salmon in the lower Bull Run River were higher in 2011 than in any previous year since the removal of Marmot Dam and the decommissioning of the PGE Bull Run Hydroelectric Project in 2007, as indicated in Table 1.

Table 1. Summary Statistics for Chinook Spawning Runs in the Lower Bull Run River, 2007—2011

Year	Peak Count	Minimum Escapement	Cumulative Redd Count	% Hatchery (n)[b]	% Female (n)
2011	84	99	94	43.1% (72)	54.7% (75)
2010	70	77	43	36.8% (19)	75.0% (16)
2009	61	70	89	11.8% (34)	52.9% (34)
2008	31	38	37	11.5% (26)	73.1% (26)
2007	34	39	62	41.7% (12)	76.9% (13)

[a]Includes peak count, minimum escapement estimate, percent of identifiable carcasses with clipped adipose fins (n=number of carcasses where the state of the adipose fin could be determined), and percent of identifiable carcasses that were female (n=number of carcasses where the sex could be determined).

[b]Fish with clipped adipose fins. A small portion of unclipped fish may also be of hatchery origin.

Peak counts continue to be lower, on average, than they had been prior to the Marmot Dam removal in 2007 (t-test$_{\text{one-tailed}}$, p=0.01, df=9), as indicated in Figure 2, but with a large amount of variation. The average peak count prior to removal was 129 (±133 95% confidence interval). In the years after decommissioning, the average has been 56 (±45), but with a significantly increasing trend (p=0.01).

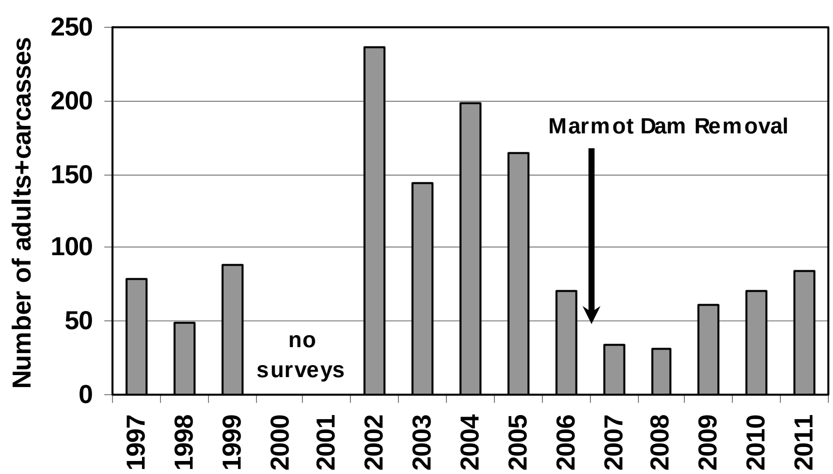

Figure 2. Chinook Salmon Peak Counts for All Years when Surveys Were Conducted

Prior to the removal of Marmot Dam, adult Chinook counts in the Bull Run River reflected trends in the greater Sandy River Basin. Marmot Dam diverted Sandy River water to the adjacent Little Sandy River Basin, where it was further diverted by way of Roselyn Lake to the Bull Run River at RM 1.5. Following chemical cues in the water, a portion of adult Chinook salmon intent on returning to their natal streams in the upper Sandy River Basin apparently strayed into the Bull Run River by mistake. During these years, lower Bull Run adult Chinook peak counts showed a significant positive correlation (R^2=0.715, p=0.008) with the estimated spring Chinook run size upstream of Marmot Dam (Sandy spring Chinook data from ODFW; Kirk Schroeder, pers. comm. See Figure 3). As soon as Marmot Dam stopped diverting Sandy River water into the Bull Run River, adult Chinook peak counts declined dramatically (see Figure 2).

The increases in adult Chinook counts observed in the lower Bull Run River since 2007 do not reflect an increasing trend in that time period throughout the greater Sandy River Basin (Figure 3). After the removal of Marmot Dam, there has been no significant correlation (R^2=0.0367, p=0.758). There has also been no positive correlation between lower Bull Run adult Chinook peak counts and fall Chinook escapement estimates in the Sandy River since 2007 ($Regression_{2007-2010}$, slope=-0.032, R^2=0.145, p=0.340; a fall Chinook escapement estimate was not ready as of the writing of this report. Sandy fall Chinook data from ODFW, Tanna Takata, pers. comm.). The positive trend in adult Chinook counts observed in the lower Bull Run River since the removal of Marmot Dam is therefore independent of broader Sandy River Basin trends.

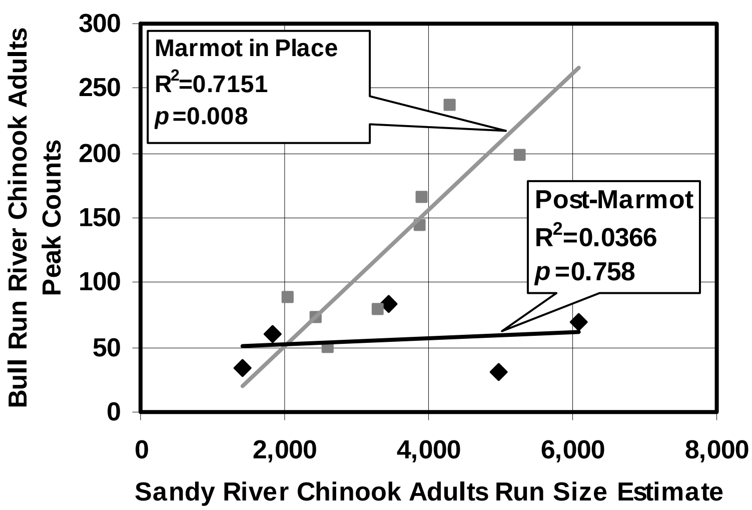

Figure 3. Relationship of Peak Counts of Adult Chinook in the Lower Bull Run River with Estimated Run Size of Spring Chinook in the Upper Sandy River Basin, Before and After the Removal of Marmot Dam

It is unclear whether the observed trend is due to the removal of Marmot Dam, efforts by PWB to improve habitat conditions in the lower Bull Run River, chance, or a combination of all three. The removal of Marmot Dam might benefit fish in the lower Bull Run River directly and/or indirectly. Halting the input of glacially turbid Sandy River water to the Bull Run River could have directly improved rearing conditions in the lower 1.5 miles of the stream. The removal of Sandy River water as an attractant to migrating Chinook adults bound for the upper Sandy River basin could have indirectly benefited Chinook that intentionally returned to the Bull Run River by allowing them to genetically adapt as a run to its unique environment without constant genetic dilution from straying fish. PWB has also improved habitat in the lower Bull Run River by providing cool minimum stream flows in the summer and fall, adding spawning gravel to the channel, and avoiding rapid downramping of flows. Only five years have passed, however, since the removal of Marmot Dam. Additional years of Chinook spawner counts will show whether or not the observed increase is due to unlikely coincidence or restoration efforts.

7.2.2 Timing

Adult Chinook salmon were observed in the Bull Run River between September 14 and December 1. As Table 2 documents, both the peak fish count and peak redd count date of the highest minimum escapement estimate were in early October, earlier than what has been observed in previous years. This may reflect a spring Chinook run that was large relative to the fall Chinook run. Limited genetic testing has confirmed the presence of both runs in the Bull Run River (City of Portland, unpublished data), but not enough individual fish have been tested throughout the season to adequately describe the respective timing of the two runs and their degree of overlap. Generally, the end of October is considered the time when fall Chinook begin to predominate in the lower Bull Run River.

Table 2. Timing of Adult Chinook Peak Counts, Highest Minimum Escapement Estimate, and Peak Redd Count, 2007–2011

Year	Peak Count	Highest Minimum Escapement	Peak Redd Count
2011	Oct. 5	Nov. 10	Oct. 5
2010	Oct. 20	Oct. 20	Oct. 20
2009	Oct. 21	Oct. 21	Oct. 21
2008	Oct. 22	Oct. 29	Oct. 15 & 22
2007	Oct. 24	Oct. 24	Oct. 18

Very few Chinook adults appeared to hold in the Bull Run River during the summer, as indicated in Figure 4. This is in contrast to years prior to the decommissioning of the Marmot Dam and the PGE Bull Run Hydroelectric Project (Portland 2005 and 2006).

Large numbers of Chinook salmon adults once held every year through the summer in the large pool at the upstream end of Reach 4 and downstream of Larson's Falls.

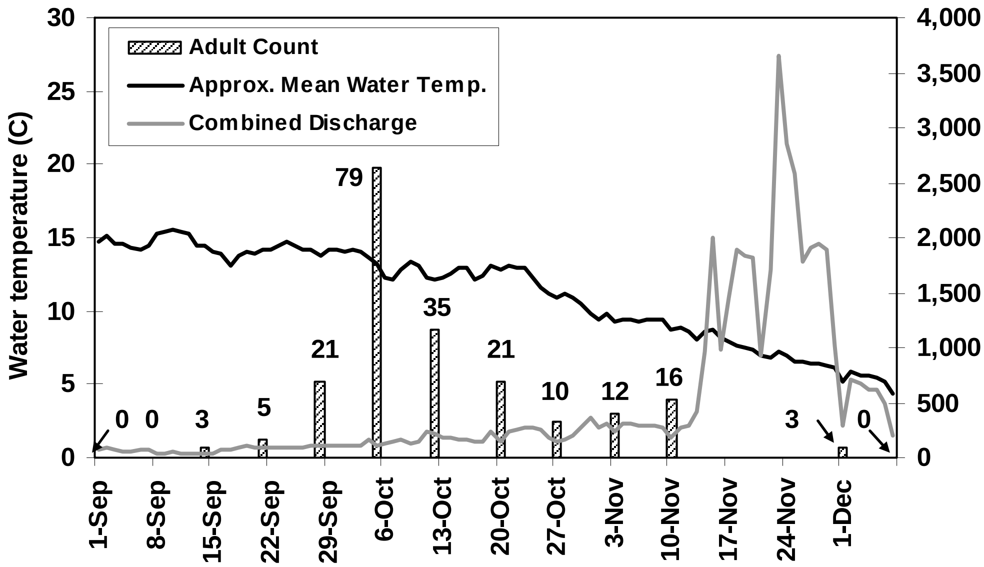

Figure 4. Environmental Variables[a] that May Be Useful in Explaining Chinook Salmon Run Timing in the Lower Bull Run River

[a]Includes the estimated mean daily water temperature near the mouth and discharge near the mouth.

Neither discharge nor water temperature appeared to explain the timing of movement of adult Chinook into the Bull Run River (Figure 3). A sharp increase in adult counts occurred between September 29 and October 5, after a small increase in discharge and a small drop in water temperature. Other increases in flow or declines in water temperature were not accompanied by increases in fish counts. The discharge values used were the combination of discharges measured at USGS Gage No. 1414000 (Bull Run) and Gage No. 14141500 (Little Sandy). The approximate mean daily water temperature used was the discharge-weighted average of water temperatures measured at the USGS Gage No. 1414000 (Bull Run) and Gage No. 14141500 (Little Sandy).

7.3 Redds

7.3.1 Cumulative Count

The cumulative Chinook salmon redd count in the lower Bull Run River was the highest that it has been since Marmot Dam was removed in 2007 (Table 1). This corresponds with the relatively high peak adult count. It is probable that a certain amount of redd building was missed in 2011 because of high flows. Surveys had to be cancelled two weeks in a row in November because flows were too high. This period occurred while the number of Chinook in the river appeared to be increasing slightly. When surveys resumed on December 1, the high flows had scoured away most evidence of redd construction during the intervening weeks.

