Bonneville Power Administration

and

US Bureau of Reclamation

Research, Monitoring and Evaluation (RM&E)
Habitat Information Resources
for
Upper Columbia Spring Chinook

Presented for

The FCRPS 2015 Tributary Habitat
Expert Panel Review Process

By

Bonneville Power Administration

&

United States Bureau of Reclamation

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Introduction

The Federal Columbia River Power System (FCRPS) Action Agencies (AAs) — US Army Corps of Engineers, Bonneville Power Administration, and Bureau of Reclamation — are implementing a tributary habitat program of work that is guided by the 2008 FCRPS Biological Opinion (BiOp) and 2010 and 2014 supplements. The 2010 supplement incorporates the 2008 FCRPS BiOp and an Adaptive Management Implementation Plan resultant of the court-ordered remand of the 2008 BiOp. The Reasonable and Prudent Alternatives (RPA) in the 2008 BiOp and 2010 and 2014 supplements direct achievement of improvements to tributary habitat by 2018.

The process used to estimate changes in habitat quality improvements (HQIs) involves local expert panels that evaluate tributary habitat improvement actions for improvements to factors limiting salmon and steelhead. The work of the expert panels is facilitated by the AAs, who convene a forum to review and evaluate habitat improvement actions specific for Chinook and steelhead populations included in Table 5 of the 2008 BiOp. In 2014, NOAA-Fisheries directed the AAs to bring research, monitoring and evaluation (RM&E) information to the panel process.

The document provides a framework for focusing efforts to assemble RM&E information for the expert panels. This document also serve as a primer for the expert panel process and includes supporting information for those not directly involved in the process.

Four documents covering four Evolutionary Significant Units/Distinct Population Segments (ESUs/DPSs) for Chinook and steelhead covered under the 2008 FCRPS BiOp. The documents listed below are hyperlinks that cover:

1. Upper Columbia Spring Chinook ESU
2. Upper Columbia Steelhead DPS
3. Snake River Spring/Summer Chinook ESU
4. Snake River Steelhead DPS

This document is intended to guide panel members and interested parties to available RM&E resources. Resources will be accessible in the form of referenced literature; hyperlinks to reports/documents/websites portals; and data/information available from entities/programs such as: Columbia Habitat and Aquatic Monitoring Program (CHaMP), PACFISH/INFISH Biological Opinion (PIBO) aquatic and riparian monitoring program, and the USDA Forest Service Air Water and Aquatic Environments Program (AWAE) NorWeST stream temperature database. The hyperlinks provided above for each ESU/DPS serve as portals to the AAs expert panel website. Hyperlinks provided throughout this document guide readers to specific reports/documents that include greater detail and guidance on topics important to the expert panel process.

Expert Panel Process

The expert panel process was developed as a means to evaluate the effect of tributary habitat improvement actions on factors limiting salmon and steelhead production and survival[1]. RPA 34 and RPA 35, Table 5 includes the HQIs the AAs are required to deliver by 2018 (2008-2018 is the period of the current BiOp). Habitat improvement actions that address key limiting factors affecting survival and production of Chinook salmon and steelhead are the focus of the AAs work. The expert panels are convened to evaluate changes to limiting factors consequent of implementing those actions[2]. During the workshops, panels evaluate and then estimate changes in tributary habitat limiting factor function resulting from completed habitat improvement actions. The evaluation is called the "look back" because the panels look back to see what work was completed from the time the panels were last convened to the present. During the workshops the panels also evaluate anticipated changes in tributary habitat function resulting from planned habitat improvement actions. This evaluation is called the "look forward" and covers the period from the present time forward to when the next expert panel workshop will be convened (Figure 1).

Different expert panels are assembled throughout the Columbia Basin, corresponding to the areas where the HCW determined expert input would be necessary not only to evaluate the current condition for salmonids; but further to evaluated the potential benefits of the tributary habitat program of work to improved function of limiting factors. The panels were designated for areas where it was determined that salmon and steelhead were the most imperiled.

The expert panels were convened formally for the first time in 2009, then again in 2012. The next expert panel workshop will be convened in 2016. The timing of the third expert panel workshops relates to agreements struck during the development of the 2014 BiOp supplement.

Assessment Units

The spatial unit of evaluation used in the expert panel process is the Assessment Unit (AU). AUs are set based on geographic boundaries delimiting where Chinook or steelhead use a watershed or subwatershed for a specific purpose and where certain limiting factors affect that use. For example, if a certain area of a watershed or subwatershed is limited by water quality and as well is an area used by fish for a specific purpose (e.g., spawning or rearing) the geographic boundary of that area establishes the AU boundary. Each AU within a population's watershed or subwatershed has different capacities and/or production potentials; and so are weighted accordingly. For example, if one AU receives more use by one life stage of fish than another AU, that AU will be weighted higher relative to the weights of other AUs where fish use is lower. All of the weighting factors assigned AUs in a watershed or subwatershed total 100% when summed. Again, AU weighting is based on the percent use of the AU relative to other AUs in the area used by the population.

[1] The expert panel process was an outcome of the Habitat Collaboration Workgroup (HCW) convened subsequent to issuance of the Record of Decision on the 2008 BiOp. The expert panel approach is described in Appendix C of the 2007 FCRPS Comprehensive Analysis.

[2] The Action Agencies prepared a paper on the guidance for evaluating limiting factors related to habitat improvement actions implemented pursuant to the FCRPS BiOp.

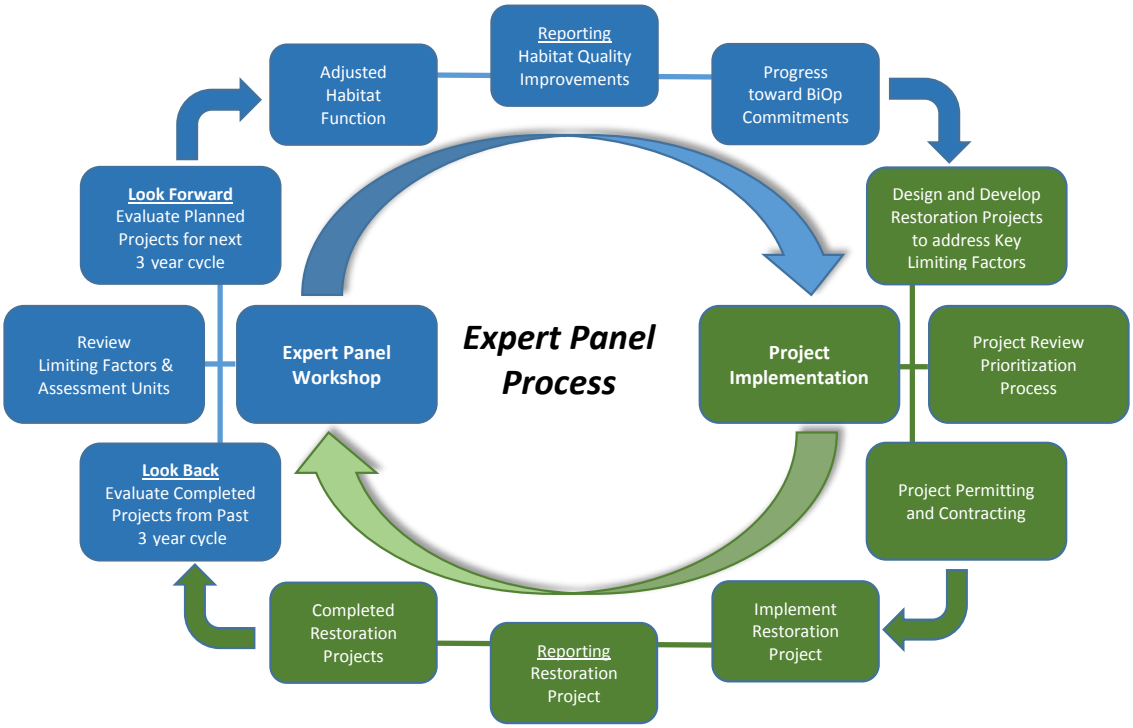

Figure 1. Diagram of the expert panel process used to implement and evaluate habitat improvement actions necessary to fulfill FCRPS BiOp Commitments.

The approach to weighting AUs was based on the analysis of habitat intrinsic potential conducted by NOAA Fisheries (Cooney and Holzer 2006). The analysis of intrinsic potential evaluated historic production potential across tributary habitats used by Interior Columbia Basin yearling type Chinook and steelhead populations. The qualification of "potential" was based on empirically derived relationships between salmon spawner densities and channel characteristics (Montgomery et al., 1999). Thus, the weight of an AU within a population reflects the relative importance of that AU to other AUs within the population.

For each AU, the expert panel also identifies limiting factors, the discussion that follows. Like AUs, once the limiting factors for an AU are identified they are weighted and indicate which factors are most limiting Chinook and steelhead in a watershed or subwatershed. The higher weighted limiting factors indicate their importance relative to other limiting factors in the AU. The number of limiting factors per AU and population can be extensive. So, in 2012 to facilitate the work of the expert panels the AAs rolled up the limiting factor information into a series of pie maps to display AUs and their weights and the limiting factors and their weights.

Ecological Concerns and Limiting Factors

In 2011, NOAA-Fisheries adopted standardized limiting factors with definitions of Ecological Concerns and Ecological Sub-Concerns (Appendix 1). The standardized terminology and definitions were intended to improve understanding about what a specific limiting factor was referring to when the expert panels were in discussion. During the 2012 expert panel workshops the panels were asked to cross walk the original limiting factors with the new standardized terms. To be assured that nothing would be lost in translation the AAs retained the reference to the original limiting factors.

