Yakima River Basin Study

Fish Benefits Analysis
Technical Memorandum

U.S. Bureau of Reclamation
Contract No. 08CA10677A ID/IQ, Plan of Study Task 7

Prepared by

U.S. Bureau of Reclamation

HDR Engineering

Anchor QEA

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

State of Washington
Department of Ecology
Office of Columbia River

May 2011

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1.0 Introduction

This technical memorandum summarizes the fish benefits analysis conducted for the Final Integrated Water Resources Management Plan of the Yakima River Basin Water Enhancement Project. The purpose of the analysis was to estimate the population abundance of anadromous salmon, steelhead and bull trout under three scenarios: the Future Without Integrated Plan, the Restoration scenario, and the Restoration with Fish Passage scenario. Each of these was also compared to a baseline condition.

1.1 Background

The U.S. Bureau of Reclamation (Reclamation) and the Washington State Department of Ecology (Ecology) convened the Yakima River Basin Water Enhancement Project Workgroup (YRBWEP) in 2009 to develop a preliminary Integrated Water Resource Management Plan (Integrated Plan) to address fisheries and water supply needs. The preliminary Integrated Plan was completed in December 2009. Jointly funded by Reclamation and Ecology under Reclamation's WaterSMART Program, the Yakima River Basin Study was initiated in 2010 to further develop the technical basis and decision support for the Integrated Plan. Task 7 of the Basin Study was to analyze the total ecosystem benefits of implementing the proposed suite of actions (i.e., tributary and mainstem habitat restoration; fish passage; and flow improvements) in the Integrated Plan.

The Yakima Basin Fish and Wildlife Recovery Board (YBFWRB), Yakama Nation, Reclamation and the supporting consultant team collaborated in scoping an approach to estimating the anadromous fish benefits for habitat, fish passage and flow improvements proposed in the preliminary Integrated Plan. This included use of the Yakima Basin Ecosystem Diagnosis and Treatment (EDT) model (see Section 2.1) that was used previously for the Yakima River Basin Water Storage Feasibility Study Final Planning Report and Environmental Impact Statement (Reclamation 2008).

For this study the EDT model was used to estimate the fish benefit for the wild (natural) anadromous salmon and steelhead population resulting from the prescribed restoration actions. The All H Analyzer (AHA) model (http://www.fws.gov/pacific/Fisheries/Hatcheryreview/documents/All-HAnalyzerDraftUsersGuideAug05.pdf) was used in conjunction with the EDT model to derive an integrated wild and hatchery population abundance estimate. Sockeye adult abundance for the five Reclamation storage reservoirs was estimated using the spawners per hectare surface area method.

1.2 Scenario Descriptions

Baseline

Baseline represents existing habitat conditions and fish population levels in the Yakima Basin. The baseline database in the Yakima Basin EDT model was updated to account for readily available information on improvements for selected stream reaches that have occurred over the past 10 years. Since this was not a comprehensive update, not all habitat actions that have occurred in recent years are reflected in the EDT model baseline for this analysis. However, the accuracy of the baseline was considered sufficient for the Integrated Plan fish benefits analysis.

Future without Integrated Plan

The Future Without Integrated Plan (FWIP) represents fish population increases from tributary fish passage, habitat and water conservation improvements that are expected to continue under current programs and funding levels. This represents an average 18 percent increase in anadromous salmon and steelhead populations in the Yakima Basin once these improvements are fully implemented, which is expected to occur over the next 10 to 15 years. The FWIP also incorporates increased water usage from

expected growth in future municipal and industrial demand, and ongoing agricultural related conservation measures.

Restoration

The Restoration scenario (Restoration) represents fish population increases from habitat improvements that would result from implementing the water conservation, habitat and tributary fish passage elements described in the Integrated Water Resources Management Plan. The actions identified in the Yakima Steelhead Recovery Plan were used in the modeling effort to characterize habitat improvements that would result from the Integrated Plan fish habitat enhancement program (Yakima Basin Fish and Wildlife Recovery Board 2009).

Restoration with Fish Passage

The Restoration with Fish Passage scenario (Restoration + Passage) represents fish population increases with the Restoration scenario plus providing fish passage at Cle Elum, Keechelus, Kachess, Bumping Lake and Tieton dams.

1.3 Modeling Approach

Three different approaches were used to analyze fish benefits for the FWIP, Restoration, and Restoration + Passage scenarios depending on the salmonid species. The EDT model was used in conjunction with the AHA model to analyze benefits for spring, summer and fall Chinook, coho and steelhead. Sockeye benefits were estimated based on the spawners per hectare of reservoir surface-area method (Reclamation [Cle Elum Sockeye] 2007) because the EDT model is not applicable to sockeye. A qualitative score card method was used to characterize both the positive and negative effects of each scenario on bull trout. Further information on methods is provided in Section 2.

2.0 Methods

2.1 Ecosystem Diagnosis and Treatment Model

The EDT model (Lestelle, Mobrand and McConnaha 2004) is a Microsoft ACCESS scientific application that represents the relationship between anadromous fish habitat quality and population performance. The model provides the user with a means to diagnose a basin's current environmental limiting factors in time (i.e. by month) and space (i.e. by stream reach or subbasin) specific to anadromous salmonid populations within a watershed. A diagnosis of current conditions is based on the rating (i.e., good to poor) of 40+ measurable environmental attributes that are rated for each stream reach in the watershed, for each month of the year. This rating system represents the condition of the current environmental landscape.

Each anadromous salmonid population experiences this landscape in a unique way due to variations in its freshwater life cycle (i.e. how a fish moves in time and space throughout the river system). As a result of this each population has a unique suite of limiting factors, though there are often commonalities across populations. . Examination of a population's limiting factors provides the basis to identify healthy and unhealthy stream reaches or subbasins specific to a salmon or steelhead population. The diagnosis provides a means to model restoration actions directed at unhealthy areas, and evaluate the resulting benefits (i.e., increased population abundance, productivity and life history diversity).

Table A-1 in Appendix A summarizes the standard EDT Level 2 attributes and their associated Level 3 attributes. Level 2 attributes are measurable abiotic or biotic parameters that are used to assess the habitat condition of every stream reach (approximately 400 stream reaches for the Yakima Basin model) for historic, current and future desired condition. Level 3 attributes are associated with a suite of Level 2

attributes that varies depending on the species and/or life stage. They provide an empirical estimate of survival (or survival improvement) by species and life stage for each stream reach. Table A-2 in Appendix A summarizes the standard EDT Level 3 attributes.

The preliminary Integrated Plan developed in 2009 provided a generalized list of habitat restoration, fish passage and flow improvement actions that could be implemented in the mainstem and tributary reaches of the Yakima River Basin. However, the study team decided that the link between specific actions and specific stream reaches needed to be stronger to sufficiently populate Level 2 attribute ratings in the EDT model. Level 2 attributes are physical (abiotic) and biological (biotic) parameters that can be measured in either quantitative or qualitative terms. For example water temperature is a physical parameter, while the risk of predation by other fishes is a biological parameter. The study team decided that the Yakima Basin Steelhead Recovery Plan (Recovery Plan) (YBFWRB 2009) provided a sufficiently detailed list of habitat restoration, fish passage, and flow improvement actions organized geographically to serve as a basis for building the Integrated Plan scenarios for the EDT model. Beyond serving to build the Integrated Plan scenarios for the EDT model, it was anticipated that this approach, which links actions in the Recovery Plan to Level 2 EDT attributes, could be incorporated into a more tangible product useful to the Yakima Basin Fish and Wildlife Recovery Board and other organizations that are active in salmon and steelhead recovery planning and implementation of restoration actions. More specifically the EDT model provides a framework for local fisheries biologists to establish a set of working hypotheses on how anadromous salmonid populations are affected by existing environmental conditions in the Yakima Basin. Since the EDT model baseline is based on measurable Level 2 attributes, local fisheries biologists are interested in using the model as a monitoring and evaluation tool to track the effectiveness (i.e., abiotic and biotic responses) of implemented restoration actions. There is also long-term interest in knowing how well the EDT model will predict an expected population response from a proposed floodplain/flow restoration action (e.g., do we see the expected population response?).

Association of Recovery Plan Actions to EDT Level 2 Attributes

The study team used Reclamation's registered version ("BOR 2010 Basin Study 08_17_10 dataset [registered]") of the EDT model (the baseline database) for all analyses, and all Integrated Plan scenarios were constructed and analyzed with the EDT model Scenario Builder (see Section 2.1.2).

The initial step was to sort the applicable Recovery Plan actions into 15 common restoration action categories (Table 2-1).

Table 2-1. Yakima Basin Steelhead Recovery Plan Action Categories Utilized

Recovery Plan Action Categories[1]	Number of Actions within Category and Their Subbasin Locations
Fish Passage	Naches - 2, Satus - 2, Toppenish - 2, Upper Yakima - 7
Fish Screens	Basin Wide - 1
Flip Flop	Naches - 1, Upper Yakima - 1
Flow	Naches - 1
Forest Health	Basin Wide - 1
Habitat	Basin Wide - 2, Lower Mainstem - 2, Naches - 15, Satus - 3, Toppenish - 3, Upper Yakima - 8
Infrastructure	Lower Mainstem - 1
Nutrients	Basin Wide - 1
Power Subordination	Lower Mainstem - 1, Upper Yakima - 1
Reservoir Operations	Basin Wide - 1, Naches - 1, Upper Yakima - 1
Roads	Naches - 1, Satus - 1, Toppenish - 1
Sediment Transport	Naches - 2
Storage	Lower Mainstem - 2, Naches- 2
Water Conservation	Basin Wide - 3, Lower Mainstem - 1, Naches - 7, Toppenish - 2, Upper Yakima - 2
Water Quality	Lower Mainstem - 1, Satus - 2, Toppenish - 1, Upper Yakima - 1

The next step was to associate each applicable Recovery Plan action to all Level 2 attributes that applied. Table 2-2 lists those EDT Level 2 attributes used to associate with the Recovery Plan actions. Table A-3 in Appendix A lists the association between the Recovery Plan actions and the EDT Level 2 attributes.

[1] The categories in Table 3-1 do not appear in the YBFWRB Recovery Plan, but were developed for organizational purposes for the Integrated Plan fisheries benefit analysis.

Table 2-2. Ecosystem Diagnosis and Treatment (EDT) Level 2 Attributes Associated with Recovery Plan Actions

Level 2 Attribute Code	Level 2 Attribute Name	Level 2 Attribute Definition
BdScour	Bed scour	Average depth of bed scour in salmonid spawning areas (i.e., in pool-tailouts and small cobble-gravel riffles) during the annual peak flow event over approximately a 10-year period. The range of annual scour depth over the period could vary substantially. Particle sizes of substrate modified from Platts et al. (1983) based on information in Gordon et a. (1991): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).
WidthMx	Channel width – month maximum width (ft)	Average width of the wetted channel during peak flow month (average monthly conditions). If the stream is braided or contains multiple channels, then the width would represent the sum of the wetted widths along a transect that extends across all channels. Note: Categories are not to be used for calculation of wetted surface area; categories here are used to designate relative stream size.
WidthMn	Channel width – month minimum width (ft)	Average width of the wetted channel. If the stream is braided or contains multiple channels, then the width would represent the sum of the wetted widths along a transect that extends across all channels. Note: Categories are not to be used for calculation of wetted surface area; categories here are used to designate relative stream size.
ConfineHdro	Confinement - Hydromodifications	The extent that man-made structures within or adjacent to the stream channel constrict flow (as at bridges) or restrict flow access to the stream's floodplain (due to streamside roads, revetments, diking or levees) or the extent that the channel has been ditched or channelized, or has undergone significant streambed degradation due to channel incision/entrenchment (associated with the process called "headcutting"). Flow access to the floodplain can be partially or wholly cutoff due to channel incision. Note: Setback levees are to be treated differently than narrow-channel or riverfront levees--consider the extent of the setback and its effect on flow and bed dynamics and micro-habitat features along the stream margin in reach to arrive at rating conclusion. Reference condition for this attribute is the natural, undeveloped state.
Emb	Embeddedness	The extent that larger cobbles or gravel are surrounded by or covered by fine sediment, such as sands, silts, and clays. Embeddedness is determined by examining the extent (as an average %) that cobble and gravel particles on the substrate surface are buried by fine sediments. This attribute only applies to riffle and tailout habitat units and only where cobble or gravel substrates occur.
FnSedi	Fine sediment	Percentage of fine sediment within salmonid spawning substrates, located in pool-tailouts, glides, and small cobble-gravel riffles. Definition of "fine sediment" here depends on the particle size of primary concern in the watershed of interest. In areas where sand size particles are not of major interest, as they are in the Idaho Batholith, the effect of fine sediment on egg to fry survival is primarily associated with particles <1mm (e.g., as measured by particles <0.85 mm). Sand size particles (e.g., <6 mm) can be the principal concern when excessive accumulations occur in the upper stratum of the stream bed (Kondolf 2000). See guidelines on possible benefits accrued due to gravel cleaning by spawning salmonids.
FlwHigh	Flow - change in average annual peak flow	The extent of relative change in average peak annual discharge compared to an undisturbed watershed of comparable size, geology, orientation, topography, and geography (or as would have existed in the pristine state). Evidence of change in peak flow can be empirical where sufficiently long data series exists, can be based on indicator metrics (such as TQmean, see Konrad [2000]), or inferred from patterns corresponding to watershed development. Relative change in peak annual discharge here is based on changes in the peak annual flow expected on average once every two years (Q2yr).

Table 2-2. Ecosystem Diagnosis and Treatment (EDT) Level 2 Attributes Associated with Recovery Plan Actions (continued)

Level 2 Attribute Code	Level 2 Attribute Name	Level 2 Attribute Definition
FlwLow	Flow - change in average annual low flow	The extent of relative change in average daily flow during the normal low flow period compared to an undisturbed watershed of comparable size, geology, and flow regime (or as would have existed in the pristine state). Evidence of change in low flow can be empirically-based where sufficiently long data series exists, or known through flow regulation practices, or inferred from patterns corresponding to watershed development. Note: low flows are not systematically reduced in relation to watershed development, even in urban streams (Konrad 2000). Factors affecting low flow are often not obvious in many watersheds, except in clear cases of flow diversion and regulation.
HbBckPls	Habitat type – backwater pools	Percentage of the wetted channel surface area comprising backwater pools.
HbBvrPnds	Habitat type - beaver ponds	Percentage of the wetted channel surface area comprising beaver ponds. Note: these are pools located in the main or side channels, not part of off-channel habitat.
HbGlide	Habitat type - glide	Percentage of the wetted channel surface area comprising glides. Note: There is a general lack of consensus regarding the definition of glides (Hawkins et al. 1993), despite a commonly held view that it remains important to recognize a habitat type that is intermediate between pool and riffle. The definition applied here is from the ODFW habitat survey manual (Moore et al. 1997): an area with generally uniform depth and flow with no surface turbulence, generally in reaches of <1% gradient. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. They are generally deeper than riffles with few major flow obstructions and low habitat complexity.
HbLrgCbl	Habitat type - large cobble/boulder riffles	Percentage of the wetted channel surface area comprising large cobble/boulder riffles. Particle sizes of substrate modified from Platts et al. (1983) based on information in Gordon et a. (1991): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).
HbOfChFctr	Habitat type - off-channel habitat factor	A multiplier used to estimate the amount of off-channel habitat based on the wetted surface area of the all combined in-channel habitat.
HbPlTails	Habitat type - pool tailouts.	Percentage of the wetted channel surface area comprising pool tailouts.
HbPls	Habitat type - primary pools	Percentage of the wetted channel surface area comprising pools, excluding beaver ponds
HbSmlCbl	Habitat type - small cobble/gravel riffles	Percentage of the wetted channel surface area comprising small cobble/gravel riffles. Particle sizes of substrate modified from Platts et al. (1983) based on information in Gordon et a. (1991): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).
MscToxWat	Miscellaneous toxic pollutants - water column	The extent of miscellaneous toxic pollutants (other than heavy metals) within the water column.
NutEnrch	Nutrient enrichment	The extent of nutrient enrichment (most often by either nitrogen or phosphorous or both) from anthropogenic activities. Nitrogen and phosphorous are the primary macro-nutrients that enrich streams and cause build ups of algae. These conditions, in addition to leading to other adverse conditions, such as low DO can be indicative of conditions that are unhealthy for salmonids. Note: care needs to be applied when considering periphyton composition since relatively large mats of green filamentous algae can occur in Pacific Northwest streams with no nutrient enrichment when exposed to sunlight.

Table 2-2. Ecosystem Diagnosis and Treatment (EDT) Level 2 Attributes Associated with Recovery Plan Actions (continued)

Level 2 Attribute Code	Level 2 Attribute Name	Level 2 Attribute Definition
Obstr	Obstructions to fish migration	Obstructions to fish passage by physical barriers (not dewatered channels or hindrances to migration caused by pollutants or lack of oxygen).
PredRisk	Predation risk	Level of predation risk on fish species due to presence of top level carnivores or unusual concentrations of other fish eating species. This is a classification of per-capita predation risk, in terms of the likelihood, magnitude and frequency of exposure to potential predators (assuming other habitat factors are constant). NOTE: This attribute is being updated to distinguish risk posed to small bodied fish (<10 in) from that to large bodied fish (>10 in).
Regulated flow decrease	FlwRegDecrease	The month-specific combination of a negative deviation of relative mean monthly flow and the relative variability of mean daily flows for the same month. Deviations of mean flows and flow variabilities are expressed relative to unregulated flows that could be expected under the same set of land use conditions. The metric used to describe the attribute is derived from a Z-score of regulated and unregulated mean monthly flows and a ratio of the Coefficient of Variation (CV) of regulated to unregulated mean daily flows.
Regulated flow increase	FlwRegIncrease	The month-specific combination of a positive deviation of relative mean monthly flow and the relative variability of mean daily flows for the same month. Deviations of mean flows and flow variabilities are expressed relative to unregulated flows that could be expected under the same set of land use conditions. The metric used to describe the attribute is derived from a Z-score of regulated and unregulated mean monthly flows and a ratio of the Coefficient of Variation (CV) of regulated to unregulated mean daily flows.
RipFunc	Riparian function	A measure of riparian function that has been altered within the reach.
SalmCarcass	Salmon Carcasses	Relative abundance of anadromous salmonid carcasses within watershed that can serve as nutrient sources for juvenile salmonid production and other organisms. Relative abundance is expressed here as the density of salmon carcasses within subdrainages (or areas) of the watershed, such as the lower mainstem vs the upper mainstem, or in mainstem areas vs major tributary drainages.
TmpMonMx	Temperature - daily maximum (by month)	Maximum water temperatures within the stream reach during a month.
TmpMonMn	Temperature - daily minimum (by month)	Minimum water temperatures within the stream reach during a month.
TmpSptVar	Temperature – spatial variation	The extent of water temperature variation (cool or warm water depending upon season) within the reach as influenced by inputs of groundwater or tributary streams, or the presence of thermally stratified deep pools.