7.3.2 Timing

Chinook salmon redds were observed in the Bull Run River between September 28 and November 10. The date of the peak Chinook redd count was October 5, two weeks before the period of peak redd counts (October 20-November 3). Figure 5 summarizes the timing of redd construction and compares it to the timing of adults observed in the lower Bull Run River. Fish that first entered the Bull Run River early in the season appeared to delay spawning by at least two weeks. By mid-October, however, fish apparently were spawning as soon as they entered the river. Figure 4 also includes the cumulative redd count.

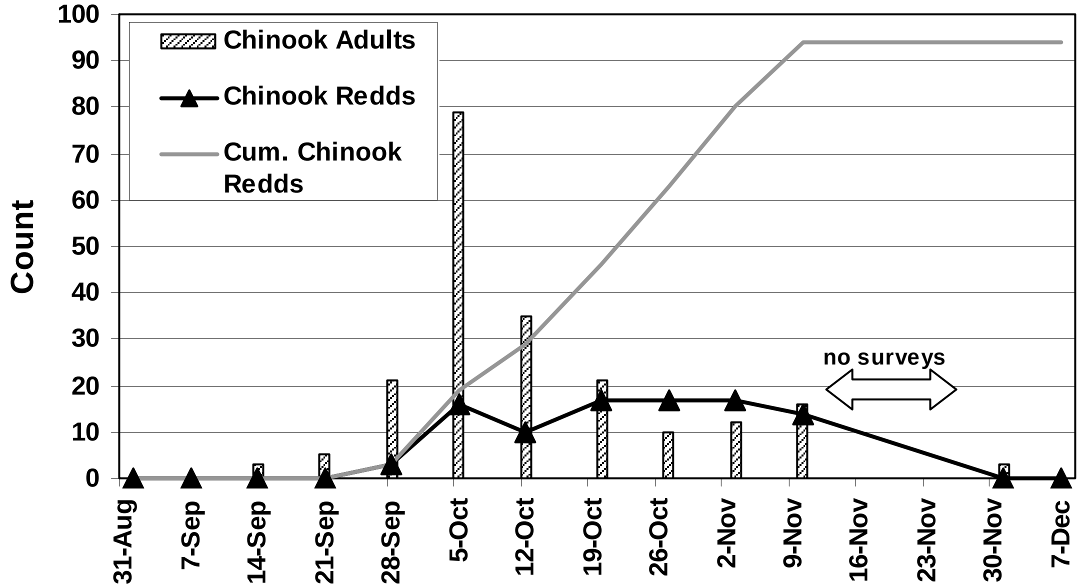

Figure 5. Comparison of the Timing of the Presence of Adult Chinook Salmon and the Construction of Redds in 2011

7.4 Carcasses

7.4.1 Hatchery Fish

The percentage of Chinook spawning in the lower Bull Run River in 2011 that were of hatchery origin is the largest ever observed. A total of 87 Chinook salmon carcasses were found in the lower Bull Run River over the course of the 2011 survey season. Of this total, 72 carcasses were intact enough to discern the condition of the adipose fin. Of the 72 carcasses, about 43.1 percent had clipped adipose fins. The previous highest percentage of hatchery fish was 41.7 percent in 2007 (Table 1).

The actual percentage of hatchery fish may have been higher than 43.1 percent. Some Chinook have inadequately clipped adipose fins or their fins grow back. For this reason, ODFW collects otolith samples from spring Chinook salmon carcasses with adipose fins. The percentage of unclipped fish that are of hatchery origin can be determined from the growth structure of these otoliths. The percentage of unclipped Chinook salmon carcasses that were of hatchery origin in the Bull Run River was not available at the writing of this report.

7.4.2 Sex Ratio

There were almost equal numbers of females and males in the lower Bull Run River in 2011. Of the 87 carcasses observed in the river in 2011, 75 were intact enough to determine their sex. Of these 75, 54.7 percent were female. Only 2009 had a lower percentage of females, 52.9 percent.

Females tend to make up a larger percentage of carcasses recovered in the lower Bull Run River. Their percentage has ranged between 52.9 percent and 76.9 percent. The reason for this observed asymmetry is unknown. It may reflect actual difference between the sexes or differences in the detectability of their carcasses. Females, for instance, appear to remain near their redds for longer periods of time than males, and they may die, on average, in shallower water where they are more readily found by surveyors. Actual differences in sex ratio can arise through differences between the sexes in pre-spawning survival, life-history differences, or other factors such as gender-reversal (Olsen et al. 2006).

Differences in marine survival can come about due to differences in, for instance, size, which in turn can influence susceptibility to predation or harvest. No differences in size, however, were observed between male and female middle eye to posterior scale (MEPS) lengths in the Bull Run River in 2011 (66.9 and 66.4 centimeters, respectively).

Life-history differences can, in theory, lead to differences in sex ratio if, for example, a significant number of one gender return at a different age than the other. A portion of male Chinook salmon return to spawn after only one year in the ocean. These are called jacks. Only two jacks were observed in the Bull Run River in 2011, both carcasses whose lengths were not included in the above comparison of male and female lengths. The number of jacks observed in the past have also been low, but this may reflect detectability. Jacks are much smaller than adult salmon and would be harder to observe by surveyors.

Gender-reversal, generally male to female, can occur when developing embryos are exposed to high water temperatures or estrogen-imitating chemicals in the environment

(Olsen et al. 2006). The possible role of either of these factors in influencing the Chinook salmon sex ratio in the Bull Run River cannot be evaluated with current data.

It is also possible that the biased sex ratios observed in the past few years in the Bull Run River is entirely due to chance, given the relatively small sample sizes.

8. Findings and Conclusions

The findings and conclusions directly address the key questions posed in Section 4.0:

- **How many Chinook salmon adults enter the Bull Run River to spawn each year?**

  At least 99 adult Chinook salmon returned to the Bull Run River to spawn in 2011. The peak daily count of live adults plus carcasses was 84.

- **How many Chinook salmon redds are built in the Bull Run River each year?**

  A total of 94 Chinook redds were identified in the Bull Run River in 2011.

- **What is the long-term trend (20 years) in spawning Chinook salmon abundance?**

  The long-term (20 year) trend in spawning Chinook salmon abundance will be calculated in 2028. Since the Marmot Dam removal in 2007, the number of spawning Chinook salmon has been increasing in the lower Bull Run River. This short term trend is significant (p=0.01).

- **What is the timing (range of dates and peak date) of adult Chinook presence and redd creation in the lower Bull Run River?**

  Live adult Chinook salmon were observed in the Bull Run River between September 14 and December 1, 2011. The peak date was October 5, 2011. Chinook redds were observed between September 28 and November 10, 2011. High river flows prevented adult and redd counts between November 10 and December 1.

- **What proportion of the spawning Chinook salmon are of hatchery origin (clipped adipose fin)?**

  In 2011, the proportion of hatchery (clipped adipose fin) fish among the observed Chinook salmon carcasses where the condition of the adipose fin could be determined was 0.43. The proportion of hatchery fish has ranged from 0.12 to 0.43 since 2007.

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Appendix E. Sandy River Basin Smolt Monitoring

2011

January 25, 2012

Burke Strobel, Portland Water Bureau

Photo (left) of Mount Hood and Sandy River provided by Josh Kling/Western Rivers Conservancy

Photo (right) of rotary smolt trap provided by the Portland Water Bureau.

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1. Summary

The Portland Water Bureau and the U.S. Forest Service collaborated in 2011 to continue a long-term, 50-year study monitoring steelhead and coho smolt production throughout the Sandy River Basin in Oregon. The study, initiated in 2009, is intended to detect declines or increases in abundance and productivity of smolts at the basin scale and to provide useful data at the scale of individual tributaries to guide restoration efforts. The sampling design involves monitoring different sets of tributaries every year. Some tributaries are monitored every year; others are monitored on an irregularly rotating basis. The study is intended to provide basin-scale trends after 20 years.

The late issuance of a scientific take permit delayed the initiation of smolt monitoring in 2011. A large but unknown portion of the smolt outmigration was missed on all streams. Improved protocols, however, led to increased precision of estimates for the actual monitored portion of the run compared to previous years, especially in the Bull Run River.

Smolt numbers, fork length, condition factors, and emigration timing were monitored using rotary smolt traps in six streams. A technique was developed to expand population estimates to the full emigration season. Provisional population estimates were calculated for steelhead and coho smolts in four streams. No estimates were generated for the remaining two streams and species because captures were very low or nonexistent. In some cases, actual captures can be used for future trend analysis. Estimates will be refined with the addition of future data.

The mean fork length of smolts may be related to water temperature regimes of their respective streams. Coho and steelhead fork lengths correlated with accumulated thermal units[1] for the previous summer.

Steelhead and coho smolts from different streams in the Sandy River Basin showed significant differences in mean condition factors. The streams with smolts having the longest and shortest weighted mean fork lengths generally had the lowest and highest condition factors, respectively.

Steelhead and coho smolts appeared to generally emigrate earlier in the year in lower-elevation streams than in high elevation streams, but the analysis of emigration data was confounded by the late start of trapping.

[1] One ATU equals one degree Celsius of average daily temperature. Two days of 7 degrees mean daily water temperature, for example, would result in 14 ATUs.

2. Introduction

2.1 Background

The Portland Water Bureau (PWB) and the Mt. Hood National Forest (U.S. Forest Service [USFS]) collaborated in 2011 to continue a long-term study, monitoring steelhead and coho smolt production throughout the Sandy River Basin in Oregon. The Sandy River enters the lower Columbia River just east of Portland, Oregon, and includes several large tributaries—the Bull Run, Salmon, and Zigzag rivers—as well as many smaller tributaries such as Beaver, Cedar, Clear, Gordon, and Lost creeks, and the Clear Fork Sandy River.

Smolt monitoring has been conducted in various Sandy River tributaries in the past. The USFS has monitored smolt production continuously in Still Creek, a tributary of the Zigzag River, since 1994 and sporadically in the Clear Fork Sandy River, Lost Creek, and the Salmon River. The purpose of these efforts originally included monitoring the benefits of stream restoration projects and, more recently, supporting efforts to evaluate the effects of the removal of Marmot Dam in 2007. The USFS also operated a smolt trap on the Little Sandy River in 2007 and 2008, upstream of a diversion dam operated as part of Portland General Electric's Bull Run Hydroelectric Project. The Portland Water Bureau has operated a smolt trap in the Bull Run River near its mouth since 2007 and assumed the management of the Little Sandy trap in 2009.

Two related factors led to an expansion of salmonid smolt monitoring in the Sandy River Basin, beginning in 2009. The first was the formation of the Sandy River Basin Partners in 1999— a group intended to coordinate the fish and fish habitat management efforts of various agencies and groups. This coordination led to a broadening of the monitoring focus to better correspond with an emerging holistic approach to watershed restoration and to mesh with other programs that collect biological information at a basin scale. The second factor was that PWB created a Habitat Conservation Plan (HCP; PWB 2008) in 2008 to bring its municipal water supply operations in the Bull Run River into compliance with the Endangered Species Act.[2] Among the many measures detailed in the HCP is a commitment to contribute resources toward smolt monitoring in the Sandy River Basin.

Monitoring smolt production can benefit a number of management efforts on many spatial scales, including viability analyses and adaptive restoration. Given limited resources, however, managers face potential tradeoffs between collecting smolt information that is meaningful at the population scale (e.g., enumerating smolts at the mouths of large rivers) and collecting smolt information at a scale that is most meaningful to individual restoration efforts (e.g., enumerating smolts in tributaries). The

[2] To learn more about the HCP, visit www.portlandonline.com/water/index.cfm?c=46157.

sampling plan adopted by the monitoring subgroup of the Sandy River Basin Partners is intended to provide information at both scales in order to maximize the usefulness of the data-collection effort, and is summarized in the HCP Appendix F (PWB 2008).

