Northwest **Power** and **Conservation** Council

July 1, 2014

MEMORANDUM

TO: Fish and Wildlife Committee members

FROM: Nancy Leonard, fish wildlife and ecosystem monitoring and evaluation manager
Mark Fritsch, project implementation manager

SUBJECT: Update on the Okanogan Basin Monitoring and Evaluation Program (OBMEP), Project #2003-022-00.

John Arterburn of the Colville Confederated Tribes will brief the Council on the Okanogan Basin Monitoring and Evaluation Program (OBMEP) and the tribe's experience using the Ecosystem Diagnosis &Treatment (EDT) model to apply this information to improve restoration planning. He will be joined by Chip McConnaha and Eric Doyle of ICF International. ICF developed the EDT model for the Okanogan subbasin and assists the tribe with habitat status and trends analysis.

Jason Sweet (Bonneville) will be present to provide information about the relationship of OBMEP to the approach being applied by Bonneville to meet the FW Program's monitoring and evaluation needs (approach described in June 2013 Council decision and that will be revisited March 2015).

BACKGROUND

The OBMEP approach (attachment 1) contributes to the Fish and Wildlife Program monitoring and evaluation needs by providing information at the management scale that informs aquatic habitat restoration priorities and needs and by estimating the biological benefits of aquatic habitat investments (correlating changes in aquatic habitat with fish performance). The OBMEP

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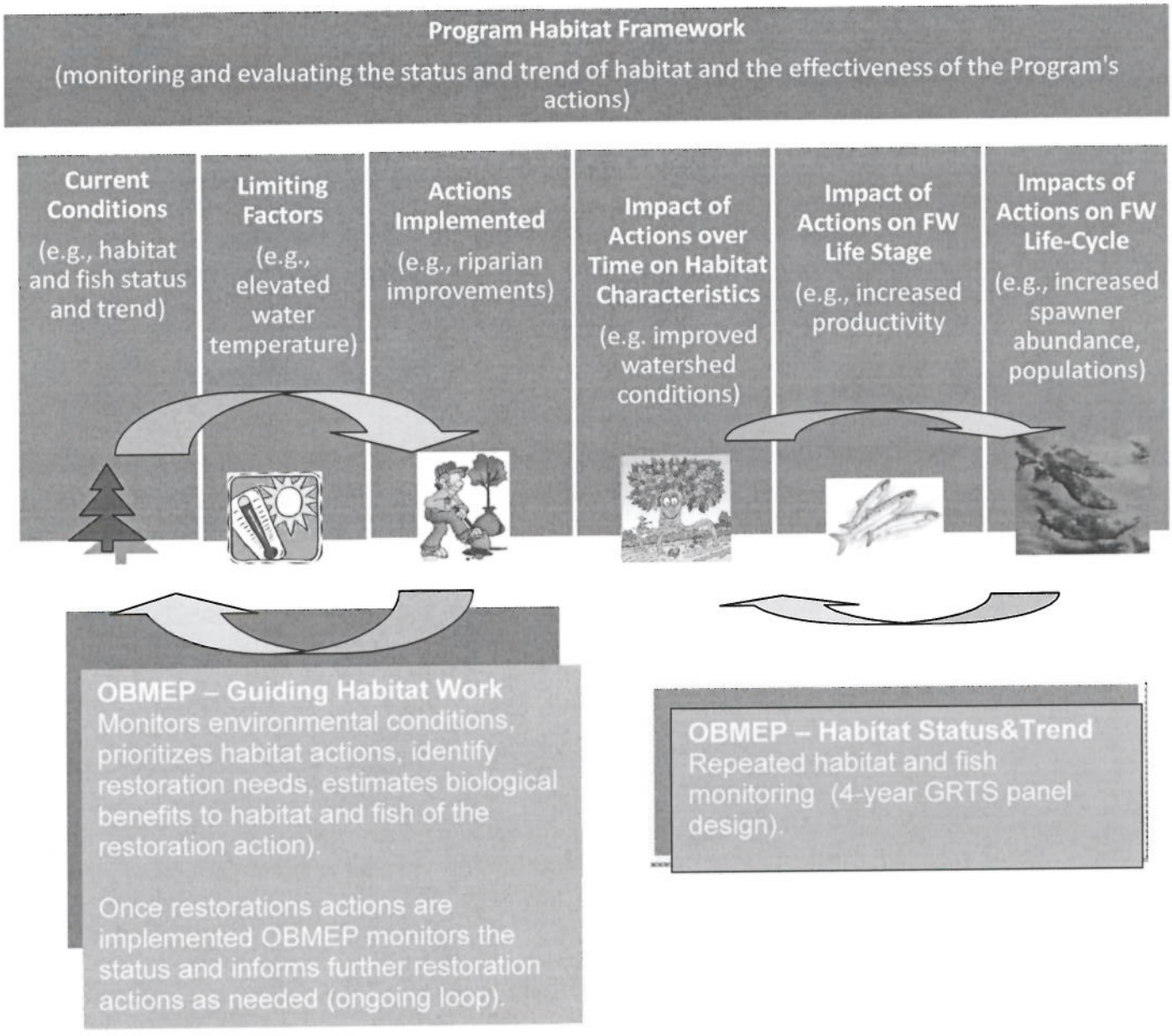
is supported by other entities as a valid approach (see attachments 2, 3 and 4). The OBMEP approach complements the broader monitoring programs under the Fish and Wildlife Program that provide watershed scale aquatic habitat status and trend (CHaMP), data for salmon and steelhead fish population viable salmonid parameters (VSP), and action effectiveness monitoring at the project scale (AEM) which were revisited during June 2013 by the Council. OBMEP complements these broader scale efforts by guiding restoration efforts on-the-ground that aim to reduce limiting factors thereby improving habitat conditions at the local scale, translating to improved conditions at the broader watershed and fish population scale (Figure 1). OBMEP also provides status and trend information on fish and habitat by monitoring on a 4-year GRST panel design.



Attachment 1: Okanogan Basin Monitoring and Evaluation Program (OBMEP)

Synopsis

BPA and other federal, state, private and local agencies expend considerable funds each year to restore salmon and steelhead habitat in the Columbia Basin and to rehabilitate key ecological functions. BPA also funds an extensive research and monitoring efforts to address basic scientific issues, evaluate restoration techniques and monitor physical and biological change. These include monitoring efforts like OBMEP as well as the Columbia River Habitat Monitoring Program (CHaMP) and the Integrated Status and Effectiveness Monitoring Program (ISEMP). Although much of this data collection is technically sophisticated, it has been difficult to effectively use the information to guide the selection of habitat projects and to develop restoration strategies. The OBMEP program has addressed this need by integrating systematic monitoring of environmental conditions in the Okanogan subbasin with EDT to provide annual updates on restoration priorities, identify restoration needs and to estimate the biological benefits of BPA investments. This application of EDT can enhance the value of monitoring efforts like OBMEP by deriving useful conclusions regarding habitat trends and evolving restoration priorities.

OBMEP

The OBMEP was created by the Colville Confederated Tribes to track the status and trends in the condition of aquatic habitat and fish production in the Okanogan Basin. Its purpose is to monitor habitat conditions over time, provide a rationale for prioritizing investments in habitat restoration, and track progress towards the tribes' fishery management goals. The program is designed to be consistent with recent policy guidance for habitat status and trends monitoring developed by federal resource management agencies, BPA and the Council. This guidance provided seven objectives that policy makers considered to be critical for an effective habitat status and trend monitoring program:

1) Integrate habitat monitoring with VSP[1] criteria set forth for ESA salmon recovery
2) Inform the expert panel process[2]
3) Provide information to update limiting factors and planning documents
4) Integrate multiple life stages into limiting factors
5) Inform the development of future habitat actions
6) Provide a mechanism for prioritizing habitat actions
7) Help inform higher level indicators of regional environmental conditions

The OBMEP is the tribes' response to this policy guidance. The tribes' published their first EDT-based habitat status and trends report in 2013. This analysis incorporated data collected by OBMEP from 2005 to 2009 into the tribes' EDT model and compared fish performance under current habitat to performance under pre-development

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[1] VSP refers to the Viable Salmonid Population concept developed by NMFS to characterize performance of salmonid populations listed under ESA. This concept describes desired qualities for viable populations in terms of fish abundance, productivity, biological diversity and spatial population structure.

[2] The expert panels were created by NMFS under the FCRPS Biological Opinion to report on habitat status and trends.

conditions. The tribes' and ICF International staff will complete the status and trends analysis for the 2010 to 2013 monitoring cycle by late 2014 or early 2015. This analysis will compare fish performance between the 2013 and 2009 habitat conditions. This process will continue in the future as OBMEP monitors habitat conditions to provide an explicit tracking of potential fish performance in response to habitat change. The process provides decision makers with important information on habitat restoration needs, priority areas for restoration and effectiveness of the program to meet management goals. Over time, the process will track progress toward the tribes' goals and may point to new priorities for restoration.

Ecosystem Diagnosis & Treatment

The Ecosystem Diagnosis & Treatment (EDT) model used by the OBMEP evaluates habitat for salmon and steelhead and identifies priority habitats and limiting factors. The model uses available information to guide investments in habitat restoration and to assess the impacts of past and future changes in habitat on fish production and weight these decisions based on the certainty in the model inputs. EDT has been widely used by federal and state agencies and tribes in the Columbia Basin, Puget Sound and California to develop watershed plans (e.g. Columbia Basin Subbasin Plans), species recovery plans (e.g. Puget Sound Chinook, upper Columbia Chinook and lower Columbia River Chinook recovery plans) and to evaluate climate change impacts on salmon and steelhead.

History. Development of EDT started in the late 1990's as part of the Council's Model Watershed program in the Grande Ronde basin. The first widely used version of the model, referred to as EDT1, was applied in several Columbia Basin and Puget Sound subbasins and was used in the Council's Multi-Species Framework process which was the fore-runner of the Subbasin Planning process. EDT was used to develop the majority of salmon-related sub-basin plans for the Council's program. Because of the need in Sub-Basin Planning for a broad spectrum of users to be able to conduct habitat assessment modeling, a second version of EDT, designated EDT2, was created. EDT2 had a simplified interface that allowed users to evaluate habitat within a set of pre-developed assumptions for the mainstem Columbia River and ocean. A new version of EDT, designated EDT3, has been recently released that will become the prevailing version of the model. EDT3 is built to contemporary software standards and provides the transparency and flexibility necessary to address modern resource management challenges.

EDT has been developed over a two decades through the cooperative efforts of numerous users in the Columbia Basin and Puget Sound. A private consulting group has taken responsibility for maintenance and software innovation and has been the primary practitioner assisting clients in the use of EDT. The model was originally developed by Mobrand Biometrics, Inc. and, by acquisition, is now managed by ICF International. The EDT computer code is available publically as are all datasets and results.

The future—how EDT could be used to enhance the value of monitoring and research efforts

The OBMEP approach and its application of EDT offer a unique way to synthesize research and monitoring data into useful information for decision makers. This approach is complementary with and can enhance the value of parallel research and monitoring like ISEMP and CHaMP. Basic scientific information developed through these programs can refine and enhance EDT and improve restoration effectiveness. The EDT3 model and habitat status and trend reporting tools directly address the seven monitoring program priorities outlined above and support informed conclusions using factors and scales that are useful to policy decisions.

There is now interest in using the OBMEP/EDT approach in other sub-basins to move from data collection to policy-level synthesis and guidance. For example, the Upper Columbia Salmon Recovery Board and the Regional Technical Team and have both endorsed OBMEP's application of EDT model and their related status and trend reporting tools and are interested in developing similar capabilities themselves (see attached letters from the Board and the RTT). Expansion of the OBMEP type monitoring in the Methow, Wenatchee and Entiat sub-basins awaits funding. Interest has been expressed for other sub-basins as well. A common thread through all of these is the need to create useful information and to use monitoring data to improve decision making.

Much of the attraction to the Colville's approach stems from the need to address the "Expert Panel" approach resulting from the FCRPS Biological Opinion. The Upper Columbia Salmon Recovery Board and others see EDT as a tool for synthesizing the results of their monitoring programs into useful information on habitat status and trends for the Expert Panels and provide a systematic rationale for prioritizing habitat restoration.

Climate Change. The ability of EDT to evaluate alternative habitat conditions makes it possible to evaluate the effects of future climate conditions on salmon and steelhead populations. Increasingly, EDT analyses evaluate restoration actions while considering future climate conditions that differ from those today. In some cases, prioritization of restoration actions looks quite different in the context of future climate compared to priorities based on a continuation of current conditions in the future. EDT analysis also indicates that future climate may favor a different mix of salmon and steelhead life histories and dramatically alter the distribution of productive habitat in many sub-basins. These types of analyses have important implications for BPA funding priorities for restoration and to meet species recovery needs under ESA.

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Attachment 2: Upper Columbia Salmon Recovery Board's Letter of Support of the OBMEP and application of EDT.