Table 2-2. Ecosystem Diagnosis and Treatment (EDT) Level 2 Attributes Associated with Recovery Plan Actions (continued)

Level 2 Attribute Code	Level 2 Attribute Name	Level 2 Attribute Definition
Turb	Turbidity	The severity of suspended sediment (SS) episodes within the stream reach. (Note: this attribute, which was originally called turbidity and still retains that name for continuity, is more correctly thought of as SS, which affects turbidity.) SS is sometimes characterized using turbidity but is more accurately described through suspended solids, hence the latter is to be used in rating this attribute. Turbidity is an optical property of water where suspended, including very fine particles such as clays and colloids, and some dissolved materials cause light to be scattered; it is expressed typically in nephelometric turbidity units (NTU). Suspended solids represents the actual measure of mineral and organic particles transported in the water column, either expressed as total suspended solids (TSS) or suspended sediment concentration (SSC)—both as mg/l. Technically, turbidity is not SS but the two are usually well correlated. If only NTUs are available, an approximation of SS can be obtained through relationships that correlate the two. The metric applied here is the Scale of Severity (SEV) Index taken from Newcombe and Jensen (1996), derived from: SEV = a + b(lnX) + c(lnY) , where, X = duration in hours, Y = mg/l, a = 1.0642 , b = 0.6068, and c = 0.7384. Duration is the number of hours out of month (with highest SS typically) when that concentration or higher normally occurs. Concentration would be represented by grab samples reported by USGS. See rating guidelines.
Wdrwl	Water withdrawals	The number and relative size of water withdrawals in the stream reach.
WdDeb	Wood	The amount of wood (large woody debris or LWD) within the reach. Dimensions of what constitutes LWD are defined here as pieces >0.1 m diameter and >2 m in length. Numbers and volumes of LWD corresponding to index levels are based on Peterson et al. (1992), May et al. (1997), Hyatt and Naiman (2001), and Collins et al. (2002). Note: channel widths here refer to average wetted width during the high flow month (< bank full), consistent with the metric used to define high flow channel width. Ranges for index values are based on LWD pieces/CW and presence of jams (on larger channels). Reference to "large" pieces in index values uses the standard TFW definition as those > 50 cm diameter at midpoint.

After associating each Recovery Plan action to one or more EDT Level 2 attributes, the next step was to determine which EDT stream reaches were affected by each specific Recovery Plan action. This step was further refined to associate specific EDT Level 2 attributes to specific EDT stream reaches (see Table A-4 in Appendix A). For some stream reaches there was no prescribed restoration action(s) identified in the Recovery Plan that could be applied for this analysis. The upper Ahtanum and upper Tieton (above the reservoir) subbasins, and Wide Hollow, Wenas, Snipes and Spring creeks were the main geographic areas where no restoration action(s) identified were in the Recovery Plan.

Determination of Action Effectiveness

The EDT Scenario Builder is a Microsoft ACCESS application that allows the user to define a suite of restoration actions that can be packaged in different configurations to create a unique EDT scenario. Thirty-four Scenario Builder defined actions were constructed for the Integrated Plan anadromous fish benefit analysis. These actions represented application of the Recovery Plan actions and their associated Level 2 attributes to specific EDT-defined stream reaches for a geographic area, typically a subbasin or a portion of the Yakima and Naches rivers mainstems (Table 2-3.).

Table 2-3 Defined Actions (Geographic Areas) used in the EDT Scenario Builder

Above Reservoir Carcass Abundance	Mid Yakima – Satus to Ahtanum Creek
Ahtanum Creek	Naches Mainstem
American River	Nile Creek
Big and Little Creeks	Rattlesnake Creek
Bumping River	Reservoir passage basin wide
Bumping Reservoir Tributary Passage	Satus Creek
Cle Elum River	South Fork Tieton
Cowiche Creek	Swauk Creek
Deep Creek	Taneum Creek
Deep Creek/Bumping Creek Inundation	Teanaway River
Gold Creek	Tieton River
Kachess River	Toppenish Creek
Little Naches	Tributaries with summer dewatered reach(es)
Lower Yakima – Below Prosser	Tributary dams and blockages
Lower Yakima – Prosser to Satus Creek	Upper Cle Elum
Manastash Creek	Yakima Mainstem Flow
Mid Yakima – Ahtanum to Roza Dam	Wilson Creek

The Scenario Builder generates several types of reports that display in various ways how much and why fish population performance improved.

Construction of an action requires the user to define what EDT stream reaches and which Level 2 attributes would be affected by the proposed restoration action, which in this case referred back to the Recovery Plan actions. The user also must determine how effective the action would be toward improving baseline (current) habitat conditions back toward the historic condition. The historic condition in the EDT model is defined as the state of the environment prior to European settlement and development. In the Scenario Builder, effectiveness is expressed as a percent improvement relative to the historic condition (e.g., how much can the baseline condition be improved back toward the historic condition). Based on this approach, the absolute increase in restoration benefit is less for more pristine stream reaches with little change from historic conditions, while the benefit progressively increases the more degraded the stream reach is compared to its historic condition.

Project time constraints required the development of a method that expedited the assignment of an effectiveness value to each EDT stream reach for a suite of proposed restoration actions. The traditional method would be to focus on a single stream reach and, through group discussion, determine the level of effectiveness based on the stream reach location, specific stream reach constraints and the proposed suite of restoration actions. For this analysis a more generalized approach was taken that considered primarily land use designation and land ownership Each stream reach was classified according to the following three categories of restoration effectiveness:

- Low – Reaches with a high amount of permanent infrastructure (e.g., highways, cities)
- Medium – Reaches of mixed land ownership with predominately rural or agricultural land-use practices
- High – Reaches located mostly under public land ownership with few constraints to successful restoration.

The majority of stream reaches were classified by the study team in the medium effectiveness category. The study team recognized there was much more variation in restoration potential for medium classified stream reaches than for the other two categories. Variability in factors such as an agency's ability to execute a project based on financial, staff levels and authorization capabilities; the number of landowners involved; and the political will of the community and local, state and federal agencies were deemed by the study team to have a greater influence on determining restoration effectiveness for stream reaches classified in the medium category. For this reason the study team decided to create three effectiveness levels to capture the wide restoration potential for medium classified stream reaches.

The following values were agreed upon for each restoration effectiveness category:

- Low Effectiveness – 15 percent
- Medium Effectiveness – 30 percent, 50 percent or 70 percent
- High Effectiveness – 85 percent

The EDT model has three types of Level 2 attributes: 1) index attributes (e.g. water temperature and bed scour) that rate habitat conditions on a 0.0 to 4.0 scale, where 0 is considered pristine and 4 highly degraded; 2) non-proportional attributes (e.g. minimum and maximum channel width), which are directly measurable; and 3) proportional attributes totaling 100 percent of a stream reach's surface area (i.e. the percent composition of habitat types such as pool, riffle, glide, etc.). Except for the Level 2 Salmon Carcass attribute, restoration effectiveness was applied the same for all three Level 2 attribute types as expressed in the following equation:

(Index Attribute Rating A_{CC} - Index Attribute Rating A_{HC}) x Percent Effectiveness

Where,

Index Attribute Rating A_{HC} = The historic attribute rating (e.g., 0.5),

Index Attribute Rating A_{CC} = The current attribute rating (e.g., 3.5), and

Percent Effectiveness = The applied restoration effectiveness value for that specific Level 2 attribute and stream reach.

Restoration effectiveness for the Salmon Carcass Level 2 attribute was more complicated than simply applying the habitat restoration effectiveness rating associated with each EDT stream reach. The specific stream reach restoration effectiveness value was modified by considering 1) the additional benefit of multiple salmon and steelhead species spawning within a stream reach, and 2) the cumulative benefit of the proposed habitat restoration actions on habitat capacity and habitat productivity.

2.2 EDT Numeric Fish Benefits Using All H Analyzer Model

The AHA model was used in conjunction with the EDT Productivity and Capacity output parameters for the spring, fall and summer Chinook, coho and steelhead populations, plus any associated hatchery programs, to estimate the annual minimum, mean and maximum adult recruitment, harvest, number of fish to the Yakima River mouth and total escapement. This method was used to estimate fish abundance numbers for the baseline, FWIP, Restoration, and Restoration + Passage scenarios.

The AHA model was initiated by the Washington Department of Fish and Wildlife (WDFW) and the Northwest Indian Fisheries Commission (NWIFC), and developed by the Hatchery Science Review Group (HSRG) to facilitate the discussion of strategy options to restore and manage salmon populations in the Pacific Northwest. The model allows managers to explore the implications of different ways of balancing habitat restoration, hatchery practices, harvest, and the operation of hydroelectric dams. For this analysis the AHA model was used to integrate the natural and hatchery populations to estimate total

fish abundance by species for each of the four categories: adult recruitment, harvest, number of fish to the Yakima River mouth and total escapement.

Below is a definition for each of the four categories used in the analysis:

- **Recruitment** – Population that returns from the ocean to the mouth of the Columbia River.
- **Harvest –** Includes Columbia River commercial, sport and Tribal harvest and Yakima River sport and Tribal harvest; but no migratory losses.
- **Yakima River Mouth** – Population that returns to the mouth less Columbia River harvest and migratory losses.
- **Escapement** – Population that returns to Yakima River spawning grounds after harvest and migratory losses.

As stated previously FWIP fish abundance numbers were based on an 18 percent average increase from baseline fish abundance estimates, based on the expected level of ongoing restoration action in the near term (approximately 10 to 15 years).

2.3 Spawner per Hectare Method for Estimating Sockeye Abundance

The spawner per hectare method (Reclamation [Cle Elum Sockeye] 2007) was used to estimate adult sockeye abundance for the five Reclamation storage reservoirs. Application of this method to estimate adult sockeye abundance is based on the observed range of 10 to 30 sockeye spawners per hectare of lake surface area for Frazer River Lakes (Burgner 1991). A value of 30 spawners per hectare was used for this analysis, which represents the upper range of observed sockeye spawner density per hectare by Burgner.

The low abundance estimate was based on:

- median[2] reservoir pool
- 5% egg-to-smolt survival rate
- 1% smolt-to-adult survival rate

The medium abundance estimate was based on:

- full reservoir pool[3]
- 5% egg-to-smolt survival rate
- 2% smolt-to-adult survival rate

The high abundance estimate was based on:

- full reservoir pool[3]
- 5% egg-to-smolt survival rate
- 4% smolt-to-adult survival rate

[2] Median reservoir pool represents the amount of reservoir surface area analyzed over several years that is greater than this amount 50% of the time and less than this amount of surface area 50% of the time.

[3] Maximum pool level was deemed appropriate for these estimates due to the high water levels generally coinciding with late fall through winter spawning and incubation of sockeye. Reservoir area and pool elevation is expected to be less limiting for sockeye fry and smolts during the summer, when water levels are lower.

The parameters used to estimate low adult abundance for the five storage reservoirs is presented in Table 2-4; while Table 2-5 presents medium and high adult abundance for the five storage reservoirs. Estimated adult abundance was calculated as the product of the following equation:

Adult Abundance = Surface Area x Spawners/ha x Sex Ratio x Fecundity x $Surv_{egg\text{-}smolt}$ x $Surv_{smolt\text{-}adult}$

Where,

Surface Area=Reservoir pool surface area (ha), used full and median pool surface area;

Spawners/ha=Number of spawners per hectare of reservoir pool surface area; used 30 fish;

Sex Ratio=Ratio of females to males; used 1:1 sex ratio;

Fecundity=Number of eggs per female; used 2,700 eggs per female;

$Surv_{egg\text{-}smolt}$=Percent egg-to-smolt survival rate; used 5%; and

$Surv_{smolt\text{-}adult}$=Percent smolt-to-adult survival rate; used 1% or 2% or 4%.

Table 2-4. Summary of Parameters used to Estimate Low Adult Sockeye Abundance in Reclamation Storage Reservoirs

Calculation Parameters	Keechelus	Kachess	Cle Elum	Tieton	Enlarged Bumping
Median Surface Area (hectares)	671	1,618	1,515	745	994
No. of Spawners (30 fish/hectare)	20,130	48,540	45,450	22,350	29,816
No. of females (1:1 sex ratio)	10,065	24,270	22,725	11,175	29,816
No. of eggs (2,700 eggs/female)	27,175,500	65,529,000	61,357,500	30,172,500	40,251,549
No. of smolts (egg-smolt survival 5 percent)	1,358,775	3,276,450	3,067,875	1,508,625	2,012,577
No. of Adults at 1 percent SAR	13,588	32,765	30,679	15,086	20,126
Total low abundance all reservoirs	112,243				

SAR = Smolt-to-Adult Survival Rate

Table 2-5. Summary of Parameters used to Estimate Medium and High Adult Sockeye Abundance in Reclamation Storage Reservoirs

Calculation Parameters	Keechelus	Kachess	Cle Elum	Tieton	Enlarged Bumping
Full Surface Area (hectares)	1,319	2,585	1,948	1,393	1,166
No. of Spawners (30 fish/hectare)	39,562	77,539	58,440	41,796	34,980
No. of females (1:1 sex ratio)	19,781	38,769	29,220	20,898	34,980
No. of eggs (2,700 eggs/female)	53,409,232	104,677,646	78,894,000	56,423,995	47,222,568
No. of smolts (egg-smolt survival 5 percent)	2,670,462	5,233,882	3,944,700	2,821,200	2,361,128
No. of Adults at 2 percent SAR	53,409	104,678	78,894	56,424	47,223
Total medium abundance all reservoirs	340,627				
No. of Adults at 4 percent SAR	106,818	209,355	157,788	112,848	94,445
Total high abundance all reservoirs	681,255				

SAR = Smolt-to-Adult Survival Rate

3.0 Results and Discussion

3.1 EDT Model Diagnosis

An EDT diagnosis is specific to a particular anadromous salmonid population and expresses through the affected Level 3 attributes the biological benefit to that population as a result of a restoration action(s). A specific restoration action(s) may or may not affect the same Level 3 attribute or to the same degree for two different salmonid populations residing within the same subbasin. For example, if a restoration action(s) affected Level 3 attributes "Key Habitat" and "Sediment Load" for the Upper Yakima Spring Chinook population, they may or may not affect the Upper Yakima Steelhead population; and if they do, the degree of impact will likely be different for each population.

Diagnostic results are presented for only the Restoration + Passage scenario and for eight of the 16 modeled anadromous salmonid populations, which collectively represent the benefits of the restoration and fish passage actions of the Integrated Plan for the four major geographic regions of the basin. Results are only needed for the Restoration + Passage scenario because the FWIP and Restoration scenarios are both subsets of this scenario.

The eight selected populations include the following:

- Upper Yakima – Upper Yakima spring Chinook and Upper Yakima Steelhead
- Naches – Naches spring Chinook and Naches Steelhead
- Middle/Lower Yakima – Lower Yakima Fall Chinook and Yakima Summer Chinook
- Toppenish – Toppenish Steelhead
- Satus – Satus Steelhead

These populations were selected and presented below because they generally use the full range of habitat used by all anadromous salmonid populations in the Yakima River Basin (i.e., mainstem and tributaries). Appendix B summarizes the diagnostic results for the remaining eight anadromous populations.

Diagnostic results are organized by user defined geographic areas (GAs), and the greater the geographic range of the fish population the greater the number of GAs. Results presented below consist of percent improvement in two metrics: 1) population abundance and 2) population productivity, which was calculated for each geographic area and presented for the five highest-ranked areas. Results for the five topmost ranked GAs will be presented, since they capture the majority of benefit ascribed to the population resulting from the applied restoration actions.

Percent improvement in abundance and productivity is the biological expression of the benefit of improved population performance as a result of the restoration and fish passage actions modeled for the Restoration + Passage scenario.

The geographic area rank is the average of the abundance rank and productivity rank generated by the EDT model for each geographic area for each population. The significance of the geographic area rank is to provide an understanding of the relative importance of a particular area's contribution to the overall improved population performance. Factors that influence the relative importance of one geographic area over another include:

- Extent of restoration actions within the geographic area
- Amount of utilization (i.e., time and space) by the salmonid population within the area
- Size of the geographic area

- Location (i.e., headwater, lower river and tributary) of the geographic area within the Yakima Basin

Upper Yakima Spring Chinook

Table 3-1 shows the relative benefit to the Upper Yakima Spring Chinook population from proposed Integrated Plan actions by geographic area. Table 3-2 shows, by geographic area, the Level 3 attributes and degree of improvement (i.e., high, medium, low or none) that contributed to the improved population performance.

The top five geographic areas that influenced Upper Yakima Spring Chinook population performance from the proposed actions in the Restoration + Passage scenario were:

First: The Lower Cle Elum geographic area showed the greatest benefit to overall population performance. Abundance increased 26 percent and productivity 15 percent, largely attributed to providing fish passage (Obstruction) at Cle Elum Dam, which would allow access to upstream habitat (Key Habitat).

Second: The Upper Yakima area increased 18 percent in abundance and 40 percent in productivity due to improved fish passage at mainstem diversion dams, an increase in the amount of Key Habitat, and improvement to Sediment Load and Habitat Diversity.

Third: The Yakima Lower Wapato Floodplain area increased 8 percent in abundance and 3 percent in productivity, primarily due to an increase in the amount of Key Habitat.

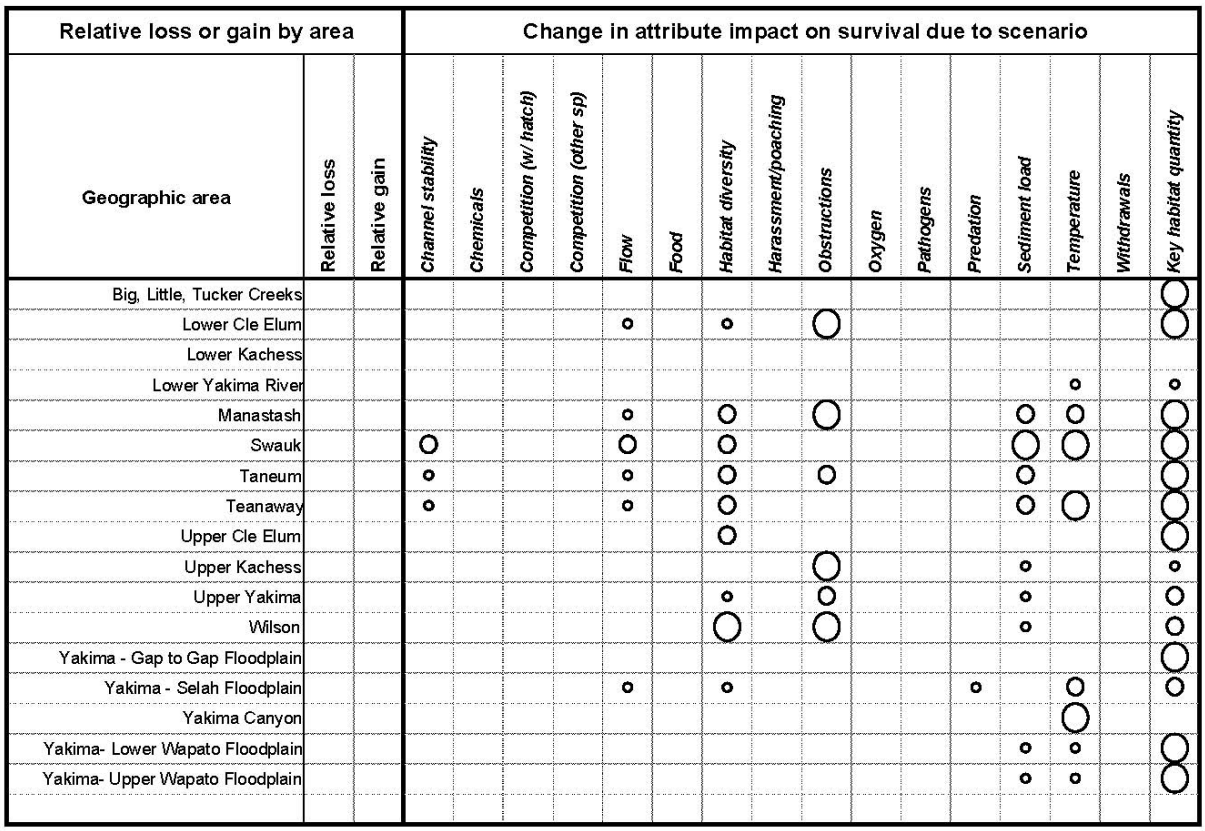
Fourth: The Teanaway area increased 20 percent in abundance and 2 percent in productivity due to improvements in Key Habitat and Temperature, and to a lesser extent improved Habitat Diversity, Sediment Load, Channel Stability, and Flow.