2.2 Goal and Objectives

The goal of the Sandy River smolt monitoring project is to contribute to the viability assessment of salmonid stocks in the Sandy River Basin and support their adaptive management. The objectives of the Sandy River smolt monitoring project are to

- collect information to assess the long-term (20-year) trend in steelhead and coho smolt populations for as much of the Sandy River Basin as possible (population scale),
- collect information to assess the long-term (20-year) trend in steelhead and coho smolt populations at the scale of individual tributaries (tributary scale),
- evaluate steelhead and coho smolt production of individual tributaries relative to one another (tributary scale),
- evaluate steelhead and coho smolt physical quality from individual tributaries relative to one another (tributary scale), and
- determine the values of various life-history characteristics at the scale of individual tributaries in the Sandy River Basin (tributary scale).

The proximate objectives each year will be to determine the values for the following variables for each stream that is trapped:

- Smolt population (for every salmonid species possible)
- Mean fork length (by species)
- Mean condition factor ((weight/(fork length^3))×100,000)
- Mean date of emigration (by species)

2.3 Sample Area and Scope

2.3.1 Study Area

The portions of the Sandy River Basin that are accessible to anadromous fish include approximately 190 miles of streams and rivers spanning a wide range of environments from cold, high-elevation, high-gradient streams in wilderness areas to warm, low-gradient, and tidally influenced streams within the Portland urban growth boundary, as indicated in Figure 1. About 30 percent of these stream miles are influenced by glacial runoff, often with high turbidity.

2.3.2 Sample Area

Not all of the Sandy River Basin that is accessible to anadromous fish is included in the sample area. Streams selected for smolt sampling total 106 miles, or 56 percent of the total habitat in the Sandy River accessible to anadromous fish. Over 80 percent of the clear water stream miles are included. Clear water streams are streams not influenced by glacial runoff. These are the streams expected to contribute most to total smolt production, due to the suitability of spawning habitat (Suring et al. 2006) and relatively greater primary productivity and ease of locating prey. The remaining clear water streams are generally small, have relatively high gradients, and are not expected to produce a large number of salmon or steelhead smolts. This sample area covers nearly the full range of environmental conditions that salmon and steelhead encounter in the Sandy River Basin and is considered by the Sandy River Basin Partners monitoring group to constitute a representative index for the entire basin for steelhead and coho. It also closely corresponds with the area for which steelhead and coho spawner counts are developed annually by the Oregon Department of Fish and Wildlife (ODFW; Suring et al. 2006; Hutchinson et al. 2007). The products of this effort will eventually be applicable to the entire basin. Information that is collected will be immediately applicable at the scale of individual tributaries.

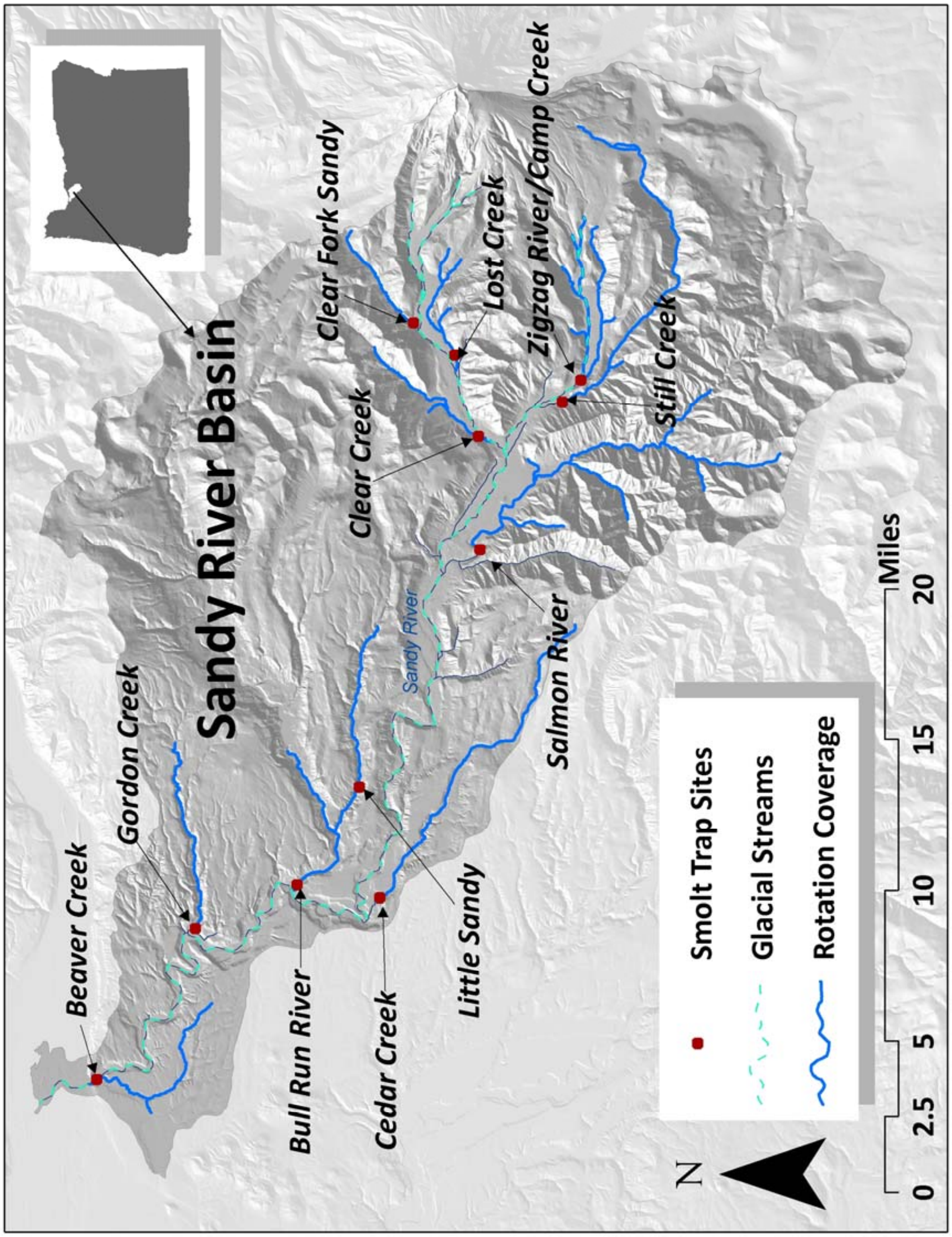


Figure 1. Sandy River Basin—Smolt trap sites, streams covered by rotating smolt trap study, and streams receiving glacial runoff.

3. Methods

3.1 Sampling

Juvenile outmigrant (JOM) sampling in the Sandy River Basin is implemented following a carefully coordinated, long-term sampling schedule, using methods that are consistent across geography and time.

3.1.1 Sampling Schedule

Twelve streams were identified by the monitoring subgroup as being feasible and appropriate for operating a smolt trap. These streams are summarized in Table 1.

Table 1. Streams sampled for salmon and steelhead smolts, with sampling category, range of elevations of anadromous reaches, and average gradient.

Stream	Miles Used by Anadromous Fish	Sampling Category[a]	Anadromous Elevation Range (feet above mean sea level)	Average Gradient
Bull Run River (without the Little Sandy River)	7.5	Fixed	240–700	1.3%
Little Sandy River	5.9	Fixed	430–1,600	2.9%
Cedar Creek	13.2	Fixed	360–3,240	4.1%
Clear Fork Sandy River	4.3	Rotation	2,130–3,390	5.4%
Lost Creek	4.9	Rotation	1,770–2,660	3.7%
Clear Creek	5.5	Rotation	1,440–2,780	4.6%
Still Creek	8.7	Rotation	1,580–3,120	3.1%
Zigzag River/ Camp Creek	16.4	Rotation	1,840–3,360	4.1%
Salmon River	24.0	Rotation	1,010–1,850	1.2%
Gordon Creek	7.4	Rotation	100–1,630	4.0%
Beaver Creek	7.7	Rotation	20–550	1.3%

[a]Sampling category: Fixed=sampled annually, Rotation=sampled according to rotating schedule

Once monitoring commences in Cedar Creek (tentatively planned for 2012), it is anticipated that seven smolt traps will be operated each year. The provisional sampling schedule is summarized in Table 2. Three trap locations will be fixed and operated every year, because of additional monitoring needs. The Bull Run River and Little Sandy River will be monitored annually to meet specific commitments in the HCP. Cedar Creek will be monitored annually to document recolonization by salmon and steelhead after 2010, when adult salmon and steelhead were again allowed access to historic habitat blocked

Table 2. Provisional schedule for sampling major tributaries in the Sandy River Basin[a].

Year	Cedar Creek	Little Sandy River	Bull Run River	Clear Fork Sandy River	Lost Creek	Clear Creek	Still Creek	Zigzag River/ Camp Creek	Salmon River	Gordon Creek	Beaver Creek
2009		x	x		x	x	x			x	
2010		x	x	x				x	x		x
2011		x	x		x		x	x		x	
2012	?[b]	x	x				x	x	x		x
2013	x	x	x	x	x				x	x	
2014	x	x	x			x	x	x			x
2015	x	x	x	x	x		x				x
2016	x	x	x			x			x	x	x
2017	x	x	x		x	x		x	x		
2018	x	x	x		x	x			x		x
2019	x	x	x	x			x	x		x	
2020	x	x	x	x	x	x					x
2021	x	x	x	x		x		x		x	
2022	x	x	x	x			x		x	x	
2023	x	x	x				x		x	x	x
2024	x	x	x	x		x	x		x		
2025	x	x	x		x	x		x		x	
2026	x	x	x	x	x			x			x
2027	x	x	x		x			x		x	x
2028	x	x	x	x		x	x		x		

[a]Schedules for years 2009, 2010, 2018, 2019, 2027, and 2028 (shaded gray) are fixed, but the remaining years may be changed to accommodate other monitoring needs, as long as all sites scheduled for a given year remain grouped together as a unit.

[b]It is not known at this time when smolt monitoring will begin in Cedar Creek.

by the ODFW hatchery at RM 1.5. This smolt monitoring plan extends the reference area of the remaining four traps by rotating them among eight streams according to the following constraints (assuming that Camp Creek and the Zigzag River are combined):

- Each site will be trapped, on average, every other year.
- All sites will be trapped once in the first two years, once in the middle two years and once in the last two years of a 20-year period.

Rotated sites will be trapped according to a schedule that maximizes the pair-wise comparisons between them.

The original provisional smolt trap rotation schedule established in 2009 was adjusted in 2011 to accommodate logistical needs. The group of traps scheduled for 2011 was traded with that scheduled for 2021. Table 2 reflects the new schedule.

3.1.2 Sampling in 2011

Smolt production was monitored in Lost Creek, Still Creek, Zigzag River, Bull Run River, Little Sandy River, and Gordon Creek in 2011. An eight-foot-diameter rotary trap was used on the Bull Run River. Five-foot-diameter rotary screw traps were used on all other streams. The Lost Creek, Still Creek, and Zigzag River traps were checked and maintained by the USFS Zigzag Ranger District. PWB checked and maintained the Little Sandy River, Bull Run River, and Gordon Creek traps. All traps were operated seven days per week throughout the season. The periods of operation for each site are summarized in Table 3, together with the number of days when each trap was not in operation due to scheduling, high flows, or other considerations. Table 3 and all other results are presented in streams from the highest-elevation Lost Creek to the lowest-elevation Gordon Creek.