Attachment 3: Upper Columbia Regional Technical Team's Letter of Support for OBMEP

Attachment 4: Monitoring and Data Management Committee (MaDMC) 's Memorandum on Research and monitoring information in the Upper Columbia; what is collected, why it is collected, and what else is needed

UPPER COLUMBIA SALMON RECOVERY BOARD

The mission of the Upper Columbia Salmon Recovery Board is to restore viable and sustainable populations of salmon, steelhead, and other at-risk species through the collaborative, economically sensitive efforts, combined resources, and wise resource management of the Upper Columbia region.

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June 23, 2014

Tony Grover
Northwest Power & Conservation Council
Fish and Wildlife Division Director
851 SW 6th Avenue, Suite 1100
Portland, OR 97204

Dear Mr. Grover:

I am writing this letter in support of the Okanogan Basin Monitoring and Evaluation Program (OBMEP) and their application of the Ecosystem Diagnosis and Treatment (EDT) model and reporting tools. We understand representatives of OBMEP are presenting at your July 8th meeting in Portland. We strongly support habitat monitoring investments in the region and are actively working to make those investments as valuable as possible to recovery efforts. Closely aligning habitat investments, monitoring, and biological priorities moves the region closer to its stated recovery targets. The OBMEP monitoring program is one of several large-scale monitoring programs in the region and is on the leading edge of collaboration, monitoring, analysis, and reporting for the Upper Columbia. Their adaptive approach and use of the EDT model to make complex and extensive habitat monitoring data more useful to decision making and project development is forward-thinking and is very responsive to our organization's initiative to make monitoring and research applicable to recovery plan implementation. This project is a high priority for salmon and steelhead recovery and habitat restoration and protection in the Upper Columbia region, and through OBMEP has proven a useful approach.

Since federal approval of the *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan* (UCSRB, 2007), monitoring programs have been collecting large amounts of data on fish and habitat in the region, but few tools have been developed from these efforts to help guide decision makers and habitat restoration partners. The Colville Tribe's Fish and Wildlife Program is currently in the unique position of having the right partners and staff in place to design and implement the OBMEP program to provide the right information, at the right scale (reach and watershed scale), and in the right format that is easily interpretable and accessible to their partners working to design and implement habitat projects in the Okanogan subbasin. This project provides for a strategy to target watersheds where the greatest opportunities exist to improve habitat and advance recovery efforts. The OBMEP program is actively

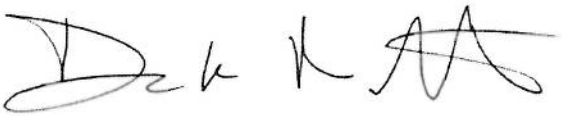
working to help fill important data and information gaps identified by the Upper Columbia Salmon Recovery Board and the Upper Columbia Regional Technical Team within the Okanogan.

The Colville Tribe's OBMEP Program has a proven track record of collaboration, and a reputation for providing a high level of service. The scientific integrity of their monitoring, comprehensive analyses, reporting, and data and information accessibility stand out within the Upper Columbia region. In comparison with other large-scale monitoring programs, OBMEP is currently being implemented explicitly to identify and prioritize actions through use of an applied model (EDT). Development of an applied EDT model will add value to the UCSRB's on-going efforts to prioritize and evaluate habitat restoration actions, particularly in the Okanogan subbasin, and will help fill some of the critical information gaps identified for the region. These include tributary and reach scale habitat status, restoration project effectiveness, and survival bottlenecks. Additionally, the fish and habitat monitoring that is being conducted by the OBMEP program to help inform the model and better understand fish and habitat in the Okanogan subbasin may help us better understand juvenile steelhead distribution and habitat use.

We are impressed with the Okanogan EDT project and are actively trying to expand a modeling effort to the Methow, Entiat, and Wenatchee subbasins. Having regional-scale modeling that would provide consistent, comparable information for all Upper Columbia subbasins, consistent and comparable with past and other results from across the Columbia Basin, would be invaluable. Possible uses for such information include updates to regional recovery strategies, information and analyses for regional expert panels, and easily understandable information for project sponsors. Currently, in the absence of such a regional-scale program, we are working with monitoring funders and implementers in the region to better align monitoring and modeling with the information needs identified for recovery plan implementation (such as those identified in the 2010 Upper Columbia Adaptive Management Conference).

Please do not hesitate to contact me if you have any questions (509-670-1462 or derek.vanmarter@ucsrb.org).

Sincerely,



Derek Van Marter
Executive Director

cc: Tom Karier – WA Council Member
Phil Rockefeller – WA Council Member
Nancy Leonard – Council Staff
John Arterburn – Colville Tribes
Chuck Peven – RTT Chair
Keely Murdoch – RTT Monitoring and Data Management Committee Chair

UCRTT
UPPER COLUMBIA
REGIONAL
TECHNICAL TEAM

July 1, 2014

Mr. Tony Grover, Fish and Wildlife Division Director
Northwest Power & Conservation Council
Fish and Wildlife Division Director
851 SW 6th Avenue, Suite 1100
Portland, OR 97204

Dear ~~Mr. Grover:~~ Tony

It is our understanding that the Colville Confederated Tribes (CCT) will present an overview of the Okanogan Basin Monitoring and Evaluation Program (OBMEP) during your July 8th meeting. The Upper Columbia Regional Technical Team (UCRTT) welcomes this opportunity to voice our support for OBMEP and provide information concerning monitoring in the Upper Columbia. Attached is a memorandum that was recently completed by a subgroup of the UCRTT, the Monitoring and Data Management Committee (MaDMC).

We are very fortunate in the Upper Columbia to have a number of monitoring programs being implemented for various reasons (please see attached memo for details). The MaDMC has done much to coordinate these efforts, including sponsoring annual meetings to ensure mutual awareness among the monitoring practitioners.

Over the years, the UCRTT has assisted co-managers and funders by evaluating and providing input to the large regional monitoring programs, such as OBMEP, the Integrated Status and Effectiveness Monitoring Program (ISEMP), and the Columbia Habitat and Monitoring Program (CHaMP). These programs use similar protocols that have been modified based on UCRTT comments. As we discussed in the MaDMC memo, information to guide restoration projects is needed at various scales:

> *. . . These on-going programs have effectively collected fish and habitat information at the population (or subbasin) scale. However, information at the project or reach spatial scale is also needed to inform habitat restoration projects, and there is a limited amount of monitoring that has been conducted at these spatial scales. Both types of monitoring are required to understand how habitat projects affect fish abundance and to better inform future habitat project development. Population (or subbasin) scale monitoring can inform a population level response in abundance or productivity but will not inform project sponsors which projects or project types are working, while information at the project scale is not sufficient to understand how populations respond to habitat improvements.*

The UCRTT views the use of EDT to help the CCT select appropriate restoration treatments as a positive step in the development of project-prioritization methodology, and we support the CCT to continue this effort in the Okanogan Basin. However, we also support the continuation of the FCRPS BiOp RPA-based approach in the other Upper Columbia subbasins through the ISEMP, CHaMP, and adaptive management implementation plan (AMIP) related programs. We believe that the development of both tools is wise and hope to be able to compare the use of each one in the future.

The UCRTT is encouraged by OBMEPs progress in habitat monitoring and fish response and we reiterate our support for the OBMEP program. However, the UCRTT views all modeled prioritization processes, including the OBMEP/EDT program in the Okanogan River basin as experimental. Nevertheless, along with OBMEP/EDT, we believe the development of other programs and models that rely on and integrate data collected from ongoing monitoring programs such as ISEMP, CHaMP, and status and trend monitoring by the PUDs and Yakama Nation, will assist the region in the long term to meet restoration obligations and recovery goals.

Please feel free to call or get in touch if you have any questions or need additional information.

Best regards,

Chuck Peven
UCRTT Chair

CC: UCRTT
MaDMC
Tom Karier
Phil Rockefeller
Nancy Leonard
Derek Van Marter

MEMORANDUM

To: Upper Columbia salmon recovery stakeholders
From: Monitoring and Data Management Committee (MaDMC)
Date: May 2014

Topic: **Research and monitoring information in the Upper Columbia; what is collected, why it is collected, and what else is needed.**

Introduction

Research and monitoring in the Upper Columbia Region (UCR) for salmonids has been on-going for over 60 years. As part of the preparation for the Grand Coulee Relocation Project, several assessments were conducted in the 1930s, which is also when counts of anadromous fish began at mainstem Columbia River dams (Rock Island Dam, 1933). In the 1950s, the USFWS and the Public Utility Districts (PUDs) began collecting information on spawning populations of Chinook and sockeye salmon. These early monitoring efforts were not comprehensive and efforts at more appropriate spatial and temporal scales did not start until the 1980s.

In recent years, efforts to monitor and restore both fish and habitat have increased dramatically. Monitoring for hatchery programs have increased in scope and scale and information is collected on fish returning to (adults) and leaving (smolts) their natal subbasins in addition to other information such as life history characteristics. Concurrent with an increase in monitoring for hatchery programs has been an increase in efforts to monitor bull trout and other fish species.

As a result of the need by federal agencies to address reasonable and prudent alternatives (RPAs) of the Federal Columbia River Power System biological opinion (FCRPS BiOp), monitoring efforts are being implemented in the UCR to track status and trend of fish and habitat, fish use of habitat, and the response of fish and habitat to restoration actions, primarily at the population scale. Within the next few years, it is expected that information from these programs will be adequate to be summarized and available for use by habitat restoration stakeholders. These on-going programs have effectively collected fish and habitat information at the population (or subbasin) scale. However, information at the *project* or *reach*[1] spatial scale is also needed to inform habitat restoration projects, and there is a limited amount of monitoring that has been conducted at these spatial scales Both types of monitoring are required to understand how habitat projects affect fish abundance and to better inform future habitat project development. Population (or subbasin) scale monitoring can inform a population level response in abundance or productivity but will not inform project sponsors which projects or project types are working, while information at the project scale is not sufficient to understand how populations respond to habitat improvements.

At the same time that monitoring has been ramping up across the region, so too has habitat restoration and protection. Since 2007, when the UC Recovery Plan was approved, an average of 28 habitat projects are implemented each year, representing a significant investment in resources

[1] "Project" refers to an area in which a habitat restoration project was constructed and the affected vicinity. A "reach" is generally composed of geomorphically similar subsections of larger portions of a stream.

going toward habitat improvement for listed salmon and steelhead in the region. The development, design, and implementation of these projects relies on accurate, timely, and relevant information of fish and habitat within a tributary and project area to ensure the maximum biological benefit and efficient use of resources.

The purpose of this memorandum is to define what information is needed for fish habitat restoration project development, what information is currently being collected, and recommend additional monitoring to better inform project sponsors.

Overarching Goal

> Ensure that necessary monitoring information to guide habitat project development and implementation is being collected and establish an information flow pathway from monitoring programs to project sponsors.

Objectives

1. Determine what information is needed, and at what spatial and temporal scales, by project sponsors to assist in habitat project development and implementation.

2. Identify key information gaps.

3. Create recommendations to address key information gaps.

Background

Current Monitoring Programs

Current monitoring programs in the UCR are primarily funded for the mitigation of hydrosystem effects on anadromous salmon, progress towards fish recovery, forest management, and effectiveness of habitat improvement projects. In the following sections, each of the major monitoring programs within the UCR are briefly described, including the mandate under which they operate, the program goals, and the primary indicators they collect (Table 1).

PUD Hatchery Monitoring Programs

The three UCR PUDs (Grant, Chelan, and Douglas) all have large hatchery programs to mitigate for the effects on ESA-listed fish caused by operation of their hydro projects. As part of their licenses[2] to operate through the Federal Energy Regulatory Commission (FERC), they are required to monitor their hatchery programs to ensure that they meet the number of fish released and in-hatchery levels of survival (compliance monitoring) and how effective they are in meeting the goals of the programs (effectiveness monitoring). Many of the indicators collected through this monitoring can assist regional managers in evaluating the viable salmonid population (VSP) parameters. The monitoring and evaluation plan for this combined effort can be downloaded at

[2] Douglas and Chelan PUDs have habitat conservation plans (HCPs) that have been incorporated into their licenses that dictate the goals of the hatchery programs (and associated monitoring). Grant PUD has a Settlement Agreement and Biological Opinion that dictates their programs.

http://www.grantpud2.org/rc/supportingdocs/Monitoring%20and%20Evaluation%20Plan%20for%20PUD%20Hatchery%20Programs%202013%20Year%20Update.pdf

Integrated Status and Effectiveness Monitoring Project (ISEMP)

ISEMP was established in 2003 with the objective of "developing management decision support tools from quantitative relationships of stream habitat quality and quantity's impact on anadromous salmonid population abundance and productivity in the Columbia River basin."

ISEMP has developed fish and habitat status and trends monitoring efforts in the Upper Columbia (Wenatchee, Methow, and Entiat), John Day, South Fork Salmon and Lemhi subbasins to answer questions related to the management supporting the proposed tributary habitat-based, off-site mitigation strategy of the FCRPS BiOp. Questions include "what is the best way to measure stream habitat?" and "what is the best way to measure salmonid populations?"