Fifth: The Lower Yakima River area increased 5 percent in abundance and 2 percent in productivity, primarily due to an increase the amount of Key Habitat and improved water temperatures, and to a lesser extent improved Habitat Diversity, Sediment Load, Channel Stability, and Flow.

Table 3-1. Benefit to Upper Yakima Spring Chinook Population from Proposed Integrated Plan Actions by Geographic Area

Geographic Area	Average Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Lower Cle Elum	1.5	26.2%	1	15.4%	2
Upper Yakima	2	17.6%	3	39.8%	1
Yakima – Lower Wapato Floodplain	3.5	8.3%	4	3.3%	3
Teanaway	4	19.9%	2	1.6%	6
Lower Yakima River	5	4.7%	6	2.4%	4
Yakima – Upper Wapato Floodplain	6.5	6.3%	5	1.4%	8
Taneum	7	3.2%	9	1.7%	5
Wilson	8.5	4.0%	7	0.0%	10
Yakima – Selah Floodplain	9	3.9%	8	0.0%	10
Yakima – Gap to Gap Floodplain	10	2.6%	10	0.0%	10
Manastash	10.5	2.6%	11	0.0%	10
Upper Kachess	10.5	1.3%	14	1.6%	7
Swauk	11	2.0%	13	0.2%	9
Yakima Canyon	11	2.1%	12	0.0%	10
Big, Little, Tucker Creeks	12.5	0.2%	15	0.0%	10
Lower Kachess	13	0.0%	16	0.0%	10
Upper Cle Elum	13	0.0%	16	0.0%	10

Table 3-2. Upper Yakima Spring Chinook – Summary of Scenario Effects on Survival Factors and Overall Performance



Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Upper Yakima Steelhead

Table 3-3 shows the relative benefit to the Upper Yakima Steelhead population from proposed actions in the Integrated Plan by geographic area. Table 3-4 shows, by geographic area, the Level 3 attributes and extent of improvement that contributed to the improved change in population performance. The top five geographic areas that influenced Upper Yakima Steelhead population performance from the proposed actions in the Restoration + Passage scenario were:

First: The Taneum geographic area increased 38 percent in abundance and 53 percent in productivity due to improved fish passage (Obstructions) at diversion dams and access to upstream habitat (Key Habitat). Other attributes that showed lesser improvement were Sediment Load, Channel Stability, Flow and Habitat Diversity. (At the time of this writing fish passage improvements had been completed for all but for the Brain Ranch ford crossing).

Second: The Teanaway area increased 49 percent in abundance and 21 percent in productivity, primarily due to improved Temperature and Key Habitat. Other improved attributes were Channel Stability, Sediment Load, Habitat Diversity and Pathogens.

Third: The Lower Cle Elum area increased 46 percent in abundance and 14 percent in productivity due to provision of fish passage (Obstructions) at Cle Elum Dam and an increase in the amount of Key Habitat.

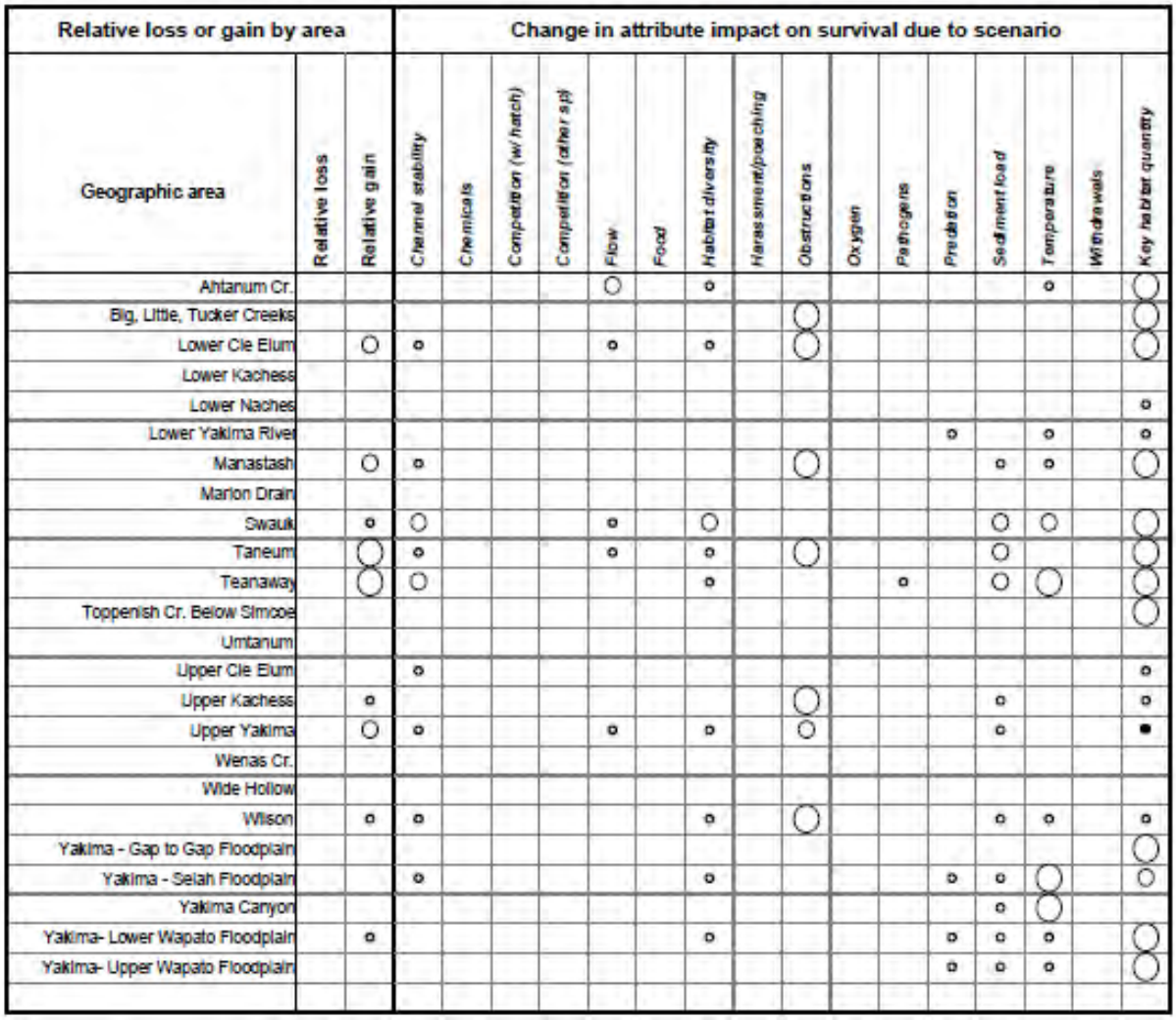
Fourth: The Upper Yakima area increased 25 percent in abundance and 17 percent in productivity due to improvements in Obstructions, Channel Stability, Flow, Habitat Diversity, Sediment Load, and Key Habitat.

Fifth: The Manastash area increased 30 percent in abundance and 13 percent in productivity due to the provision of fish passage (Obstructions) at several diversion dams and an increase in the amount of Key Habitat. Other minor improved attributes were Channel Stability, Sediment Load, and Temperature.

Table 3-3. Benefit to Upper Yakima Steelhead Population from Proposed Integrated Plan Actions by Geographic Area

Geographic Area	Average Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Taneum	1	52.6%	1	37.6%	1
Teanaway	2	49.1%	2	21.1%	2
Lower Cle Elum	3.5	46.1%	4	14.0%	3
Upper Yakima	4	24.5%	3	17.2%	5
Manastash	4.5	30.0%	5	12.7%	4
Swauk	6.5	13.8%	6	4.4%	7
Upper Kachess	8	6.4%	7	3.5%	9
Yakima – Lower Wapato Floodplain	8	8.0%	8	1.6%	8
Wilson	8.5	24.1%	11	0.3%	6
Lower Yakima River	9.5	4.7%	9	1.0%	10
Yakima – Upper Wapato Floodplain	10.5	2.9%	10	0.5%	11
Lower Naches	13.5	0.9%	14	0.0%	13
Yakima – Gap to Gap Floodplain	13.5	0.6%	12	0.1%	15
Yakima – Selah Floodplain	13.5	1.9%	15	0.0%	12
Yakima Canyon	14.5	0.6%	15	0.0%	14
Ahtanum Creek	15	0.0%	13	0.0%	17
Umtanum	15.5	0.0%	15	0.0%	16
Big, Little, Tucker Creeks	16	0.0%	15	0.0%	17
Lower Kachess	16	0.0%	15	0.0%	17
Marion Drain	16	0.0%	15	0.0%	17
Toppenish Creek below Simcoe	16	0.0%	15	0.0%	17
Upper Cle Elum	16	0.0%	15	0.0%	17
Wenas Creek	16	0.0%	15	0.0%	17
Wide Hollow	16	0.0%	15	0.0%	17

Table 3-4. Upper Yakima Summer Steelhead – Summary of Scenario Effects on Survival Factors and Overall Performance



Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Naches Spring Chinook

Table 3-5 shows the relative benefit to the Naches Spring Chinook population from proposed actions in the Integrated Plan by geographic area. Table 3-6 shows, by geographic area, the Level 3 attributes and degree of improvement that contributed to the improved change in population performance.

The top five geographic areas that influenced Naches Spring Chinook population performance from the proposed actions in the Restoration + Passage scenario were:

First (Tie): The Lower and Upper Naches geographic areas showed an increase in abundance of 107 percent and 40 percent respectively, and for productivity 50 percent and 53 percent respectively. For both geographic areas improvements in summer water temperature and the amount of Key Habitat were the key attributes responsible for increased population performance. Lesser improved attributes for the Lower Naches geographic area were Habitat Diversity, Sediment Load, Flow, Food and Harassment/Poaching, and for the Upper Naches geographic area they were Habitat Diversity and Sediment Load.

Third: The Little Naches area increased 32 percent in abundance and 47 percent in productivity, primarily due to improved Habitat Diversity, Sediment Load, Temperature, and Key Habitat, and to a lesser degree Flow.

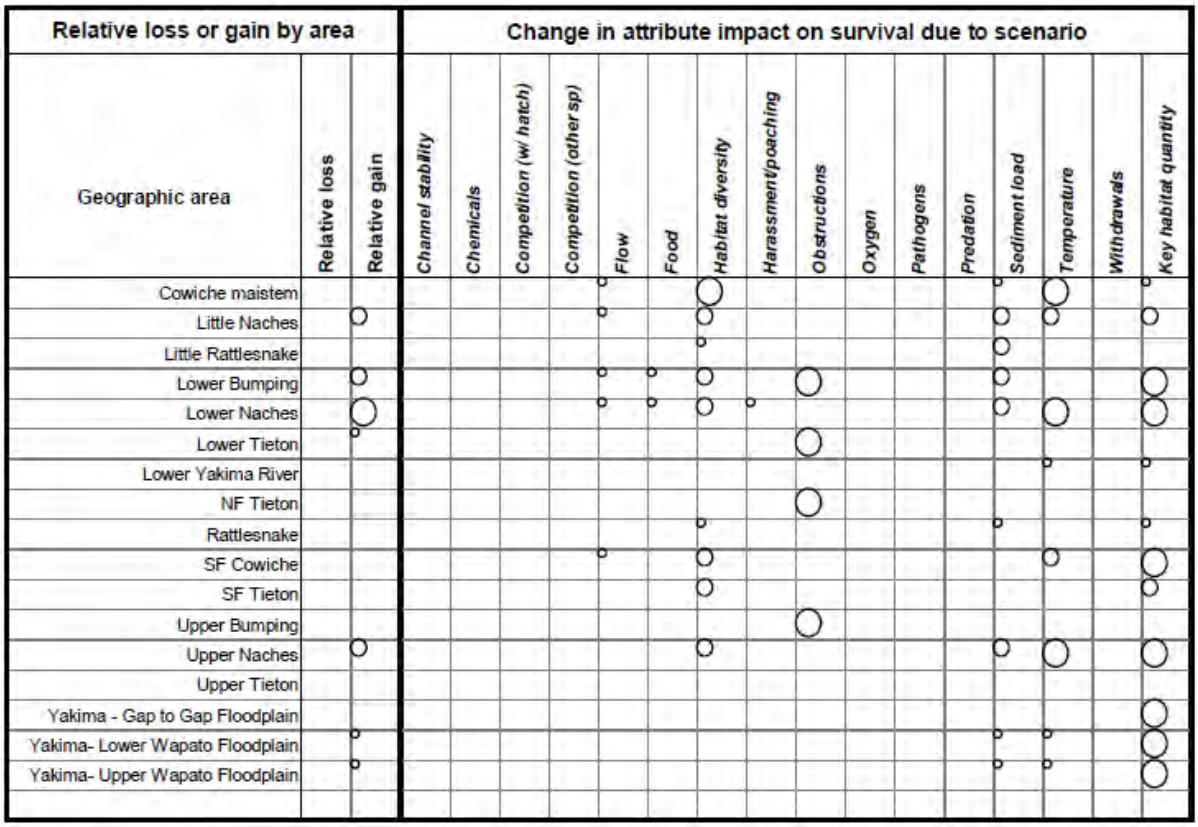
Fourth: The Lower Bumping area increased 27 percent in both abundance and productivity, primarily due to provision of fish passage (Obstructions) past Bumping Dam and an increase in the amount of Key Habitat. Other improved contributing attributes were Habitat Diversity, Sediment Load, Flow, and Food.

Fifth: The Lower Tieton area increased 17 percent in abundance and 2 percent in productivity, primarily due to provision of fish passage at Tieton Dam. Other improved attributes were passage improvement (Obstructions) at Tieton Dam and Flow.

Table 3-5. Benefit to Naches Spring Chinook population from Proposed Integrated Plan Actions by Geographic Area

Geographic Area	Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Lower Naches	1.5	106.6%	1	50.0%	2
Upper Naches	1.5	40.4%	2	53.3%	1
Little Naches	3	31.9%	3	46.8%	3
Lower Bumping	4	27.0%	4	27.5%	4
Lower Tieton	6	17.2%	5	2.2%	7
Yakima – Lower Wapato Floodplain	6	14.5%	7	3.2%	5
Lower Yakima River	7.5	5.6%	9	2.4%	6
Yakima – Upper Wapato Floodplain	7.5	15.4%	6	1.7%	9
Rattlesnake	9	2.8%	10	2.1%	8
Yakima - Gap to Gap Floodplain	9	9.3%	8	1.1%	10
Cowiche mainstem	11.5	2.7%	11	0.0%	12
Little Rattlesnake	11.5	0.2%	12	0.2%	11
NF Tieton	12.5	0.0%	13	0.0%	12
SF Cowiche	12.5	0.0%	13	0.0%	12
SF Tieton	12.5	0.0%	13	0.0%	12
Upper Bumping	12.5	0.0%	13	0.0%	12
Upper Tieton	12.5	0.0%	13	0.0%	12

Table 3-6. Naches Spring Chinook – Summary of Scenario Effects on Survival Factors and Overall Performance



Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Naches Steelhead

Table 3-7 shows the relative benefit to the Naches Steelhead population from proposed actions in the Integrated Plan by geographic area. Table 3-8 shows, by geographic area, the Level 3 attributes and degree of improvement that contributed to the improved change in population performance.

The top five geographic areas that influenced Naches Steelhead population performance from the proposed actions in the Restoration + Passage scenario were:

First: The Little Naches geographic area increased 28 percent in abundance and 16 percent in productivity due to improved Sediment Load, Key Habitat, Channel Stability, Habitat Diversity, and Temperature.

Second: The Lower Naches area increased 22 percent in abundance and 5 percent in productivity, primarily due to an increase in Key Habitat, followed by improved Channel Stability, Sediment Load, Temperature, and Habitat Diversity.

Third: The Upper Naches area increased 19 percent in abundance and 10 percent in productivity due to the same suite of attributes as for the Lower Naches geographic area.

Fourth: The Little Rattlesnake increased 4 percent in abundance and 2 percent in productivity due to actions that improved Sediment Load.

Fifth: The Yakima Lower Wapato Floodplain increased 8 percent in abundance and 1 percent in productivity, primarily due to an increase in Key Habitat and to a lesser degree Habitat Diversity, Predation, Sediment Load, and Temperature.

Table 3-7. Benefit to Naches Steelhead Population from Proposed Integrated Plan Actions by Geographic Area

Geographic Area	Average Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Little Naches	1	28.5%	1	16.2%	1
Lower Naches	2.5	21.8%	2	5.5%	3
Upper Naches	2.5	19.4%	3	10.4%	2
Little Rattlesnake	5.5	4.1%	7	2.4%	4
Yakima – Lower Wapato Floodplain	5.5	8.5%	5	1.4%	6
Lower Bumping	7	5.6%	6	1.0%	8
Lower Tieton	7.5	9.5%	4	0.2%	11
Oak Cr	8	2.6%	11	1.4%	5
Rattlesnake	8.5	2.9%	10	1.2%	7
Lower Yakima River	9	3.8%	8	0.4%	10
Yakima – Upper Wapato Floodplain	9	3.1%	9	0.4%	9
Yakima – Gap to Gap Floodplain	12.5	0.7%	12	0.0%	13
Yakima – Selah Floodplain	13	0.3%	13	0.0%	13
Ahtanum Creek	13.5	0.0%	15	0.0%	12
NF Cowiche	13.5	0.0%	14	0.0%	13
American	14	0.0%	15	0.0%	13
Cowiche maistem	14	0.0%	15	0.0%	13
Marion Drain	14	0.0%	15	0.0%	13
NF Tieton	14	0.0%	15	0.0%	13
Nile	14	0.0%	15	0.0%	13
SF Cowiche	14	0.0%	15	0.0%	13
SF Tieton	14	0.0%	15	0.0%	13
Toppenish Creek below Simcoe	14	0.0%	15	0.0%	13
Upper Bumping	14	0.0%	15	0.0%	13
Upper Tieton	14	0.0%	15	0.0%	13
Wide Hollow	14	0.0%	15	0.0%	13

Table 3-8. Naches Summer Steelhead – Summary of Scenario Effects on Survival Factors and Overall Performance

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Ahtanum Cr.							O		o							o		O
American																		
Cowiche maistem			O				o		O						o			o
Little Naches			O						o						O	o		O
Little Rattlesnake			o												O			
Lower Bumping			o						o		O				O			O
Lower Naches			O						o						O	o		O
Lower Tieton											O							
Lower Yakima River														o		o		o
Marion Drain																		
NF Cowiche			o												O			
NF Tieton											O							
Nile															O			
Oak Cr		o	O												O	O		O
Rattlesnake		o	o												o			o
SF Cowiche			o						o						o	o		o
SF Tieton			o						o									o
Toppenish Cr. Below Simcoe							o											O
Upper Bumping											O							
Upper Naches			o						o						O	o		O
Upper Tieton																		
Wide Hollow																		
Yakima - Gap to Gap Floodplain																		O
Yakima - Selah Floodplain									o									o
Yakima- Lower Wapato Floodplain		O							o					o	o	o		O
Yakima- Upper Wapato Floodplain														o	o	o		O

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Lower Yakima Fall Chinook

Table 3-9 shows the relative benefit to the Lower Yakima Fall Chinook population from proposed actions in the Integrated Plan by geographic area. Table 3-10 shows, by geographic area, the Level 3 attributes and amount of improvement that contributed to the improved change in population performance. There are only three geographic areas for the Lower Yakima Fall Chinook population. They are ranked as follows:

First: The Lower Yakima River geographic area increased 33 percent in abundance and 13 percent in productivity, primarily due to improved water temperature and to a lesser extent the Chemicals, Pathogens, Predation, and Key Habitat attributes.