Habitat Improvement Actions

Reviewing and evaluating benefits of habitat improvement actions is fundamental to the expert panel process and establishes the change in limiting factors associated with each AU. Pursuant to the BiOp, every three years the AAs complete a comprehensive evaluation of what has been accomplished insofar as benefits of tributary habitat program of work is considered. The document that is developed is referred to as the 2013 Comprehensive Evaluation (CE) and summarizes by population the improvements that have been achieved over the preceding three year interval. The last CE was completed in 2013 (FCRPS AAs 2013). Table 1 displays the percent HQIs resulting from tributary habitat improvement actions for Upper Columbia spring Chinook (CE Section 2, Table 35, pg. 150).

Table 1. Percent HQIs from actions benefitting spring Chinook in the Methow, Entiat and Wenatchee. Projects completed through 2011 and projected through 2018 (Source: Comprehensive Evaluation, Sec 2 Table 35). Percent HQI is based on RPA action 35 Table 5 commitments by 2018.

ESU/DPS	MPG	Population	Percentage at or above 2018 Table 5 Habitat Quality Improvement (HQI)	
			Percentage of HQI through 2011	Projected Percentage of HQI through 2018
Upper Columbia Spring Chinook	Upper Columbia-Below Chief Joseph	Entiat River	14%	109%
		Methow River	33%	133%
		Wenatchee River	33%	167%

The tributary habitat discussion in the 2014 supplement drew attention to the utility and necessity of RM&E to inform the AAs program of work in delivering HQIs. With increasing efforts to expand RM&E to inform the tributary habitat program, the AAs recognized the need to focus data collection efforts and to organize the information that will come on line over the next several years. Information to support the planning and assessment of benefits for tributary habitat improvement actions includes habitat status and trend monitoring and action effectiveness monitoring. Fish and habitat status and trend monitoring informs identification of limiting factors and assessment of benefits from tributary habitat improvement actions, based on relationships between habitat condition and fish productivity and capacity. Action effectiveness monitoring supports identification of linkages between the effect of habitat actions on fish numbers and habitat condition at the project or site level and the watershed level. The background that is documented in the "Columbia Basin Tributary Habitat Improvement: A Framework for Research Monitoring, and Evaluation" is supplemented by this document that outlines the approach and thought process for organizing information.

In a recent literature review on the benefits of restoration actions, initial results have identified fish passage improvements, in-stream wood and rock structures, livestock grazing controls, connection or construction of off-channel habitat and flow augmentation among the most proven forms of habitat improvements benefitting fish (BPA and BOR 2013). According to the review these types of projects have the most rapid response time, while benefits of projects like riparian habitat restoration can take longer to be realized (see table "Response Time and Longevity"). The literature review also points to the life stages for spring-summer Chinook (e.g., parr-to-smolt) that benefit from these actions. The study demonstrated that survival was generally highest in the least disturbed watersheds but also revealed that survival was higher in treated watersheds (Paulsen and Fisher 2005). Examples of different types of habitat improvement actions implemented to address limiting factors are presented in the AAs CE (CE Section 1, Pg. 56).

The combined efforts of the Integrated Status and Effectiveness Monitoring Program (ISEMP) and Columbia Habitat Monitoring Program (CHaMP) have started to illuminate fish and habitat responses to restoration actions (ISEMP/CHaMP 2015). Information collected in Intensively Monitored Watersheds (IMWs) like Bridge Creek, Oregon; the Entiat River, Washington; and Lemhi River, Idaho have begun to show benefits of these habitat improvement actions. For example, in Bridge Creek installation of structures to encourage dam building have significantly reduced channel incision and increased both the number and size of pool habitat. The response has been rapid and encouraging, showing a degree of reconnection to the floodplain, increase in water table elevation and a reduction in maximum daily water temperatures. In the Entiat, adding rocks and wood to the stream as well as reconnecting the floodplain are increasing pool frequency and depth and the amount of large wood. In one particular study on the Entiat, fish density and affinity for treated microhabitat increased compared to untreated habitats (BPA and BOR 2013). In the Lemhi River, tributary reconnection among other habitat improvements has shown that juvenile Chinook are taking advantage of habitat that would not otherwise be accessible (ISEMP/CHaMP 2015). These habitat improvement actions and monitoring efforts are beginning to show increases in survival, abundance and productivity (ISEMP/CHaMP 2015).

RM&E Information & Organization

RM&E information organized for the expert panel process is available on a Bureau of Reclamation website that was developed specifically to support the expert panel process. The following flow diagram displays an overview of the organizational tree for RM&E resources (Figure 3). Under the main heading of expert panel, there are five main topics; Workshops, Meetings, Quick References, Map Tools and Background that provide navigation to different information associated with the expert panel process. The quick references link or the links provided earlier for each of the ESUs/DPSs allows panel members and interested parties to view information organized down to the population level (Figure 3; light blue boxes). In a general category named "Other RM&E Resources" information topics such as climate change, habitat use, habitat improvement, and other categories of interest are available. In prior years, this information was made available through directories that were not necessarily organized by watershed or population. For the 2016 workshops, the AAs are preparing population by population directories to guide panel members to information relevant to their area. The AAs have also been coordinating with CHaMP project

to develop current habitat information that corresponds to a specific set of limiting factors (i.e., sediment, temperature, etc.). This RM&E resource is discussed in more depth in the following section.

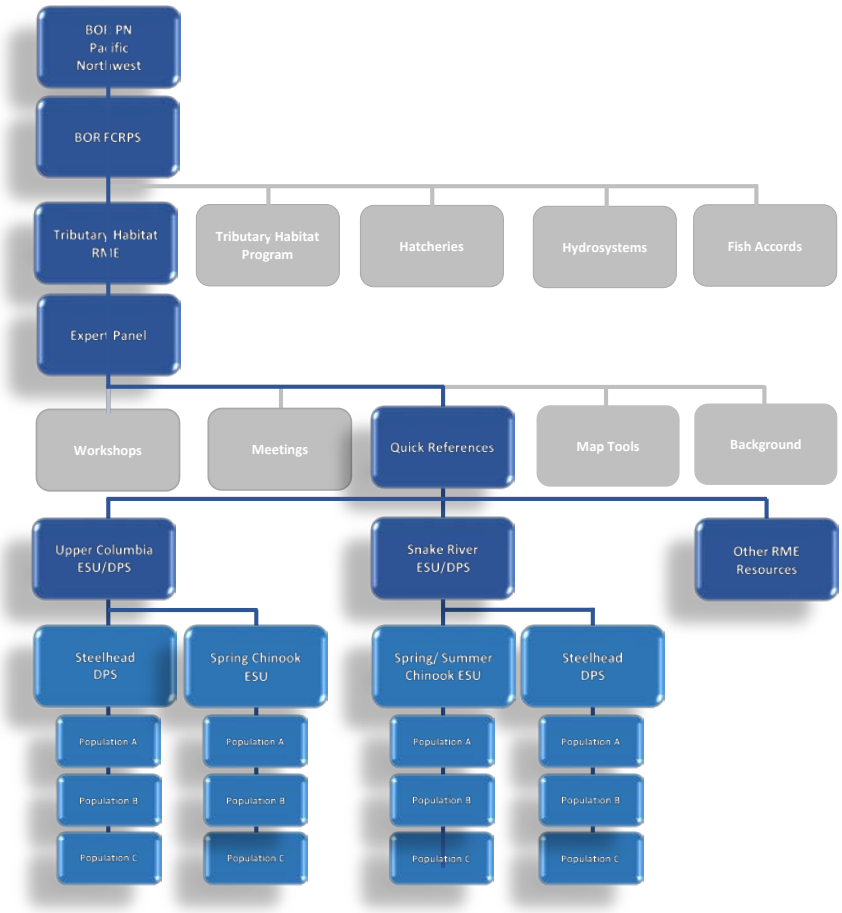

Figure 2. Flow diagram of Bureau of Reclamation website to RM&E information organized down to the population level.

Columbia Habitat Monitoring Program (CHaMP)

The AAs have collaborated with the CHaMP project to create detailed habitat information to assist the expert panels in describing current conditions for limiting factors that overlap CHaMP metrics. The AAs and CHaMP have focused their effort on providing habitat metrics for several focus populations (Appendix 3).

Request for RM&E

In an effort to provide a comprehensive RM&E resource to each expert panel, the AAs requested that watershed group members, agencies, tribes and participants share available data and information. The objective is to build a resource that will inform panel members during panel meetings as well as a resource to inform others about current research on habitat. Appendix 2 provides a more detailed request from the AAs on RM&E information.

Upper Columbia Spring Chinook ESU

In the Upper Columbia River (UCR) spring Chinook ESU, there are three major population groups (MPGs) distributed among 30 AUs (Figure 3). The UCR spring Chinook ESU includes all naturally spawned populations of spring Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River (64 FR 14208: March 24, 1999). Six artificial propagations are considered to be part of the ESU: the Twisp River, Chewuch River, Methow Composite, Winthrop National Fish Hatchery, Chiwawa River, and White River spring-run Chinook hatchery programs (NMFS 2011; 5-Year Status Review).

Within this ESU, there is a great deal of overlap in ecological concerns and factors limiting fish production largely because of current and historic land use and resource development. However, two of the 12 current limiting factors (i.e., increased water temperature and quantity) noted in the ESU are not designated within all the MPGs. During the initial assembly of the expert panel for the Upper Columbia spring Chinook ESU, 12 limiting factors/ecological concerns and their current habitat function were identified for spring Chinook. From this template, different agencies, tribes, and organizations have developed, designed, and implemented habitat improvement actions to address those 12 limiting factors.