In the UCR, ISEMP was initiated in 2004 as a pilot project focused on monitoring program development in the Wenatchee River basin. The project grew in 2006 to focus on restoration project effectiveness monitoring and evaluation methods in the Entiat River. The program is intended to collect information at the subbasin scale for long time periods, and therefore has not been focused at the "project" scale (ISEMP 2012), though some project-scale monitoring in the Entiat has fallen under the purview of ISEMP.

Annual reports can be found online at http://www.isemp.org .

Columbia Habitat Monitoring Program (CHaMP)

In 2010, ISEMP developed a fish-centric standardized stream habitat monitoring program, the Columbia Habitat Monitoring Program (CHaMP), which is being implemented in 15 watersheds throughout the Columbia River basin as of 2014, including the Wenatchee, Entiat and Methow River subbasins in the UCR. The purpose of CHaMP is to implement a habitat monitoring protocol for habitat status and trends throughout the portion of the Columbia Basin that is accessible to anadromous salmonids. CHaMP uses a programmatic approach to standardized data collection and management. CHaMP supports effective data summarization at various spatial scales important for the management of fish and habitat that answer key management questions from the 2009 Columbia River Basin Fish and Wildlife Program document (http://www.nwcouncil.org/library/2009/2009-09/Default.asp) and the 2008 FCRPS BiOp (Ward et al. 2011).

Okanogan Basin Monitoring and Evaluation Program (OBMEP)

The OBMEP, initiated in 2004, monitors key components of the ecosystem related to anadromous salmonids, including adult escapement, juvenile populations, fish habitat, and water quality, and was designed specifically to be a status and trends monitoring program (OBMEP 2014). Protocols were developed to assess abundance, productivity, diversity, and spatial structure of steelhead in the Okanogan River and its tributaries. Although data and analysis derived from OBMEP may help to address effectiveness of habitat or hatchery projects, identifying causal mechanisms was not the intent of the original program objectives.

Statewide and Regional Reach- and Project-Scale Effectiveness monitoring

As part of the development of a monitoring strategy across the state, the Salmon Recovery Funding Board (SRFB) established the Reach-Scale Effectiveness Monitoring Program in 2004 to provide programmatic project effectiveness monitoring across the state. This program samples a subset of projects from each of eight different habitat restoration project types to determine the effectiveness of different types of SRFB-funded projects in achieving objectives. Several other project funders are taking advantage of this monitoring program to add additional sites within the UCR. The Upper Columbia Salmon Recovery Board (UCSRB) developed a programmatic Project Scale Effectiveness Monitoring Program in 2011 to collect additional data on project effectiveness that would be compatible and comparable with the SRFB monitoring effort across the state.

PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring

The goal of the PIBO is to implement a monitoring program with the capability of determining whether the aquatic conservation strategies within PACFISH and INFISH biological opinions, or revised land management plans, are effective in maintaining or restoring the structure and function of riparian and aquatic systems. The objectives of the program are to determine whether a suite of biological and physical attributes, processes, and functions of upland, riparian, and aquatic systems are being degraded, maintained, or restored across the PIBO landscape; to determine the direction and rate of change in riparian and aquatic habitats over time as a function of management practices; and to determine if specific Designated Management Area practices related to livestock grazing are maintaining or restoring riparian vegetation structure and function. Currently PIBO monitoring occurs in the upper elevations of the eastern portion of Methow subbasin and federally-owned portions of the Okanogan subbasin.

Additional information can be found at: http://www.fs.fed.us/biology/fishecology/emp/.

BOR Methow Basin Monitoring

The Bureau of Reclamation (BOR) funds monitoring and evaluation for the effectiveness of BOR stream restoration in the Methow subbasin. Two projects have been completed since 2004. The first project focused on the evaluation of barrier removal and steelhead recolonization in Beaver Creek. The second project (2008–2012) evaluated the use and productivity prior to implementing a suite of habitat projects in the middle Methow River (rkm 65–80).

USFWS Monitoring

The Mid-Columbia River Fishery Resource Office has been part of the Leavenworth Fisheries Complex since 2010. The Complex also includes the Leavenworth, Entiat, and Winthrop National Fish Hatcheries. Two of their primary areas of work are hatchery evaluation and planning for Leavenworth, Entiat, and Winthrop National Fish Hatcheries and native fish and habitat assessment and monitoring with a focus on spring Chinook salmon, steelhead, bull trout, and Pacific lamprey. Reports and publications can be found at: http://www.fws.gov/midcolumbiariverfro/reports.html

Post-Project Implementation/Compliance and Effectiveness Monitoring

A small proportion of habitat projects receive either implementation/compliance or effectiveness monitoring. This monitoring if often conducted by individual sponsors and monitors a range of metrics and outcomes. Often the monitoring is geared toward evaluating the short-term success of projects in providing fish habitat during a target time of year or in providing specific habitat attributes during a target season. The BOR and UCSRB conducted programmatic implementation monitoring for a number of years in order to evaluate whether projects were implemented as designed. Additional monitoring is conducted on a site by site basis by CCNRD, YN, MSRF, TU, WDFW, and CCFEG.

USFS Stream Inventory

The USFS manages several monitoring activities in the UCR including the Stream Habitat Inventory (USFS Region 6 Level II Survey Protocol), stream temperature, Aquatic Biota (Fisheries Survey and Inventory), Sediment (core samples), and aquatic organism passage assessments on selected forest roads. Due to decreases in funding, much of this monitoring has been reduced or discontinued but the data remain available.

UC Habitat Reach Assessments

Though not a standalone monitoring program, habitat reach assessments are comprehensive reach-based surveys which measure current habitat condition. Reach assessments have been completed for most of the areas listed as high priority in the Upper Columbia Biological Strategy http://www.ucsrb.org/Assets/Documents/Library/REVISED%20Upper%20Columbia%20Revised%20Biological%20Strategy%202014%20%28March%20%29.pdf . To date, partners (primarily the Bureau of Reclamation and Yakama Nation) have completed 23 tributary and reach-scale assessments in the highest priority watersheds and reaches. A total of 113 miles in priority areas have been geomorphically assessed since 2008 (34 miles in the Wenatchee, 23 miles in the Entiat, and 56 in the Methow).

A common thread for most of these assessments is the use of the USFS Level II habitat survey protocol to characterize the existing habitat in the subject reach. The Level II survey collects data on physical features including channel morphology (width-depth), habitat unit composition (pools-riffles), off-channel habitat, large wood, substrate and fine sediment, and others. Accompanying this data in some coarse analysis in the form of Reach Based Ecosystem Indicators that rate the condition of various indicates (e.g. LWD). Overall, the assessments provide a wealth of information on current habitat condition distilled into formats for use by project proponent.

National Water Information System (NWIS)

The NWIS database is a joint effort between USGS and U.S. EPA to provide water quality data, including stream discharge, from a vast array of sites across the United States. In the Upper Columbia, over 25 sites are operational and provide real-time and archived data for stream discharge. A site list can be found at: http://waterdata.usgs.gov/wa/nwis/current/?type=flow.

Environmental Assessment Program (EAP)

The WA Department of Ecology's EAP includes a statewide surface and ground water quality monitoring program that has been underway for over 50 years. The goals of this effort are to provide timely, high quality water quality status and trend data that can be used to evaluate inter and intra annual variation and to determine whether water quality at particular sites exceed standards. Numerous sites have been established throughout the Upper Columbia, but water quality parameters and duration vary. Information regarding this program with links to site data can be found at: http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html.

Watershed Health Monitoring (WHM)

The WA Department of Ecology's WHM program is a statewide stream habitat monitoring program designed to track the status and trends of a suite of stream health indicators associated with channel condition and diversity, riparian structure, fish cover, and water quality. Monitoring under this program was initiated in the Upper Columbia in 2012 within a panel of 50 sites. The next sampling visit is scheduled for 2016. Information, including sampling sites and protocols for this program can be found at: http://www.ecy.wa.gov/PROGRAMS/eap/stsmf/index.html

Table 1. A list of important indicators that are collected by various monitoring programs within the Upper Columbia Region. M=Methow, W=Wenatchee, E=Entiat, O= Okanogan

Agency/ program	Status and Trend Indicators							Effectiveness Indicators				Scale	
	Adult spawning escapement	Spatial structure (adults)	Life history (e.g., length, age, migration timing, etc.)	Genetic diversity	Juvenile fish distribution or density(excludes smolt trapping)	Juvenile emigration abundance and productivity (smolt traps)	Habitat condition	Life-stage survival	Fish-habitat relationship	Habitat response to restoration	Fish response to habitat restoration	Temporal	Spatial
PUD hatcheries	M,W,O	M,W	M,W	M,W		M, W		M,W				On-going	Population, sub-population
WDFW VSP & RRS	M,W	M,W	M,W					M.W				On-going (RRS for steelhead done in 2018)	Population-sub-population
ISEMP	E	E	E, W	E	E, W	E		E, W	E, W		E	10-20 years	Subbasin-tributary, valley segment, reach
OBMEP	O	O	O	O	O		O	O			O	On-going	Subbasin-tributary
CHaMP							W,E, M		W, E, M	W, E, M		On-going	Subbasin-tributary, reach, site
State-wide, regional reach-and project-scale monitoring					W, E, M, O				W, E, M, O	W, E, M, O	W, E, M, O	10-20 years	Reach and project (site specific)
PIBO							M, O					On-going	
USGS-BOR Methow Basin Monitoring			M		M			M	M	M	M	10 years	Reach
USFWS FRO Monitoring	W,M,E	M,W,E	E		M,W.E	E						On-going	Subbasin-tributary

Methods

Objective 1. To determine what information is needed, and at what scale, by project sponsors to assist in habitat project development and implementation

We queried project sponsors, the MaDMC, and RTT to determine what information is currently used and needed by project sponsors to assist in habitat project development and implementation. The results of the survey lead to development of 14 fish and habitat monitoring questions (Table 2).

Objective 2: Identify key information gaps.

To address Objective 2, indicators were assigned to each monitoring question and staff from UCR monitoring programs were surveyed to identify and document which of these indicators are currently being collected, for which species, and at what spatial and temporal scale.

We determined if current monitoring programs are designed and funded to address the project sponsors needs, and if not, what information still needs to be collected.

Objective 3: Create recommendations to address key information gaps.

We crafted recommendations regarding the data gaps and information transfer.

Results

Project Sponsor Information Needs

Based on our survey on information needs, fish and habitat monitoring information is very important for project development and implementation and certain types of information are more useful and available than others. Data currently used in project development includes spawning location (97% of respondents) followed by flow and geomorphology (69% each). Fish life history and habitat quality were also commonly used (65% each). Low on the list of data used in project development was fish abundance, distribution and fish response to restoration. These types of information are likely undervalued because they are not widely available at the site or reach scale, not because they are viewed as unnecessary. Results indicated a general consensus between groups that reach scale data are most often desired (>95%), followed by project scale information (80%), and assessment unit scale (70%). The top 3 data most needed for project development and design are (1) Fish response to restoration (82%); (2) Fish distribution by life stage (74%); and (3) Habitat response to restoration (67%).

Monitoring Information Availability

A total of 17 monitoring programs filled out the survey on data and information available in the region. The results indicate that the majority of monitoring in the region is related to status and trends monitoring (82%), effectiveness monitoring (ISEMP, CHaMP, hatchery habitat program and projects) (35%) and research (29%). The scale of most Upper Columbia monitoring is the subbasin or tributary scale (63%) with a substantial amount of reach (44%) monitoring and few programs that focus on project or regional-scale monitoring (Table 1). Most monitoring programs work in the Wenatchee and Methow subbasins (75%) while fewer monitoring programs focus on the Entiat and Okanogan subbasins. Almost all the monitoring programs have been collecting data for over 5 years in the region and a majority have data going back over 10 years. Generally, data is distributed and communicated using tools such as annual reports and through general data requests. Websites, peer-reviewed publications, and other forms of communication are less used.

A Summary of Monitoring Data and Information Needs

Based on the project sponsor survey we developed a list of 9 key information types needed for habitat restoration development and implementation.

General Species Distribution (Presence/Absence)

Information on species distribution is needed and available for Upper Columbia listed species and is being confirmed by several monitoring programs. In addition, this information is also being collected for coho salmon, lamprey, and resident fish species.

Spawning Areas

For the most part, information concerning spawning areas for spring Chinook, steelhead, and bull trout is currently being collected and used by projects sponsors.

Adult Holding

Very limited information is currently available on specifically where adult spring Chinook and steelhead are holding, or staging prior to spawning. There is, however, information pertaining to the type of habitat that is normally used by staging fish. As such, it is important that projects try

to emulate that type of habitat if the goal is to increase holding habitat. Information on bull trout is available, but limited. Information on habitat use by adults is lacking, as is a thorough empirical study on adult holding/pre-spawning mortality that would help us better understand all of the factors (e.g., temperature) that play a role in survival from tributary entry and spawning.

Juvenile Rearing Distribution

Information is being collected by current monitoring programs on spring Chinook and steelhead juvenile distribution, although this information is limited to a few streams and is generally collected at the site scale (which may or may not relate to a habitat project). The intention is to expand these estimates to larger scales based on fish-habitat relationships and to develop a more complete data set. The information is also generally limited to summer parr rearing distribution. Little information exists for juvenile bull trout. This type of information has been identified as a major information need given that most habitat projects are aimed at improving habitat for juvenile salmon and steelhead.