Second/Third: The Yakima – The Upper Wapato Floodplain and Lower Wapato Floodplain areas were closely ranked second and third with an increase of 10 percent and 8 percent, respectively, in abundance, and no increase to either area for productivity. For both areas an increase in the amount of Key Habitat

was primarily responsible for the increase in abundance. For the Yakima Lower Wapato Floodplain area, lesser contributing attributes were: Sediment Load, Chemicals, Pathogens, Predation, and Temperature, and for Yakima Upper Wapato Floodplain geographic area they were: Chemicals, Habitat Diversity, Pathogens, Predation, Sediment Load, and Temperature.

Table 3-9. Summary of the Percent Change of Lower Yakima Fall Chinook Population Performance (Abundance and Productivity) and the Average Combined Abundance and Productivity Rank by Geographic Area

Geographic Area	Average Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Lower Yakima River	1	32.9%	1	13.0%	1
Yakima – Upper Wapato Floodplain	2	10.4%	2	0.0%	2
Yakima – Lower Wapato Floodplain	2.5	7.7%	2	0.0%	3

Table 3-10. Lower Yakima Fall Chinook – Summary of Scenario Effects on Survival Factors and Overall Performance

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Lower Yakima River		◯		o									o	o		◯		o
Yakima- Lower Wapato Floodplain		◯		o									o	o	◯	o		◯
Yakima- Upper Wapato Floodplain		◯		o					o					o	o	o		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Yakima Summer Chinook

Table 3-11 shows the relative benefit to the Lower Yakima Fall Chinook population from proposed actions in the Integrated Plan by geographic area. Table 3-12 shows, by geographic area, the Level 3 attributes and degree of improvement that contributed to the improved change in population performance. The top five geographic areas that influenced Lower Yakima Fall Chinook population performance from the proposed actions in the Restoration + Passage scenario were:

First: The Yakima Gap to Gap Floodplain geographic area increased 78 percent in abundance and 25 percent in productivity, primarily due to an increase in the amount of Key Habitat, followed by Sediment Load and Harassment/Poaching.

Second: The Lower Naches area increased 55 percent in abundance and 18 percent in productivity due to improvements to Key Habitat, Temperature, Sediment Load, and Habitat Diversity.

Third: The Lower Yakima River area increased 34 percent in abundance and 9 percent in productivity due to improvements in Temperature, Pathogens, Predation, and Key Habitat.

Fourth: The Yakima Upper Wapato Floodplain increased 30 percent in abundance and 3 percent in productivity, primarily due to improvements in Key Habitat, and to a lesser degree Temperature, Chemicals, Predation, and Sediment Load.

Fifth: The Yakima Lower Wapato Floodplain increased 13 percent in abundance and 3 percent in productivity, primarily due to increases in Key Habitat, and to a lesser degree improvements in Pathogens, Predation, Sediment Load, and Temperature.

Table 3-11. Summary of the Percent Change of Yakima Summer Chinook Population Performance (Abundance and Productivity) and the Average Combined Abundance and Productivity Rank by Geographic Area

Geographic Area	Average Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Yakima – Gap to Gap Floodplain	1	78.4%	1	25.1%	1
Lower Naches	2	55.3%	2	18.5%	2
Lower Yakima River	3	34.1%	3	8.6%	3
Yakima – Upper Wapato Floodplain	4	29.9%	4	3.1%	4
Yakima – Lower Wapato Floodplain	5	13.5%	5	3.1%	5
Yakima – Selah Floodplain	6	9.4%	6	2.4%	6

Table 3-12. Yakima Summer Chinook – Summary of Scenario Effects on Survival Factors and Overall Performance

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Lower Naches		◯							○						◯	◯		◯
Lower Yakima River		○											○	○		◯		○
Yakima - Gap to Gap Floodplain		◯								○					◯			◯
Yakima - Selah Floodplain		○					○			○						○		○
Yakima- Lower Wapato Floodplain		○											○	○	○	○		◯
Yakima- Upper Wapato Floodplain		○		○			●							○	○	◯		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Toppenish Steelhead

Table 3-13 shows the relative benefit to the Toppenish Steelhead population from proposed actions in the Integrated Plan by geographic area. Table 3-14 shows, by geographic area, the Level 3 attributes and extent of improvement that contributed to the improved change in population performance. The top five geographic areas that influenced Toppenish steelhead population performance from the proposed actions in the Restoration + Passage scenario were:

First: Toppenish Creek geographic area above Simcoe increased 39 percent in abundance and 15 percent in productivity, primarily due to improved fish passage at diversion dams (Obstructions) and an increase in the amount of Key Habitat. Other improved attributes were Sediment Load, Channel Stability, Flow, and Habitat Diversity.

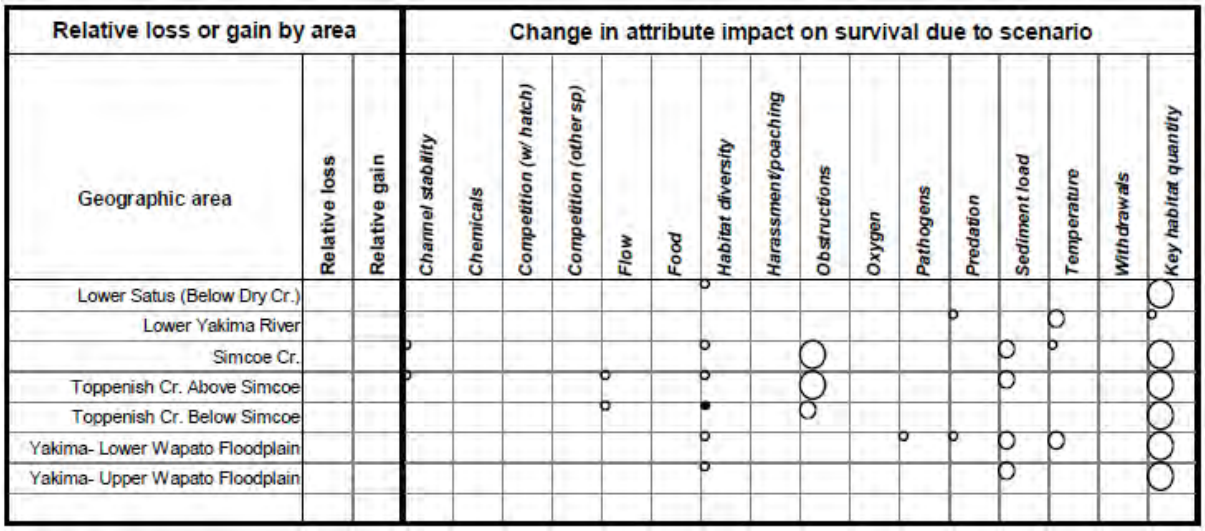
Second (Tie): The Toppenish Creek area below Simcoe increased 11 percent increase in abundance and 4 percent in productivity due to an increase in Key Habitat followed by improved fish passage at diversion dams (Obstructions), and Flow. Also tied for second rank was the Yakima Lower Wapato Floodplain area with a 10 percent increase in abundance and 4 percent increase in productivity due to an increase in Key Habitat followed by improvements to Sediment Load, Temperature, Habitat Diversity, Pathogens, and Predation.

Third (Tie): The Lower Yakima River and Simcoe Creek areas both ranked third. The Lower Yakima River area increased 4 percent in abundance and 2 percent in productivity due to improvements in Temperature, Predation, and Key Habitat. Simcoe Creek increased 6 percent in abundance and 1 percent in productivity, primarily due to increased Key Habitat and improved fish passage (Obstructions), followed by improvements in Sediment Load, Channel Stability, Habitat Diversity, and Temperature.

Table 3-13. Summary of the Percent Change of Toppenish Steelhead Population Performance (Abundance and Productivity) and the Average Combined Abundance and Productivity Rank by Geographic Area

Geographic Area	Average Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Toppenish Creek above Simcoe	1	39.2%	1	15.5%	1
Toppenish Creek below Simcoe	2.5	11.1%	2	3.6%	3
Yakima – Lower Wapato Floodplain	2.5	10.0%	3	4.2%	2
Lower Yakima River	4.5	3.8%	5	2.4%	4
Simcoe Creek	4.5	6.5%	4	1.3%	5
Lower Satus (Below Dry Creek)	6	0.1%	6	0.0%	6
Yakima – Upper Wapato Floodplain	6.5	0.0%	7	0.0%	6

Table 3-14. Toppenish Summer Steelhead – Summary of Scenario Effects on Survival Factors and Overall Performance



Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Satus Steelhead

Table 3-15 shows the relative benefit to the Satus Steelhead population from proposed actions in the Integrated Plan by geographic area. Table 3-16 shows, by geographic area, the Level 3 attributes and level of improvement that contributed to the improved change in population performance. The top five geographic areas that influenced Satus steelhead population performance from the proposed actions in the Restoration + Passage scenario were:

First: The Upper Satus (Above Dry Creek) geographic area increased 69 percent in abundance and 50 percent in productivity, primarily due to improvements in Key Habitat and Temperature, and to a lesser degree Sediment Load, Flow, and Habitat Diversity.

Second (Tie): The Dry Creek (Satus) area increased 22 percent in abundance and 13 percent in productivity, primarily due to Temperature and Key Habitat improvements, and to a lesser degree Sediment Load, Channel Stability, Flow, Habitat Diversity, and Pathogens. The Lower Satus (Below Dry Creek) area increased 37 percent in abundance and 10 percent in productivity, primarily due to improvements in Temperature and Key Habitat, followed by Sediment Load, Channel Stability, Flow, Habitat Diversity, and Pathogens.

Fourth: The Yakima Lower Wapato Floodplain area increased 3 percent in abundance and 2 percent in productivity due to improvements in Pathogens, Predation, Sediment Load, and Temperature.

Table 3-15. Summary of the Percent Change of Satus Steelhead Population Performance (Abundance and Productivity) and the Average Combined Abundance and Productivity Rank by Geographic Area

Geographic Area	Average Combined Rank	Change in Abundance	Rank in Abundance	Change in Productivity	Rank in Productivity
Upper Satus (Above Dry Creek)	1	69.1%	1	50.1%	1
Dry Cr (Satus)	2.5	21.7%	3	13.4%	2
Lower Satus (Below Dry Creek)	2.5	37.0%	2	9.8%	3
Lower Yakima River	4	3.6%	4	2.7%	4
Yakima – Lower Wapato Floodplain	5	3.0%	5	2.2%	5
Mule Dry Cr (Satus)	6	2.7%	6	0.0%	6

Table 3-16. Satus Summer Steelhead – Summary of Scenario Effects on Survival Factors and Overall Performance

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Dry Cr (Satus)		○	o				o		o				o		○	◯		◯
Lower Satus (Below Dry Cr.)		○	o				o		o				o		○	◯		◯
Lower Yakima River		o												o		○		o
Mule Dry Cr (Satus)		o	o				o		o						◯	○		◯
Upper Satus (Above Dry Cr.)		◯					o		o						○	◯		◯
Yakima- Lower Wapato Floodplain													o	o	o	o		

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

3.2 EDT Numeric Fish Benefits

This section presents the estimated population abundance for recruitment, harvest, Yakima River mouth, and escapement for each Integrated Plan scenario and species (see Tables 3-17 through 3-23); and the absolute difference in population abundance and percent change compared to the baseline.

Spring Chinook

The absolute difference and percent change in recruitment, harvest, Yakima River mouth and escapement numbers for the three modeled scenarios compared to the baseline for spring Chinook are shown below:

FWIP

Recruitment – 640 to 4,780; 13% to 14%

Columbia R. Harvest – 80 to 600; 11% to 13%

Yakima River mouth – 560 to 4,180; 13% to 14%

Yakima R. Harvest – 70 to 500; 11% to 13%

Escapement – 490 to 3,650; 15%

Restoration

Recruitment – 4,040 to 26,300; 76% to 79%

Columbia R. Harvest – 510 to 3,310; 70% to 72%

Yakima River mouth – 3,530 to 22,980; 77% to 80%

Yakima R. Harvest – 420 to 2,720; 70% to 72%

Escapement – 3,110 to 20,230; 83% to 93%

Restoration + Passage

Recruitment – 5,800 to 38,400; 112% to 114%

Columbia R. Harvest – 730 to 4,860; 103% to 106%

Yakima River mouth – 5,060 to 33,550; 113% to 115%

Yakima R. Harvest – 600 to 3,990; 103% to 106%

Escapement – 4,450 to 29,500; 121% to 134%

The absolute difference and percent change in recruitment, Columbia River and Yakima River harvest, Yakima River mouth and escapement numbers for the Restoration + Passage scenario compared to the Restoration scenario for spring Chinook is shown below:

Restoration + Passage

Recruitment – 1,760 to 12,110; 19% to 20%

Columbia R. Harvest – 220 to 1,540; 19% to 20%

Yakima River mouth – 1,530 to 10,560; 19% to 20%

Yakima R. Harvest – 180 to 1270; 19% to 20%

Escapement – 1,340 to 9,270; 21%

Table 3-17. Spring Chinook Recruitment, Harvest, Yakima River Mouth and Escapement Fish Abundance Estimation by Scenario

Scenario	Minimum	Average	Maximum
Baseline			
Recruitment	5,109	10,153	33,653
Columbia R. Harvest	703	1,390	4,579
Yakima R. Mouth	4,406	8,763	29,074
Yakima R. Harvest	577	1,141	3,761
Broodstock Removal	500	570	882
Escapement	3,329	7,052	24,431
FWIP			
Recruitment	5,748	11,494	38,434
Columbia R. Harvest	783	1,559	5,181
Yakima R. Mouth	4,965	9,935	33,252
Yakima R. Harvest	643	1,280	4,256
Broodstock Removal	505	580	911
Escapement	3,817	8,076	28,086
Restoration			
Recruitment	9,149	17,909	59,949
Columbia R. Harvest	1,212	2,367	7,892
Yakima R. Mouth	7,937	15,542	52,057
Yakima R. Harvest	995	1,944	6,482
Broodstock Removal	505	580	911
Escapement	6,437	13,019	44,664
Restoration + Passage			
Recruitment	10,905	21,503	72,058
Columbia R. Harvest	1,436	2,826	9,436
Yakima R. Mouth	9,469	18,677	62,622
Yakima R. Harvest	1,179	2,321	7,750
Broodstock Removal	509	588	937
Escapement	7,781	15,769	53,935

Figure 3-1 summarizes additional benefits for Upper Yakima and Naches spring Chinook due to fish passage at Keechelus, Kachess and Cle Elum dams in the upper Yakima Basin and at Bumping and Tieton dams in the Naches Basin. Fish passage at these five Reclamation facilities resulted in an additional 1,100 to 7,500 upper Yakima Spring Chinook and 500 to 4,100 Naches spring Chinook compared to the Restoration scenario.

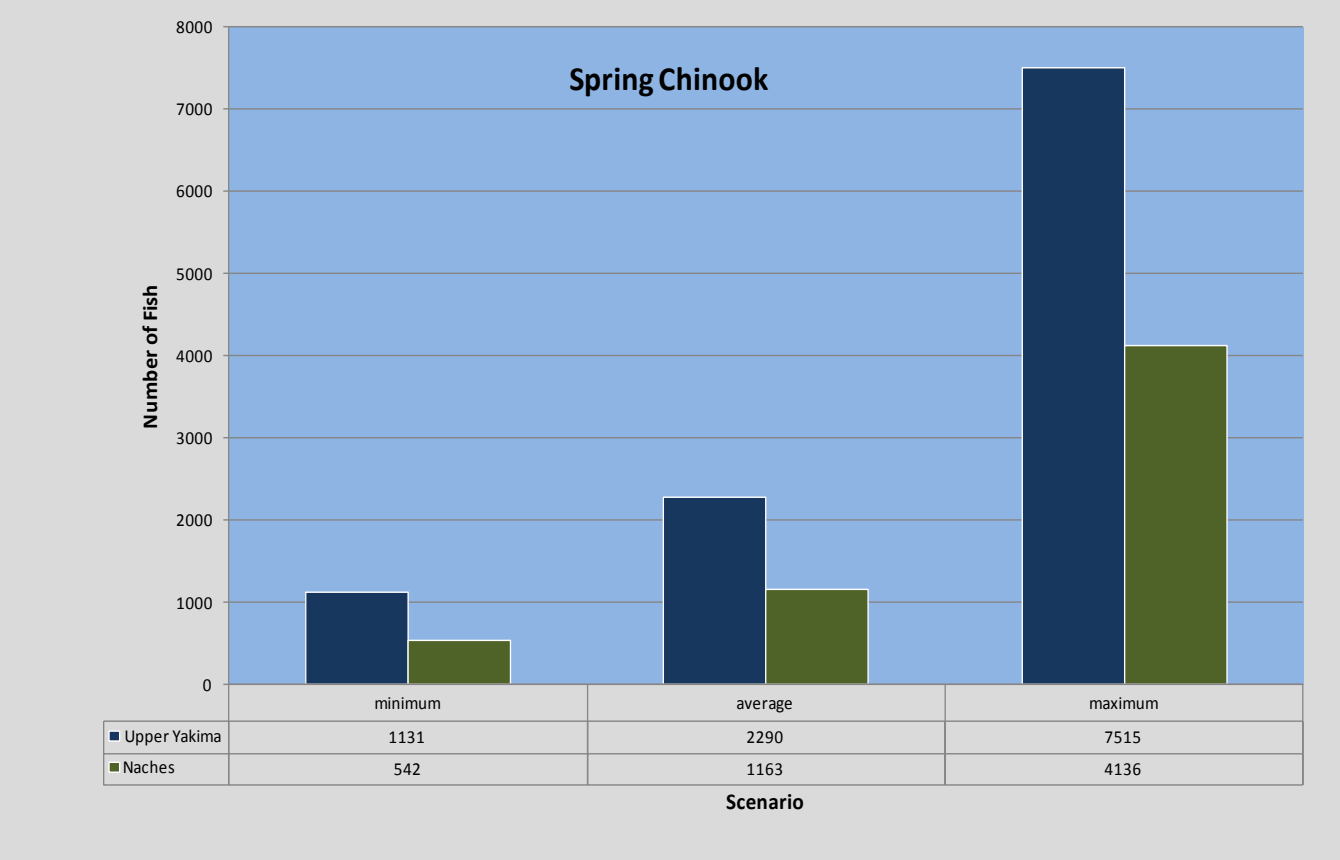


Figure 3-1. Estimated Increase in Spring Chinook Recruitment Resulting from Passage at the Five Reclamation Storage Dams

Steelhead

The absolute difference and percent change in recruitment, harvest, Yakima River mouth and escapement numbers for the three modeled scenarios compared to the baseline for steelhead are shown below:

FWIP

Recruitment – 330 to 2,960; 26% to 33%

Columbia R. Harvest – 20 to 200; 26% to 33%

Yakima River mouth – 300 to 2,760; 26% to 33%

Yakima R. Harvest – No Harvest

Escapement – 270 to 2,250; 25% to 31%

Restoration

Recruitment – 1,940 to 14,870; 145% to 165%

Columbia R. Harvest – 130 to 990; 145% to 165%

Yakima River mouth – 1,820 to 13,880; 145% to 165%

Yakima R. Harvest – No Harvest

Escapement – 1,510 to 11,220; 136% to 154%

Restoration + Passage

Recruitment – 2,380 to 18,900; 186% to 210%

Columbia R. Harvest – 160 to 1,260; 186% to 210%

Yakima River mouth – 2,220 to 17,650; 186% to 210%

Yakima R. Harvest – No Harvest

Escapement – 1,850 to 14,260; 174% to 195%

The absolute difference and percent change in recruitment, Columbia River harvest, Yakima River mouth and escapement numbers for the Restoration + Passage scenario compared to the Restoration scenario for steelhead is shown below:

Restoration + Passage

Recruitment – 440 to 4,040; 14% to 17%

Columbia R. Harvest – 30 to 80; 14% to 17%

Yakima River mouth – 410 to 3,770; 14% to 17%

Escapement – 340 to 3,030; 13% to 16%

Table 3-18. Steelhead Recruitment, Harvest, Yakima River Mouth and Escapement Fish Abundance Estimation by Scenario

Scenario	Minimum	Average	Maximum
Baseline			
Recruitment	1,263	2,871	8,995
Columbia R. Harvest	84	191	598
Yakima River Mouth	1,179	2,680	8,396
Yakima R. Pre-spawn Mortality	107	314	1,087
Escapement	1,071	2,367	7,309
FWIP			
Recruitment	1,589	3,699	11,954
Columbia R. Harvest	106	246	795
Yakima River Mouth	1,483	3,453	11,158
Yakima R. Pre-spawn Mortality	143	429	1,600
Escapement	1,340	3,024	9,559
Restoration			
Recruitment	3,207	7,041	23,868
Columbia R. Harvest	213	468	1,588
Yakima River Mouth	2,994	6,573	22,280
Yakima R. Pre-spawn Mortality	409	985	3,748
Escapement	2,585	5,588	18,532
Restoration + Passage			
Recruitment	3,646	8,198	27,904
Columbia R. Harvest	243	545	1,857
Yakima River Mouth	3,403	7,652	26,047
Yakima R. Pre-spawn Mortality	481	1,178	4,481
Escapement	2,922	6,475	21,566

Figure 3-2 summarizes additional benefits for Upper Yakima and Naches steelhead due to fish passage at Keechelus, Kachess, and Cle Elum dams in the upper Yakima Basin and at Bumping and Tieton dams in the Naches Basin. Fish passage at these five Reclamation facilities resulted in an additional 200 to 2,300 upper Yakima steelhead and 100 to 900 Naches steelhead compared to the Restoration scenario.

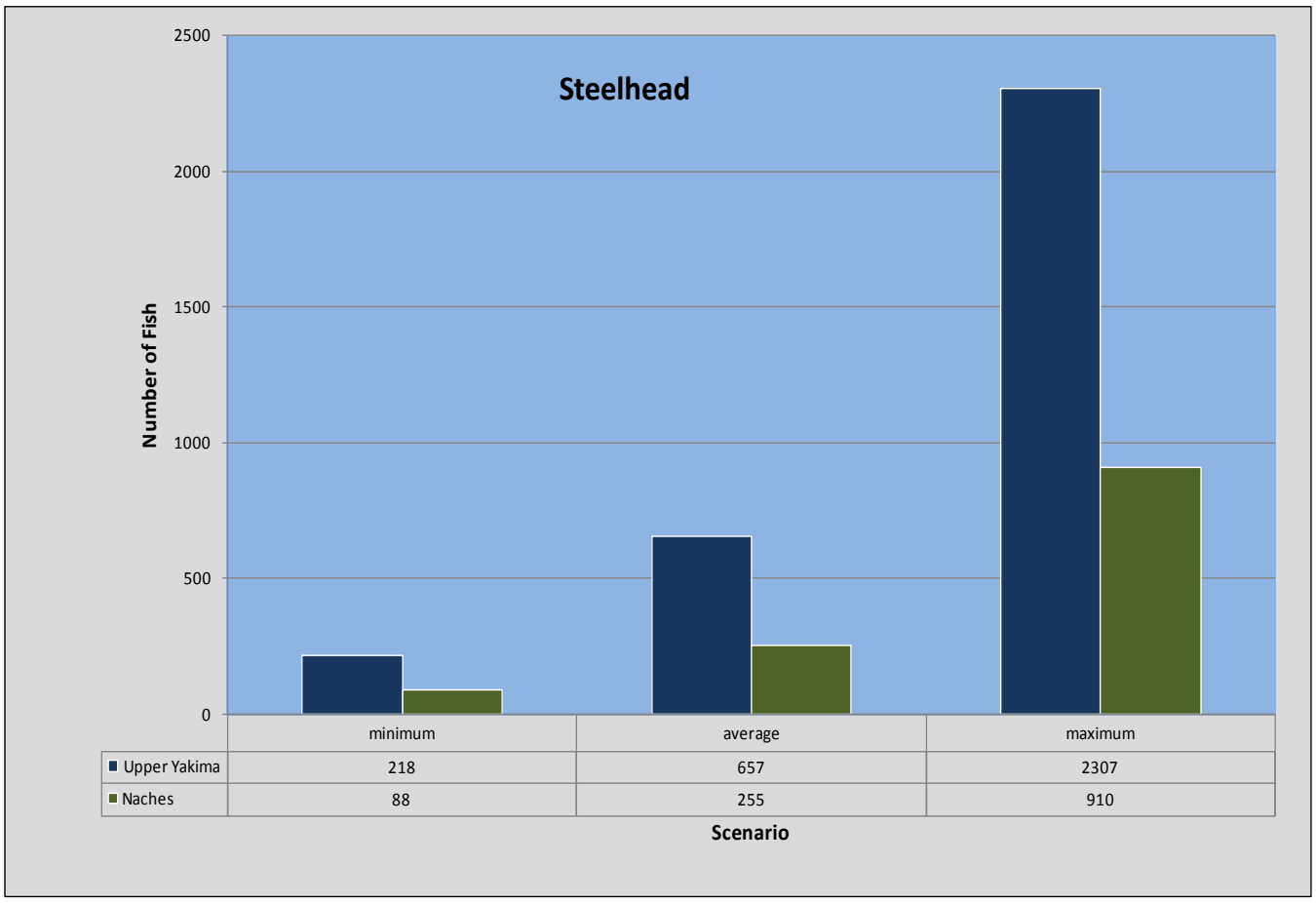


Figure 3-2. Estimated Increase in Steelhead Recruitment Resulting from Passage at the Five Reclamation Storage Dams

Coho

The absolute difference and percent change in recruitment, harvest, Yakima River mouth and escapement numbers for the three modeled scenarios compared to the baseline for coho are shown below:

FWIP

Recruitment – 1,730 to 10,170; 36% to 37%

Columbia R. Harvest – 440 to 2,670; 36% to 37%

Yakima River mouth – 1,290 to 7,600; 36% to 37%

Yakima R. Harvest – 14 to 80; 36% to 37%

Escapement – 1,040 to 7,590; 31% to 37%

Restoration

Recruitment – 2,980 to 18,720; 63% to 67%

Columbia R. Harvest – 750 to 4,730; 63% to 67%

Yakima River mouth – 2,230 to 13,990; 63% to 67%

Yakima R. Harvest – 24 to 150; 63% to 67%

Escapement – 1,920 to 13,560; 58% to 66%

Restoration + Passage

Recruitment – 3,340 to 20,870; 71% to 75%

Columbia R. Harvest – 840 to 5,270; 71% to 75%

Yakima River mouth – 2,500 to 15,600; 71% to 75%

Yakima R. Harvest – 27 to 160; 71% to 75%

Escapement – 2,190 to 15,150; 66% to 74%

The absolute difference and percent change in recruitment, Columbia River and Yakima River harvest, Yakima River mouth and escapement numbers for the Restoration + Passage scenario compared to the Restoration scenario for coho is shown below:

Restoration + Passage

Recruitment – 350 to 2,140; 5%

Columbia R. Harvest – 90 to 540; 5%

Yakima River mouth – 270 to 1,600; 5%

Yakima R. Harvest – 5 to 20; 5%

Escapement – 260 to 1,580; 5%

Table 3-19. Coho Recruitment, Harvest, Yakima River mouth and Escapement Fish Abundance Estimation By Scenario

Scenario	Minimum	Average	Maximum
Baseline			
Recruitment	4,686	8,806	27,926
Columbia R. Harvest	1,184	2,224	7,054
Yakima River Mouth	3,502	6,582	20,872
Yakima R. Harvest	37	70	222
Broodstock Removal	157	157	158
Escapement	3,308	6,355	20,492
FWIP			
Recruitment	6,414	11,983	38,098
Columbia R. Harvest	1,620	3,027	9,623
Yakima River Mouth	4,794	8,957	28,475
Yakima R. Harvest	51	95	303
Broodstock Removal	397	428	439
Escapement	4,346	8,433	28,086
Restoration			
Recruitment	7,671	14,396	46,648
Columbia R. Harvest	1,938	3,636	11,783
Yakima River Mouth	5,733	10,759	34,865
Yakima R. Harvest	61	114	371
Broodstock Removal	439	439	439
Escapement	5,233	10,206	34,056
Restoration + Passage			
Recruitment	8,026	15,069	48,791
Columbia R. Harvest	2,027	3,806	12,324
Yakima River Mouth	5,999	11,263	36,467
Yakima R. Harvest	64	120	388
Broodstock Removal	439	439	440
Escapement	5,496	10,704	35,639

Figure 3-3 summarizes additional benefits for Upper Yakima and Naches coho due to fish passage at Keechelus, Kachess, and Cle Elum dams in the upper Yakima Basin and at Bumping and Tieton dams in the Naches Basin. Fish passage at these five Reclamation facilities resulted in an additional 100 to 700 upper Yakima coho and 100 to 600 Naches coho compared to the Restoration scenario.

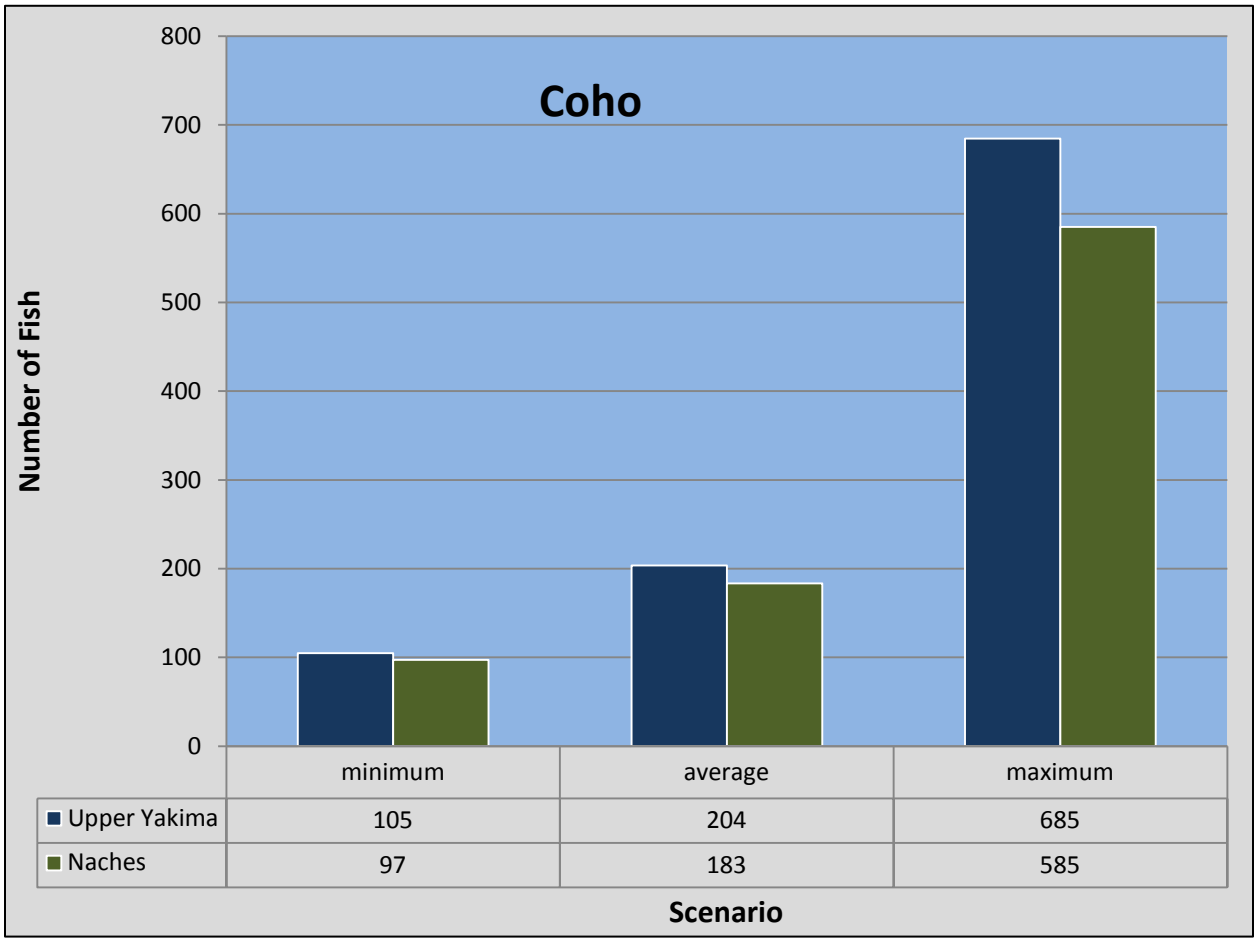


Figure 3-3. Estimated Increase in Coho Recruitment Resulting from Passage at the Five Reclamation Storage Dams

Fall Chinook

The absolute difference and percent change in recruitment, Columbia River and Yakima River harvest, Yakima River mouth and escapement numbers for the three modeled scenarios relative to the baseline for fall Chinook are shown below:

FWIP

Recruitment – 100 to 12,220; 3% to 4%

Columbia R. Harvest – 30 to 100; 3% to 4%

Yakima River mouth – 70 to 860; 3% to 4%

Yakima R. Harvest – 10 to 100; 3% to 4%

Escapement – 60 to 760; 4%

Restoration

Recruitment – 1,720 to 17,400; 54% to 58%

Columbia R. Harvest – 500 to 5,110; 54% to 68%

Yakima River mouth – 1,220 to 12,290; 54% to 58%

Yakima R. Harvest – 150 to 1,480; 54% to 68%

Escapement – 1,070 to 10,810; 60%

Restoration + Passage[4]

Recruitment – 1,720 to 17,400; 54% to 58%

Columbia R. Harvest – 500 to 5,110; 54% to 68%

Yakima River mouth – 1,220 to 12,290; 54% to 58%

Yakima R. Harvest – 150 to 1,480; 54% to 68%

Escapement – 1,070 to 10,810; 60%

There was no difference in the abundance numbers among the Restoration + Passage scenarios because fall Chinook complete their entire freshwater life-cycle downstream from the five Reclamation storage dams. They are not affected by the provision of fish passage, which is the only difference in restoration/passage actions between these two scenarios.

Table 3-20. Fall Chinook Recruitment, Harvest, Yakima River Mouth and Escapement Fish Abundance Estimation by Scenario

Scenario	Minimum	Average	Maximum
Baseline			
Recruitment	3,198	8,385	29,857
Columbia R. Harvest	939	2,462	8,765
Yakima River Mouth	2,259	5,924	21,092
Yakima R. Harvest	272	713	2,540
Broodstock Removal	192	244	531
Escapement	1,795	4,966	18,022
FWIP			
Recruitment	3,300	8,724	31,082
Columbia R. Harvest	969	2,561	9,124
Yakima River Mouth	2,331	6,163	21,958
Yakima R. Harvest	281	742	2,644
Broodstock Removal	192	244	531
Escapement	1,858	5,177	18,783
Restoration			
Recruitment	4,920	13,170	47,259
Columbia R. Harvest	1,444	3,866	13,873
Yakima River Mouth	3,475	9,304	33,386
Yakima R. Harvest	418	1,120	4,020
Broodstock Removal	192	244	531
Escapement	2,865	7,939	28,835
Restoration + Passage			
Recruitment	4,920	13,170	47,259
Columbia R. Harvest	1,444	3,866	13,873
Yakima River Mouth	3,475	9,304	33,386
Yakima R. Harvest	418	1,120	4,020
Broodstock Removal	192	244	531
Escapement	2,865	7,939	28,835

[4] Values are the same for the Restoration and Restoration + Passage scenarios since fall Chinook complete their freshwater life cycle downstream of the five Reclamation storage dams.

Summer Chinook

The absolute difference and percent change in recruitment, Columbia River and Yakima River harvest, Yakima River mouth and escapement numbers for the three modeled scenarios relative to the baseline for summer Chinook are shown below:

FWIP

Recruitment – 60 to 1,080; 4% to 12%

Columbia R. Harvest – 20 to 400; 4% to 12%

Yakima River mouth – 40 to 4,980; 4% to 12%

Yakima R. Harvest – No harvest modeled.

Escapement – 40 to 730; 6% to 14%

Restoration

Recruitment – 900 to 14,180; 62% to 133%

Columbia R. Harvest – 330 to 5,170; 62% to 133%

Yakima River mouth – 580 to 9,010; 62% to 133%

Yakima R. Harvest – No harvest modeled.

Escapement – 580 to 9,060; 79% to 143%

Restoration + Passage[5]

Recruitment – 900 to 14,180; 62% to 133%

Columbia R. Harvest – 330 to 5,170; 62% to 133%

Yakima River mouth – 580 to 9,010; 62% to 133%

Yakima R. Harvest – No harvest modeled.

Escapement – 580 to 9,060; 79% to 143%

There was no difference in the abundance numbers among the Restoration + Passage scenarios because summer Chinook complete their entire freshwater life-cycle downstream from the five Reclamation storage dams. They are not affected by the provision of fish passage, which is the only difference in restoration/passage actions between these two scenarios.

[5] Values are the same for the Restoration and Restoration + Passage scenarios since summer Chinook complete their freshwater life cycle downstream of the five Reclamation storage dams.

Table 3-21. Summer Chinook Recruitment, Harvest Yakima River Mouth and Escapement Fish Abundance Estimation by Scenario

Scenario	Minimum	Average	Maximum
Baseline			
Recruitment	1,464	3,308	10,692
Columbia R. Harvest	534	1,206	3,897
Yakima River Mouth	931	2,102	6,795
Yakima R. Harvest	0	0	0
Broodstock Removal	198	242	460
Escapement	733	1,860	6,335
FWIP			
Recruitment	1,529	3,694	11,775
Columbia R. Harvest	557	1,346	4,292
Yakima River Mouth	972	3,694	11,775
Yakima R. Harvest	0	0	0
Broodstock Removal	194	228	417
Escapement	1,529	3,694	11,775
Restoration			
Recruitment	2,372	7,390	24,877
Columbia R. Harvest	865	2,694	9,068
Yakima River Mouth	1,507	4,697	15,809
Yakima R. Harvest	0	0	0
Broodstock Removal	194	228	417
Escapement	1,314	4,468	15,392
Restoration + Passage			
Recruitment	2,372	7,390	24,877
Columbia R. Harvest	865	2,694	9,068
Yakima River Mouth	1,507	4,697	15,809
Yakima R. Harvest	0	0	0
Broodstock Removal	194	228	417
Escapement	1,314	4,468	15,392

Sockeye

Table 3-22 summarizes sockeye abundance for recruitment, Columbia River and Yakima River harvest, Yakima River mouth, and escapement, consistent with the methodology described in Section 2.1 which resulted in high, medium, and low abundance estimates. Sockeye abundance numbers are only applicable to the Restoration + Passage scenario.