In 2016 when the AAs convene the expert panels in the Upper Columbia, the panels will evaluate what was accomplished (look back) between when the panel last met in 2012 and post construction 2015. Looking forward to 2018 the panels will evaluate actions planned for implementation between post construction 2015 and 2018. Combined, there are currently 306 habitat improvement actions that have been completed or are planned in 24 of the 30 AUs in the Upper Columbia. In the sections to follow, we discuss the limiting factors and planned actions in the Wenatchee, Methow and Entiat MPGs for spring Chinook. The AAs have partnered with the different watershed groups so that brief project summaries of habitat improvement actions will be available during the panel meetings to provide an overview of completed actions, metrics addressed and locations where the actions occurred. The intent is that this information will inform expert panel deliberations in cases where panel members have not been to all of the project sites.

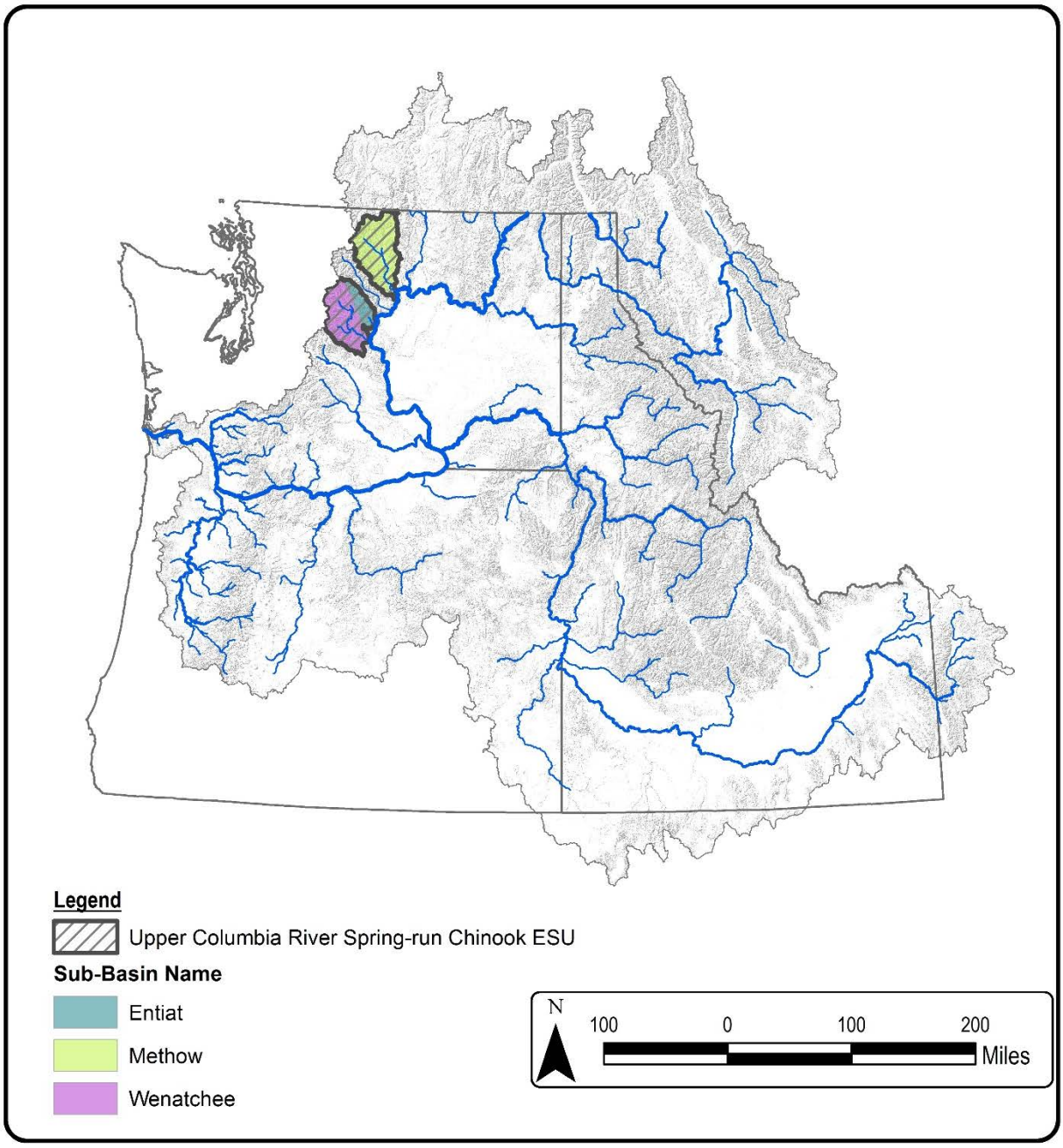

Figure 3. Display of the Upper Columbia spring Chinook ESU and populations involved in the expert panel process.

Wenatchee Population

The Wenatchee spring Chinook population contains 11 AUs with 41 planned habitat improvement actions in seven AUs (Table 1; Figure 4). These planned actions have been or will be completed by the end of 2018. Most of the planned actions are proposed or have been completed in the lower Wenatchee, Nason Creek, and Upper Wenatchee AUs. Limiting factors identified for Wenatchee spring Chinook AUs are presented in Table 2.

Table 2. Assessment Unit (AU) names, codes and weight (in percent) along with the number of planned restoration actions for the Wenatchee MPG of the Upper Columbia Spring Chinook ESU.

Assessment Unit Code	Assessment Unit Names	Assessment Unit Weight (%)	2013-2018 Planned Restoration Actions
WEC1	Chiwawa	27.3	0
WEC2	Chumstick	4.0	1
WEC3	Icicle	2.4	1
WEC4	Little Wenatchee	6.5	0
WEC5	Lower Wenatchee	5.9	4
WEC6	Mission	2.6	0
WEC7	Nason	14.0	14
WEC8	Peshastin	5.6	2
WEC9A	Middle Wenatchee	1.5	0
WEC9B	Upper Wenatchee	16.1	18
WEC10	White	14.1	1
	Total	**100.0**	**41**

The most widespread and numerous limiting factors/ecological concerns noted for the Wenatchee spring Chinook MPG are channel structure and form, riparian condition, habitat quantity and peripheral and transitional habitats (Table 2). Channel structure and form, or more specifically, instream structural complexity is a limiting factor that occurs in all AUs while bed and channel form occurs in only five AUs. In the Wenatchee, peripheral and transitional habitats are a widespread limiting factor/ecological concern and relate to the condition of side channels, wetlands, and floodplains. Two exceptions are the Icicle Creek and Middle Wenatchee AUs. Poor riparian condition and reduced habitat quantity from anthropogenic barriers are limiting factors that occur in most AUs. More localized ecological concerns were identified for water quantity, temperature, sediment, primary productivity and mechanical injury to salmon (Table 2).

There are 41 planned actions anticipated for the 2013 to 2018 period and cover five major ecological concerns/limiting factors in the Wenatchee spring Chinook MPG (Table 3). The priority for assembling existing RM&E resources for the expert panel follows the intersection of planned actions with limiting factors that will be addressed in those seven AUs.

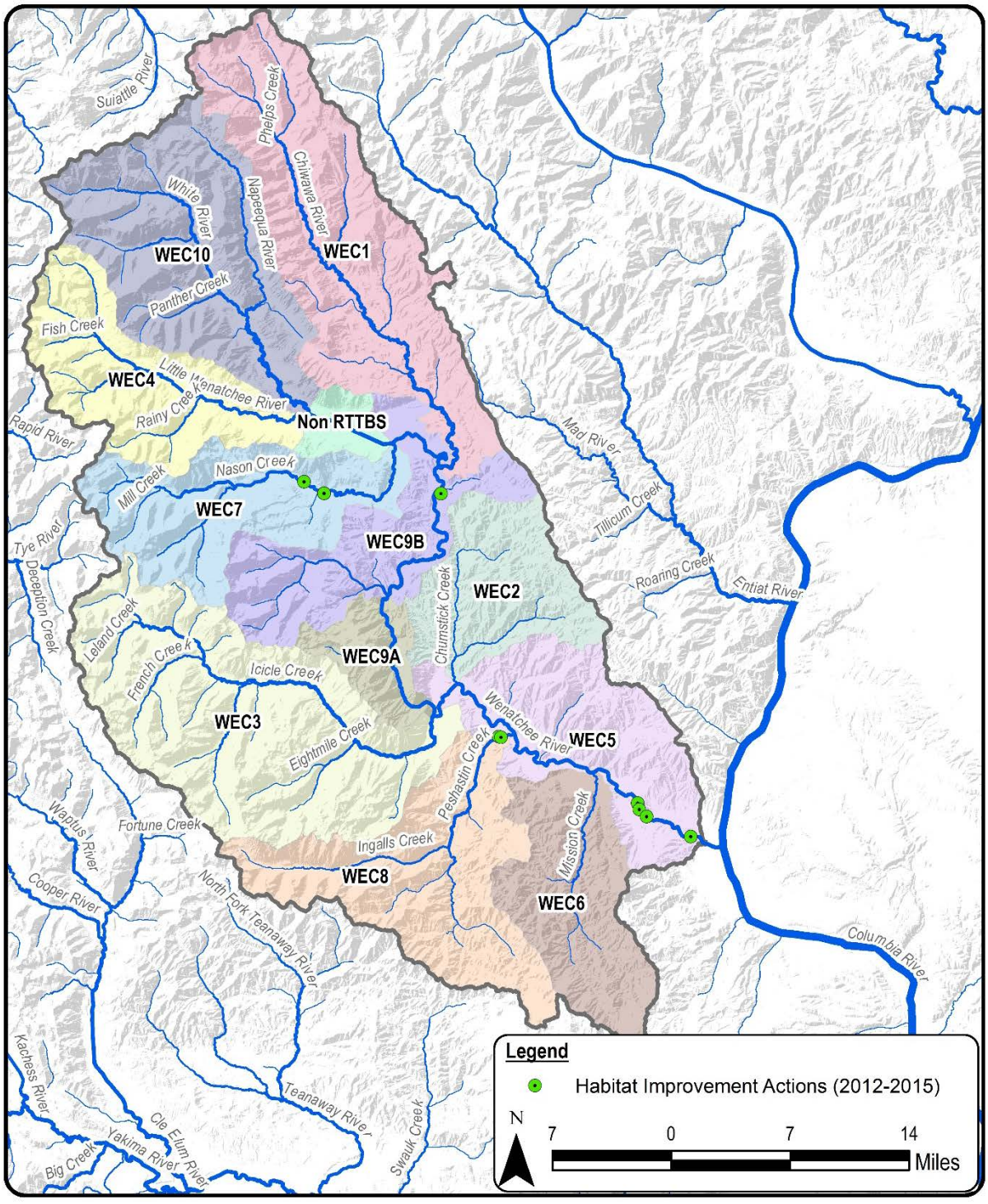

Figure 4. Upper Columbia spring Chinook Wenatchee population displaying assessment unit level boundaries and locations of restoration actions.