Fish life history

Life history traits, such as migration timing, were identified as an information needed by project sponsors. Some life history information is being collected by current monitoring programs such as juvenile and adult migration timing of salmon and steelhead in some secondary tributaries and in all of the main stem rivers (Wenatchee, Entiat, Methow, and Okanogan). In addition, the PUD hatchery programs collect age, length, and other life history information that is reported annually in their hatchery evaluation reports. Current monitoring tools (e.g. smolt traps and PIT tag arrays) limit our ability to collect more thorough information on movement and habitat use across all life stages and habitats.

Life stage-specific survival (survival bottlenecks)

Life- and survival bottlenecks were indicated as an important types of information for developing projects. Information on egg-emergence and emergence-parr survival are currently not being collected. There is some information being collected on population-level parr-emigrant survival in select locations, and some programs calculate smolt-to-adult survival but only in those tributaries where hatchery programs exist and for select species in those tributaries.

Pre-spawn mortality estimates in the tributaries are generally unavailable, however some efforts are underway to identify this life-stage survival. This type of information may become more available as additional PIT tag arrays are installed in the major tributaries. On their own, monitoring programs have limited ability to inform survival bottlenecks, but life-cycle, modeling efforts have the potential to fill data gaps and identify them at the population and tributary scale. This type of information, however it is generated, has been identified as information needed by project sponsors and is therefore an information gap in the UCR.

Current habitat quality

Information is needed by project sponsors to determine where to focus projects and what habitat attributes need to be restored or protected. Currently, monitoring programs are collecting habitat data at the sampling site scale. Reach assessments provide current habitat quality information in areas of high priority for habitat restoration. Similarly USFS level II stream inventories provide habitat quality data throughout the national forests. Multiple programs contribute to our

knowledge of habitat quality using various methodologies, including different areas, spatial resolution and habitat attributes.

Fish use of habitat

Fish use of habitat is very important to project development and implementation. Currently, habitat use information is generally limited to select sites, species, and life stages and is generally being collected with the intention of rolling the information up to general fish-habitat relationships that can be applied more broadly. If available, fish and habitat associations could be used to make predictions about fish response to restoration in the context of important habitat attributes.

Fish and habitat response to habitat improvements

Several monitoring programs have been tracking fish response to habitat actions. Some information is being collected at the project scale on fish abundance/density, but the information is limited, is not always consistent between sampling sites or species, and may not be easily applied to other projects. As discussed above, the information needed by project sponsors is primarily related to goals of the project which in most cases relate to fish response to habitat improvements at the project and reach scale over longer time scales and multiple seasons. A programmatic approach to effectiveness monitoring is underway in the state and in the Upper Columbia and should help inform project sponsors of potential for fish and habitat responses to a given project type, however the information is very general compared with the specific information needs of sponsors. A long-term assessment of collective habitat work in the Entiat subbasin is ongoing through an Intensively Monitored Watershed (IMW) approach, however, by itself, there is limited use of this information to inform to project sponsors given that it is assessing multiple project types at a population scale. Therefore, there is a need to integrate and evaluate fish response information that is being collected at various spatial scales.

Summary

Results

The results of this survey indicate that there are gaps between the information that is needed by projects sponsors to develop and implement projects and the information that is currently being generated by monitoring and research programs. Specific information gaps in the region are related to:

1. Adult holding distribution and habitat use
2. Life-stage specific survival and habitat use
3. Fish response to restoration actions

Additionally, although fish and habitat data is collected and often available at some sites and reaches, the data most often isn't summarized in a way that makes it useful to project sponsors and it is difficult for sponsors to translate beyond the site-scale at which it was collected. It is also very difficult to reconcile various monitoring data within a particular area.
In general, a mechanism is needed to communicate and summarize monitoring information in a way which is both easily accessible and understood by technical and non-technical project sponsors.

Recommendations

Current monitoring in the UCR has been guided through the RTT and MaDMC, and is generally productive, efficient, and scientifically sound. However, additional planning is needed for adaptively managing future habitat restoration project implementation, and for evaluating and understanding the benefits of past actions. Continually updating the science and information is critical to identifying, prioritizing, designing and implementing projects and to understanding our ability to meet habitat restoration and protection goals and objectives at a variety of scales from the project scale to the population scale.

From our surveys and other discussions, information that is needed by project sponsors to assist with development of habitat restoration projects needs to be collected at various spatial and temporal scales. Project scale monitoring alone is not sufficient to understand how populations respond to habitat improvement projects yet tributary (population) level monitoring does not inform on which projects or project types are effective. For this reason, to understand how projects effect habitat, both project, reach, scale monitoring are necessary. To understand how fish are affected by habitat restoration, both project and tributary (population) monitoring is necessary. Project scale monitoring will inform if fish are using the project area but to determine the overall effect of the action (or suite of actions over time) population level monitoring is needed.

The following recommendations are not in priority order:

- **Ensure better understanding of habitat status at the tributary (HUC 6), and reach scale**

  Although habitat data is being collected, the scale at which information is being collected is not always informative to project development and implementation. Collecting and reporting habitat data in a manner which is clearly linked to ecological concerns, and provides information at the appropriate scale for restoration would benefit future project development and implementation.

- **Ensure a better understanding of how fish respond to habitat actions**

  A critical uncertainty associated with the implementation of the UC Recovery Plan has been the response of the habitat and fish productivity (life-stage survival changes) from the effect of restoration actions. Therefore, we recommend that there be an increase in project- and reach scale monitoring of fish response to restoration projects.

  Current and planned projects that look once or once per year for fish use ***are not adequate*** to evaluate fish response to habitat projects. An important aspect of collecting this information is that should be collected more than once or twice per year (over several seasons if necessary) and is collected before and after implementation of restoration actions and with control sites (BACI design) whenever possible. It is also highly informative to quantify fish use of untreated habitat within a treated reach. Increases in

effort would entail a more rigorous commitment to habitat monitoring for multiple project types over space and time, with short term (annual) reporting disseminated to project sponsors and other stakeholders.

As stated above, there is a need to integrate the information being collected at the various scales so project sponsors can use it for restoration development and implementation.

- **Collect additional information on spring Chinook and steelhead juvenile distribution.**

  Current juvenile fish distribution monitoring is based on various sampling designs where site selectivity may or may not be in or near a habitat restoration project. We suggest that the lessons learned from ISEMP and other large-scale programs be used to develop juvenile sampling regimes that stakeholders feel appropriately depict the distribution and habitat preferences of juvenile fish.

- **Perform an empirical study on adult pre-spawning mortality**

  Current estimates of pre-spawning mortality for spring Chinook salmon suggest that it may play a significant role in viability of the various populations. To ensure that we better understand all of the factors (e.g., temperature) that play a role in survival from tributary entry and spawning, empirical information is needed in conjunction with studies that have occurred in other regions (e.g., Willamette River basin).

- **Ensure survival bottlenecks between adult entry into the spawning tributary and emigration of juveniles are defined.**

  Basic data on freshwater life stages (abundance and survival) is lacking from many major tributaries and is not always reported consistently even where it is being collected. Basic data on egg-to-parr, parr-to-smolt, or egg-to-emigrant survival, along with smolt-to-adult return and return-to-spawner survival at the tributary or assessment unit scale would help answer many questions related to freshwater habitat opportunity and capacity that could be limiting survival at various life stages.

  Coupling monitoring information and modeling should enable researchers to identify survival bottlenecks. Providing this information at the smallest scale possible will assist project sponsors in developing projects that address the appropriate life stage in a given area. Understanding survival bottlenecks is essential to prioritizing projects that will have the greatest affect to fish abundance and productivity.

- **Make information and data more understandable and available**

  In order to ensure that project sponsors are receiving timely information and that dialogue is occurring between monitoring entities and project sponsors, there is a need for consistent avenues for communication. We recommend the region convene workshops

with monitoring project sponsors to share available information; that monitoring programs' annual reports are posted on the UCSRB website and ensure sponsors know they are available; and that a feedback loop is created so when additional needs become apparent they can be addressed by the MaDMC working with the RTT and UCSRB staff. A plan for monitoring information summary and dissemination in the region would be incredibly helpful in establishing clear information and pathways between monitoring and implementation in the region.

Table 2. Monitoring questions and the indicators and metrics needed to answer them based on a survey conducted by the MaDMC.

Question No.	Monitoring Question	Indicator	Species	Agency/Program that Collect Information	Comment
1	What fish species are present?	Species of fish	Chinook, steelhead, bull trout, coho, lamprey	USFS, USFWS, OBMEP, PUD Hatchery M&E, ISEMP, MCCRP	Most effort is done for steelhead and spring Chinook
2	Where are the known spawning reaches (MaSA or MiSA)?	Adult spawner spatial distribution	Bull trout, Chinook, steelhead, coho	USFS , USFWS, OBMEP, PUD Hatchery M&E, WDFW VSP, YN, ISEMP	Based on redd surveys
3	Where are adult holding areas (pools/habitats)?	Adult holding distribution	Bull trout, Chinook and steelhead (limited)	USFWS, OBMEP, CHaMP	Very limited information. In general, there is a gap in our understanding of specific adult holding.
4	What life stage uses this area, when (summer/winter low flow, high flow refugia, etc.) and for what purpose (spawning/incubation, rearing, refuge, etc.)?	Parr distribution	Chinook, steelhead, coho, bull trout, and lamprey	OBMEP, PUD Hatchery M&E, WDFW VSP, ISEMP, USFWS, MCCRP, USGS-BOR	Information for lamprey and bull trout are very limited; this is a gap
		Juvenile distribution			
		Juvenile migration timing			
		Adult holding distribution	See monitoring question # 3		
		Adult spawner spatial distribution	See monitoring question # 2		
5	Where are the survival bottlenecks and for what life stage?	Egg-emergence survival	None	WDFW/NMFS	
		Egg-to-parr survival	None	PUD Hatchery M&E	
		Parr-emigrant survival	Chinook, steelhead	ISEMP, USGS-BOR, OBMEP, WDFW VSP	
		Emigrant (smolt)-adult survival (SAR)	Chinook, steelhead, coho, bull trout (limited)	PUD Hatchery M&E, USFWS, OBMEP, ISEMP	
		Adult migration survival	Mostly mainstem Columbia River for Chinook and steelhead, some tributary info emerging.		Estimates are generated for the mainstem Columbia River through PIT tag detections. With additional PIT tag arrays now deployed throughout various tributaries, additional tributary-specific information may be more available in the future. However, specific studies may be needed to provide information on this indicator.

Question No.	Monitoring Question	Indicator	Species	Agency/Program that Collect Information	Comment
		Pre-spawning survival	Anecdotal for spring Chinook (Wenatchee)	WDFW VSP and RRS	Anecdotal information for spring Chinook in the Wenatchee suggests that pre-spawn mortality may be an important factor limiting production. Specific studies are needed to verify the anecdotal information. Other species should be assessed too.
6	What is the current quality of the habitat?	Physical features of habitat	NA	AREMP/PIBO, CHaMP, OBMEP, ISEMP, USGS-BOR, YN	This is being done for status and trend monitoring at the subbasin scale. Information is available through various reach assessments at smaller scales, but that information is presented as "point" estimates.
		Water quality			
		Flow/hydrology			
		Channel condition			
		Riparian condition			
		Watershed condition			
7	How does the current habitat quality relate to fish life stage needs (habitat ecological concerns)?	Spawning habitat (effects adult spawning, embryo incubation and alevin development)	Chinook, steelhead	ISEMP, CHaMP, USGS-BOR	These indicators are currently being addressed at the subbasin scale, with very little applicability to project-scale needs.
		Holding habitat (effects pre-spawning adults)			
		Rearing habitat (effects fry emergence, fry/parr growth and development)			
		Migration (effects adult sexual maturity, adult migration survival, steelhead seaward migration (kelt), fry/parr/smolt seaward migration)			
8	What specific habitat attributes do fish need	See monitoring question # 7		OBMEP (steelhead parr-juvenile), ISEMP (Chinook	This question may more appropriately be answered through a literature search.