Smolt monitoring was delayed in 2011 by the late issuance of a scientific take permit. A significant portion of the smolt out-migration is believed to have been missed on all monitored streams.

USFS personnel check the Still Creek smolt trap during high flows.

Table 3. Dates of operation and the number of days traps did not operate in the Sandy River Basin in 2011.

Stream[a]	Trap In	Trap Out	Down Time (days)
Lost Creek	May 24	June 16	6
Zigzag River	May 14	June 24	26
Still Creek	May 11	June 27	0

Table 3. Dates of operation and the number of days traps did not operate in the Sandy River Basin in 2011.

Stream[a]	Trap In	Trap Out	Down Time (days)
Little Sandy River	April 26	June 20	3
Bull Run River (without the Little Sandy River)	April 26	June 22	4
Gordon Creek	April 26	June 8	0

[a]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

3.1.3 Data Collection

Traps were checked daily and all fish were removed from the trap's live well. Fish were anesthetized using Alka-Seltzer Gold ™ (buffered sodium bicarbonate). The following data were collected for most fish:

- Species
- Life-stage (smolt, juvenile, fry, or adults)
- Fork length (mm)
- Weight (g)
- Fin marks given or observed (see Mark-Recapture Study section below)
- Comments (e.g., injuries, pathogens, etc.)

Life stage was determined using external characteristics. Smolts show a general silvering, fading of parr marks, and a darkening of the posterior edge of the caudal fin. Juveniles are small fish but larger than 50 mm that show none of the above smolt characteristics. Fry are 50 mm or less. At times, and especially early in the season, steelhead smolts were just beginning to develop their characteristics and could be difficult to distinguish from juveniles. In these borderline cases, the following rule-set was applied:

> If a steelhead is longer than 130 mm fork length, consider it a smolt unless there are absolutely no signs that smoltification may have begun, in which case consider it a juvenile. If a steelhead is 130 mm or less, consider it a juvenile, unless there are clearly signs of it being a smolt.

Tissue and scale samples were collected from steelhead and coho smolts at all sites according to a separate sampling protocol to support other monitoring efforts.[3]

[3] Examples of other monitoring efforts include describing the recolonization of the Little Sandy River using tissue samples and aging smolts throughout the Sandy River Basin using scale samples. Most of these samples have not yet been analyzed and may eventually be analyzed by agencies other than the PWB or USFS. Some tissue samples have been analyzed by the National Oceanic and Atmospheric Administration (NOAA).

3.1.4 Mark-Recapture Study

An ongoing trap efficiency study was conducted throughout the trapping season to determine the proportion of the outmigration that was being captured in the traps. Following a modified mark-recapture protocol, up to 25 smolts of each species at each site each day were given a fin mark specific to the day of the week. Marked fish were subsequently released from approximately 0.1 to 1.5 miles upstream of the trap, depending on access to appropriate release sites. Fins were marked either with small clips or injected dye. Captured fish were sorted each day to look for fin marks from previous days' releases.

In deciding to mark fish for the trap efficiency study with only seven specific fin-clip markings—one for each weekday—researchers assumed that all marked fish would travel from the release point to the trap within seven days. An analysis of the recapture data appears to bear this assumption out. Most fish appeared to be recaptured after one to three days, with very few indicating a travel time of four or more days. The consequences of some fish taking more than seven days to travel from the release point to the trap are reduced by pooling adjacent weeks together into two-week mark-recapture periods.

Measuring fish at the Bull Run trap.

3.2 Assumptions

The mark-recapture procedures are subject to the same limitations inherent to all similar studies. The model assumes the following:

- The target species and life-stages are actively moving downstream (equivalent to the "closed population" requirement of the Peterson estimator, discussed in Volkhardt et al. 2007).
- All fish in a capture period (stratum) of a given species and life-stage have equal probability of first-time capture.
- Marking fish does not affect their catchability (e.g., they do not suffer mortality between marking and potential recapture).
- Marked and unmarked fish traveling together have an equal probability of recapture (e.g., fish do not become "trap-shy" or "trap-happy," leading to overestimated or underestimated populations, respectively).
- Fish do not lose their marks.
- All recaptured marked fish are recognized.

3.3 Data Analysis

3.3.1 Smolt Population Estimation

Smolt population sizes for individual streams are estimated using Darroch Analysis (Bjorkstedt 2005) with Rank Reduction (DARR 2.0), a program provided by the National Marine Fisheries Service (NMFS: *http://swfsc.noaa.gov/textblock.aspx?Division=FED&id=3346*). DARR 2.0 relies on a stratified Peterson estimator for mark-recapture data. Prior to calculation of the estimate, however, time periods are aggregated following rules designed to avoid the pitfalls associated with small populations and low recapture rates.

In the Sandy River Basin, fish total captures (C) and marks (M) are stratified by two-week time periods, to reduce variation associated with flows, water temperature, and changing fish behavior. The associated recaptures (R) are identified by both the time period in which they originated and the time period in which they are recaptured, resulting in a recapture matrix. The Darroch estimator uses the recapture matrix to estimate the number of marked fish passing the trap during a given time period. The total estimate is the sum of the individual time period estimates. Details of the calculation of the total estimate and its variance are fully described in Bjorkstedt (2005).

For the special cases in which all recaptures occur in the same stratum from which they originated (all non-zero values occur along the middle diagonal of the recapture matrix), the Darroch estimator reduces to a simple Peterson estimator:

$$\textbf{Stratum estimate } (N_s)=C_s\,(M_s\,/R_s) \qquad \textbf{(Equation 1)}$$

There were several days at each site when certain smolt traps were not in operation, either because of damage, potential damage, or scheduling issues (see Table 3). For these days, the daily smolt output was estimated using a two-week running average of daily population estimates (daily total capture without recaptures ÷ trap efficiency$_{stratum}$; with trap efficiency provided by DARR 2.0). Only days with actual captures within seven days before and after a particular date were included in the running average of daily population estimates.

3.3.2 Smolt Fork Lengths

Weighted average fork lengths for all smolt populations were calculated. Smolt fork lengths for each site were compiled and then weighted by capture stratum using trap efficiency (provided by DARR 2.0). If trap efficiency for a given stratum was low, the weights for fish captured in that stratum were weighted more heavily. This prevented strata with few fish but high trap efficiencies, for example, from influencing the average more than strata with many fish but low trap efficiencies. Fork lengths of actual captures were compared among streams using analysis of variance (ANOVA). If the resulting F statistic was found to be significant at an α level of 0.05, a Tukey test was applied to all combinations of pairs of streams to determine how average fork lengths differed from each other.

3.3.3 Smolt Condition Factors

Condition factors (K) were determined for all steelhead and coho smolts by basin using weights (W) and fork lengths (L) according to the following formula:

$$K=(W/L^3)*100{,}000 \qquad \text{(Equation 2)}$$

Condition factors give an indication of how thin or fat a fish is. Condition factors were compared among basins by statistically testing for differences using ANOVA. If the resulting *F* statistic was found to be significant at an α level of 0.05, a Tukey test was applied to determine how mean condition factors differed from each other. Condition factors were not weighted by capture stratum using trap efficiency because of the analytical complexities involved.

3.3.4 Emigration Dates

Steelhead and coho smolt mean and peak capture dates were calculated for each site. The mean capture date was defined as the sum of the product of daily captures corrected for stratum efficiency (C) and the date of capture (D) on any given day (i for days 1-k), divided by the sum of corrected captures using the formula:

$$\sum_{i=1}^{k}(CD)_i \Big/ \sum_{i=1}^{k} C_i \qquad \text{(Equation 3)}$$

The peak capture date was defined as the day when most fish of a species and condition were estimated to have passed the trap site (daily captures corrected for stratum trap efficiency).

4. Results

4.1 Trap Efficiencies

The efficiencies of traps varied across sites and time. Trap efficiencies are summarized in Table 4 for each site and two-week trapping period. Period 1 for each site started the week that trapping began for the respective site (see Table 3 for start dates). All else being equal, the higher the trap efficiency, the more precise the population estimate. A trap efficiency of at least 0.1 and preferably closer to 0.25 is desirable.

Table 4. Trap efficiencies for each site, species, and two-week trap period in 2011.

		Period			
Site[a]	**Species**	**1**	**2**	**3**	**4**
Lost Creek	Steelhead	NA			
	Coho	NA			
Zigzag River	Steelhead	NA			
	Coho	NA			
Still Creek	Steelhead	0.085	0.130	0.130	
	Coho	0.204	0.262	0.267	
Little Sandy River	Steelhead	0.083	0.083	0.246	0.200
	Coho	0.167	0.167	0.167	0.167
Bull Run (without Little Sandy River)	Steelhead	0.078	0.255	0.062	0.184
	Coho	0.134	0.134	0.134	0.134
Gordon Creek	Steelhead	0.116	0.094	0.200	
	Coho	0.083	0.313	0.263	

[a]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

4.2 Smolt Population Estimation

In 2011, more steelhead smolts were produced by the Bull Run River than all other monitored streams combined. The majority of coho smolts from monitored streams emigrated from Still Creek, as summarized in Table 5. Both Lost Creek and Zigzag River had negligible steelhead smolt production and no observed coho smolt production. Exhibit A summarizes the total captures at all trap sites.

The variances associated with most estimates were large, despite improved trap efficiencies over prior years at several trap sites. Coho estimates tended to be less precise than steelhead estimates in 2011 because relatively few coho were caught in most streams. An exception was Still Creek, where large numbers of marked coho, combined with relatively high trap efficiency, resulted in a narrow 95 percent confidence interval.

Table 5. Steelhead and coho smolt population estimates and 95% confidence intervals.[a]

	Steelhead		Coho	
Stream[b]	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Lost Creek	1[c]	NA	0	NA
Zigzag River	1[c]	NA	0	NA
Still Creek	1,428	53%	4,261	14%
Little Sandy	1,552	51%	39	166%
Bull Run (without Little Sandy)	7,750	33%	483	61%
Gordon Creek	839	63%	557	70%

[a]Confidence intervals are expressed as percentages of the associated estimates.

[b]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

[c]The actual number of captures is given. No estimate could be calculated due to the low number of overall captures.

The actual sizes of smolt populations were probably significantly larger than the estimates summarized in Table 5, which reflect only the portion of fish emigrating while traps were in operation. Rates of emigration observed in previous years for steelhead and coho suggest that between 12 and 71 percent of the emigrating smolt population may have been missed, depending on species and location. Still Creek probably had the greatest proportion of fish missed.

Table 6 summarizes the smolt population estimates expanded by applying the species-specific cumulative proportion of smolts that had emigrated by the start day of the year in previous years for each stream. The formula used for the estimate expansion was:

$$EE=PE/(1-p)$$

in which EE is the expanded estimate, PE is the population estimate summarized in Table 5, and p is the proportion of the total smolt population observed in a given previous year to have emigrated by the day of the year that corresponds to the day of the year that trapping started in that stream in 2011, summarized in Table 3. If multiple years of emigration data were available for a given stream, the average of estimates was used. Data from 2010 for Still Creek were not used because trapping was initiated late in that year as well. Data from Lost Creek and Zigzag River could not be evaluated due to perennially low smolt captures.

Only Bull Run and Little Sandy had ***p*** values from more than one year, so expanded 95 percent confidence intervals could not be calculated. Future years' data may be useful for retroactively adjusting both the expanded population estimates from 2011 and their associated 95 percent confidence intervals.