Table 3. Limiting factors identified by an "X" for ecological sub-categories in assessment units of the Wenatchee MPG. Assessment units in gray have no planned restoration actions for the 2013-2018 expert panel cycle.

Assessment Unit		Habitat Quantity			Injury and Mortality				Food			Riparian Condition		Peripheral and Transitional Habitats				Channel Structure and Form		Sediment Conditions		Water Quality								Water Quantity			Population Level Effects			
		Anthropogenic Barriers	Natural Barriers	HQ-Competition	Predation	Pathogens	Mechanical Injury	Contaminated Food	Altered Primary Prod.	Food-Competition	Alt. Prey Sp. Comp. & Div.	Riparian Condition	LWD Recruitment	S. Chan. & Wetland Cond.	Floodplain Condition	Estuary Conditions	Nearshore Conditions	Bed and Channel Form	Instream Structural Comp.	Decreased Sed. Quantity	Increased Sed. Quantity	Temperature	Oxygen	Gas Saturation	Turbidity	pH	Salinity	Toxic Contaminants	Increased Water Quantity	Decreased Water Quantity	Altered Flow Timing	Red. Genetic Adaptiveness	Small Population Effects	Demographic Changes	Life History Changes
Code	Name	1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	5.1	5.2	5.3	5.4	6.1	6.2	7.1	7.2	8.1	8.2	8.3	8.4	8.5	8.6	8.7	9.1	9.2	9.3	10.1	10.2	10.3	10.4
WEC1	Chiwawa	X							X			X			X				X		X														
WEC2	Chumstick	X										X		X					X		X	X								X					
WEC3	Icicle	X					X					X							X		X									X					
WEC4	Little Wenatchee								X			X			X				X		X														
WEC5	Lower Wenatchee	X										X		X				X	X			X								X					
WEC6	Mission	X										X		X				X	X		X	X								X					
WEC7	Nason	X							X			X		X				X	X		X	X													
WEC8	Peshastin	X										X		X				X	X			X								X					
WEC9A	Middle Wenatchee	X																X	X																
WEC9B	Upper Wenatchee	X										X		X					X																
WEC10	White								X			X		X					X																
Total:		9	0	0	0	0	1	0	4	0	0	10	0	7	2	0	0	5	11	0	6	5	0	0	0	0	0	0	0	5	0	0	0	0	0

Table 4. Number of planned restoration actions in the Wenatchee spring Chinook MPG for the period of 2013-2018 organized by the ecological concern and limiting factors that are being addressed.

Assessment Unit		Habitat Quantity			Injury and Mortality				Food			Riparian Condition		Peripheral and Transitional Habitats				Channel Structure and Form		Sediment Conditions		Water Quality								Water Quantity			Population Level Effects			
		Anthropogenic Barriers	Natural Barriers	HQ-Competition	Predation	Pathogens	Mechanical Injury	Contaminated Food	Altered Primary Prod.	Food-Competition	Alt. Prey Sp. Comp. & Div.	Riparian Condition	LWD Recruitment	S. Chan. & Wetland Cond.	Floodplain Condition	Estuary Conditions	Nearshore Conditions	Bed and Channel Form	Instream Structural Comp.	Decreased Sed. Quantity	Increased Sed. Quantity	Temperature	Oxygen	Gas Saturation	Turbidity	pH	Salinity	Toxic Contaminants	Increased Water Quantity	Decreased Water Quantity	Altered Flow Timing	Red. Genetic Adaptiveness	Small Population Effects	Demographic Changes	Life History Changes
Code	Name	1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	5.1	5.2	5.3	5.4	6.1	6.2	7.1	7.2	8.1	8.2	8.3	8.4	8.5	8.6	8.7	9.1	9.2	9.3	10.1	10.2	10.3	10.4
WEC1	Chiwawa																																		
WEC2	Chumstick	1																																	
WEC3	Icicle	1																																	
WEC4	Little Wenatchee																																		
WEC5	Lower Wenatchee													1					2											1					
WEC6	Mission																																		
WEC7	Nason											1		6				3	4																
WEC8	Peshastin													1					1																
WEC9A	Middle Wenatchee																																		
WEC9B	Upper Wenatchee											1		8					9																
WEC10	White																		1																
Total:		**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**16**	**0**	**0**	**0**	**3**	**17**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**

Methow MPG

The Methow spring Chinook MPG contains 15 AUs with 233 planned habitat improvement actions in 14 of the AUs (Table 4; Figure 5). These planned actions have been or will be completed by end of 2018. Most of the planned actions are concentrated within the Middle Methow, Lower Twisp, Beaver/Bear Creek, Lower Chewuch and Upper-Middle Methow AUs. Limiting factors identified for Methow spring Chinook AUs are presented in Table 5.

Table 5. Assessment Unit (AU) names, codes and weight in percent along with the number of planned restoration actions for the Methow MPG of the Upper Columbia Spring Chinook ESU.

AU Code	Assessment Unit	Assessment Unit Weight (%)	2013-2018 Planned Restoration Actions
MEC1	Beaver / Bear Creek	1.6	34
MEC2	Early Winters Creek	1.6	1
MEC4A	Gold Creek	1.7	3
MEC4B	Libby Creek	0.8	4
MEC5	Lower Chewuch	20.8	27
MEC6A	Lower Methow	9.0	5
MEC6B	Black Canyon	0.1	2
MEC7	Lower Twisp	8.5	47
MEC8A	Middle Methow	15.9	76
MEC8B	Upper-Middle Methow	4.9	12
MEC9	Upper Chewuch	7.9	4
MEC10A	Upper Methow	15.5	9
MEC10B	Lost River	3.2	0
MEC11	Upper Twisp	7.3	4
MEC12	Wolf Creek	1.2	5
	Total	**100.0**	**233**

The most widespread and numerous ecological concerns/limiting factors noted for the Methow spring Chinook MPG are channel structure and form, riparian condition, water quantity, habitat quantity and peripheral and transitional habitats (Table 6). Channel structure and form identified as instream structural complexity and bed channel and form limiting factors occurs in nearly all AUs. Similarly, poor riparian condition and decreased water quantity occur in nearly all AUs. More localized ecological concerns were identified for limiting factors such as temperature, sediment, primary productivity and mechanical injury to salmon (Table 6).

There are 233 actions planned for the 2013 to2018 period covering eight major ecological concerns/limiting factors in the Methow spring Chinook MPG (Table 7). The priority for assembling existing RM&E resource needs for the expert panel follows the intersection of currently planned actions with limiting factors that will be addressed in 14 AUs.