Table 3-22. Sockeye Recruitment, Harvest, Yakima River Mouth and Escapement Fish Abundance Estimation by Scenario

Scenario	Low	Medium	High
Restoration + Passage			
Recruitment	112,243	340,627	681,255
Columbia R. Harvest	8,979	27,250	54,500
Yakima River Mouth	92,039	279,315	558,629
Columbia R. Migration Loss	11,224	34,063	68,125
Yakima R. Harvest	13,806	41,897	83,794
Yakima R. Migration Loss	4,602	13,966	27,931
Escapement	73,631	223,452	446,903

All Species

Table 3-23 summarizes fish abundance for recruitment, Columbia River and Yakima River harvest, Yakima River mouth and escapement. High, medium, and low numbers for sockeye were correlated to minimum, average, and maximum values for all other anadromous species.

The absolute difference and percent change in recruitment, Columbia River and Yakima River harvest, Yakima River mouth and escapement numbers for the three modeled scenarios relative to the baseline for all salmon and steelhead are shown below:

FWIP

Recruitment – 2,860 to 20,220; 18%

Columbia R. Harvest – 590 to 4,120; 17%

Yakima River mouth – 2,270 to 20,390; 18% to 24%

Yakima R. Harvest – 120 to 1,190; 36% to 37%

Escapement – 1,040 to 7,240; 13% to 16%

Restoration

Recruitment – 11,600 to 91,480; 74% to 82%

Columbia R. Harvest – 2,230 to 19,310; 65% to 78%

Yakima River mouth – 9,370 to 71,170; 76% to 84%

Yakima R. Harvest – 890 to 7,010; 86% to 92%

Escapement – 8,200 to 64,890; 80% to 85%

Restoration + Passage

Recruitment – 126,390 to 791,020; 712% to 1111%

Columbia R. Harvest – 11,550 to 76,160; 306% to 449%

Yakima River mouth – 103,620 to 646,730; 363% to 606%

Yakima R. Harvest – 14,950 to 92,820; 587% to 1020%

Escapement – 83,770 to 525,680; 326% to 552%

The absolute difference and percent change in recruitment, Columbia River and Yakima River harvest, Yakima River mouth and escapement numbers for the Restoration + Passage scenario compared to the Restoration scenario for all species is shown below:

Restoration + Passage

Recruitment – 114,790 to 669,540; 420% to 578%

Columbia R. Harvest – 9,320 to 56,850; 129% to 215%

Yakima River mouth – 94,250 to 574,560; 363% to 606%

Yakima R. Harvest – 14,070 to 85,810; 587% to 1020%

Escapement – 75,570 to 460,790; 326% to 552%

Table 3-23. All Species Combined Recruitment, Harvest, Yakima River Mouth and Escapement Fish Abundance Estimation by Scenario

Scenario	Minimum	Average	Maximum
Baseline			
Recruitment	15,719	33,523	111,122
Columbia R. Harvest	3,443	7,472	24,893
Yakima River Mouth	12,277	26,051	86,229
Yakima R. Harvest	993	2,238	7,610
Broodstock Removal	1,047	1,214	2,030
Escapement	10,236	22,599	76,589
FWIP			
Recruitment	18,581	39,593	131,343
Columbia R. Harvest	4,035	8,739	29,016
Yakima River Mouth	14,545	32,201	106,619
Yakima R. Harvest	1,118	2,546	8,802
Broodstock Removal	1,288	1,480	2,297
Escapement	12,139	26,828	91,580
Restoration			
Recruitment	27,318	59,906	202,601
Columbia R. Harvest	5,671	13,032	44,204
Yakima River Mouth	21,647	46,875	158,397
Yakima R. Harvest	1,884	4,164	14,621
Broodstock Removal	1,330	1,491	2,297
Escapement	18,433	41,220	141,479
Restoration + Passage			
Recruitment	142,111	405,957	902,143
Columbia R. Harvest	26,218	75,050	169,183
Sockeye Columbia R. Migration Loss	11,224	34,063	68,125
Yakima River Mouth	115,893	330,907	732,960
Yakima R. Harvest	20,551	60,601	128,364
Sockeye Yakima R. Migration Loss	4,602	13,966	27,931
Broodstock Removal	1,334	1,500	2,325
Escapement	94,008	268,806	602,271

Notes:
Minimum values include sockeye low values.
Average values include sockeye medium values.
Maximum values include sockeye high values.

Species Composition

Figure 3-4 summarizes the composition of anadromous salmonid species by scenario for average recruitment values. The mix is very similar for the baseline, FWIP and Restoration scenarios, with the following ranges:

- Spring Chinook – 29 to 30 percent
- Coho – 24 to 30 percent
- Fall Chinook – 22 to 25 percent
- Summer Chinook and steelhead – 9 to 12 percent
- Steelhead – 9 to 12 percent
- Sockeye – 0 percent

Species composition for the Restoration + Passage scenario changed dramatically with the presence of sockeye as the dominant species. The mix under this scenario is as follows:

- Sockeye – 84 percent
- Spring Chinook – 5 percent
- Fall Chinook – 3 percent
- Summer Chinook – 2 percent
- Coho – 3 percent
- Steelhead – 2 percent

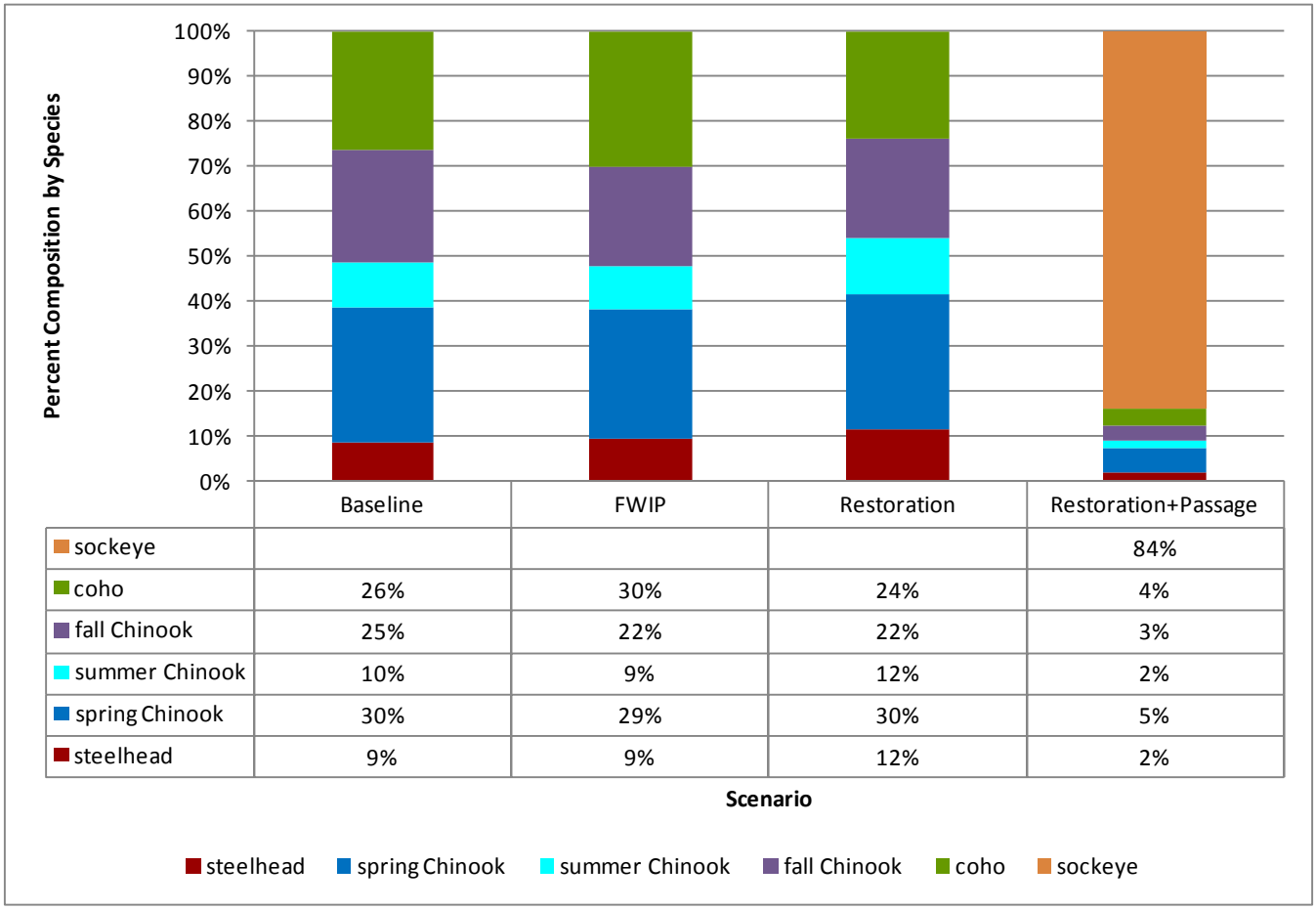


Figure 3-4. Summary of Anadromous Salmonid Percent Species Composition by Scenario

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5.0 List of Preparers

Name	Background	Responsibility
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Keith Underwood	Fisheries Biologist	Sockeye Analysis
Ian Welch	Biologist	QC review of Sockeye Analysis

Appendix A

Ecosystem Diagnosis and Treatment (EDT) Model Attributes

Table A-1. Summary of the EDT model standard Level 2 and Level 3 Attributes

Level 2 Attribute	Associated Level 3 Attribute	Level 2 Attribute Description
Alkalinity (Alka)	Water Quality	Alkalinity or acid neutralizing capacity.
Bed Scour (BdScour)	Stream Structure	Average depth of bed scour in spawning areas, during annual peak flood event (or over 10-year period).
Benthos Community Richness (BenComRch)	Biological Community	Measure of the diversity and production for the macroinvertebrate community.
Channel Length (ChLngth)	Actual Value	Length of the primary channel contained with the stream reach in miles.
Confinement-Natural (Confine)	Stream Structure	Ratio between the width of the valley (natural features only) and the bankfull channel width.
Confinement-Hydromodifications (ConfinefHdro)	Stream Structure	The extent to which flow is impeded by structures in the stream channel. Includes channelization, incision, bridges, etc.
Dissolved Oxygen (DisOxy)	Water Quality	Average dissolved oxygen within the water column.
Embeddedness (Emb)	Stream Structure	The extent to which large gravels are buried in fine sediment. Only applies to riffle and pool tailouts with gravels.
Fine Sediment (FnSedi)	Stream Structure	Percentage of fine sediment in spawning substrate.
Fish Community Richness (FshComRch)	Biological Community	Measure of the richness of the fish community.
Fish Pathogens (FshPath)	Biological Community	The presence of fish pathogens including IHNV for sockeye and kokanee, proximity to hatchery fish releases, and whirling disease.
Fish Species Introductions (FSpIntro)	Biological Community	The extent of introductions of exotic fish.
Flow- Intra Daily(diel) Variation (FlwDielVar)	Biological Community	Average diel variation in flow during a month. Can indicate level of urbanization or “flashiness”.
Flow- Change in Average Annual High Flow (FlwHigh)	Hydrology	Relative average peak annual discharge.
Flow- Intra-Annual Flow Pattern (FlwIntraAnn)	Hydrology	Variation in annual flow, or flashiness, during the primary runoff season.
Flow- Change in Average Annual Low Flow (FlwLow)	Hydrology	Relative average daily flow change in low flow seasons.
Flow- Regulated Flow Decrease (FlwRegDecrease)	Hydrology	The month-specific combination of a negative deviation of relative mean monthly flow and the relative variability of mean daily flows for the same month. Deviations of mean flows and flow variabilities are expressed relative to unregulated flows that could be expected under the same set of land use conditions. The metric used to describe the attribute is derived from a Z-score of regulated and unregulated mean monthly flows and a ratio of the Coefficient of Variation (CV) of regulated to unregulated mean daily flows.

Level 2 Attribute	Associated Level 3 Attribute	Level 2 Attribute Description
Flow- Regulated Flow Increase (FlwRegIncrease)	Hydrology	The month-specific combination of a positive deviation of relative mean monthly flow and the relative variability of mean daily flows for the same month. Deviations of mean flows and flow variabilities are expressed relative to unregulated flows that could be expected under the same set of land use conditions. The metric used to describe the attribute is derived from a Z-score of regulated and unregulated mean monthly flows and a ratio of the Coefficient of Variation (CV) of regulated to unregulated mean daily flows.
Gradient (Grad)	Hydrology	The average gradient of the main channel of the reach.
Habitat Type– Backwater pools (HabBckPls)	Key Habitat	Percentage of backwater pools in the reach.
Habitat Type– Beaver ponds (HabBvrPnds)	Key Habitat	Percentage of beaver ponds in the reach.
Habitat Type– Glide (HbGlide)	Key Habitat	Percentage of glides in the reach.
Habitat Type – Large cobble/boulder riffles (HbLrgCbl)	Key Habitat	Percentage of large cobble riffles in the reach.
Habitat Type – Off-Channel Habitat Factor (HbOfChFctr)	Key Habitat	Multiplier for estimating off channel habitat, as an expression of the total habitat in the reach.
Habitat Type – Primary Pools (HbPls)	Key Habitat	Percentage of primary pools in the reach.
Habitat Type – Pool Tailouts (HbPlTails)	Key Habitat	Percentage of pool tailouts in the reach.
Habitat – Small cobble riffles (HbSmCbl)	Key Habitat	Percentage of small cobble riffles in the reach.
Harassment (Harass)	Harassment/Poaching	Reach proximity to human population center as indication of extent of poaching and harassment of fish.
Hatchery Fish Outplants (HatFOutp)	Biological Community	Magnitude of hatchery releases of juvenile fish.
Hydrologic Regime- Natural (HydroRegimeNatural)	Biological Community	Natural flow regime (seasonal pattern of flow over the year).
Hydrologic- Regime- Regulated (HydroRegimeReg)	Hydrology	The change in the hydrograph caused by the operation of flow regulation facilities.
Icing (Icing)	Hydrology	Average extent and magnitude of icing events over 10-year period.
Metals/ Pollutants- in Sediments/Soils (MetSedSls)	Stream Structure	The extent of heavy metals in stream sediments and soils adjacent to the stream.
Metals in Water Column (MetWatCol)	Water Quality	The extent of dissolved heavy metals in the water column.
Miscellaneous Toxic Pollutants- Water Column (MscToxWat)	Water Quality	Extent of pollutants (other than heavy metals) in the water column.
Nutrient Enrichment (NutEnrch)	Water Quality	The extent of nutrient enrichment (N and P) from anthropogenic activities.
Obstructions (Obstr)	Obstructions to Fish Migration (physical barriers)	Obstructions to fish migration
Predation Risk (PredRisk)	Water Quality	Per capita risk for small and large fish of predation by species, due to a manmade structure.
Riparian Function (RipFunc)	Biological Community	How much riparian function has been altered within the reach.
Salmon Carcasses (SalmCarcass)	Stream Structure	Relative abundance of anadromous salmonid carcasses by watershed.
Temperature- Daily Maximum (TmpMonMx)	Water Quality	Max duration and heat of water temperature within the stream reach during a month.

Level 2 Attribute	Associated Level 3 Attribute	Level 2 Attribute Description
Temperature- Daily Minimum (TmpMonMn)	Water Quality	Minimum duration and heat of water temperature within the reach during a month.
Temperature- Spatial Variation (TmpSptVar)	Water Quality	Extent of water temperature variation as influenced by inputs of groundwater, tributaries, or thermal stratifications in deep pools.
Turbidity (Turb)	Stream Structure	Severity of suspended sediment within a reach.
Water Withdrawals (Wdrwl)	Hydrology	Number and size of water withdrawals in the stream reach.
Width Maximum (WidthMx)	Key Habitat	Average width of the wetted channel during high flow month.
Width Minimum (WidthMn)	Key Habitat	Average width of the wetted channel during low flow month.
Wood (WdDeb)	Stream Structure	Amount of large woody debris (greater than 0.1 meter in diameter and 2.0 meters in length) in the reach.

Table A-2. Summary of the EDT Level 3 Attributes

Factor	Definition
Channel stability	The effect of stream channel stability (within reach) on the relative survival or performance of the focus species; the extent of channel stability is with respect to its streambed, banks, and its channel shape and location.
Chemicals	The effect of toxic substances or toxic conditions on the relative survival or performance of the focus species. Substances include chemicals and heavy metals. Toxic conditions include low pH.
Competition (with hatchery fish)	The effect of competition with hatchery produced animals on the relative survival or performance of the focus species; competition might be for food or space within the stream reach.
Competition (with other species)	The effect of competition with other species on the relative survival or performance of the focus species; competition might be for food or space.
Flow	The effect of the amount of stream flow, or the pattern and extent of flow fluctuations, within the stream reach on the relative survival or performance of the focus species. Effects of flow reductions or dewatering due to water withdrawals are to be included as part of this attribute.
Food	The effect of the amount, diversity, and availability of food that can support the focus species on the its relative survival or performance.
Habitat diversity	The effect of the extent of habitat complexity within a stream reach on the relative survival or performance of the focus species.
Harassment	The effect of harassment, poaching, or non-directed harvest (i.e., as can occur through hook and release) on the relative survival or performance of the focus species.
Key habitat	The relative quantity of the primary habitat type(s) utilized by the focus species during a life stage; quantity is expressed as percent of wetted surface area of the stream channel.
Obstructions	The effect of physical structures impeding movement of the focus species on its relative survival or performance within a stream reach; structures include dams and waterfalls.
Oxygen	The effect of the concentration of dissolved oxygen within the stream reach on the relative survival or performance of the focus species.
Pathogens	The effect of pathogens within the stream reach on the relative survival or performance of the focus species. The life stage when infection occurs is when this effect is accounted for.
Predation	The effect of the relative abundance of predator species on the relative survival or performance of the focus species.
Sediment load	The effect of the amount of the amount of fine sediment present in, or passing through, the stream reach on the relative survival or performance of the focus species.
Temperature	The effect of water temperature with the stream reach on the relative survival or performance of the focus species.
Withdrawals (or entrainment)	The effect of entrainment (or injury by screens) at water withdrawal structures within the stream reach on the relative survival or performance of the focus species. This effect does not include dewatering due to water withdrawals, which is covered by the flow attribute.