Table 6. Expanded steelhead and coho smolt population estimates, assuming past observed emigration patterns for streams where expansion was possible.[a]

	Steelhead		Coho	
Stream	**Expanded Estimate**	$P_{(year)}$	**Expanded Estimate**	$P_{(year)}$
Still Creek	4,958	$0.71_{(2009)}$	6,325	$0.33_{(2009)}$
Little Sandy	2,245	$0.36_{(2009)}$ $0.26_{(2010)}$	45	$0.13_{(2010)}$
Bull Run (without Little Sandy)	8,858	$0.13_{(2009)}$ $0.12_{(2010)}$	560	$0.14_{(2009)}$ $0.13_{(2010)}$
Gordon Creek	1,051	$0.20_{(2009)}$	655	$0.15_{(2009)}$

[a]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

Of all streams monitored in 2011, steelhead smolt production per unit of stream length and per unit of surface area was highest in the Bull Run River, as summarized in Table 7 using the expanded estimates in Table 6, where possible. The Zigzag River had the lowest steelhead smolt production per unit of length and surface area.

Table 7. Steelhead and coho smolts per mile and smolts per 1000 ft² using expanded estimates where possible.

	Steelhead		Coho	
Streams[a]	**Smolts/mile**	**Smolts/1000 ft²**	**Smolts/mile**	**Smolts/1000 ft²**
Lost Creek	0.15[a]	0.00	0.00[a]	0.00
Zigzag River	0.05[a]	0.00	0.00[a]	0.00
Still Creek	332.75	1.87	866.44	3.56
Little Sandy	380.51	1.14	7.63	0.02
Bull Run (without Little Sandy)	1,067.23	2.29	67.47	0.14
Gordon Creek	142.03	0.68	90.97	0.43

[a]The actual number of captures was used to calculate a minimum smolts per mile. No estimate could be calculated due to low overall captures and recaptures.

[b]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

Of all streams monitored in 2011, coho smolt production per unit of stream length and per unit of surface area was highest in Still Creek. Neither Lost Creek nor the Zigzag River had any observed coho smolt production.

4.3 Fork Lengths

Steelhead and coho average fork lengths followed different patterns across monitored streams in 2011, as summarized in Tables 8 and 9, respectively. There were significant differences between the weighted mean fork lengths of both steelhead and coho smolts among monitored streams (ANOVA, α=0.05, p<<0.001 for both tests). Both steelhead and coho smolts emigrating from the Bull Run River were significantly larger than those emigrating from other monitored streams.

Table 8. Steelhead weighted mean fork lengths, weighted standard deviation, and range of fork lengths of steelhead smolts captured in Sandy River Basin smolt traps in 2011.

Streams[a]	n[b]	Wtd. Mean Fork Length (mm)	Wtd. St. Dev. (mm)	Minimum (mm)	Maximum (mm)
Lost Creek	1	156[c]	NA	NA	NA
Zigzag River	1	119[c]	NA	NA	NA
Still Creek	140	160	62	107	196
Little Sandy	200	161	11	133	196
Bull Run (without Little Sandy)	762	175	18	130	274
Gordon Creek	95	166	21	110	224

[a]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.
[b]n= Number of fish for which fork lengths were determined
[c]Fork length and standard deviation are not weighted because of low counts or sporadic trapping.

Figure 2 shows frequency distributions for steelhead smolt fork lengths. The results of the pair-wise comparisons are summarized below Figure 2.

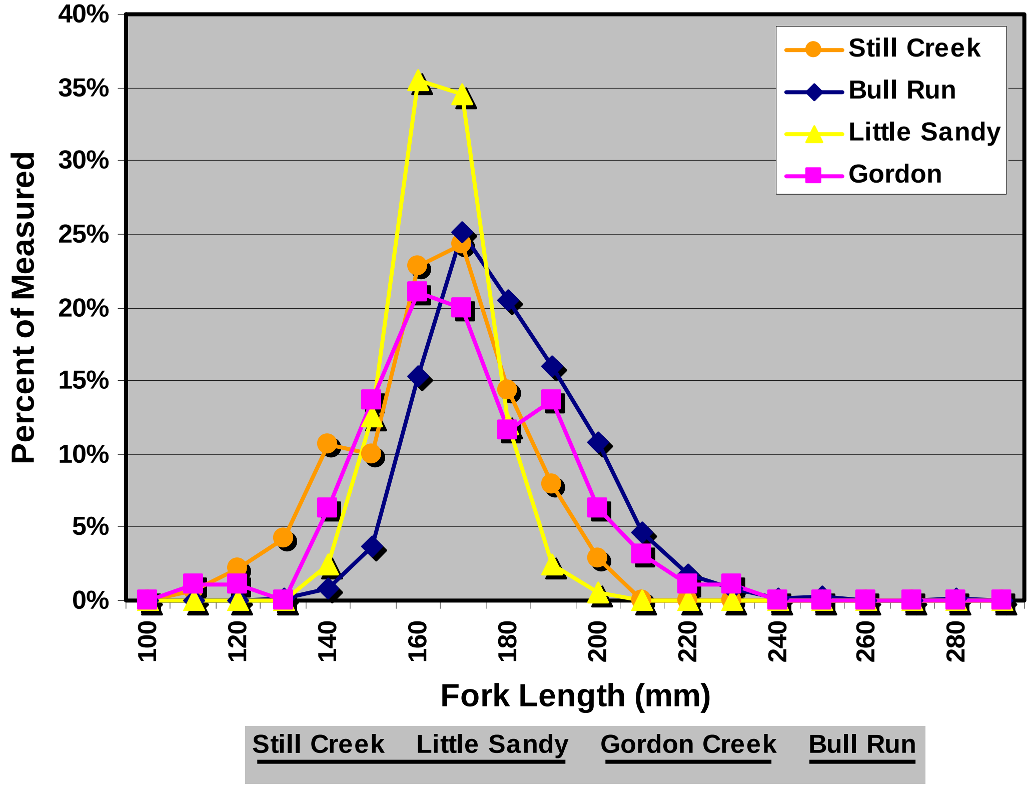


Figure 2. Steelhead smolt fork length frequency distributions for Sandy River Basin traps in 2011.

In Figure 2, streams that are grouped together by being mutually underlined are not statistically distinguishable from one another at a 95 percent level of significance (e.g., Still Creek and Little Sandy steelhead are not significantly different from each other in fork length, but steelhead from all other streams are significantly smaller than Bull Run steelhead).

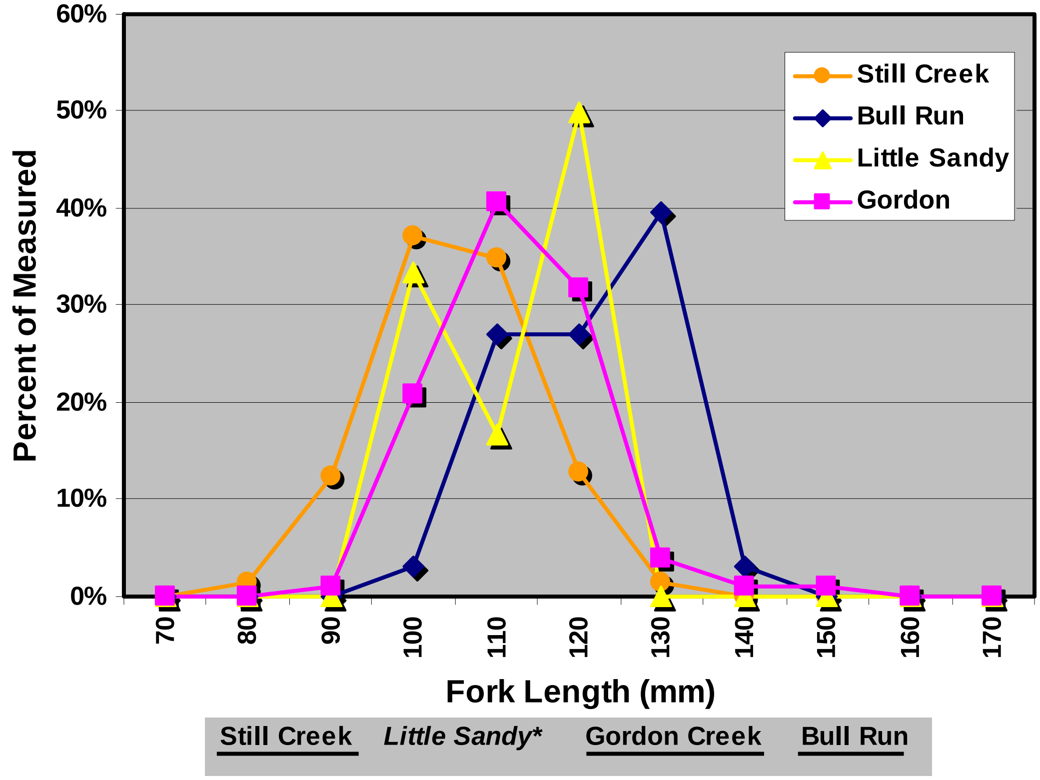
Table 9. Coho weighted mean fork lengths, weighted standard deviation, and range of fork lengths of coho smolts captured in Sandy River Basin smolt traps in 2011.

Streams[a]	n[b]	Wtd. Mean Fork Length (mm)	Wtd. St. Dev. (mm)	Minimum (mm)	Maximum (mm)
Still Creek	739	101	9	74	130
Bull Run (without Little Sandy)	63	117	8	99	135
Little Sandy	6	108	9	95	118
Gordon Creek	101	107	10	87	146

[a]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

[b]n= Number of fish for which fork lengths were determined

Figure 3 shows frequency distributions for coho smolt fork lengths. The results of the pair-wise comparisons are summarized below Figure 3.



*Little Sandy coho fork lengths could not be statistically distinguished from other streams because of small sample size.

Figure 3. Coho smolt fork length frequency distributions for Sandy River Basin traps in 2011.

In Figure 3, streams that are grouped together by being mutually underlined are not statistically distinguishable from one another at a 95 percent level of significance (e.g., Still Creek coho are significantly smaller than coho from Gordon Creek, which, in turn are significantly smaller than coho from Bull Run). Little Sandy coho were removed from the pair-wise comparisons because of the extremely small sample size.

4.4 Condition Factors

There were significant differences (ANOVA, α=0.05, p<<0.001 for both tests) among the condition factors of steelhead and coho among streams monitored in 2011. Little Sandy coho were excluded from the analysis because of the small sample size. Bull Run steelhead and coho had the lowest mean condition factors (they were thinner) and Still Creek and Gordon Creek steelhead and coho both had the highest (they were fatter) and were statistically indistinguishable from each other at a 95 percent level of confidence. Figures 4 and 5 show the results of Tukey test multiple comparisons of condition factors for these two species across monitored streams.

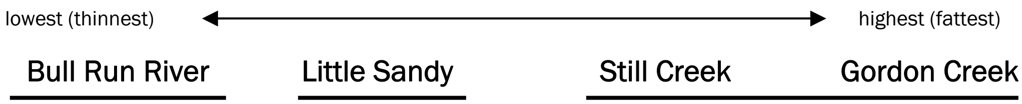
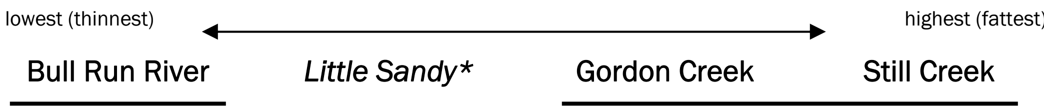


Figure 4. Steelhead smolt results of Tukey test multiple comparisons of condition factors for Sandy River streams monitored in 2011.



*Little Sandy coho condition factors could not be statistically distinguished from other streams because of small sample size.