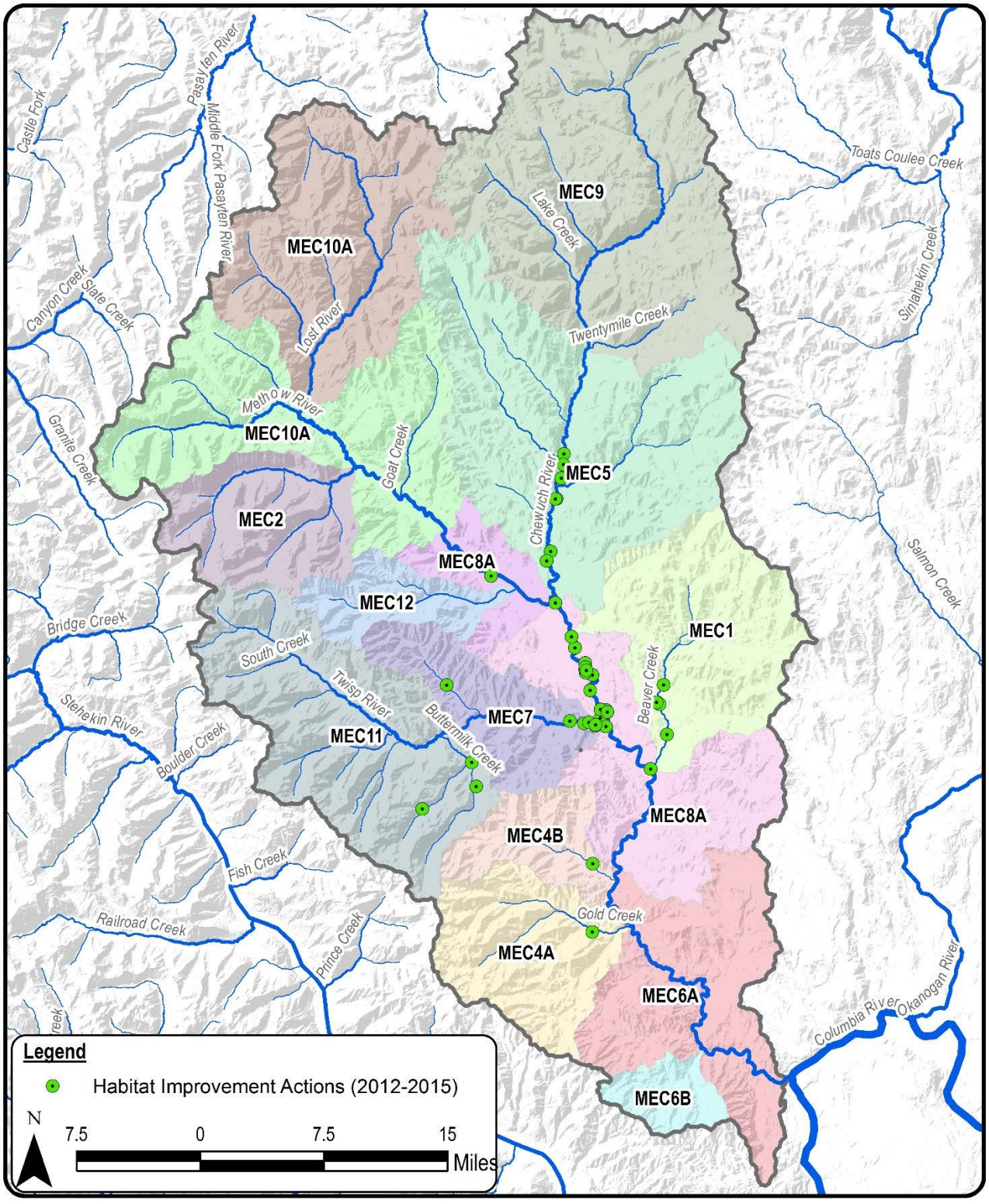

Figure 5. Upper Columbia spring Chinook Methow population displaying assessment unit level boundaries and locations of restoration actions.

Table 6. Limiting factors identified by an "X" for ecological sub-categories in assessment units of the Methow MPG. Assessment units in gray have no planned restoration action for the 2013-2018 expert panel cycle.

Assessment Unit		Habitat Quantity			Injury and Mortality				Food			Riparian Condition		Peripheral and Transitional Habitats				Channel Structure and Form		Sediment Conditions		Water Quality							Water Quantity			Population Level Effects			
Code	Name	Anthropogenic Barriers	Natural Barriers	HQ-Competition	Predation	Pathogens	Mechanical Injury	Contaminated Food	Altered Primary Prod.	Food-Competition	Alt. Prey Sp. Comp. & Div.	Riparian Condition	LWD Recruitment	S. Chan. & Wetland Cond.	Floodplain Condition	Estuary Conditions	Nearshore Conditions	Bed and Channel Form	Instream Structural Comp.	Decreased Sed. Quantity	Increased Sed. Quantity	Temperature	Oxygen	Gas Saturation	Turbidity	pH	Salinity	Toxic Contaminants	Increased Water Quantity	Decreased Water Quantity	Altered Flow Timing	Red. Genetic Adaptiveness	Small Population Effects	Demographic Changes	Life History Changes
		1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	5.1	5.2	5.3	5.4	6.1	6.2	7.1	7.2	8.1	8.2	8.3	8.4	8.5	8.6	8.7	9.1	9.2	9.3	10.1	10.2	10.3	10.4
MEC1	Beaver / Bear Creek	X					X					X						X	X		X	X								X					
MEC2	Early Winters Creek								X			X						X	X		X									X					
MEC4A	Gold Creek	X										X			X			X	X											X					
MEC4B	Libby Creek	X										X						X	X											X					
MEC5	Lower Chewuch	X							X			X		X				X	X		X	X								X					
MEC6A	Lower Methow											X		X				X	X											X					
MEC6B	Black Canyon	X										X							X		X									X					
MEC7	Lower Twisp	X					X		X			X		X				X	X			X								X					
MEC8A	Middle Methow	X					X					X		X				X	X			X								X					
MEC8B	Upper-Middle Methow	X							X			X		X				X	X											X					
MEC9	Upper Chewuch											X						X	X		X														
MEC10A	Upper Methow	X							X			X		X				X	X		X								X	X					
MEC10B	Lost River	X							X			X			X			X	X										X						
MEC11	Upper Twisp	X							X			X		X				X	X		X								X						
MEC12	Wolf Creek						X					X		X					X											X					
Total:		**11**	**0**	**0**	**0**	**0**	**4**	**0**	**7**	**0**	**0**	**15**	**0**	**8**	**2**	**0**	**0**	**13**	**15**	**0**	**7**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**12**	**0**	**0**	**0**	**0**	**0**

Table 7. Number of planned restoration actions in the Methow spring Chinook MPG for the period of 2013-2018 organized by the ecological concern and limiting factors that are being addressed.

Assessment Unit		Habitat Quantity			Injury and Mortality				Food			Riparian Condition		Peripheral and Transitional Habitats				Channel Structure and Form		Sediment Conditions		Water Quality							Water Quantity			Population Level Effects			
Code	Name	Anthropogenic Barriers	Natural Barriers	HQ-Competition	Predation	Pathogens	Mechanical Injury	Contaminated Food	Altered Primary Prod.	Food-Competition	Alt. Prey Sp. Comp. & Div.	Riparian Condition	LWD Recruitment	S. Chan. & Wetland Cond.	Floodplain Condition	Estuary Conditions	Nearshore Conditions	Bed and Channel Form	Instream Structural Comp.	Decreased Sed. Quantity	Increased Sed. Quantity	Temperature	Oxygen	Gas Saturation	Turbidity	pH	Salinity	Toxic Contaminants	Increased Water Quantity	Decreased Water Quantity	Altered Flow Timing	Red. Genetic Adaptiveness	Small Population Effects	Demographic Changes	Life History Changes
		1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	5.1	5.2	5.3	5.4	6.1	6.2	7.1	7.2	8.1	8.2	8.3	8.4	8.5	8.6	8.7	9.1	9.2	9.3	10.1	10.2	10.3	10.4
MEC1	Beaver / Bear Creek	2					1					7						5	7		3	5								4					
MEC2	Early Winters Creek																													1					
MEC4A	Gold Creek											1							1											1					
MEC4B	Libby Creek											1						1	1											1					
MEC5	Lower Chewuch											4		2				1	7		1	9								3					
MEC6A	Lower Methow											1						1	2											1					
MEC6B	Black Canyon																				1									1					
MEC7	Lower Twisp	1										10		6				2	10			13								5					
MEC8A	Middle Methow	2					1					14		12				12	17			13								5					
MEC8B	Upper-Middle Methow											3		2				3	3											1					
MEC9	Upper Chewuch											1						1	1		1														
MEC10A	Upper Methow											1		1				2	2		1								1	1					
MEC10B	Lost River																																		
MEC11	Upper Twisp											1							1		1								1						
MEC12	Wolf Creek						1					1							1											2					
Total:		5	0	0	0	0	3	0	0	0	0	45	0	23	0	0	0	28	53	0	8	40	0	0	0	0	0	0	2	26	0	0	0	0	0

Entiat MPG

The Entiat spring Chinook MPG contains four AUs with 32 planned habitat improvement actions in three AUs (Table 8; Figure 6). Limiting factors identified for these AUs are presented in Table 9. Most of the planned restoration actions occur within the Lower and Middle Entiat AUs (Table 8).

Table 8. Assessment Unit (AU) names, codes and weight in percent along with the number of planned restoration actions for the Entiat MPG of the Upper Columbia Spring Chinook ESU.

AU Code	Assessment Unit	Assessment Unit Weight (%)	2013-2018 Restoration Actions
ERC1	Lower Entiat	41.2	11
ERC2	Mad River	12.5	2
ERC3A	Middle Entiat	36.7	19
ERC3B	Upper Middle Entiat	9.6	0
	Total	**100.0**	**32**

The most widespread ecological concerns/limiting factors are channel structure and form, riparian condition, habitat quantity, sediment and food for Entiat spring Chinook (Table 9). Poor riparian condition, food and increased sediment quantity limiting factors occur in all AUs while channel structure and form identified as instream structural complexity and bed channel occur in all but one AU. Similarly, barriers that limit access to habitat occur in all AUs except the Upper Middle Entiat. More localized ecological concerns/limiting factors were identified for side channels, wetlands and floodplain condition, decreased water quantity, and mechanical injury to salmon (Table 9).

There are 32 actions planned for the 2013 to 2018 period covering five major ecological concerns/limiting factors in the Entiat spring Chinook MPG (Table 10). RM&E resource information that will assist expert panel process depends largely on the location and type of restoration actions and limiting factors that will be assessed in the next workshops.