Table A-3. The Association between the Recovery Plan Actions and the EDT Level 2 Attributes

Recovery Action Code	Subbasin Location	Recovery Action Category	EDT Level 2 Attributes
Basin Wide-1	Basin Wide	Reservoir Operations	FlwHigh, FlwLow
Basin Wide -2	Basin Wide	Fish Screens	Obstr
Basin Wide-3	Basin Wide	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Basin Wide-4	Basin Wide	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Basin Wide-5	Basin Wide	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Basin Wide-6	Basin Wide	Hatchery Supplementation	N/A
Basin Wide-7	Basin Wide	Hatchery Supplementation	N/A
Basin Wide-8	Basin Wide	Hatchery Supplementation	N/A
Basin Wide-9	Basin Wide	Administrative	N/A
Basin Wide-10	Basin Wide	Regulatory	N/A
Basin Wide-11	Basin Wide	Habitat	HbBvrPnds
Basin Wide-12	Basin Wide	Habitat	RipFunc, TmpSpatVar, WdDeb,
Basin Wide-13	Basin Wide	Forest Health	BdScour, Emb, FnSedi, FlwHigh, FlwLow, Habitat_Types, WdDeb
Basin Wide-14	Basin Wide	Regulatory	N/A
Basin Wide-15	Basin Wide	Nutrients	SalmCarcass
Basin Wide-16	Basin Wide	Regulatory	PredRisk
Lower Mainstem-1	Lower Yakima Mainstem	Power Subordination	FlwHigh, FlwLow, PredRisk, WidthMn, WidthMx
Lower Mainstem-2	Lower Yakima Mainstem	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Lower Mainstem-3	Lower Yakima Mainstem	Infrastructure	Obstr (juvenile patterns)
Lower Mainstem-5	Lower Yakima Mainstem	Storage	FlwHigh, FlwLow, WidthMn, WidthMx
Lower Mainstem-6	Lower Yakima Mainstem	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Lower Mainstem-7	Lower Yakima Mainstem	Habitat	RipFunc, WdDeb, Hb_Types, HbOfChFctr, ConfineHydro
Lower Mainstem-8	Lower Yakima Mainstem	False Attraction	N/A
Lower Mainstem-9	Lower Yakima Mainstem	Water Quality	MscToxWat, NutEnrch, TmpMonMx, Turb
Naches-1	Naches	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-2	Naches	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-3	Naches	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-4	Naches	Flip Flop	FlwLow, FlwHigh, WidthMn, WidthMx

Recovery Action Code	Subbasin Location	Recovery Action Category	EDT Level 2 Attributes
Naches-5	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-6	Naches	Sediment Transport	BdScour, ConfineHydro, FnSedi, RipFunc, WdDeb, HbOfChFctr, Hb_Types
Naches-7	Naches	Habitat	Protection- No Change to Level 2 Attributes
Naches-8	Naches	Roads	Emb, FnSedi, RipFunc
Naches-9	Naches	Fish Habitat	Obstr
Naches-10	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-11	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-12	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-13	Naches	Habitat	BdScour, ConfineHydro, Hb_Types, RipFunc
Naches-14	Naches	Habitat	Protection- No Change to Level 2 Attributes
Naches-15	Naches	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-16	Naches	Fish Passage	Obstr
Naches-17	Naches	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-18	Naches	Sediment Transport	BdScour, FnSedi, ConfineHydro, HbOfChFctr, Hb_Types, RipFunc, WdDeb
Naches-19	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-20	Naches	Habitat	Protection- No Change to Level 2 Attributes
Naches-21	Naches	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-22	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-23	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-24	Naches	Flow	FlwLow, WidthMx, WidthMn
Naches-25	Naches	Storage	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-26	Naches	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Naches-27	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-28	Naches	Habitat	Protection- No Change to Level 2 Attributes
Naches-29	Naches	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Naches-30	Naches	Reservoir Operations	FlwLow, WidthMn

Recovery Action Code	Subbasin Location	Recovery Action Category	EDT Level 2 Attributes
Satus-1	Satus	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Satus-2	Satus	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Satus-3	Satus	Water Quality	MscToxWat, NutEnrch, TmpMonMx, Turb
Satus-4	Satus	Water quality	MscToxWat, NutEnrch, TmpMonMx, Turb
Satus-5	Satus	Fish Passage	Obstr
Satus-6	Satus	Fish Passage	Obstr
Satus-7	Satus	Roads	Emb, FnSedi, RipFunc
Satus-8	Satus	Habitat	FlwLow, TmpMonMx, TmpMonMn,
Toppenish-1	Toppenish	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Toppenish-2	Toppenish	Water Quality	MscToxWat, NutEnrch, TmpMonMx, Turb
Toppenish-3	Toppenish	Fish Passage	Obstr
Toppenish-4	Toppenish	Fish Passage	Obstr
Toppenish-5	Toppenish	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Toppenish-6	Toppenish	Water Conservation	FlwHigh, FlwLow, WidthMn, WidthMx
Toppenish-7	Toppenish	Habitat	Protection- No Change to Level 2 Attributes
Toppenish-8	Toppenish	Roads	BdScour, Emb, FnSedi, FlwHigh, FlwLow, RipFunc
Toppenish-9	Toppenish	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Upper Yakima-1	Upper Yakima	Fish Passage	Obstr
Upper Yakima-2	Upper Yakima	Power Subordination	FlwHigh, FlwLow, WidthMn, PredRisk, WidthMax
Upper Yakima-3	Upper Yakima	flip Flop	FlwLow, FlwHigh, WidthMx, WidthMn,
Upper Yakima-4	Upper Yakima	Water Conservation	Wdrwl, FlwHigh, FlwLow (pattern)
Upper Yakima-5	Upper Yakima	Fish Passage	Obstr
Upper Yakima-6	Upper Yakima	Fish Passage	Obstr
Upper Yakima-7	Upper Yakima	Fish Passage	Obstr
Upper Yakima-8	Upper Yakima	Fish Passage	Obstr
Upper Yakima-9	Upper Yakima	Fish Passage	Obstr
Upper Yakima-10	Upper Yakima	Fish Passage	Obstr
Upper Yakima-11	Upper Yakima	Water Conservation	Wdrwl, FlwHigh, FlwLow
Upper Yakima-12	Upper Yakima	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx

Recovery Action Code	Subbasin Location	Recovery Action Category	EDT Level 2 Attributes
Upper Yakima-13	Upper Yakima	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Upper Yakima-14	Upper Yakima	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Upper Yakima-15	Upper Yakima	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Upper Yakima-16	Upper Yakima	Habitat	Protection- No Change to Level 2 Attributes
Upper Yakima-17	Upper Yakima	Habitat	Protection- No Change to Level 2 Attributes
Upper Yakima-18	Upper Yakima	Habitat	BdScour, ConfineHydro, FineSedi, HbOfChFctr, Hb_Types, RipFunc, TmpMonMax (tributaries only), WdDeb, WidthMn, WidthMx
Upper Yakima-19	Upper Yakima	Water Quality	MscToxWat, NutEnrch, TmpMonMx, Turb
Upper Yakima-20	Upper Yakima	Habitat	FlwLow, TmpMonMx, TmpMonMn
Upper Yakima-21	Upper Yakima	Reservoir Operations	FlwLow, WidthMn

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Table A-4. Summary of EDT Level 2 Attributes Improved by One or More of the Recovery Plan Actions for each EDT Stream Reach[6]

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
Yakima R.-1A																x			x					x	x		x
Yakima R.-1B											x	x				x	x	x	x				x	x	x		x
Yakima R.- 1C (Horn Dam)																						x					
Yakima R.-1D											x	x				x	x	x	x				x	x	x		x
Yakima R.-1E											x	x				x	x	x	x				x	x	x		x
Yakima R.-1F											x	x				x	x	x	x				x	x	x		x
Yakima R.-2											x	x				x	x	x	x				x	x	x		x
Yakima R.-2A											x	x				x	x	x	x				x	x	x		x
Yakima R.-2B (Prosser Acclimation Site)											x	x					x	x						x			
Yakima R.- 2B2 (Prosser Dam)																						x					
Yakima R.-2C											x	x				x	x	x	x					x	x		x
Yakima R.-2D											x	x				x	x	x	x					x	x		x
Yakima R.-2E											x	x				x	x	x	x					x	x		x
Yakima R.-3	x	x	x	x	x	x	x	x	x		x	x				x	x	x	x		x		x	x	x		x
Yakima R.-4	x	x	x	x	x	x	x	x	x		x	x				x	x	x	x		x		x	x	x		x
Yakima R.-4A	x	x	x	x	x	x	x	x	x		x	x				x	x	x	x		x		x	x	x		x
Yakima R.-5	x	x	x	x	x	x	x	x	x		x	x				x	x	x	x		x		x	x	x		x
Yakima R.-5B																x			x				x	x	x		x
Yakima R.- 5C (Wapato Dam)																x			x						x		x
Yakima R.-5D	x	x															x	x			x	x	x	x			
Corral Canyon Cr.																x			x						x		x
Snipes Cr.-1																											
Spring Cr.																											
Snipes Cr.-2																											
Marion Drain-1																x			x				x		x		x
Marion Drain-3																x			x				x		x		x
Wanity Slough																											
Marion Drain-4																x			x				x		x		x
Harrah Drain																											
Sulphur Cr.																						x					
Satus Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Satus Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Satus Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Satus Cr.-4	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Satus Cr.-5	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Satus Cr.-6	x												x	x									x				
Satus Cr.-7	x												x	x			x		x	x			x				
Mule Dry Cr.	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Dry Cr. (Satus)-1	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Dry Cr. (Satus)-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x		x	x			x				

[6] Blank cells denote EDT stream reaches where the corresponding Level 2 attribute was not improved through one or more of the restoration actions.

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
Logy Cr.	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Bull Cr.	x												x	x									x				
Kusshi Cr.	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x		x	x			x				
Wilson Charlie Cr.	x												x	x									x				
Toppenish Cr.-1											x	x					x	x					x				
Toppenish Cr.-2											x	x					x	x					x				
Toppenish Cr.-3											x	x					x	x					x				
Toppenish Cr.-4											x	x					x	x					x				
Toppenish Cr.-5											x	x					x	x					x				
Toppenish Cr.-6											x	x					x	x					x				
Toppenish Cr.-7	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Toppenish Cr.-8	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Toppenish Cr.-9	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Toppenish Cr.-10	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Toppenish Cr.-11	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Simcoe Cr.-1											x	x					x	x					x				
Simcoe Cr.-2											x	x					x	x					x				
Simcoe Cr.-3											x	x					x	x					x				
Simcoe Cr.-5																							x			x	x
Simcoe Cr.-6																							x			x	x
Willy Dick Canyon Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Willy Dick Canyon Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Willy Dick Canyon Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
NF Toppenish Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
NF Toppenish Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
SF Toppenish Cr.	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Agency Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Agency Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Wahtum Cr.	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
NF Simcoe Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
NF Simcoe Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
SF Simcoe Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
SF Simcoe Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x				x				
Yakima R.-6	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x		x		x		x		x
Yakima R.-6A	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x		x		x		x		x
Yakima R.-6B	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x		x		x		x		x
Yakima R.-7	x	x									x	x				x	x	x	x		x		x	x	x		x
Yakima R.-8											x	x				x	x	x	x				x	x	x		x
Yakima R.-9A (Roza Dam)																						x					
Ahtanum Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x				
Ahtanum Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x				
Ahtanum Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x				
Ahtanum Cr.-4	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x				
Ahtanum Cr.-5	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x				
Ahtanum Cr.-6	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x				

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
Ahtanum Cr.-7																							x				
Bachelor Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Bachelor Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Bachelor Spring Cr	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Hatton Cr.	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Ahtanum Cr. NF-1																											
Ahtanum Cr. NF-2																											
Ahtanum Cr. NF-3																											
Ahtanum Cr. NF-4																											
Ahtanum Cr. NF-5																											
Ahtanum Cr. NF-6																											
Foundation Cr.																											
Nasty Cr.																											
MF Ahtanum Cr.																											
Ahtanum Cr. SF-1																											
Ahtanum Cr. SF-2																											
Wide Hollow Cr.-1																											
Wide Hollow Cr.-3																											
Wide Hollow Cr.-4																											
Spring Branch Cr.																											
Wenas Cr.-1																											
Wenas Cr.-1a																											
Wenas Cr.-2																											
NF Wenas Cr.																											
SF Wenas Cr.																											
Naches R.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x					x				
Naches R.-1a	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x			x		x				
Naches R.-1b	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x			x		x				
Naches R.-1c	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x			x		x				
Naches R.-2A	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x			x		x				
Naches R.-2C																							x				
Naches R.-3	x	x	x	x	x	x	x	x	x		x	x	x		x						x		x				
Naches R.-4	x	x	x	x	x	x	x	x	x		x	x	x		x						x						
Naches R.-5	x	x	x	x	x	x	x	x	x		x	x	x		x						x		x				
S Naches Channel											x	x					x	x					x				
Cowiche Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x				
Cowiche Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x				x	x	x				x				
SF Cowiche Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x						x				x				
SF Cowiche Cr.-2	x												x	x									x				
Reynolds Cr	x												x	x									x				
NF Cowiche Cr.	x												x	x													
Buckskin Slough																							x				
Tieton R.-1																	x	x					x				
Tieton R.-2																	x	x					x				
Tieton R.-3																	x	x					x				
Tieton R.-4																	x	x					x				
Tieton R.-5																											
Oak Cr.	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
Wildcat Cr.	x												x	x									x				
NF Tieton R.-1																											
NF Tieton R.-2																											
NF Tieton R.-3																											
NF Tieton R.-3B																											
NF Tieton R.-4																											
NF Tieton R.-5																											
Indian Cr. (NF Tieton)																											
Clear Cr.																											
SF Tieton R.-1																											
SF Tieton R.-2																											
SF Tieton R.-3																											
SF Tieton R.-4																											
Rattlesnake Cr.-1	x	x	x	x	x	x	x	x	x				x		x								x				
Rattlesnake Cr.-2																							x				
Rattlesnake Cr.-3	x												x	x									x				
Rattlesnake Cr.-4																							x				
Rattlesnake Cr.-5																							x				
Little Rattlesnake Cr.	x												x	x									x				
NF Rattlesnake Cr.	x												x	x									x				
Hindoo Cr.																							x				
Nile Cr.	x										x	x	x	x			x	x					x				
Little Naches R.-1	x												x	x									x				
Little Naches R.-2	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Little Naches R.-3	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Crow Cr.	x												x	x									x				
Little Naches R.-4	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Quartz Cr.	x												x	x									x				
Little Naches R.-5	x	x	x	x	x	x	x	x	x		x	x	x	x	x				x				x				
Little Naches R.-6	x		x										x	x	x								x				
Pileup Cr.	x												x	x									x				
Little Naches R.-7	x		x										x	x	x								x				
Little Naches R.-8	x		x										x	x	x								x				
Matthew Cr.	x												x	x									x				
Little Naches R.-9	x		x										x	x	x								x				
SF Little Naches R.	x												x	x									x				
Little Naches R.-10	x		x										x	x	x								x				
Bear Cr. (L. Naches)-1	x												x	x									x				
WF Bear Cr. (L. Naches)	x												x	x									x				
Bear Cr. (L. Naches)-2	x												x	x									x				
Little Naches R.-11	x												x	x									x				
MF Little Naches R.	x												x	x									x				
NF Little Naches R.-1	x												x	x									x				
Blowout Cr.-1	x												x	x									x				
Blowout Cr.-2	x												x	x									x				
NF Little Naches R.-2	x												x	x									x				
Pyramid Cr.	x												x	x									x				

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
NF Little Naches R.-3	x												x	x									x				
NF Little Naches R.-4	x												x	x									x				
Bumping R.-1	x	x	x	x	x	x	x	x	x		x	x	x		x								x				
Bumping R.-2a	x	x	x	x	x	x	x	x	x		x	x	x		x								x				
Bumping R: Bumping Dam																						x					
Bumping R.-3a (Bumping Lake Reach 1)																											
Bumping R.-3b (Bumping Lake Reach 2)																											
Bumping R.-4																							x				
Bumping R.-4b																							x				
Bumping R.-5																							x				
Bumping R.-5b																							x				
Bumping R.-6																							x				
Deep Cr.-1																							x				
Deep Cr.-2																							x				
American R.-1																							x				
American R.-2																							x				
American R.-3																							x				
American R.-3A																							x				
American R.-3B																							x				
American R.-4																							x				
American R.-4A																							x				
American R.-5																							x				
American R.-6																							x				
American R.-6A																							x				
American R.-6B																							x				
Kettle Cr.																							x				
Miner Cr.																							x				
Morse Cr.																							x				
Rainier Fork																							x				
Union Cr.																							x				
Yakima R.-9B																x			x				x		x		x
Yakima R.-10																x			x				x		x		x
Yakima R.-11	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x			x		x				
Yakima R.-11A	x	x	x	x	x	x	x	x	x		x	x	x		x		x						x				
Yakima R.-11B	x	x	x	x	x	x	x	x	x		x	x	x		x		x						x				
Yakima R.-11C	x	x	x	x	x	x	x	x	x		x	x	x		x		x						x				
Yakima R.-12	x	x	x								x	x					x	x					x				
Yakima R.-13											x	x					x	x					x				
Yakima R.-13A (Clark Flats Acclimation Site)																											
Yakima R.-13B											x	x					x	x					x				
Yakima R.-14	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x					x				
Yakima R.-15	x	x									x	x					x	x			x		x				
Yakima R.-16	x	x	x	x	x	x	x	x	x		x	x	x		x								x				

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
Yakima R.-17																							x				
Yakima R.-17A	x	x	x	x	x	x	x	x	x		x	x	x		x								x				
Yakima R.-17B	x	x	x	x	x	x	x	x	x		x	x	x		x								x				
Yakima R.-17C (Easton Acclimation Site)																											
Yakima R.-18																							x				
Easton Dam																						x					
Yakima R.-19B (Lake Easton)																											
Yakima R.-20																							x				
Yakima R.-21											x						x						x				
Yakima R.-22B (Keechelus Lake)																											
Umtanum Cr.																							x				
Wilson Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Wilson Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Wilson Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Wilson Cr.-4	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Bull Ditch																							x				
Wilson Cr.-4A																x			x				x		x		x
Wilson Cr.-5																x			x				x		x		x
Wilson Cr.-6																x			x				x		x		x
East Branch Wilson Cr.-1																x			x				x		x		x
East Branch Wilson Cr.-2																x			x				x		x		x
Wilson Cr.-7																x			x				x		x		x
Wilson Cr.-8																							x				
Wilson Cr.-9																							x				
Wilson Cr.-10																							x				
Wilson Cr.-11																							x				
Cherry Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Cherry Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Cherry Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Cherry Cr.-4	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Badger Cr.-1																							x				
Badger Cr.-2																							x				
Park Cr.																							x				
Caribou Cr.																							x				
Cooke Cr.																							x				
Lower Naneum Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Lower Naneum Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Lower Naneum dam																						x					
Lower Naneum Cr.-3																							x				
Lower Naneum Cr.-4																							x				
Upper Naneum Cr.																							x				
Coleman Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x
Coleman Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x	x			x				x		x		x

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
Coleman Cr.-3																							x				
Mercer Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Mercer Cr.-2																							x				
Reecer Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Reecer Cr.-1B	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Reecer Cr.-2																							x				
Currier Cr.	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Manastash Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Barnes R Diversion Dam																						x					
Manastash Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Manastash Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Old Anderson Diversion Dam																						x					
Manastash Cr.-4	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
New Anderson Diversion Dam																						x					
Manastash Cr.-5	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Reed Diversion Dam																						x					
Manastash Cr.-6	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Hadfield Diversion Dam																						x					
Manastash Cr.-7	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Manastash Cr.-8	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Keach/Jenson Div. Dam																						x					
Manastash Cr.-9	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Manastash Ditch Div. Dam																						x					
Manastash Cr.-10	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
NF Manastash Cr.																	x		x	x			x				
SF Manastash Cr.-1																	x		x	x			x				
SF Manastash Cr.-2																	x		x	x			x				
SF Manastash Cr.-3																	x		x	x			x				
Taneum Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Bruton dam																						x					
Taneum Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Tanuem dam																						x					
Taneum Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Taneum Cr.-4																							x				
Knudsen dam	x	x	x	x	x	x	x	x	x		x	x	x		x				x			x					
Taneum Cr.-5	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Taneum Cr.-6	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Taneum Cr.																	x		x	x			x				
SF Taneum Cr.																	x		x	x			x				
Swauk Cr.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x	x			x			x	x
First Creek																											
Swauk Cr.-2	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x	x			x			x	x
Swauk Cr.-3	x	x	x	x	x	x	x	x	x		x	x	x		x		x		x	x			x				