Question No.	Monitoring Question	Indicator	Species	Agency/Program that Collect Information	Comment
	at different life stages?			and steelhead parr-juvenile, overwinter), CHaMP, USGS-BOR (Chinook, steelhead emergence-parr)	Some of the current monitoring may define UCR-specific information, but most likely at a broad scale.
9	What is/are the limiting habitat factors (habitat condition limiting the lowest stage survival)?	See monitoring questions #s 7 and 10			Some additional information may be forthcoming from current monitoring efforts that could assist in answering this monitoring question, but verification fo habitat limiting factors is beyond the scope of most monitoring efforts.
10	What are the life stage and species-specific response (e.g., growth, survival, productivity) and/or use of restoration projects?	Life stage: Adult holding Indicator: pre-spawning mortality (PSM)	See monitoring question # 5, but this would be post-project monitoring to answer specific question (not being done)		
		Life stage: Adult spawning Indicator: Spawning habitat use	See monitoring question # 2, but this would be post-project monitoring to answer specific question (not being done)		
		Life stage: egg-emergence Indicator: egg-emergence survival			This is gap
		Life stage: emergence-parr Indicator: emergence-parr survival; fry growth;			
		Life stage: parr-emigrant Indicator: parr-emigrant survival; parr growth; age at emigration; size at emigration		UC Project Scale Monitoring Program, ISEMP, USGS-BOR, SRFB/UCSRB Effectiveness Monitoring	Sample sizes are limited
		Prespawn Mortality		a	
11	How does the habitat respond to specific	Fish passage		UC Project Scale Monitoring Program, ISEMP, CHaMP,	
		Instream flow			

Question No.	Monitoring Question	Indicator	Species	Agency/Program that Collect Information	Comment
	restoration efforts?	Water quality		SRFB/UCSRB Effectiveness Monitoring	
		Instream structure			
		Sediment			
		Riparian			
		Peripheral and transitional habitat			
		Channel structure and form			
12	How do specific types of restoration actions address ecological concerns?	Fish injury		UC Project Scale Monitoring Program, ISEMP, CHaMP, USGS-BOR, SRFB/UCSRB Effectiveness Monitoring	
		Fish passage			
		Instream structures			
		Riparian condition			
		Sediment reduction			
		Water quality			
		Water quantity			
		Off-channel habitat			
13	How do different restoration actions influence fish growth, survival, and productivity?	See monitoring question # 10		ISEMP	
14	What is the response of a specific project type on a given species and life stage?			UC Project Scale Monitoring Program, SRFB/UCSRB Effectiveness Monitoring,	

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OBMEP. 2014. Okanogan Basin Monitoring and Evaluation Program, 2013 Annual Report. Colville Confederated Tribes Fish and Wildlife Department, Nespelem, WA. Report submitted to the Bonneville Power Administration, Project No. 2003-022-00.

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EDT History

- Developed in late 1990's
  - Council's Model Watershed Process: Grande Ronde sub-basin
  - Expert knowledge driven
- Production model: EDT1 ~2000
  - Sub-basins in Puget Sound and Columbia Basin
  - Council's Multi-Species Framework
- Sub-basin Planning: EDT2
  - Simplified interface
  - Applied to most salmon-bearing watersheds outside of Idaho
  - More than 100 registered users
  - Created the world's largest salmon-habitat dataset
- The Future: EDT3
  - Just released
  - Modern software standards
  - Much more flexible and versatile
  - Responds to needs/criticisms

Why Use EDT?

Pool Density
- Then – 13/mile
- Now – 31/mile

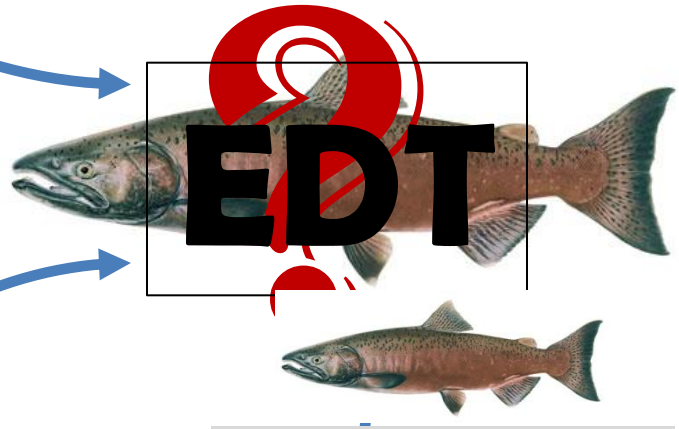
Bank hardening
- Then – 81%
- Now – 30%

Spawning habitat
- Then – 12.2 ac
- Now – 37.9 ac

Off-channel habitat
- Then – 2.2 ac
- Now – 27.8 ac

Mainstem habitat
- Then – bad
- Now – better

Logjams
- Then – 1.7/mile
- Now – 5.9/mile

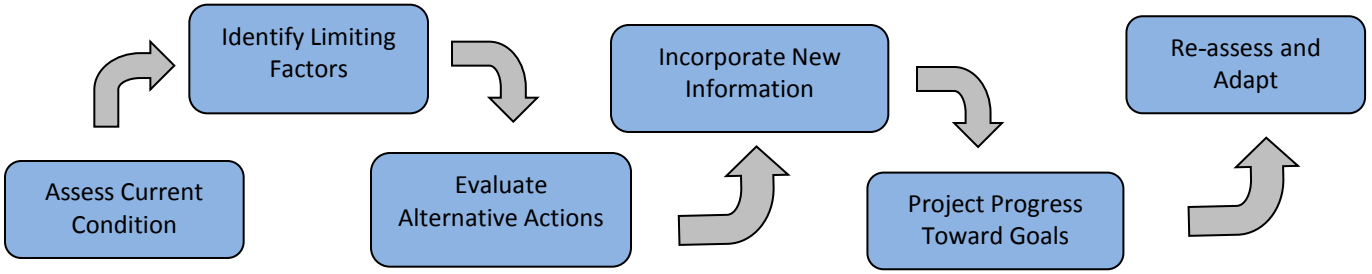


- Abundance
- Productivity
- Biological Diversity
- Spatial Structure

Value of EDT

- Provides information that directly ties to important decisions
  - Funding priorities
  - Value of investments
- Scaleable
  - Reaches → Diagnostic Units → Watershed→ Ecological Provinces
  - Life stages → Life history → Populations → ESUs
- Fully compatible with existing research and monitoring
  - CHaMP
  - ISEMP
  - OBMEP

Relationship of EDT to Council Habitat Framework



Current Conditions (e.g., habitat and fish status and trend)	Limiting Factors (e.g., elevated water temperature)	Actions Implemented (e.g., riparian improvements)	Impact of Actions over Time on Habitat Characteristics (e.g. improved watershed conditions)	Impact of Actions on FW Life Stage (e.g., increased productivity	Impacts of Actions on FW Life-Cycle (e.g., increased spawner abundance, populations)
					

Applications: Climate Change

- EDT suited for evaluation of future climate on salmon and steelhead
- Physical models estimate environmental condition
- EDT evaluates biological change
    - How will populations respond?
        - Some extirpated
        - More restricted distribution
    - How can climate change affect BPA funding of restoration?
        - Shift focus to core populations
        - Different restoration priorities

Upper Columbia Initiative

- Okanogan Basin—OBMEP/EDT will continue
- Upper Columbia River Salmon Recovery Board
  - Endorses OBMEP/EDT because they provide useful and timely information of value to the Board
  - Compatible with CHaMP and ISEMP
  - Applicable to:
    - Wenatchee
    - Entiat
    - Methow
- Waiting for funding

OBMEP/EDT Integration

Evaluating Habitat Status and Trends in the Okanogan Subbasin using the Ecosystem Diagnosis and Treatment Model

An Okanogan EDT Primer

- Why use EDT for monitoring, reporting, and decision support?
- What is EDT?
- How does it Work?
- Customizing EDT for the Okanogan:
  - How is habitat performing across multiple scales?
  - What are the priority habitats and limiting factors?
  - What life stages are most affected?
  - What are the trends?

Why Use EDT for Status and Trends?

Pool Density
- Then – 13/mile
- Now – 31/mile

Bank hardening
- Then – 81%
- Now – 30%

Spawning habitat
- Then – 12.2 ac
- Now – 37.9 ac

Off-channel habitat
- Then – 2.2 ac
- Now – 27.8 ac

Mainstem habitat
- Then – bad
- Now – better

Logjams
- Then – 1.7/mile
- Now – 5.9/mile

FISH & WILDLIFE DEPARTMENT COLVILLE TRIBES

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EDT: A Life Cycle-Based Habitat Model

OBMEP Habitat Data

OBMEP Life History Information

Species/Habitat Rules

Key Components

- Reach Network
-
-

Life History Information

- Spawn Timing, Location
- Life Stages and Duration
- Movement Patterns
- Life history diversity?
- Protection and restoration priorities?
- Key limiting factors?

ESA-relevant results

- How much habitat is there?
- How good is it?
- What level of abundance can it support?

Species Response

- Benchmarks
- Performance Rules

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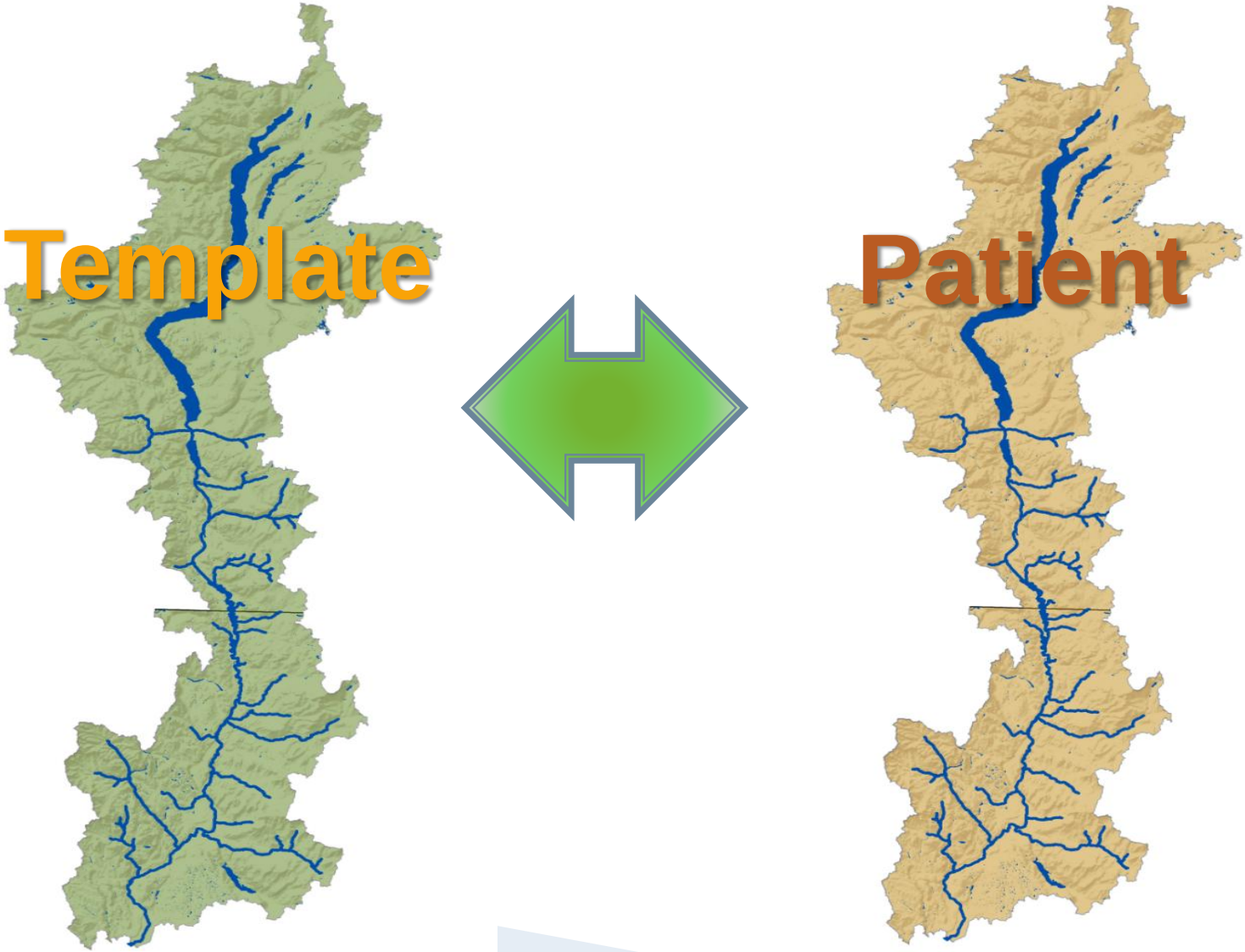
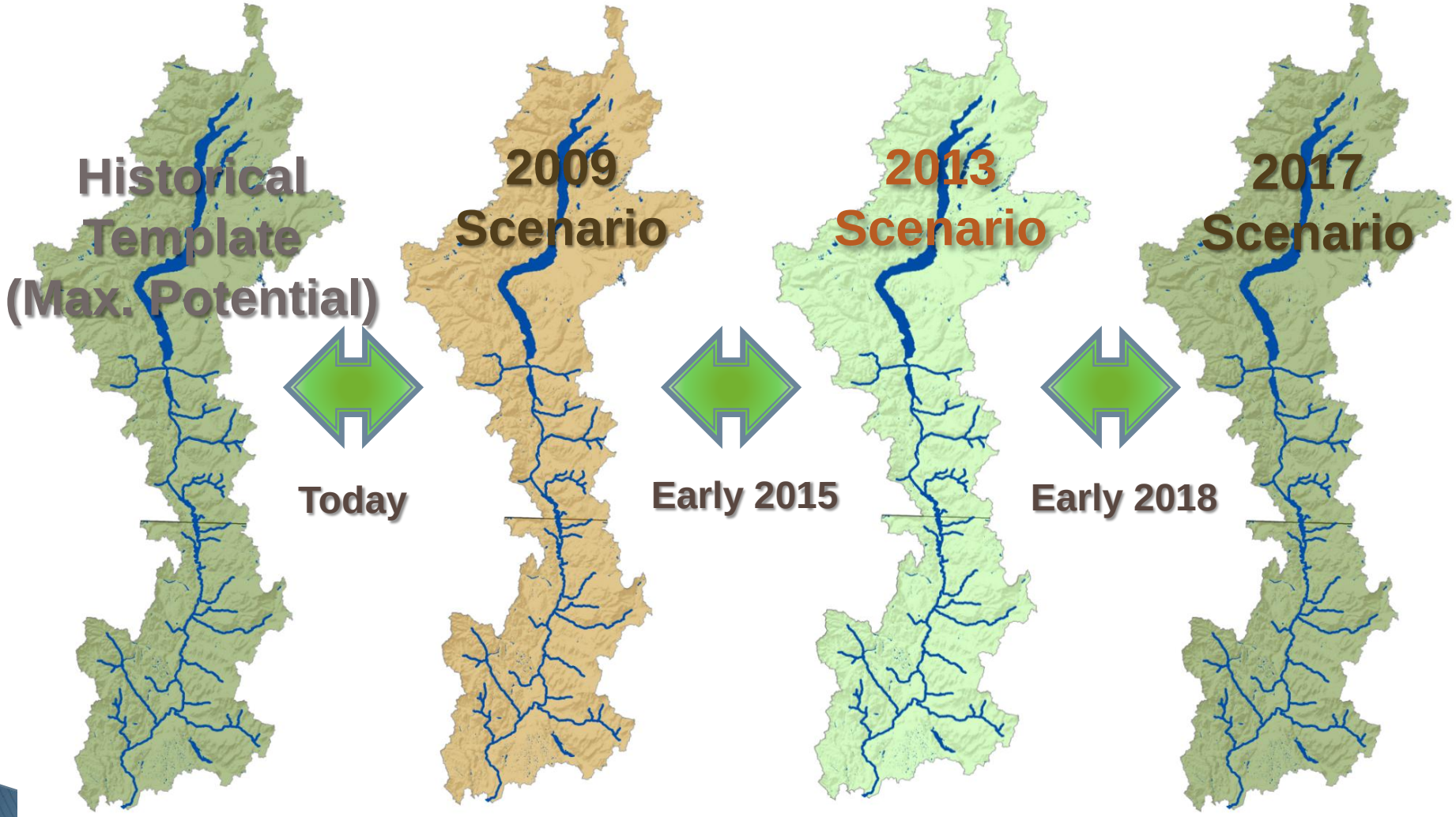
EDT Works by Comparing Scenarios