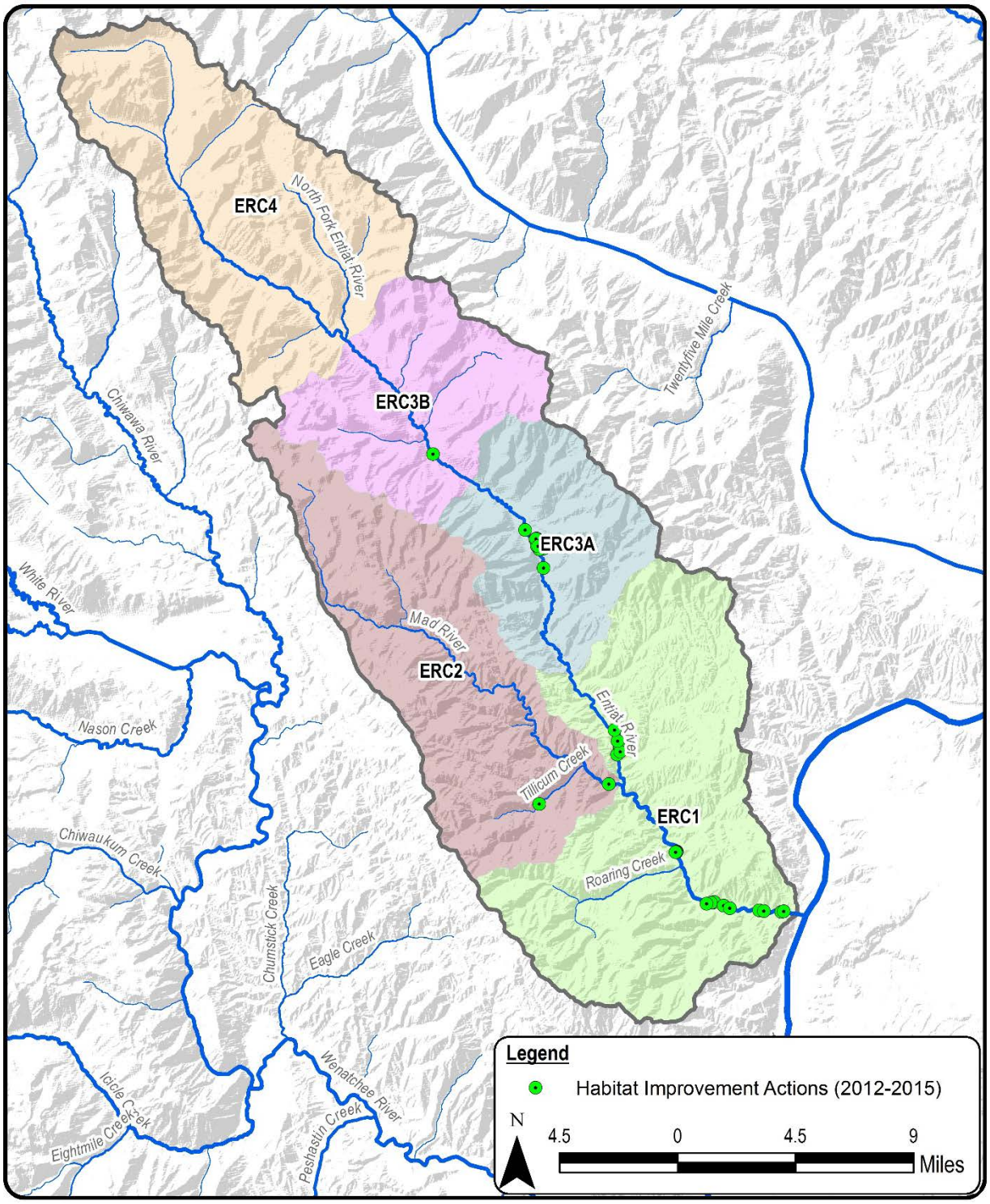

Figure 6. Upper Columbia spring Chinook Entiat population displaying assessment unit level boundaries and locations of restoration actions.

Table 9. Limiting factors identified by an "X" for ecological sub-categories in assessment units of the Entiat MPG. Assessment units in gray have no planned restoration action for the 2013-2018 expert panel cycle.

Assessment Unit		Habitat Quantity			Injury and Mortality				Food			Riparian Condition		Peripheral and Transitional Habitats				Channel Structure and Form		Sediment Conditions		Water Quality								Water Quantity			Population Level Effects			
Code	Name	Anthropogenic Barriers 1.1	Natural Barriers 1.2	HQ-Competition 1.3	Predation 2.1	Pathogens 2.2	Mechanical Injury 2.3	Contaminated Food 2.4	Altered Primary Prod. 3.1	Food-Competition 3.2	Alt. Prey Sp. Comp. & Div. 3.3	Riparian Condition 4.1	LWD Recruitment 4.2	S. Chan. & Wetland Cond. 5.1	Floodplain Condition 5.2	Estuary Conditions 5.3	Nearshore Conditions 5.4	Bed and Channel Form 6.1	Instream Structural Comp. 6.2	Decreased Sed. Quantity 7.1	Increased Sed. Quantity 7.2	Temperature 8.1	Oxygen 8.2	Gas Saturation 8.3	Turbidity 8.4	pH 8.5	Salinity 8.6	Toxic Contaminants 8.7	Increased Water Quantity 9.1	Decreased Water Quantity 9.2	Altered Flow Timing 9.3	Red. Genetic Adaptiveness 10.1	Small Population Effects 10.2	Demographic Changes 10.3	Life History Changes 10.4
ERC1	Lower Entiat						X		X			X		X	X			X	X		X									X					
ERC2	Mad River	X							X			X						X	X		X														
ERC3A	Middle Entiat	X							X			X			X			X	X		X														
ERC3B	Upper Middle Entiat	X							X			X							X		X														
Total:		3	0	0	0	0	1	0	4	0	0	4	0	1	2	0	0	3	4	0	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Table 10. Number of planned restoration actions in the Entiat spring Chinook MPG for the period of 2013-2018 organized by the ecological concern and limiting factors that are being addressed.

Assessment Unit		Habitat Quantity			Injury and Mortality				Food			Riparian Condition		Peripheral and Transitional Habitats				Channel Structure and Form		Sediment Conditions		Water Quality								Water Quantity			Population Level Effects			
		Anthropogenic Barriers	Natural Barriers	HQ-Competition	Predation	Pathogens	Mechanical Injury	Contaminated Food	Altered Primary Prod.	Food-Competition	Alt. Prey Sp. Comp. & Div.	Riparian Condition	LWD Recruitment	S. Chan. & Wetland Cond.	Floodplain Condition	Estuary Conditions	Nearshore Conditions	Bed and Channel Form	Instream Structural Comp.	Decreased Sed. Quantity	Increased Sed. Quantity	Temperature	Oxygen	Gas Saturation	Turbidity	pH	Salinity	Toxic Contaminants	Increased Water Quantity	Decreased Water Quantity	Altered Flow Timing	Red. Genetic Adaptiveness	Small Population Effects	Demographic Changes	Life History Changes
Code	Name	1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2	5.1	5.2	5.3	5.4	6.1	6.2	7.1	7.2	8.1	8.2	8.3	8.4	8.5	8.6	8.7	9.1	9.2	9.3	10.1	10.2	10.3	10.4
ERC1	Lower Entiat						1								4			2	4																
ERC2	Mad River	2																																	
ERC3A	Middle Entiat											3			4			6	6																
ERC3B	Upper Middle Entiat																																		
Total:		**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**8**	**0**	**0**	**8**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

References

BPA (Bonneville Power Administration) and BOR (U.S. Bureau of Reclamation). 2013a. Benefits of tributary habitat improvement in the Columbia River Basin: A framework for research, monitoring and evaluation. Bonneville Power Administration and Bureau of Reclamation.

Bonneville Power Administration (BPA). 2013b. Science and the evaluation of habitat restoration projects in the Columbia River estuary 2012-2017. The expert regional technical group process. Bonneville Power Administration and U. S. Army of Corps of Engineers.

Cooney, T., and Holzer, D. 2006. Appendix C: Interior Columbia Basin stream type Chinook salmon and steelhead populations: habitat intrinsic potential analysis Preliminary Review Draft: NWFSC.

FCRPS Action Agencies (AAs). 2013. Endangered Species Act Federal Columbia River Power System (FCRPS), 2013 Comprehensive Evaluation: Section 1-3 + Appendices: Bonneville Power Administration, U.S. Army Corps of Engineers, U.S. Department of the Interior and Bureau of Reclamation.

Integrated Status and Effectiveness Monitoring Program (ISEMP)/Columbia Habitat Monitoring Program (CHaMP). 2015. Combined Annual Report for the Integrated Status and Effectiveness Program and Columbia Habitat Monitoring Program: 2014. Prepared by ISEMP and CHaMP for the Bonneville Power Administration. Published by Bonneville Power Administration. 148 pages + Appendices.

Montgomery, D.R., E.M. Beamer, G.R. Pess and T.P. Quinn. 1999. Channel type and salmonid spawning distribution and abundance. Can. J. Aquat. Sci. 56:377-387.

National Marine Fisheries Service. 2011a. 5-Year review: summary & evaluation of Snake River sockeye Snake River spring-summer Chinook Snake River Snake River fall-run Chinook Snake River basin steelhead. U.S. Department of Commerce, National Oceanic and Atmospheric Administration National Marine Fisheries Service, Portland, OR.

National Marine Fisheries Service. 2011b. 5-Year review: summary & evaluation of Upper Columbia River steelhead, Upper Columbia River Spring-run chinook: U. S. Department of Commerce, National Oceanic and Atmospheric Administration National Marine Fisheries Service, Portland, OR.

National Marine Fisheries Science. 1996. Making endangered species act determinations of effect for individual or grouped actions at the watershed scale. Seattle, WA: The National Marine Fisheries Service Environmental Technical Services Division, Habitat Conservation Branch.

NOAA's National Marine Fisheries Service. 2007. Appendix C: analysis of the effects of tributary habitat actions 2007 FCRPS Comprehensive Analysis: Prepared for U. S. Army Corps of Engineers, Bonneville Power Administration, and U.S. Bureau of Reclamation.

NOAA's National Marine Fisheries Service. 2008. Endangered species act section 7(a)(2) consultation: final biological opinion and Magnuson-Stevens fishery conservation and management act consultation: consultation on remand for operation of the Federal Columbia River Power System,

11 Bureau of Reclamation projects in the Columbia Basin and ESA Section 10(a)(1)(A) permit for juvenile fish transportation program (revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE (D. Oregon)): Prepared for U.S. Army Corps of Engineers, Bonneville Power Administration, and U.S. Bureau of Reclamation.