Figure 5. Coho smolt results of Tukey test multiple comparisons of coho smolt condition factors for Sandy River streams monitored in 2011.

4.5 Emigration Dates

Too much of the smolt emigration period was missed in 2011 to directly determine emigration statistics other than the end date in any of the monitored streams. Median emigration dates could be estimated for most streams by utilizing the same p statistic used to expand steelhead and coho population estimates in Table 6. Mean emigration dates could not be calculated in a similar way without also making assumptions about how the daily smolt emigration varied through time during the missed period.

The weighted mean and median emigration dates for the trapping period are summarized, along with the estimated median emigration date for the population and the dates of first and last capture, in Tables 10 and 11 for steelhead and coho, respectively. Gordon Creek had the earliest median population emigration dates for both species. Bull Run and Still Creek had the latest median population emigration dates for steelhead and coho smolts, respectively. The median population emigration date for Still Creek steelhead smolts could not be estimated because more than half of the steelhead emigration is believed to have been missed in that stream.

The Lost Creek and Zigzag River traps only captured one steelhead smolt each. The associated emigration statistics are not considered representative of a steelhead population emigrating from these streams.

Table 10. Steelhead smolt weighted mean date of emigration for the trapping period, the associated standard deviation, weighted median date of emigration for the trapping period, estimated median emigration date for the population, and the earliest and latest capture dates in Sandy River streams monitored in 2011.

Streams[a]	Wtd. Mean Emigration[b] (trapping)	Wtd. St. Dev.	Wtd. Median Emigration[b] (trapping)	Median Emigration (population)	Earliest Date[c]	Latest Date
Lost Creek[d]	May 25	NA	NA	NA	NA	NA
Zigzag River[d]	June 28	NA	NA	NA	NA	NA
Still Creek	May 21	10 days	May 18	NA[e]	May 11	June 26
Little Sandy	May 21	8 days	May 21	May 14	April 27	June 20
Bull Run River	May 18	11 days	May 23	May 22	April 26	June 13
Gordon Creek	May 8	10 days	May 8	May 2	April 27	June 7

[a]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

[b]Weighted mean and median emigration dates are not considered representative of the actual means and medians.

[c]Earliest date reflects the initiation of trapping, not the earliest date of emigration. Emigration was already underway in all streams.

[d]Lost Creek and Zigzag River emigration date statistics are not considered representative for what a larger population in these streams would show because of the small sample size (Lost Creek n=1, Zigzag n=1).

[e]Median emigration date for the population could not be estimated on Still Creek, because more than half of the total emigration is believed to have been missed.

Table 11. Coho smolt weighted mean date of emigration for the trapping period, the associated standard deviation, weighted median date of emigration for the trapping period, estimated median emigration date for the population, and the earliest and latest capture dates in Sandy River streams monitored in 2011.

Streams[a]	Wtd. Mean Emigration[b] (trapping)	Wtd. St. Dev.	Wtd. Median Emigration[b] (trapping)	Median Emigration (population)	Earliest Date[c]	Latest Date
Still Creek	May 25	10 days	May 25	May 18	May 11	June 27
Little Sandy	May 14	7 days	May 13	May 13	April 27	May 28
Bull Run River	May 18	10 days	May 17	May 16	April 26	June 7
Gordon Creek	May 11	11 days	May 7	May 5	April 26	June 4

[a]Streams are presented in order from highest-elevation Lost Creek to lowest-elevation Gordon Creek.

[b]Weighted mean and median emigration dates are not considered representative of the actual means and medians.

[c]Earliest date reflects the initiation of trapping, not the earliest date of emigration. Emigration was already underway in all streams.

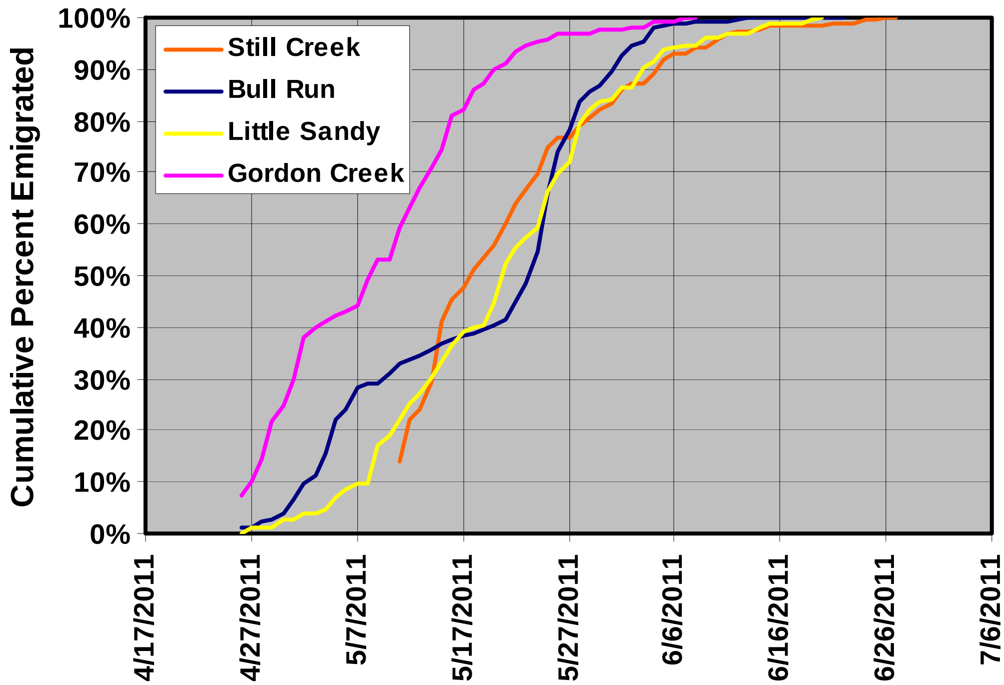


Figure 6. Steelhead smolt cumulative percentage of total emigration from Sandy River streams monitored in 2011. Steepest portions of each curve indicate peak capture periods.

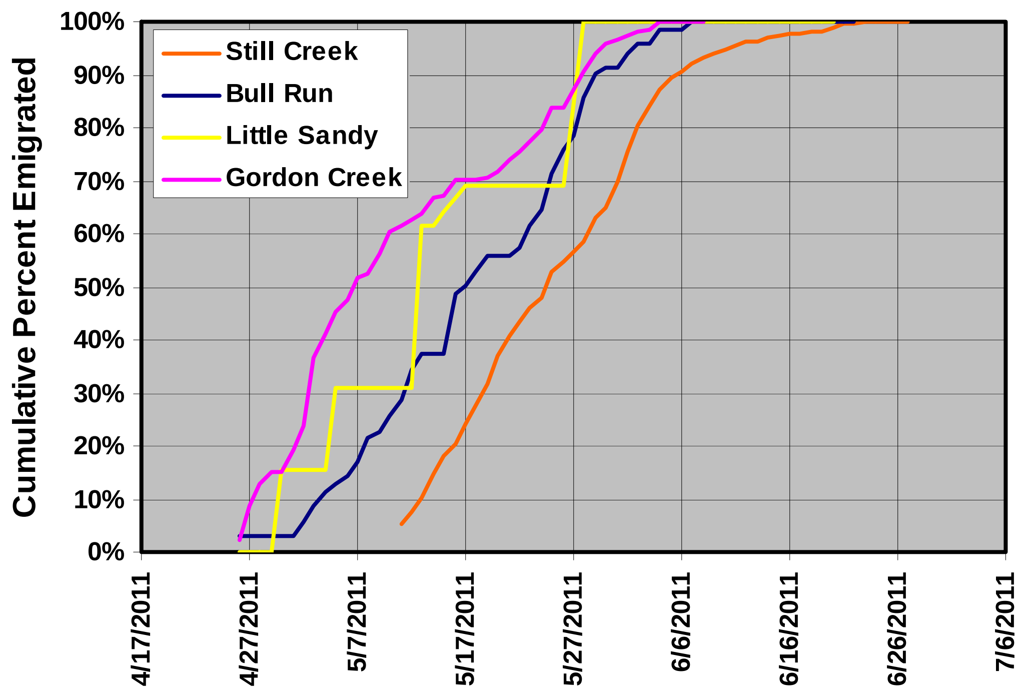


Figure 7. Coho smolt cumulative percentage of total emigration from Sandy River streams monitored in 2011. Steepest portions of each curve indicate peak capture periods.

5. Discussion

5.1 Smolt Population Estimation

Although reliable smolt population estimates, or approximations useful for long-term trend detection in the Sandy River Basin, could not be directly calculated for steelhead or coho in 2011 because of the late start of the trapping season, a technique was developed for estimating the missed portion of the run in each stream. This technique relies on the species- and stream-specific smolt-emigration patterns observed in other years. After the streams trapped in 2011 have been monitored for multiple years, the expanded population estimates presented in this report can be refined and confidence intervals can be calculated. The resulting statistics will be useful for Sandy Basin-wide trend analysis.

Confidence intervals were generally broader than desired, decreasing the eventual power to detect trends, but trapping efficiencies were largely improved over previous years. Broad confidence intervals associated with the population estimates resulted principally from few overall captures (e.g., Little Sandy coho smolts). For example, steelhead smolts generally had lower recapture rates than coho, but their population estimates had narrower confidence intervals in most streams because more steelhead than coho were marked.

Unequal trap avoidance by different groups of fish is a perennial concern with studies such as this that rely on mark-recapture methodologies and could have affected the estimation of smolt population sizes in the Sandy River in 2011. If marked individuals become “trap-shy” (i.e., are caught a second time at a rate lower than fish passing the trap for the first time), this results in an inflated population estimate. Trap avoidance was suspected in 2010 when the Bull Run steelhead population estimate, 11,701 fish, seemed unreasonably large. The more precise results from 2011, however, support the idea that the Bull Run River and the Little Sandy downstream of the Little Sandy trap site constitute a productive system for steelhead and that the large population estimates obtained in 2011 and in previous years are, in fact, reasonable.

Large fish of a given species are probably also stronger swimmers than small fish and may have a greater ability to avoid capture when they recognize a trap in their downstream path. Were this effect to occur equally during the initial capture and subsequent recapture of fish, the result would be an underestimated population size. Were it to happen during both phases of capture, but more strongly during the recapture phase, the result would vary depending on the strength of the effect. Consequences of this effect are discussed more fully in Strobel (2009). Biases in the fork lengths of recaptured coho and steelhead towards smaller fish were not apparent in 2011.

The low numbers of steelhead and absence of coho emigrating from Lost Creek and the Zigzag River in 2011 could be due to low productivity in the portions of the basin upstream of the trap site due to low water temperatures or—in the case of the Zigzag

River—chronically turbid water from glacial runoff. Cold water can slow metabolic rates and subsequently slow growth in fish. Very cold water could possibly limit productivity. Turbid glacial water can make finding prey difficult for salmonids. There are several streams, however, that are tributary to the Zigzag River upstream of the trap site that have clear water. The reasons these tributaries did not produce any salmon or steelhead smolts are unknown. A large number of Chinook fry, however, were caught in the Zigzag smolt trap, suggesting the river or its tributaries are used for spawning by this species.

The total Sandy River Basin steelhead and coho smolt populations, the trends in smolt numbers over time, and Sandy River Basin freshwater productivity (smolts per adult) will be calculated after 20 years of annual smolt monitoring. Tentative calculations will be made annually starting in HCP year 8 (2016), when all sites have been trapped at least three times.