Where we were or would like to be

Where we are or expect to be



OBMEP/EDT Status and Trends



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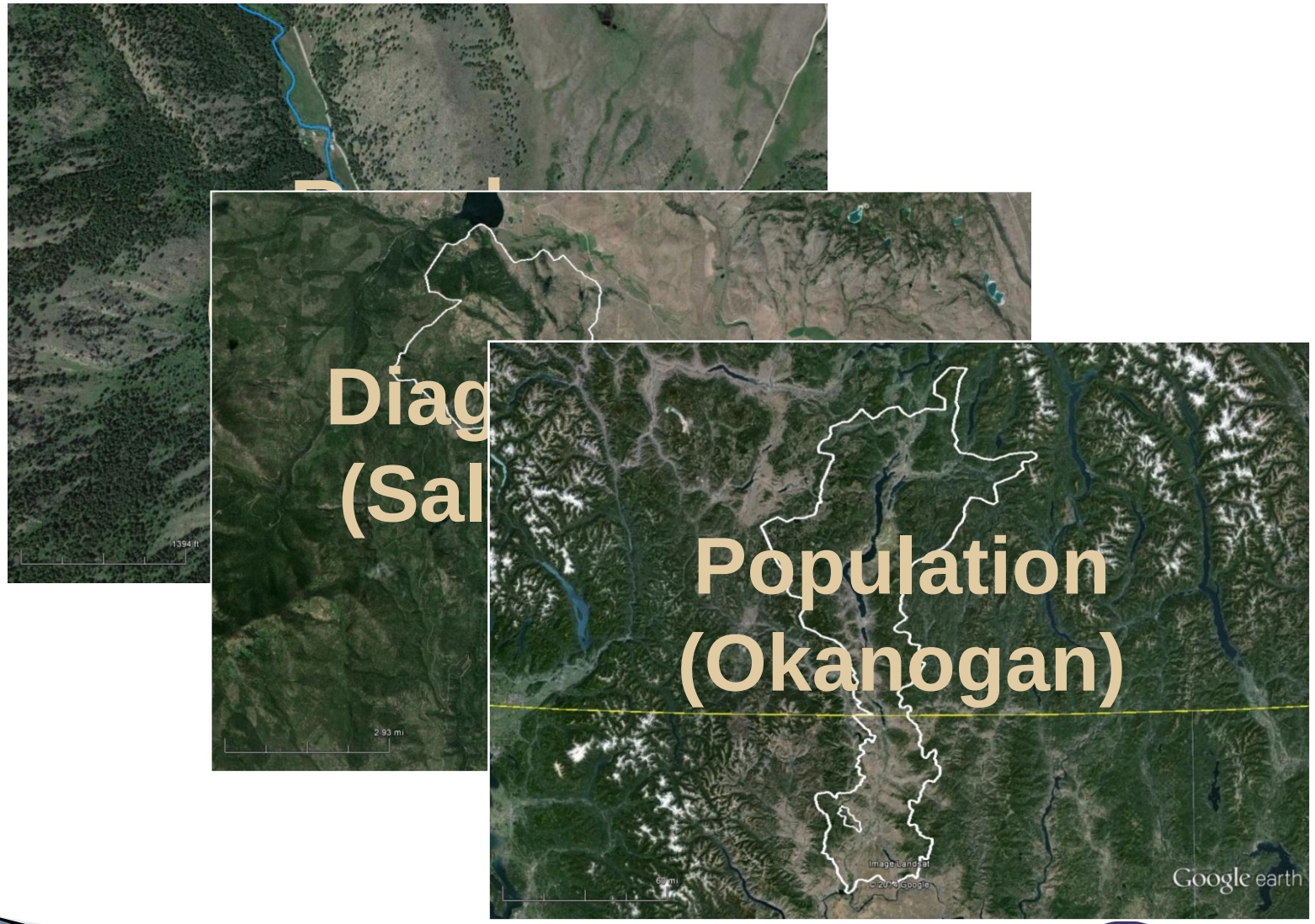
Customized Scalable Results



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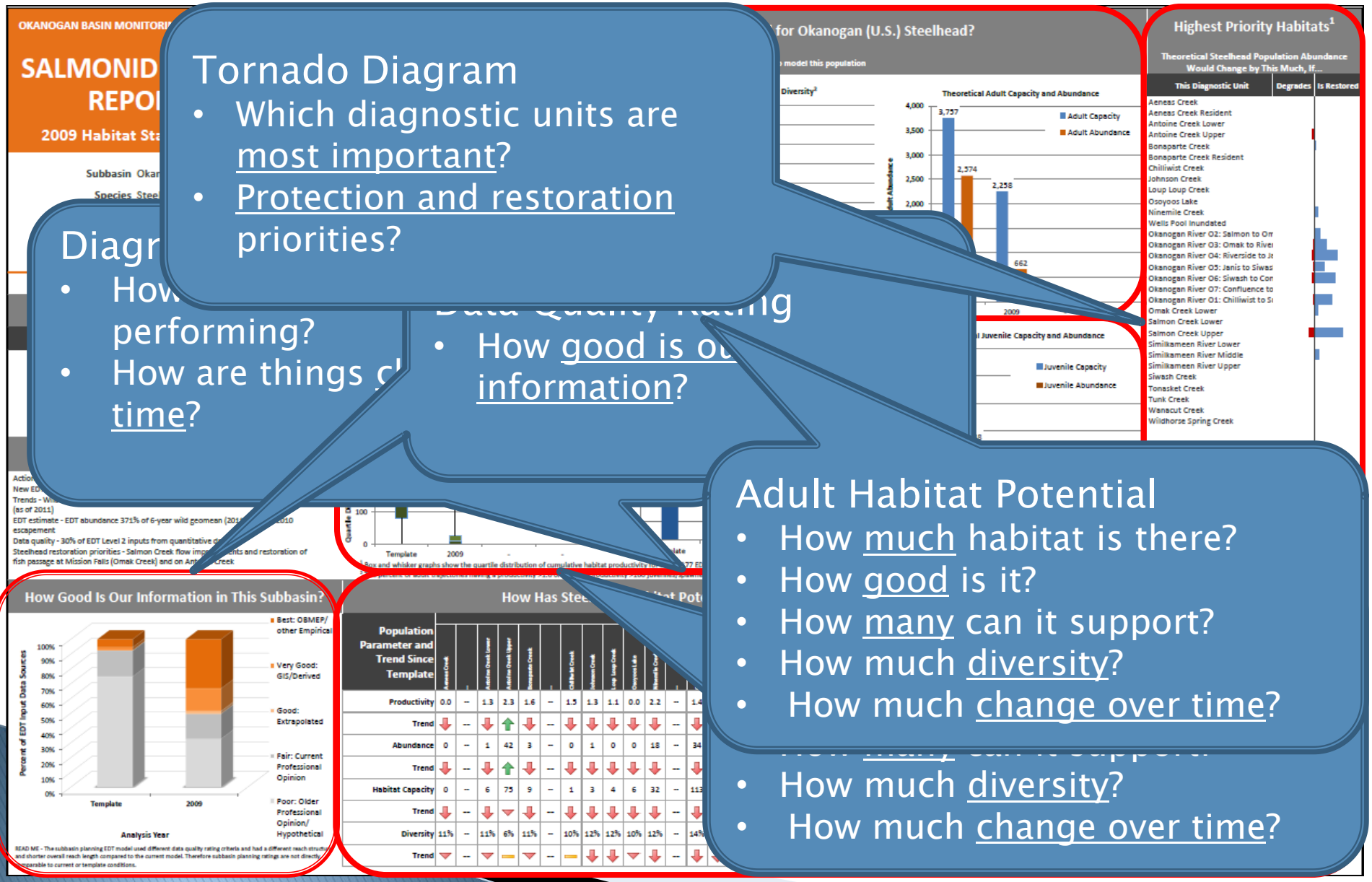
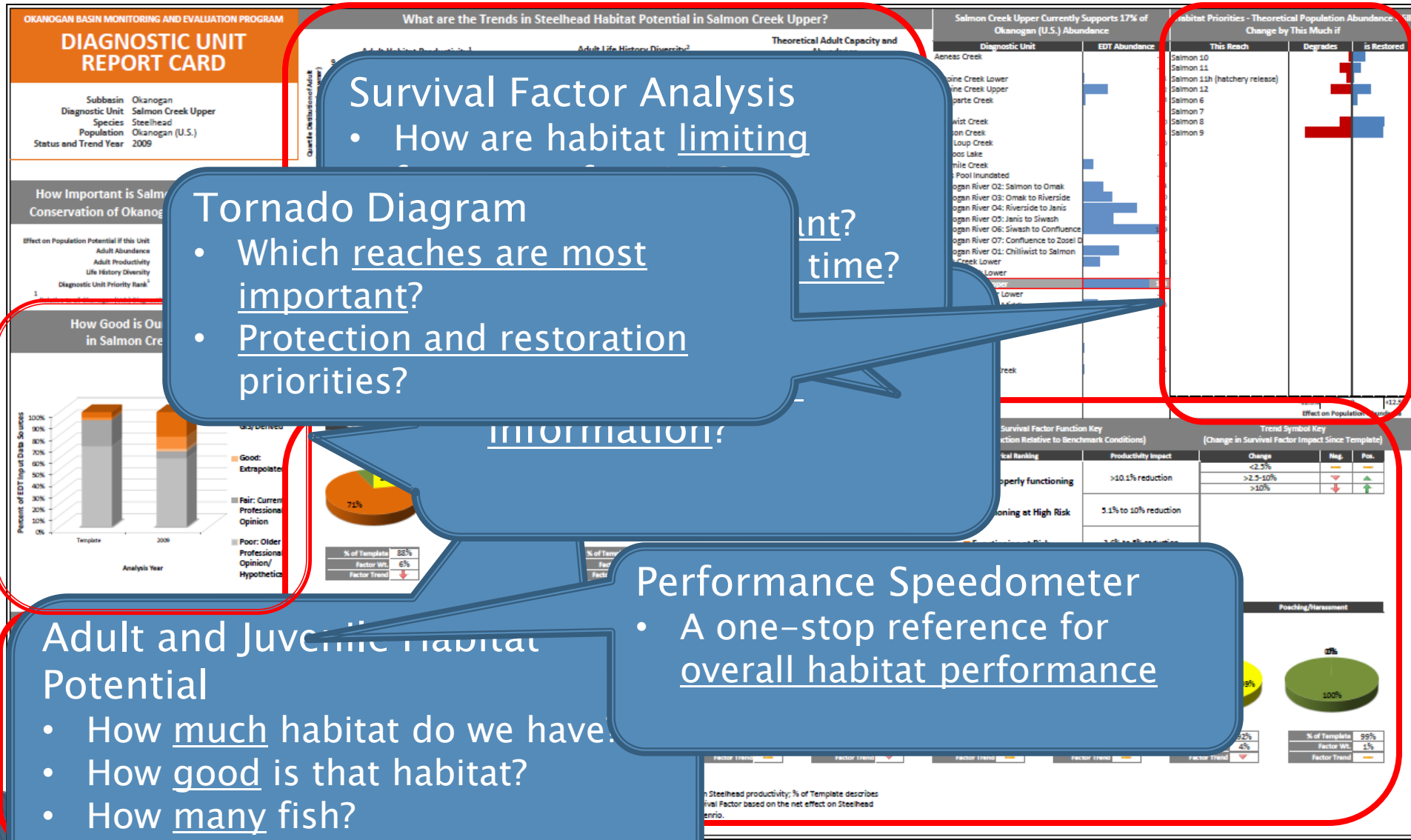
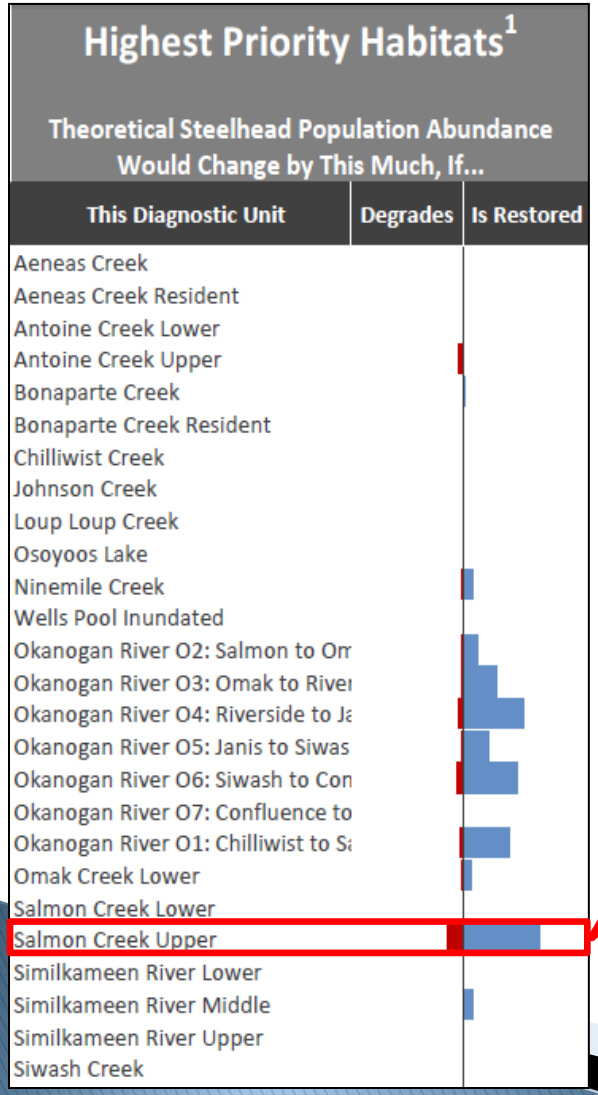
Population Report Card (Subbasin)