NOAA's National Marine Fisheries Service. 2009. FCRPS adaptive management implementation plan: 2008-2018 Federal Columbia River Power System biological opinion: Prepared for U. S. Army Corps of Engineers, Bonneville Power Administration, and U.S. Bureau of Reclamation.

NOAA's National Marine Fisheries Service. 2010. Endangered species act section 7(a)(2) consultation supplemental biological opinion. Supplemental consultation on remand for operation of the Federal Columbia River Power System, 11 Bureau of Reclamation projects in the Columbia Basin and ESA Section 10(a)(I)(A) permit for juvenile fish transportation program: Prepared for U.S. Army Corps of Engineers, BPA, U.S. Bureau of Reclamation, NMFS.

NOAA's National Marine Fisheries Service. 2014(a). *Endangered species act section 7(a)(2) supplemental biological opinion*: Prepared for U. S. Army Corps of Engineers, Bonneville Power Administration, U. S. Bureau of Reclamation.

NOAA's National Marine Fisheries Service. 2014(b). Endangered species act section 7(a)(2) supplemental biological opinion: Prepared for U. S. Army Corps of Engineers, Bonneville Power Administration, U. S. Bureau of Reclamation.

Spinazola, J., and Tweeten, R. 2009. Guidance for Evaluating Limiting Factor Habitat Functions for FCRPS Biological Opinion Tributary Habitat Actions: U.S. Bureau of Reclamation.

Appendices

Appendix 1. Ecological Concerns used to designate limiting factors for Upper Columbia spring Chinook in the Wenatchee, Methow and Entiat MPGs. Limiting factors were identified by the ID code and ecological sub-category for each assessment unit.

ID	Ecological Concern	Definition	Included Categories	ID	Ecological Concern-Sub Category	Definition	Included Categories	VSP parameter effects	Primary Life Stages Affected	Metric Assessment Guidelines
1	**Habitat Quantity**	Insufficient quantity of total habitat or habitat diversity due to the elimination of access	Connectivity, Access, Structure, Simplification, Availability	**1.1**	**Anthropogenic Barriers**	Loss of access to habitat and/or habitat sub-types due to anthropogenic activity. Includes partial or ephemeral barriers.	Access, Barriers, Flap Gates, Tidal Gates, Culverts, Obstacles, Obstructions, Passage Issues, Blocked	Compensation/Carrying Capacity/Spatial Structure and Diversity	1,4,5,8	stream miles of access
				1.2	**Natural Barriers**	Lasting natural barriers to stream or estuary access, including waterfalls, sand bars, log jams, sufficiently steep gradients or insufficient water. May represent the end of good quality habitat	Water Falls, Sand Bar, Bar Breach, Log Jams, Steep Gradient, Thermal Barriers, Low Water	Compensation/Carrying Capacity	1,4,5,8	stream miles of access
				1.3	**HQ-Competition**	Limited physical space and the protection from predators or physical forces it provides, due to the addition of competing salmonid stocks, species or hatchery produced fish.	Refugia, Hatchery Fish, Predation, Stocking, Swamping	Compensation/Carrying Capacity/Spatial Structure and Diversity	4,5,6	Increased mortality from interactions
2	**Injury and Mortality**	Lethal and sub-lethal effects due to other organisms, including human activities	Death, Injury, Predation	**2.1**	**Predation**	Introduced salmon predators or changes to the habitat that increase native predator numbers or increase predator success.	Invasive/Exotic Fish or Invertebrate Predators, Native Fish, Native Bird, Native Pinnipeds, Fishing	Density Dependent-Positive and Negative- at Low Abundance/High Abundance Effects	1,2,3,4,5,6,7,8	Increased mortality
				2.2	**Pathogens**	Increased mortality due to disease causing organisms or parasites.	Disease, Sea Lice, Introduced Diseases, Native Diseases, Whirling Disease, Myxobolus Cerebralis, Gyrodactylus, Sea Lice, Ulcerative dermal necrosis (UDN), IHNV, VHSV, Kudoa, Henneguya, White Spot, Ich, Gill Amoeba	Negative Density Dependence- High Abundance Effects	1,2,4,5,6,7,8	Increased mortality
				2.3	**Mechanical Injury**	Mortality or injury due to anthropogenic structures or as the result of mechanical forces due to anthropogenic structures	Inadequate screening, Barging, Snagging, Stranding, Entrainment	Compensation/Carrying Capacity	4,5,6,8	Increased mortality
				2.4	**Contaminated Food**	Toxics substances found in prey that negatively affect salmon. Includes persistent toxic substances that are concentrated as they are consumed and move to the next trophic level.	Bioaccumulation Toxicity, PBDEs, PCBs, Oil, Organochlorides, Pesticides	Density Independent	4,5,6,7	Increased mortality

ID	Ecological Concern	Definition	Included Categories	ID	Ecological Concern-Sub Category	Definition	Included Categories	VSP parameter effects	Primary Life Stages Affected	Metric Assessment Guidelines
3	Food	Insufficient or inadequate food for salmonids.	Competition, Prey Availability, Species Interactions	3.1	Altered Primary Productivity	Alteration of ecological dynamics affecting the quantity, quality and/or species composition of phytoplankton or detritus resulting in insufficient food available for salmonids or prey species.	Micro and Macro-Detrital Inputs, Loss of Marine Derived Nutrients, Carcasses, Down-welling, Ocean Conditions, Detritus, Phytoplankton	Compensation/Carrying Capacity	4,5,6,7	Increased mortality
				3.2	Food-Competition	Insufficient food due to the addition of competing salmonid stocks, species or hatchery produced fish.	Hatchery Fish, Increased Natural Competitors, Invasive Species	Compensation/Carrying Capacity	4,5,6,7	Increased mortality
				3.3	Altered Prey Species Composition and Diversity	Alteration of ecological dynamics affecting the species composition, distribution or nutritional quality of zooplankton, macroinvertebrates, forage-fish or other prey resulting in insufficient food for salmonids.	Species Diversity, Prey Species Abundance, Invasive Species, Altered Food Web Dynamics	Compensation/Carrying Capacity	4,5,6,7	Increased mortality
4	Riparian Condition	Degradation of the habitat adjacent to streams, rivers, lakes and nearshore environments. Impairment of the near-bank environment to support plants including large trees that help stabilize stream banks, provide shade, add primary production to the aquatic ecosystem and includes the supply of mature trees into streams as LWD.	Impaired Riparian Function/Condition, microclimate, lack of shade	4.1	Riparian Condition	Disturbance to streamside ecological relationships, including but not limited to, loss of flora, erosion and increased light and temperatures	Bank degradation, Cover, Canopy, Inability to supply organic matter and filter sediments, Insufficient buffers, Light, Loss of natural shade	Compensation/Carrying Capacity/High Abundance Effects	1,2,3,4,5,6,8	stream miles and/or acres of riparian buffer
				4.2	LWD Recruitment	Loss of mature streamside trees that may become instream structures and associated decline in habitat complexity	LWD supply, Mature riparian, Mature trees	Compensation/Carrying Capacity	1,2,3,4,5,6,8	miles of improved stream complexity and/or # of LWD's added per mile

ID	Ecological Concern	Definition	Included Categories	ID	Ecological Concern-Sub Category	Definition	Included Categories	VSP parameter effects	Primary Life Stages Affected	Metric Assessment Guidelines
5	**Peripheral and Transitional Habitats**	Loss and/or degradation of the peripheral habitat of streams and rivers, including standing water, connected channels and areas that are periodically inundated during high flows.	High quality over-winter rearing habitat, Summer rearing habitat, Peripheral Habitat, Habitat Diversity, (Key) Habitat Quantity/Quality, Refugia Habitat	**5.1**	**Side Channel and Wetland Conditions**	Degradation, elimination and loss of access to peripheral freshwater habitat, including side-channels and freshwater wetlands.	Side Channels, Loss of peripheral habitat, Freshwater Wetlands, Swamp, Oxbows, Ponds, Alcoves	Compensation/Spatial Structure and Diversity	4,5,6	miles of side channel
				5.2	**Floodplain Condition**	Degradation, elimination and loss of access to the over or beyond bank habitat, of streams and rivers that is periodically inundated during high flows.	Floodplain, Bank condition, Overbank area, Diking	Compensation/Spatial Structure and Diversity	4,5,6	acres of floodplain accessed and/or stream miles
				5.3	**Estuary Conditions**	Loss and degradation of saltwater transition zone	Estuary, Salt-water transition zone, Lagoon, Estuary plume, Delta, Slough, Pocket estuary	Compensation/Carrying Capacity	6,8	N/A
				5.4	**Nearshore Conditions**	Loss and degradation of shallow water nearshore habitat	Beaches, Tidal flats, Eelgrass beds, Eelgrass meadows, Kelp forest, Baitfish spawning grounds	Compensation/Carrying Capacity	7,8	N/A
6	**Channel Structure and Form**	Changes to river, stream, lake, estuarine tributary and distributary channel form, including instream structural complexity, width to depth ratios, sinuosity and bedload movement such as the loss (scour) or fill (aggradation) of the channel.	Channel Conditions, Channel Form, Channel morphology, Channel Instability, Channel Stability, Loss of Spawning Substrate due to high flow, Bedload Movement	**6.1**	**Bed and Channel Form**	Changes to river, stream, lake, estuarine tributary and distributary channel form, including width to depth ratios, sinuosity and bedload movement such as the loss (scour) or fill (aggradation) of the channel.	Loss of sinuosity, Bank hardening, Channel incision, Channelized, Aggradation, Bed substrate stability, Armoring, Bridge crossings, Confinement, Nearshore sediment loss, Beach erosion	Compensation/Carrying Capacity	1,2,3,4,5,6,8	stream miles and/or miles restored to a percentage of functioning condition
				6.2	**Instream Structural Complexity**	Decline of the instream habitat quality. Based on the degree of habitat complexity and variety, includes the quantity and variability of stream depth and pools of varying size and depth.	LWD, Pools, Boulders, Bank overhang, Cover, Habitat structure, Instream habitat, Habitat, Stream complexity, Habitat diversity, (Key) Habitat quantity/quality, Refugia habitat, Channel conditions, Instream roughness, Poor gravel/sediment sorting, Rugosity	Compensation/Carrying Capacity	1,2,3,4,5,6,8	stream miles and/or increased complexity component