5.2 Recolonization of the Little Sandy

More steelhead emigrated past the Little Sandy trap in 2011 than in previous years. This reveals a rapid recolonization of the stream upstream of the Little Sandy dam site after its removal in 2008 (Figure 8). 2011 is the first year that steelhead smolts were expected to result from the first steelhead adults spawning in the newly reopened portion of the stream. The steelhead smolts observed emigrating from the Little Sandy in 2010—with an estimated population of 160 fish—were either individuals that had migrated upstream since the fall of 2008/2009 or were produced by upstream rainbow trout.[4] The sudden increase from zero to an estimated 160 and then to an estimated 416 steelhead from 2008 to 2009 to 2010 suggests that upstream migration since 2008/2009 is the dominant source of 2009 and 2010 steelhead smolts.

The 2011 estimate of 1,552 smolts was also preceded by a sudden, dramatic increase in the capture of juvenile (probably age-1) steelhead in the Little Sandy trap in 2010. The subsequent decrease in the number of juvenile steelhead caught in 2011 from what was caught in 2010 may be due to fewer steelhead spawning upstream of the trap site in the spring of 2010, steelhead spawning further upstream in the spring of 2010 than they did in the spring of 2009, or incubating eggs suffering higher mortality during the winter of 2010/2011 than during the winter of 2009/2010.

This was the second year that coho smolts could be expected in the Little Sandy trap, originating from adults that spawned upstream of the trap site after dam removal in 2008. The number of coho fry caught has decreased every year from a high of 339 in 2009—the first year that fry could have been present—to 14 in 2009, and no fry in 2010. The number of coho smolts, however, remained relatively unchanged from 2010 to 2011.

[4] Rainbow trout are the same species as steelhead *(Oncorhynchus mykiss)*.

These observations suggest that the decrease in fry captures from 2009 to 2010 was due to coho spawning further upstream in the fall of 2009 than they did in the fall of 2008 or from incubating coho eggs suffering higher mortality during the winter of 2010/2011 than during the winter of 2009/2010, rather than to an overall decrease in spawning activity.

Spawning by both coho and steelhead upstream of the trap site has been documented. The large difference between coho and steelhead population estimates, therefore, supports the idea that the Little Sandy, with its relatively high gradient and constrained nature, is better suited to steelhead production than to coho production.

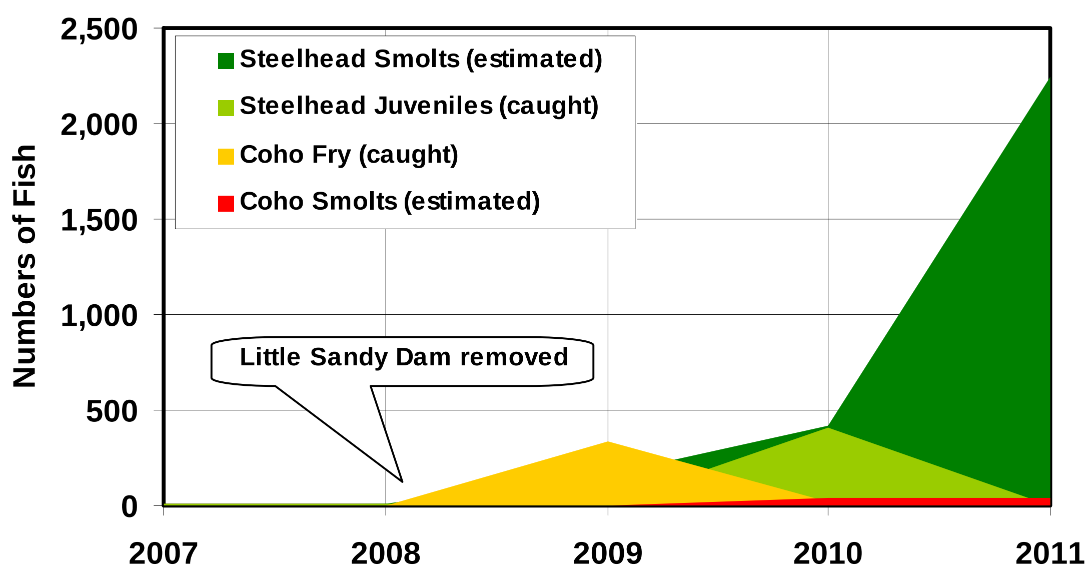


Figure 8. Recolonization of the Little Sandy River by steelhead and coho after the removal of the Little Sandy Dam.

5.3 Fork Lengths

The observed differences in fork length distribution for steelhead and coho smolts among Sandy River Basin streams monitored in 2011 may be due to one or both of two factors: 1) how rapidly fish are able to grow in each stream, relating to stream productivity, and 2) how long they have had to grow.

Steelhead and coho weighted mean fork lengths showed an apparent correlation with water temperature during the period of time when juvenile steelhead and coho did most of their growing (Figure 9). The number of accumulated thermal units (ATUs) during the summer of 2010 explained 84 percent of the observed variation in coho smolt fork length. Steelhead weighted mean fork lengths also generally increased with ATUs over the same portion of the summer of 2010, but only explained 52 percent of the observed variation. Steelhead smolts can vary in age from 1 to 3 years (Hansen et al. 2001). Their fork lengths, therefore, can reflect varying growth conditions over multiple years, as well as variations from stream to stream in the average length of time spent growing.

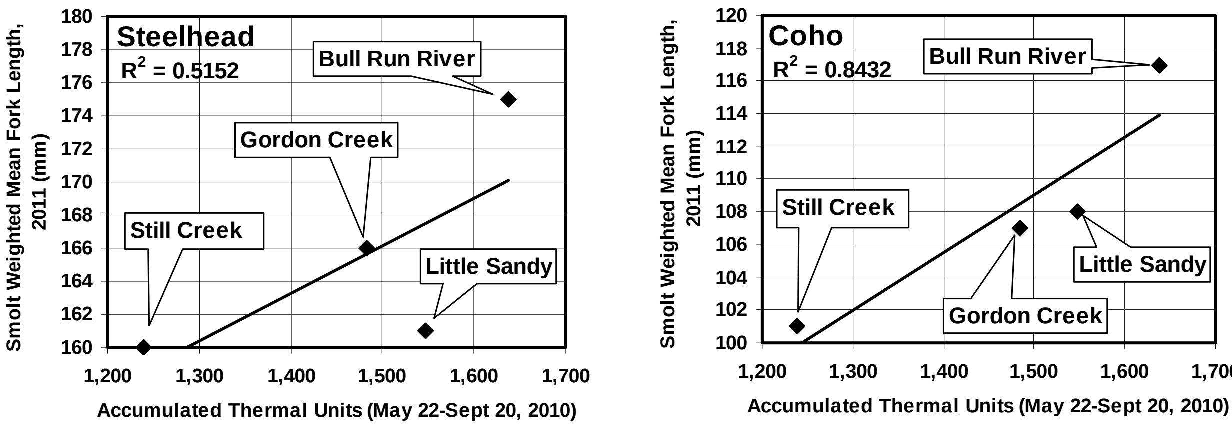


Figure 9. Relationship of steelhead and coho smolt weighted mean fork length to accumulated thermal units.

5.4 Condition Factors

In 2011 several streams with relatively high condition factors had relatively low fork lengths. In particular, Still Creek had relatively small, fat steelhead and coho; the Bull Run, in contrast, had large, relatively thin fish. A similar relationship has been observed in previous years, especially with coho. This pattern may reflect that relatively higher water temperatures in lower-elevation streams allow for some growth during the winter, using up more stored body fat. It is also possible that over-wintering conditions in the specific low-elevation streams are poor, requiring fish to expend more energy to survive. It is unlikely, however, that lower condition factors reflect poor rearing conditions throughout the year in these streams or it would probably be evident in the observed patterns of fork length as well.

5.5 Emigration Dates

A valid comparison of mean and median emigration dates among streams monitored in 2011 is confounded by two factors: 1) the fact that monitoring at all sites began after the steelhead and coho smolts were already in the midst of their emigration, and 2) that other sites experienced lengthy periods of down time during the peak emigration period.

The estimated median emigration dates suggest that smolts in higher-elevation streams may have emigrated later, overall, than smolts in lower-elevation streams, as has been observed in other years. No conclusions, however, can be drawn.

6. Findings, Conclusions, and Recommendations

- Population estimates for the trapping period were able to be generated for steelhead and coho smolts in four streams in 2011. The remaining streams and species had very few or no captures.
- Though a large portion of the smolt emigration was missed in all streams because of the late issuance of take permits, a technique was developed to expand population estimates to the full emigration season. Provisional population estimates were calculated for steelhead and coho smolts in four streams in 2011 (Tables 5 and 6). Estimates will be refined with the addition of future data.
- Steelhead and coho smolt fork length appeared to correlate with water temperature over time.
- Steelhead and coho smolts from different streams in the Sandy River Basin showed significant differences in the average condition factor in 2011. The streams with smolts having the longest and shortest weighted mean fork lengths generally had the lowest and highest condition factors, respectively.
- Steelhead and coho smolts appeared to generally emigrate earlier in the year in lower-elevation streams than in high-elevation streams, but the analysis of emigration data was confounded by the late start to trapping.
- These data represent the third installment of a long-term data set that will help both evaluate the viability of Sandy River steelhead and coho and guide the restoration efforts that seek to ensure their continued existence.

7. Works Cited

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Exhibit A

Table A-1. All species and life stages captured at smolt traps in the Sandy River Basin in 2011

	Lost Creek	Zigzag River	Still Creek	Bull Run River	Little Sandy	Gordon Creek
Catfish	0	0	0	0	1	0
Chinook Fry	0	465	102	7	0	4,103
Chinook Smolts	0	0	0	27	0	0
Coho Fry	0	0	1	3	0	94
Coho Smolts	0	0	993	64	6	102
Coho Juvenile	0	0	9	1	0	8
Cutthroat Smolts	0	0	10	2	0	4
Cutthroat Juveniles	0	0	1	1	7	9
Cutthroat Adults	2	1	1	2	6	5
Long Nose Dace	0	0	0	125	7	384
Speckled Dace	0	0	0	3	0	9
Lamprey Ammocoetes	0	0	3	1	0	418
Pacific Lamprey Adults	0	0	0	0	0	1
Rainbow Trout	0	0	0	2	9	6
Salmonid Fry[a]	0	0	0	0	0	3,790
Sucker	0	0	0	11	0	27
Sculpin	4	0	4	44	2	276
Steelhead Fry	0	0	0	16	29	22
Steelhead Smolt	1	1	141	765	172	96
Steelhead Juvenile	0	6	33	8	4	122
Steelhead Adult	0	0	5	0	0	0

[a]These fish were too numerous to individually speciate. They were subsampled instead (see numbers for Chinook fry, coho fry, and steelhead fry).

Appendix F. Correspondence on Measure Adjustments

Note: Each item comprises two pieces of correspondence: a letter from the Portland Water Bureau (PWB) to the National Marine Fisheries Service (NMFS) requesting authorization and the response from NMFS granting authorization. Letters are presented in chronological order.

Item 1. April 26, 2011, letter from Steve Kucas, PWB, to Ben Meyer, NMFS, proposing to create conservation easements in another subbasin of the Sandy River watershed to replace the benefits of Measure H-22, Boulder 1 Riparian Easement

May 11, 2011, letter from Michael Tehan, NMFS, to Steve Kucas, PWB, authorizing the City to implement conservation easements in Gordon Creek to compensate for Measure H-22

Item 2. July 22, 2011, letter from Steve Kucas, PWB, to Ben Meyer, NMFS, proposing to place large wood pieces in another subbasin of the Sandy River tributary to replace the benefits of Measure H-26, Boulder 0 and 1 LW Placement

August 16, 2011, letter from Ben Meyer for Michael Tehan, NMFS, to Steve Kucas, PWB, authorizing the City to place large wood in Gordon Creek to compensate for Measure H-26

Item 3. August 22, 2011, letter from Steve Kucas, PWB, to Ben Meyer, NMFS, requesting authorization to use riparian easements on lower Bull Run River parcels of purchased from the Western Rivers Conservancy in fulfillment of HCP riparian easement targets.