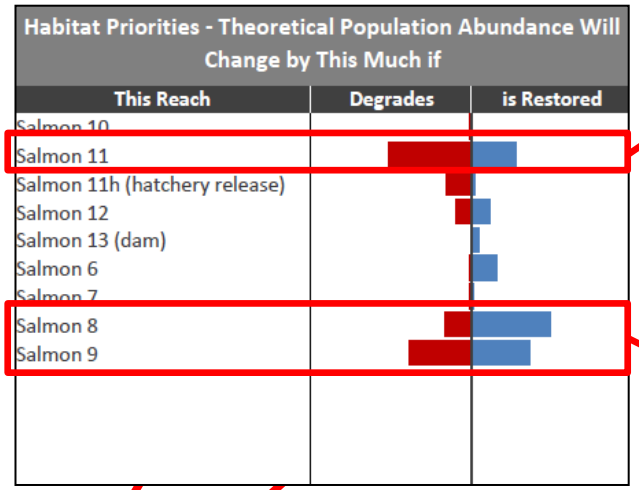


Drilling Down: Identifying Habitat Priorities

Population (Subbasin) Report Tornado Diagram



Diagnostic Unit Report Tornado Diagram



Priority Reaches

- **Salmon 8**
  - Restore
- **Salmon 9 & 11**
  - Protect and restore

ICF Jones & Stokes
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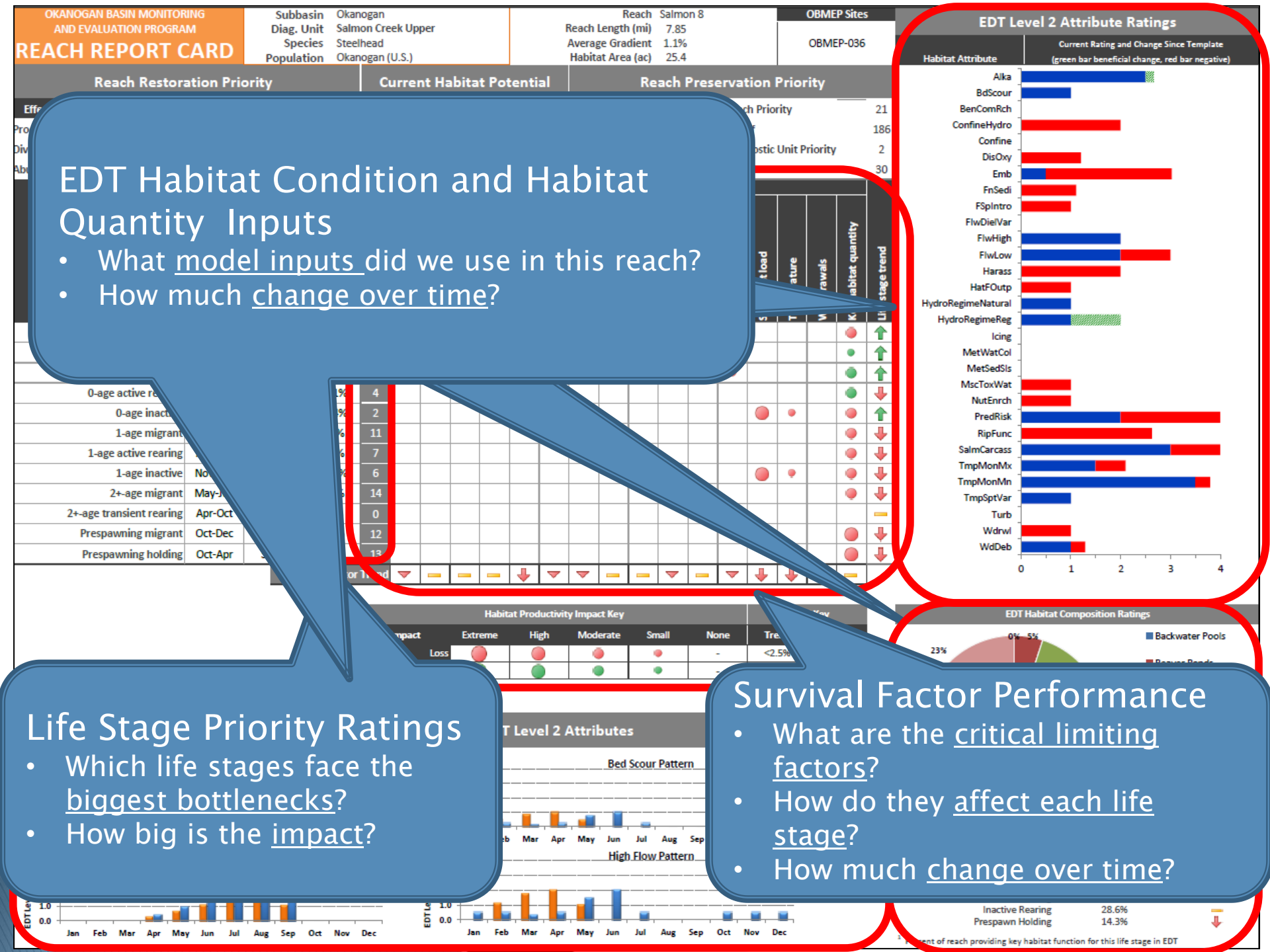
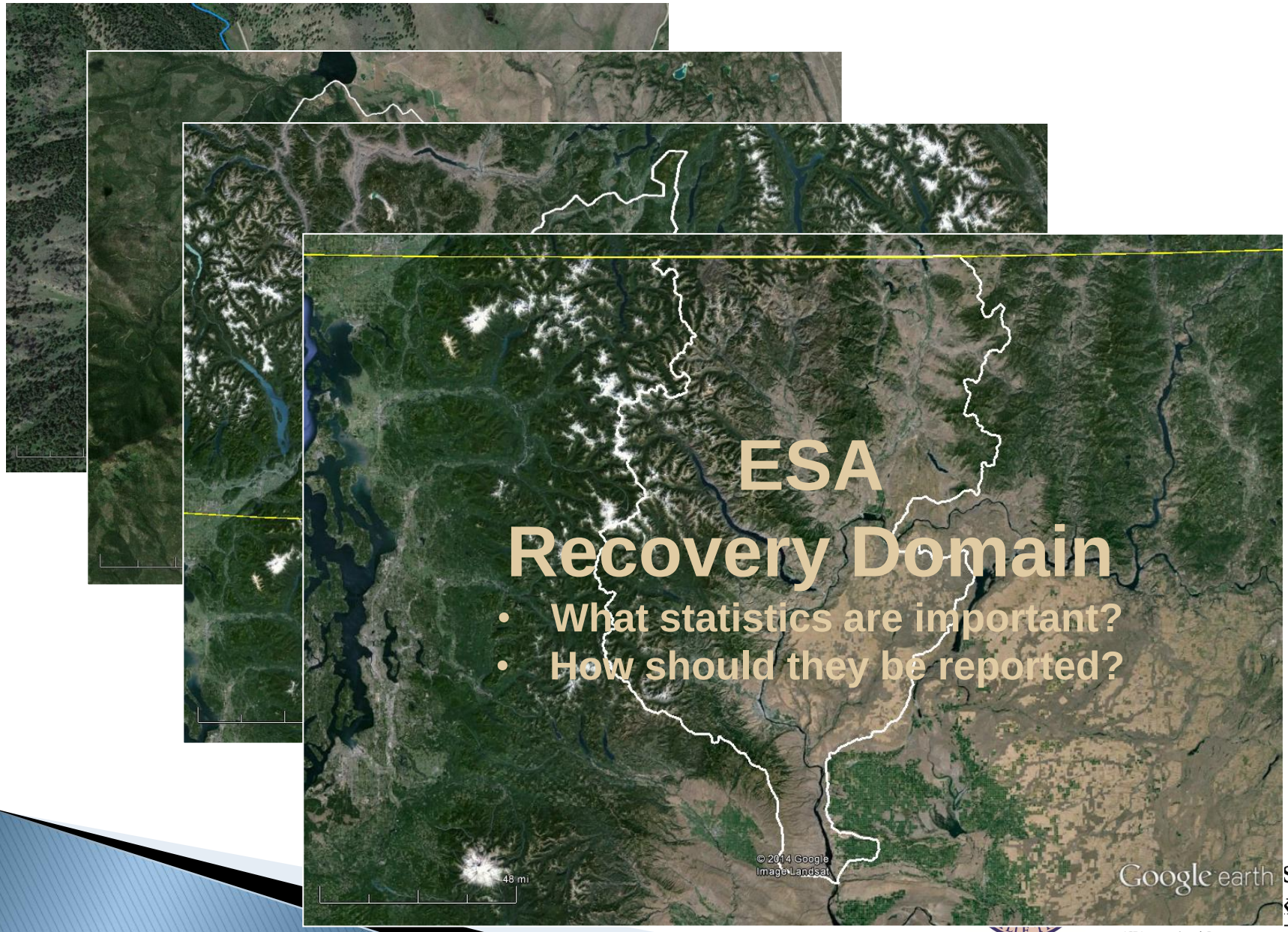

OKANOGAN BASIN MONITORING AND EVALUATION PROGRAM
REACH REPORT CARD
Subbasin Okanogan
Diag. Unit Salmon Creek Upper
Species Steelhead
Population Okanogan (U.S.)
Reach Salmon 8
Reach Length (mi) 7.85
Average Gradient 1.1%
Habitat Area (ac) 25.4
OBMEP Sites
OBMEP-036
Reach Restoration Priority
Current Habitat Potential
Reach Preservation Priority
EDT Level 2 Attribute Ratings
Habitat Attribute
Current Rating and Change Since Template (green bar beneficial change, red bar negative)
Alka
BdScour
BenComRch
ConfineHydro
Confine
DisOxy
Emb
FnSedi
FSpIntro
FlwDielVar
FlwHigh
FlwLow
Harass
HatFOutp
HydroRegimeNatural
HydroRegimeReg
Icing
MetWatCol
MetSedSls
MscToxWat
NutEnrch
PredRisk
RipFunc
SalmCarcass
TmpMonMx
TmpMonMn
TmpSptVar
Turb
Wdrwl
WdDeb
0
1
2
3
4
EDT Habitat Condition and Habitat Quantity Inputs
What model inputs did we use in this reach?
How much change over time?
0-age active rearing
0-age inactive
1-age migrant
1-age active rearing
1-age inactive
2+-age migrant
2+-age transient rearing
Prespawning migrant
Prespawning holding
Habitat Productivity Impact Key
Extreme
High
Moderate
Small
None
Loss
Life Stage Priority Ratings
Which life stages face the biggest bottlenecks?
How big is the impact?
Bed Scour Pattern
High Flow Pattern
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
EDT Habitat Composition Ratings
Backwater Pools
23%
Inactive Rearing 28.6%
Prespawn Holding 14.3%
Survival Factor Performance
What are the critical limiting factors?
How do they affect each life stage?
How much change over time?