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
Swauk Cr.-4	x	x	x	x	x	x	x	x	x		x	x	x		x		x		x	x			x				
Williams Cr.																							x				
Iron Cr.																							x				
Cle Elum R.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x		x				x				
Cle Elum Dam																						x					
Cle Elum R.-2B (Lake Cle Elum)																											
Cle Elum R.-3																	x		x	x			x				
Cle Elum R.-4																	x		x	x			x				
Cle Elum R.-5																	x		x	x			x				
Cle Elum R.-6																							x				
Cle Elum R.-7																							x				
Cle Elum R.-8																							x				
Cle Elum R.-9																											
Cle Elum R.-10																							x				
Cle Elum R.-11																							x				
Cle Elum R.-12																											
Cooper R.																							x				
Waptus R.-1																							x				
Waptus R.-2																							x				
Waptus R.-3																							x				
Waptus R.-4																											
Waptus R.-5																							x				
Little Cr.-1																							x				
Little Cr.-2																							x				
Big Cr.-1																							x				
Big Cr.-2																							x				
Big Cr.-3																							x				
Big Cr.-4																							x				
Big Cr.-5																							x				
Big Cr.-6																							x				
Tucker Cr.-1																							x				
Tucker Cr.-2																							x				
Kachess R.-1											x						x						x				
Kachess R.-2B (Kachess Lake first reach)																											
Kachess R.-3 (Kachess Lake second reach)																											
Kachess R.-4																							x				
Box Canyon Cr.																							x				
Cabin Cr.																							x				
Gold Cr.																							x				
Teanaway R.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
Teanaway R.-2	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
NF Teanaway R.-1	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-2	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-3	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				

Reach Name	RipFunc	WdDeb	ConfineHydro	HbPls	HbGlide	HbSmCbl	HbLgCbl	HbBckPls	HbOfChlFctr	HbBvrPd	WidthMin	WidthMax	FnSedi	Emb	BdScour	Turb	FlwLow	FlwHigh	TmpMonMax	TmpMonMin	TmpSpatVar	Obstr	SalmCarcass	PredRisk	NutEnrch	Wdrwl	MscToxWat
NF Teanaway R.-4	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-4A	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-4B (Jack Creek Acclimation Site)																											
NF Teanaway R.-5	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-6	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-7	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-7A	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-8	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
NF Teanaway R.-9	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
Lick Cr.																							x				
Dickey Cr.																							x				
Middle Cr.																							x				
Indian Cr. (Teanaway)																							x				
Jack Cr.																							x				
Jungle Cr.																							x				
Stafford Cr.-1																							x				
Stafford Cr.-2																							x				
Stafford Cr.-3																							x				
Bear Cr.(Teanaway)																							x				
Johnson Cr.																							x				
MF Teanaway R.-1																							x				
MF Teanaway R.-2																							x				
MF Teanaway R.-3																							x				
MF Teanaway R.-4																							x				
WF Teanaway R.-1	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x				x			x	x
WF Teanaway R.-2	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
WF Teanaway R.-3	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				
WF Teanaway R.-4	x	x	x	x	x	x	x	x	x		x	x	x		x				x				x				

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Appendix B

Diagnostic Results for Anadromous Salmonid Populations in the Yakima Basin

Ahtanum

1. Coho- Summary of Survival Effects on Survival Factors and Overall Performance
2. Coho- Change in Performance due to Scenario's Effect Within Geographic Area
3. Spring Chinook- Summary of Survival Effects on Survival Factors and Overall Performance
4. Spring Chinook- Change in Performance due to Scenario's Effect Within Geographic Area
5. Steelhead- Summary of Survival Effects on Survival Factors and Overall Performance
6. Steelhead- Change in Performance due to Scenario's Effect Within Geographic Area

American

7. Spring Chinook- Summary of Survival Effects on Survival Factors and Overall Performance
8. Spring Chinook- Change in Performance due to Scenario's Effect Within Geographic Area
9. Steelhead- Summary of Survival Effects on Survival Factors and Overall Performance
10. Steelhead- Change in Performance due to Scenario's Effect Within Geographic Area

Marion Drain

11. Fall Chinook- Summary of Survival Effects on Survival Factors and Overall Performance
12. Fall Chinook- Change in Performance due to Scenario's Effect Within Geographic Area

Naches

13. Coho- Summary of Survival Effects on Survival Factors and Overall Performance
14. Coho- Change in Performance due to Scenario's Effect Within Geographic Area

Upper Yakima

15. Coho- Summary of Survival Effects on Survival Factors and Overall Performance
16. Coho- Change in Performance due to Scenario's Effect Within Geographic Area

Table B-1. Summary of Scenario Effects on Survival Factors and Overall Performance for Ahtanum Coho

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Ahtanum Cr.		◯	○				○		○	○	◯				○	○		◯
Lower Satus (Below Dry Cr.)		○							○									◯
Lower Yakima River		○												○				○
Marion Drain		○																
Toppenish Cr. Below Simcoe		○							•									◯
Yakima - Gap to Gap Floodplain		○																◯
Yakima - Selah Floodplain		○							○									○
Yakima- Lower Wapato Floodplain		○												○	○			◯
Yakima- Upper Wapato Floodplain		○							○						○	○		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-2. Change in Performance Due to Scenario's Effect within Geographic Area for Ahtanum Coho

Geographic Area	Loss category		Gain category		Loss or Gain in Abundance				Change in Productivity with				Change in Diversity Index with			
	Category/rank		Category/rank		Loss		Gain		Loss		Gain		Loss		Gain	
Ahtanum Cr.	E	2	A	1												
Lower Satus (Below Dry Cr.)	E	1	B	8												
Lower Yakima River	E	2	B	4												
Marion Drain	E	2	B	8												
Toppenish Cr. Below Simcoe	E	2	B	7												
Yakima - Gap to Gap Floodplain	E	2	B	5												
Yakima - Selah Floodplain	E	2	B	6												
Yakima- Lower Wapato Floodplain	E	2	B	2												
Yakima- Upper Wapato Floodplain	E	2	B	3												
					-7250%	0%	7250%		-7250%	0%	7250%		-7250%	0%	7250%	
					Percentage change				Percentage change				Percentage change			

Table B-3. Summary of Scenario Effects on Survival Factors and Overall Performance for Ahtanum Spring Chinook

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Ahtanum Cr.		◯					o		◯	o	◯				o	◯		◯
Lower Yakima River		o														o		o
Yakima- Lower Wapato Floodplain		o													o	o		◯
Yakima- Upper Wapato Floodplain		o												o	o	o		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-4. Change in Performance Due to Scenario's Effect within Geographic Area for Ahtanum Spring Chinook

Geographic Area	Loss category		Gain category		Loss or Gain in Abundance		Change in Productivity with		Change in Diversity Index with	
	Category/rank		Category/rank		Loss	Gain	Loss	Gain	Loss	Gain
Ahtanum Cr.	E	4	A	1						
Lower Yakima River	E	4	B	4						
Yakima- Lower Wapato Floodplain	E	4	B	2						
Yakima- Upper Wapato Floodplain	E	4	B	3						

-760% 0% 760% Percentage change

-760% 0% 760% Percentage change

-760% 0% 760% Percentage change

Table B-5. Summary of Scenario Effects on Survival Factors and Overall Performance for Ahtanum Steelhead

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Ahtanum Cr.		◯	○				o		o		◯		o		o	◯		◯
Lower Satus (Below Dry Cr.)		○							o							o		◯
Lower Yakima River		○												o		o		o
Marion Drain		○																
Toppenish Cr. Below Simcoe		○																◯
Yakima - Gap to Gap Floodplain		○																◯
Yakima- Lower Wapato Floodplain		○							o					o	◯	o		◯
Yakima- Upper Wapato Floodplain		○					●						o	o	o	o		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-6. Change in Performance Due to Scenario's Effect within Geographic Area for Ahtanum Steelhead

Geographic Area	Loss category		Gain category		Loss or Gain in Abundance	Change in Productivity with	Change in Diversity Index with
	Category	rank	Category	rank	Loss / Gain	Loss / Gain	Loss / Gain
Ahtanum Cr.	E	3	A	1			
Lower Satus (Below Dry Cr.)	E	1	B	6			
Lower Yakima River	E	3	B	4			
Marion Drain	E	3	B	8			
Toppenish Cr. Below Simcoe	E	1	B	6			
Yakima - Gap to Gap Floodplain	E	3	B	5			
Yakima- Lower Wapato Floodplain	E	3	B	2			
Yakima- Upper Wapato Floodplain	E	3	B	3			

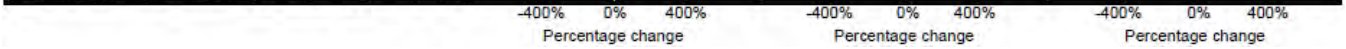

Table B-7. Summary of Scenario Effects on Survival Factors and Overall Performance for American Spring Chinook

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
American																		
Lower Bumping								o	○									○
Lower Naches									o									○
Lower Yakima River																o		o
Upper Naches									○									○
Yakima - Gap to Gap Floodplain																		○
Yakima- Lower Wapato Floodplain															o	o		○
Yakima- Upper Wapato Floodplain															o	o		○

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-8. Change in Performance Due to Scenario's Effect within Geographic Area for American Spring Chinook

Geographic Area	Loss category		Gain category		Loss or Gain in Abundance	Change in Productivity with	Change in Diversity Index with
	Category	rank	Category	rank	Loss / Gain	Loss / Gain	Loss / Gain
American	E	8	E	8			
Lower Bumping	E	8	E	6			
Lower Naches	E	8	E	1			
Lower Yakima River	E	8	E	5			
Upper Naches	E	8	E	4			
Yakima - Gap to Gap Floodplain	E	8	E	6			
Yakima- Lower Wapato Floodplain	E	8	E	3			
Yakima- Upper Wapato Floodplain	E	8	E	2			

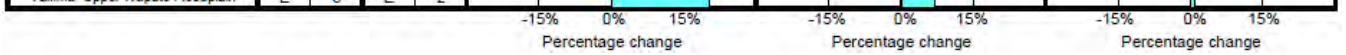

Table B-9. Summary of Scenario Effects on Survival Factors and Overall Performance for American Steelhead

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
American																		
Little Naches		○					○		◯									
Lower Bumping		◯							○									
Lower Naches		◯							○									○
Lower Tieton																		
Lower Yakima River		○												○		○		○
Nile																		
Rattlesnake							○		○									
Upper Naches		◯							○									○
Wide Hollow																		
Yakima - Gap to Gap Floodplain																		◯
Yakima - Selah Floodplain																		○
Yakima- Lower Wapato Floodplain		○												○	○	○		◯
Yakima- Upper Wapato Floodplain		○												○	○	○		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-10. Change in Performance Due to Scenario's Effect within Geographic Area for American Steelhead

Geographic AreaA	Loss category		Gain category		Loss or Gain in Abundance		Change in Productivity with		Change in Diversity Index with	
	Category/rank		Category/rank		Loss	Gain	Loss	Gain	Loss	Gain
American	E	2	D	10						
Little Naches	E	2	C	7						
Lower Bumping	E	2	A	2						
Lower Naches	E	2	A	3						
Lower Tieton	E	2	D	13						
Lower Yakima River	E	2	C	5						
Nile	E	2	D	12						
Rattlesnake	E	1	D	8						
Upper Naches	E	2	A	1						
Wide Hollow	E	2	D	13						
Yakima - Gap to Gap Floodplain	E	2	D	11						
Yakima - Selah Floodplain	E	2	D	8						
Yakima- Lower Wapato Floodplain	E	2	B	4						
Yakima- Upper Wapato Floodplain	E	2	C	5						

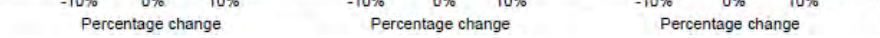

Table B-11. Summary of Scenario Effects on Survival Factors and Overall Performance for Marion Drain Fall Chinook

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Lower Yakima River		○											◦	◦		○		◦
Marion Drain		◦																
Yakima- Lower Wapato Floodplain		◯											◦	◦	◦	○		◯
Yakima- Upper Wapato Floodplain		◦																

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-12. Change in Performance Due to Scenario's Effect within Geographic Area for Marion Drain Fall Chinook

Geographic Area	Loss category		Gain category		Loss or Gain in Abundance		Change in Productivity with		Change in Diversity Index with	
	Category	rank	Category	rank	Loss	Gain	Loss	Gain	Loss	Gain
Lower Yakima River	E	4	B	2						
Marion Drain	E	4	C	3						
Yakima- Lower Wapato Floodplain	E	4	A	1						
Yakima- Upper Wapato Floodplain	E	4	C	3						

-30% 0% 30% Percentage change

-30% 0% 30% Percentage change

-30% 0% 30% Percentage change

Table B-13. Summary of Scenario Effects on Survival Factors and Overall Performance for Naches Coho

Relative loss or gain by area			Change in attribute impact on survival due to scenario																
Geographic area	Relative loss	Relative gain	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other spp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Ahtanum Cr.							o		o							o		◯
American																		
Cowiche mainstem		o					o		◯						o			o
Little Naches		◯							◯						◯			◯
Little Rattlesnake															◯			
Lower Bumping		◯					o	o	◯		◯				◯			◯
Lower Naches		◯						o	◯						o			◯
Lower Satus (Below Dry Cr.)									o									◯
Lower Tieton		o									◯							
Lower Yakima River														o				o
Marion Drain																		
NF Cowiche															o			
NF Tieton											◯							
Nile															◯			
Oak Cr		o					o		◯						o	o		◯
Rattlesnake		◯							◯						o			o
SF Cowiche									◯						o			◯
SF Tieton									◯									◯
Toppenish Cr. Below Simcoe									•									◯
Upper Bumping											◯							
Upper Naches		◯							◯						◯			◯
Upper Tieton																		
Wide Hollow																		
Yakima - Gap to Gap Floodplain		o							o									◯
Yakima - Selah Floodplain									◯									◯
Yakima Canyon																		
Yakima- Lower Wapato Floodplain														o	o			◯
Yakima- Upper Wapato Floodplain									o					o	o	o		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-14. Change in Performance Due to Scenario's Effect within Geographic Area for Naches Coho

Geographic Area	Loss category		Gain category		Loss or Gain in Abundance		Change in Productivity with		Change in Diversity Index with	
	Category/rank		Category/rank		Loss	Gain	Loss	Gain	Loss	Gain
Ahtanum Cr.	E	4	D	12						
American	E	4	D	16						
Cowiche maistem	E	4	C	7						
Little Naches	E	4	B	3						
Little Rattlesnake	E	4	D	18						
Lower Bumping	E	4	B	4						
Lower Naches	E	4	A	1						
Lower Satus (Below Dry Cr.)	E	4	D	20						
Lower Tieton	E	4	C	8						
Lower Yakima River	E	4	D	12						
Marion Drain	E	4	D	22						
NF Cowiche	E	4	D	21						
NF Tieton	E	4	D	22						
Nile	E	1	D	16						
Oak Cr	E	4	C	6						
Rattlesnake	E	4	B	5						
SF Cowiche	E	4	D	15						
SF Tieton	E	4	D	22						
Toppenish Cr. Below Simcoe	E	4	D	19						
Upper Bumping	E	4	D	22						
Upper Naches	E	4	A	2						
Upper Tieton	E	4	D	22						
Wide Hollow	E	4	D	22						
Yakima - Gap to Gap Floodplain	E	4	C	8						
Yakima - Selah Floodplain	E	2	D	14						
Yakima Canyon	E	2	D	22						
Yakima- Lower Wapato Floodplain	E	4	D	10						
Yakima- Upper Wapato Floodplain	E	4	D	11						

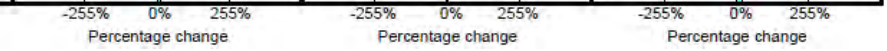

Table B-15. Summary of Scenario Effects on Survival Factors and Overall Performance for Upper Yakima Coho

Relative loss or gain by area			Change in attribute impact on survival due to scenario															
Geographic area	Relative loss	Relative gain	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Ahtanum Cr.							o		o							o		◯
Big, Little, Tucker Creeks											◯							◯
Keechelus											◯							
Lower Cle Elum							o		o		◯							◯
Lower Kachess																		
Lower Naches									○									◯
Lower Yakima River														o				o
Manastash									○		◯				o			◯
Marion Drain																		
Swauk			○				o		○						○	o		◯
Taneum			o				o		◯		○				○			◯
Teanaway			o				o		○						o	o		◯
Toppenish Cr. Below Simcoe							o		•									◯
Umtanum																		
Upper Cle Elum									○									◯
Upper Kachess											◯				o			o
Upper Yakima									○		o				o			○
Wenas Cr.																		
Wide Hollow																		
Wilson									o		◯				o			o
Yakima - Gap to Gap Floodplain									o									◯
Yakima - Selah Floodplain									○									○
Yakima Canyon																o		
Yakima- Lower Wapato Floodplain														o	o			◯
Yakima- Upper Wapato Floodplain									o					o	o	o		◯

Key to amount of change in Level 3 attributes. An open and closed circle denotes a population benefit and loss, respectively. High benefit/loss = large size circle; Medium benefit/loss = medium size circle; and Low benefit/loss = small size circle. A blank cell denotes that the benefit/loss to the population for that geographic area and corresponding Level 3 attribute was neutral or insignificant.

Table B-16. Change in Performance Due to Scenario's Effect within Geographic Area for Naches Coho

Geographic Area	Loss category		Gain category		Loss or Gain in Abundance		Change in Productivity with		Change in Diversity Index with	
	Category/rank		Category/rank		Loss	Gain	Loss	Gain	Loss	Gain
Ahtanum Cr.	E	8	E	14						
Big, Little, Tucker Creeks	E	4	E	14						
Keechelus	E	4	E	19						
Lower Cle Elum	E	8	E	3						
Lower Kachess	E	8	E	19						
Lower Naches	E	3	E	16						
Lower Yakima River	E	8	E	10						
Manastash	E	8	E	8						
Marion Drain	E	8	E	19						
Swauk	E	8	E	6						
Taneum	E	8	E	3						
Teanaway	E	8	E	1						
Toppenish Cr. Below Simcoe	E	6	E	19						
Umtanum	E	6	E	18						
Upper Cle Elum	E	8	E	19						
Upper Kachess	E	8	E	13						
Upper Yakima	E	8	E	2						
Wenas Cr.	E	8	E	19						
Wide Hollow	E	8	E	19						
Wilson	E	8	E	5						
Yakima - Gap to Gap Floodplain	E	2	E	12						
Yakima - Selah Floodplain	E	1	E	10						
Yakima Canyon	E	8	E	17						
Yakima- Lower Wapato Floodplain	E	8	E	6						
Yakima- Upper Wapato Floodplain	E	8	E	9