September 16, 2011, letter from Michael Tehan, NMFS, to Steve Kucas, PWB, authorizing the City to purchase some parcels of land on the lower Bull Run River and create riparian easements to fulfill HCP easement targets

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Randy Leonard, Commissioner
David G. Shaff, Administrator

1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926
Information: 503-823-7404
www.portlandonline.com/water

An Equal Opportunity Employer

April 26, 2011

Ben Meyer
National Marine Fisheries Service
1201 NE Lloyd Blvd., Ste. 1100
Portland, OR 97232

RE: Clarification of Bull Run Water Supply Habitat Conservation Plan Conservation Easements—Boulder Creek and Gordon Creek

Dear Ben:

I would like your affirmation about implementation of the Bull Run Water Supply Habitat Conservation Plan (HCP) conservation measures. The land ownership of several subbasins of the Sandy River watershed has changed significantly and that has complicated the implementation of conservation easements in the Boulder and Gordon creek subbasins.

Under the terms of the HCP, the City of Portland (City) needs to create conservation easements with willing private landowners for 15 acres of land in the Boulder Creek subbasin (see HCP Measure H-22 Boulder 1 Riparian Easement and Improvement). However, most of the private land in the subbasin has recently been purchased and is in the process of being conveyed to public management. There is not enough private land acreage to implement Measure H-22. The City proposes to create conservation easements in another subbasin of the Sandy River watershed to replace the benefits of Measure H-22.

The City would like to create additional conservation easements in the Gordon Creek subbasin to compensate for Measure H-22 and there is a sound biological basis for doing this. Both Boulder and Gordon creeks support steelhead, coho salmon, and cutthroat trout. The streams are similar in size and conservation easements in the drainages would produce similar habitat benefits for fish.

In addition to adding more conservation easement area in the Gordon Creek subbasin to make up for Measure H-22, the City proposes to pursue conservation easements with widths that are 200 feet. The land ownership of the Gordon Creek subbasin has also changed significantly in recent years. With the remaining land parcels the City would not be able to meet their land easement targets (78 acres in addition to the 15 acres needed from Boulder Creek) with 100 foot easement widths. The City proposes to pursue conservations easements with 200 foot widths to meet the total acreage goals of 93 acres.

Ben, please verify (via letter) that the City's approach is appropriate.

Sincerely,

Steve Kucas
Senior Environmental Program Manager

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

Refer to NMFS No.:
2008/03771

May 11, 2011

Steve Kucas
Portland Water Bureau
1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926

Re: Clarification of Bull Run Water Supply Habitat Conservation Plan Conservation Conservation Easements — Boulder Creek and Gordon Creek

Dear Mr. Kucas:

The National Marine Fisheries Service (NMFS) has received your request, dated April 26, 2011, regarding conservation easements within the Boulder Creek subbasin. We understand that due to the recent purchase of private land in the basin, the City of Portland (City) is unable to implement Conservation Measure H-22—Boulder 1 Riparian Easement and Improvement. The City has proposed to implement additional conservation easements within the Gordon Creek subbasin to compensate. In this case, NMFS supports the City's request to implement conservation easements within Gordon Creek. The streams are similar in size, contain the same species, and would provide similar benefits.

In addition, the City proposes to increase buffer zones greater to 200 feet in width for the parcels in Gordon Creek. Like Boulder Creek, there have been substantial land acquisitions in this basin and 200-foot buffers are needed to meet acreage targets. In this case, NMFS believes that the change to 200-foot buffers is warranted due to the increased ecological value that will be realized. The acreages that you protect via these conservation easements will apply to the City's overall acreage targets for the Sandy River watershed.

While NMFS supports pursuing the wider buffer widths for this subbasin, any future requests for buffers not proscribed within the HCP will need to be reviewed by NMFS on a case-by-case basis.

Questions regarding this letter should be directed to Ben Meyer, Branch Chief of the Willamette Basin Habitat Branch, at 503.230.5425.

Sincerely,

for Michael P. Tehan
Assistant Regional Administrator
Habitat Conservation Division

Appendix F, Item 2

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Randy Leonard, Commissioner
David G. Shaff, Administrator

1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926
Information: 503-823-7404
www.portlandonline.com/water

CITY OF PORTLAND OREGON 1851

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July 22, 2011

Ben Meyer
National Marine Fisheries Service
1201 NE Lloyd Blvd., Ste. 1100
Portland, OR 97232

RE: Clarification of Bull Run Water Supply Habitat Conservation Plan
Measure H-26 Boulder 0 and 1 LW Placement

Dear Ben:

I would like your affirmation about implementation of the Bull Run Water Supply Habitat Conservation Plan (HCP) conservation measures. The City of Portland (City) is not able to implement HCP Measure H-26 Boulder 0 and 1 LW Placement. To make up for the projected habitat benefits of this measure, the City would like your permission to create commensurate habitat in another Sandy River tributary by adding large wood.

The City tried very hard to implement the Boulder Creek measure. The City worked with Boulder Creek landowners for over a year, completed pre-construction stream surveys, and created site drawings that were suitable to withstand a 100-year flood event. Those designs were to be signed by a licensed professional engineer. The City presented the drawings to three landowners on Boulder Creek. Their land was ideally suitable for building large wood structures to create fish habitat. No other parcels were suitable for the large wood structures. After all of the up front design efforts, one landowner decided not to allow the City to construct the structures because it would negatively "affect their stream views." Another landowner was reluctant to sign an easement, which was necessary for the City to monitor the structures during their expected life. Because of this input, the City decided to look for stream enhancement opportunities in other Sandy River tributaries.

The City proposes to add large wood to Gordon Creek to create similar habitat that was projected with Measure H-26 Boulder 0 and 1 LW Placement. The City is already planning to add large wood to several reaches of Gordon Creek (see HCP Measure Gordon 1A and 1B LW Placement). The City would just add additional large wood pieces to the stream to make up for the habitat projected with Measure H-26.

There is a good biological justification for adding additional wood in Gordon Creek. The creek currently supports coho salmon, steelhead, fall Chinook, and cutthroat, which are the same anadromous fish species in Boulder Creek. The large wood structures would create fish habitat conditions similar to those that were anticipated in Boulder Creek. And lastly, there are enough land parcels to accommodate the additional large wood that the City plans to place in Gordon Creek.

Ben, please verify (via letter) that the City's approach is appropriate.

Sincerely,

Steve Kucas
Senior Environmental Program Manager

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

Refer to NMFS No.:
2008/03771

August 16, 2011

Steve Kucas
Senior Environmental Program Manager
City of Portland Water Bureau
1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926

Re: Clarification of Bull Run Water Supply Habitat Conservation Plan Conservation Conservation Easements — Boulder Creek and Gordon Creek

Dear Mr. Kucas:

On July 25, 2011, the National Marine Fisheries Service (NMFS) received a letter from you requesting concurrence on an issue relative to the Bull Run Water Supply Habitat Conservation Plan (HCP). Specifically, if NMFS agrees with the concept of modifying HCP Measure H-26 Boulder 0 and 1 LW Placement to place large wood in Gordon Creek rather than Boulder Creek.

The reason for the change being the unwillingness of landowners to allow the placement of the wood on their property.

NMFS has reviewed the request and believe it fits within the parameters of the HCP and agrees with your proposal.

Please direct questions regarding this letter to Ben Meyer, Chief of the Willamette Basin/Lower Columbia Branch, Oregon State Habitat Office, at 503.230.5425.

Sincerely,

Ben Meyer

Michael P. Tehan
Assistant Regional Administrator
Habitat Conservation Division

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Randy Leonard, Commissioner
David G. Shaff, Administrator

1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926
Information: 503-823-7404
www.portlandonline.com/water

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August 22, 2011

Ben Meyer
National Marine Fisheries Service
1201 NE Lloyd Blvd., Ste. 1100
Portland, OR 97232

RE: Clarification of Bull Run Water Supply Habitat Conservation Plan
Conservation Easements and Purchase of Lands in the Lower Bull Run Watershed

Dear Ben:

I would like your affirmation about implementation of the Bull Run Water Supply Habitat Conservation Plan (HCP) conservation measures. The City of Portland (City) has an opportunity to purchase lands along the lower Bull Run River. The City would like your permission to count the acreage obtained from those acquisitions towards the total conservation easement targets defined in the HCP.

Portland General Electric is transferring its lands in the lower Bull Run River to Western Rivers Conservancy (WRC), as part of its Bull Run powerhouse decommissioning process. Several of those parcels are on the lower Bull Run or the Sandy River near the confluence of the two streams. WRC has approached the City about acquisition of the properties. The City would like to consider purchasing those parcels and having the riparian buffer acreage count toward its overall conservation easement targets expressed in the HCP. The City would only count any acreage within a 100-foot buffer, from the ordinary high water mark of the river, on either side of the river. This buffer width aligns with the width expressed for the conservation easements in the HCP.

The City believes that the benefits from acquiring the land in the lower Bull Run River would directly benefit the ESA-listed fish species covered by the HCP. Four of the species (spring Chinook, fall, Chinook, coho salmon, and steelhead) all use the lower Bull Run River. The lands are mostly zoned as "forestry", which would otherwise allow commercial timber removal under Oregon's Department of Forestry rules. If the City were to acquire them, the riparian corridors would be protected and enhanced to benefit aquatic habitat. Also, the City would maintain the long-term condition of the entire parcels that they would acquire.

Ben, please verify (via letter) that the City's approach is appropriate and that the acquired riparian corridor acreage could count towards the HCP targets.

Sincerely,
Steve Kucas
Steve Kucas
Senior Environmental Program Manager

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

Refer to NMFS No.:
2008/03771

September 16, 2011

Steve Kucas
Senior Environmental Program Manager
City of Portland Water Bureau
1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926

Re: Clarification of Bull Run Water Supply Habitat Conservation Plan. Conservation Easements and Purchase of Lands in the Lower Bull Run Watershed

Dear Mr. Kucas:

On August 23, 2011, the National Marine Fisheries Service (NMFS) received a letter from you requesting concurrence on an issue relative to the Bull Run Water Supply Habitat Conservation Plan (HCP). Specifically, if NMFS agrees with allowing the purchase of some parcels along the lower Bull Run River or Sandy River near their confluence to count towards the overall conservation easement targets expressed in the HCP. The City would only count any acreage within a 100-foot buffer, from the ordinary high water mark of the river, on either side of the river. This buffer width aligns with the width expressed for the conservation easements in the HCP. Four of the species covered by the HCP (spring Chinook, fall Chinook, coho salmon, and steelhead) all use the lower Bull Run River. The lands are mostly zoned as "forestry", which would otherwise allow commercial timber removal under Oregon's Department of Forestry rules. If the City were to acquire them, the riparian corridors would be protected and enhanced to benefit aquatic habitat. Also, the City would maintain the long-term condition of the entire parcels that they would acquire.

NMFS has reviewed the request and believe it fits within the parameters of the HCP and agrees with your proposal.

Please direct questions regarding this letter to Ben Meyer, Chief of the Willamette Basin/Lower Columbia Branch of the Oregon State Habitat Office, at 503.230.5425.

Sincerely,

for Michael P. Tehan
Assistant Regional Administrator
Habitat Conservation Division