ID	Ecological Concern	Definition	Included Categories	ID	Ecological Concern-Sub Category	Definition	Included Categories	VSP parameter effects	Primary Life Stages Affected	Metric Assessment Guidelines
7	**Sediment Conditions**	Reduction of the quantity or quality of spawning habitat due to changes to the background (natural) quantity, rate, and size of sediment inputs to the stream system.	Sediment, Stream Spawning Habitat, Spawning Gravel, Beach Spawning Habitat (lake), Substrate, Benthic Habitat	**7.1**	**Decreased Sediment Quantity**	Decreased input of sediment to the stream system or some part of the stream system.	Substrate Quantity, Scour, Entrenchment, Loss of Spawning Habitat, Lack of spawning Gravel, Sediment transport	Compensation/Carrying Capacity	1,2,3,4,5,6	stream miles with improved substrate conditions
				7.2	**Increased Sediment Quantity**	Increased input of sediment to the stream system.	Bank Erosion, Excessive sedimentation, Aggradation, Sediment Load, Excess Fines, Embeddedness, Sediment Size Ratio	Compensation/Carrying Capacity/positive density dependence-high abundance effects	1,2,3,4,5,6	stream miles with improved substrate conditions and/or tons of sediment reduced
8	**Water Quality**	Degraded chemical, physical, and biological characteristics of water with respect to its suitability for a salmon, excluding toxins and pathogens.		**8.1**	**Temperature**	Water temperature deviations, either in intensity or duration, sufficient to have adverse effects on listed salmonids	High temperature	Density Independent	1,2,3,4,5,6,8	7 day average max stream temp decrease riparian shading potential increased stream flow riparian improvement
				8.2	**Oxygen**	Oxygen concentration deviations sufficient to induce adverse effects in listed salmonids.	Eutrophication, Excess nutrients, Oxygen depleted bottom water	Density Independent	1,2,3,4,5,6,8	miles restored to sustainable O2 limits
				8.3	**Gas Saturation**	Pathological condition due to saturated gases leaving solution into an animal's tissue.	Gas bubble disease (GBD), Dissolved gasses, Nitrogen	Density Independent	1,2,3,4,5,6,8	N/A
				8.4	**Turbidity**	Increased concentrations of suspended fine particulate matter sufficient to have adverse effects in listed salmonids, including reduction of their foraging ability and/or degradation of ecosystem function.	Suspended sediments, Plume Effects,	Density Independent	1,2,3,4,5,6,8	miles where turbidity lessened to acceptable levels
				8.5	**pH**	Acidity/alkalinity deviations sufficient to adversely affect salmonids or the species on which they feed.	Alkalinity, Ocean acidification, CO2	Density Independent	1,2,3,4,5,6,8	miles restored to acceptable range
				8.6	**Salinity**	Salinity at concentrations harmful to salmon	Refuge from salinity regimes	Density Independent	6	N/A
				8.7	**Toxic Contaminants**	Direct exposure to toxic substance in the water column.	Short-term Toxicity, Storm water Discharge, Outfalls, Wastewater, Non-point Source Pollution, Spills, Marine Debris, Point Source Pollution, Copper, Mercury	Density Independent	1,2,3,4,5,6,8	miles of stream of reduced toxic conditions

ID	Ecological Concern	Definition	Included Categories	ID	Ecological Concern-Sub Category	Definition	Included Categories	VSP parameter effects	Primary Life Stages Affected	Metric Assessment Guidelines
9	**Water Quantity**	Detrimental effects of deviations to the background (natural) amount and timing of water quantity instream, including lowered water quality and barriers to access.	Changes in Flow Regime, Spring Freshets, Piped Outfalls of Surface and Ground Water, Withdrawals, Flow-Related Plume Changes	**9.1**	**Increased Water Quantity**	Habitat disturbance associated with abnormally (compared to background) high water flow and increased "flashiness", including loss of channel substrate and the flushing of young fish downstream.	High flow, High volume, Flooding, Increased velocity, Increased peak flows, Decreased flood lag time, Redd scouring, Flashiness, Increased runoff, Water storage capability, Road density	Density Independent	1,2,3,4,5,6	flows at optimal levels to maximize survival, CFS
				9.2	**Decreased Water Quantity**	Habitat disturbances associated with abnormally (compared to background) low water flow, including but not limited to, increased temperature, loss of sediment, nutrients and barriers to passage and redd dewatering.	Low Volume, Plume Changes, Redd Dewatering, Water Withdrawals, Surface Impoundments, Diversions, Lake Level	Carrying Capacity/Spatial Structure and Diversity/Density Independent	1,2,3,4,5,6,8	flows at optimal levels to maximize survival, CFS
				9.3	**Altered Flow Timing**	Habitat changes associated with alterations to the background (natural) timing of water quantity instream.	Water Releases, Impervious Surfaces, Urbanization, Low Flows, Dewatering	Spatial Structure and Diversity/Density Independent	1,2,3,4,5,6,8	Flow timing at optimal range to maximize survival
10	**Population Level Effects**			**10.1**	**Reduced Genetic Adaptiveness**	Genetic changes that result in the loss of adaptedness to the habitat or set of habitats a population experiences.	Domestication Selection, Harvest selection, Outbreeding depression, Loss of life history types	Spatial Structure and Diversity/Density Dependent	1	N/A
				10.2	**Small Population Effects**	Reductions in reproductive rate, loss of genetic resilience or loss of genetic adaptedness in a population due to reductions in abundance that result in further losses of abundance.	Depensation, Loss of genetic diversity, Inbreeding, Genetic Drift, Increased predator effectiveness	Spatial Structure and Diversity/Density Dependent	1,2,3,4,5,6,7,8	N/A
				10.3	**Demographic Changes**	Changes to the age, size or developmental makeup of a population that result in a reduction to abundance, fecundity or reproductive rate.	Smaller size at return/maturity, greater age at return/maturity, reduced egg quality	Spatial Structure and Diversity/Carrying Capacity	7,8	N/A
				10.4	**Life History Changes**	Changes to the behavior of individuals that result in a population wide loss of adaptedness, including changes in the composition of life-history types or the timing of migration and reproduction.	Changes to migration timing, loss of reproductive strategies, loss of life-history types (timing of release), increased residual/precocial males/females, run timing, increased jacks/jills	Spatial Structure and Diversity/Density Dependent	4,5,6,8,1	N/A

Appendix 2

Bonneville Power Administration

US Bureau of Reclamation

July 15, 2015

From: FCRPS Action Agencies
Rosy Mazaika, Bonneville Power Administration
Jude Trapani, US Bureau of Reclamation

To: Expert Panel Watershed Coordinators

Re: Request for RM&E resource information

The FCRPS Action Agencies are requesting RM&E information from the different expert panel groups. This request is part of a larger effort to gather and organize RM&E information that will be useful to the expert panel process. The goal of this effort is to maintain this information so that panel members can distribute and access information at a common website to help stay informed on research at the population level. Because there is an overwhelming amount of information available on salmon habitat and ecology, the request is specific to the fish, habitat and limiting factors identified for each population. However, we encourage researchers to also consider information on general topics such as; habitat improvement, fish-habitat relationships, status and trend, action effectiveness, and other materials related to salmonid habitat and limiting factors. These types of resources will be placed under a general category in which researchers, implementers and managers can access to inform their decision making process.

There are a multitude of information resources available from peer reviewed journals to websites and databases for research. For journal articles, reports and documents, we request that you provide a reference to the document and an electronic copy if it is not copy right protected or the website hyperlink where the document can be obtained. We want to acknowledge the entities that produced the information.

The Bureau of Reclamation will host the website and provide a point of contact for people to send information for inclusion of RM&E information. We thank the expert panels and their members for their contributions.

Sincerely,

Appendix 3. FCRPS AAs focus populations and limiting factors for developing CHaMP habitat metrics for the expert panel process.

Species	ESU	Population	Limiting Factor / Ecological Concern-Sub Categories							
			4.1 Riparian Condition	4.2 LWD Recruitment	5.1 Side Channel and Wetland Conditions	5.2 Floodplain Conditions	6.1 Bed and Channel Form	6.2 Instream Structural Complexity	7.2 Increased Sediment Quantity	8.1 Temperature
Chinook	Upper Columbia	Entiat	X			X	X	X	X	
	Snake River	Tucannon	X			X	X	X	X	X
		Upper GR	X	X			X	X	X	X
		Catherine Cr	X	X	X	X	X	X	X	X
		Yankee Fork		X		X	X	X		
		Upper Salmon above Redfish	X						X	X
Steelhead	Snake River	Clearwater Lower	X				X	X	X	X
		Lolo Cr					X		X	X
		SF Clearwater	X	X	X	X	X	X	X	X
		Lochsa	X	X				X	X	X
Base Metric Guideline			stream length and/or area of riparian buffer	Stream length of improved complexity and/or # LWD added/mile	stream side-channel length	stream length and/or areas	stream length restored to functioning condition	Stream length and/or increased complexity	Stream length with improved substrate conditions and/or tons of sediment input reduced	Stream length/flow/ temperature improvement