Customized Scalable Results



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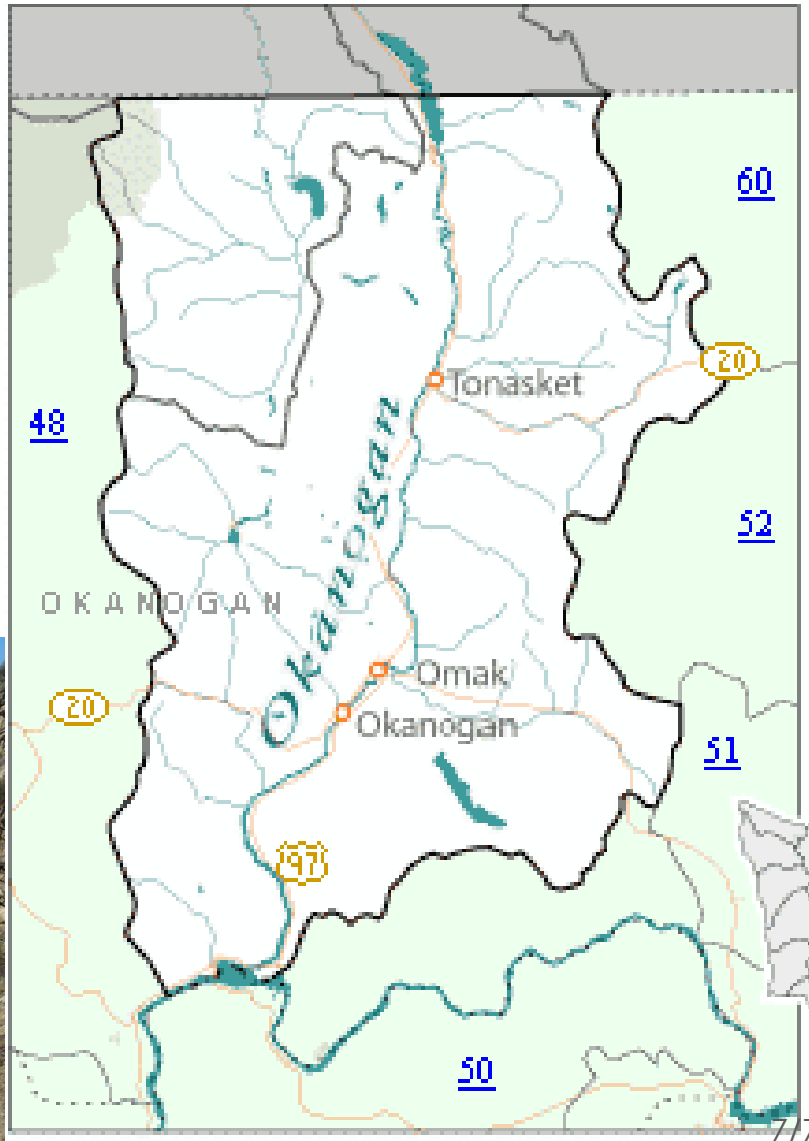
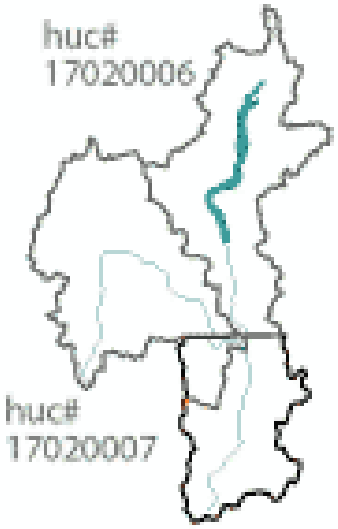
In Closing

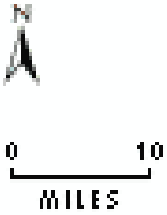
- EDT is a Life Cycle-Based Habitat Model
- Results
  - How much, how good, how many, diversity
  - Critical habitat limiting factors, diagnostic unit and reach
  - Life stage-level impacts
  - Habitat protection and restoration priorities
  - Change over time
  - Level of confidence
- EDT Makes Monitoring Data Useful!
- Next Steps → Extend OBMEP Approach Across Upper Columbia Recovery Domain

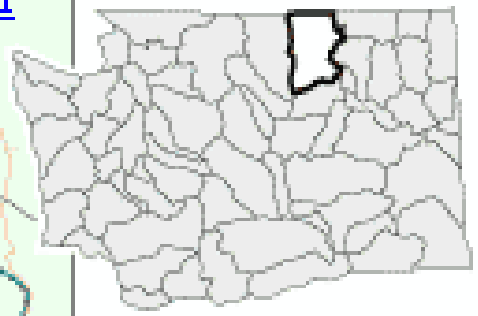
The Okanogan Basin Monitoring and Evaluation Program (OBMEP), Project #2003-022-00

The Okanogan River Basin







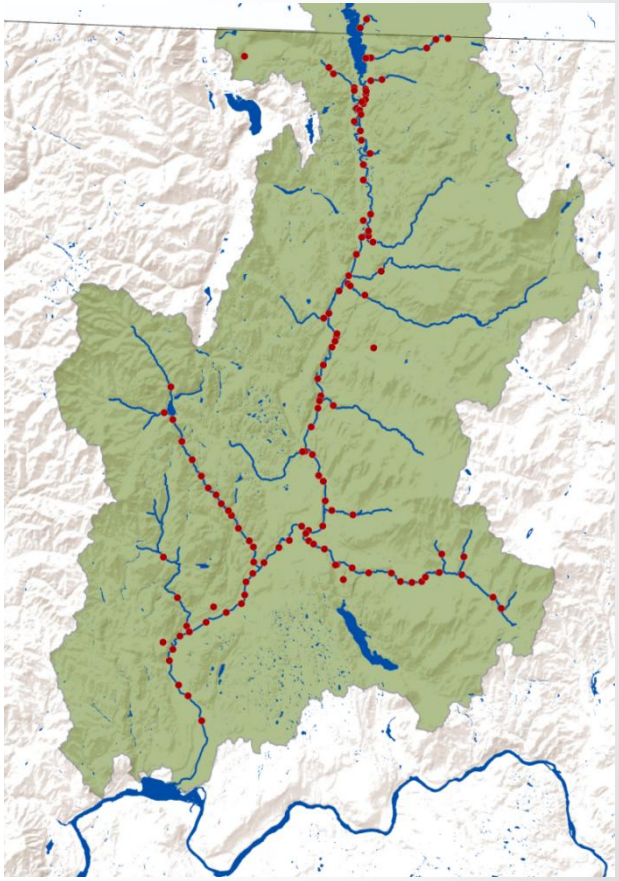


Before OBMEP We Were Driving Blind

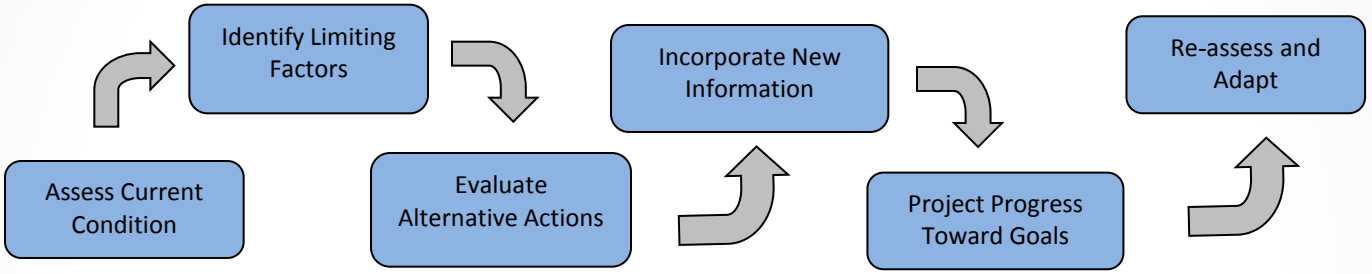
- Subbasin Planning → Expert understanding of Okanogan poor, little or no empirical data
- Knowledge about habitat potential and priorities limited
- The Okanogan Basin Monitoring and Evaluation program proposed to address critical information needs.

The early Years of OBMEP

- 2003, Proposed, reviewed and recommended(Proposal #29033) as part of the Columbia Cascade Provincial Review
- 2004-05: OBMEP funded, protocol development and implementation
  - Barrier surveys - Identify current and potential anadromous habitat
  - Steelhead abundance and distribution
- Designed and Implemented quantitative habitat surveys
  - Created new digitized diagnostic unit and reach layers
  - 150 fixed/rotating panel sites U.S. and Canada
  - 4-year monitoring cycle
- Habitat metrics selected to provide EDT model inputs



Relationship of EDT to Council Habitat Framework

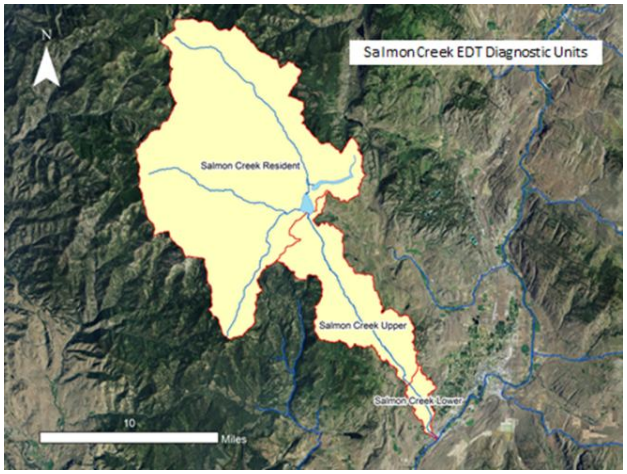


Current Conditions (e.g., habitat and fish status and trend)	Limiting Factors (e.g., elevated water temperature)	Actions Implemented (e.g., riparian improvements)	Impact of Actions over Time on Habitat Characteristics (e.g. improved watershed conditions)	Impact of Actions on FW Life Stage (e.g., increased productivity	Impacts of Actions on FW Life-Cycle (e.g., increased spawner abundance, populations)
					

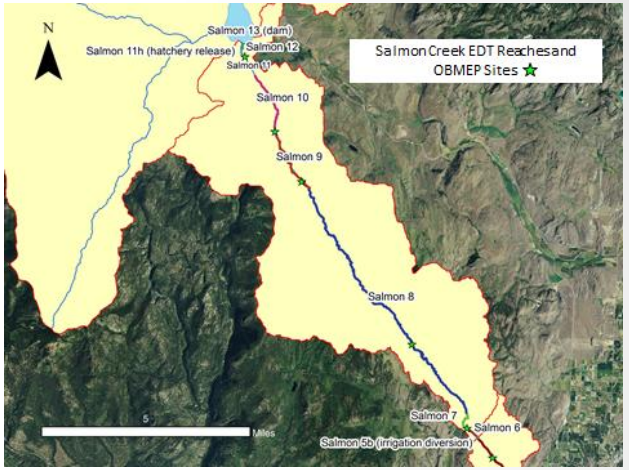
Nested Spatial Structure

Okanogan Basin

Diagnostic Unit



Reach



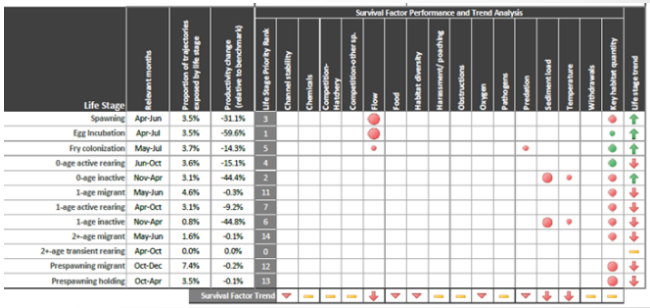
Highest Priority Habitats[1]

Theoretical Steelhead Population Abundance Would Change by This Much, If...

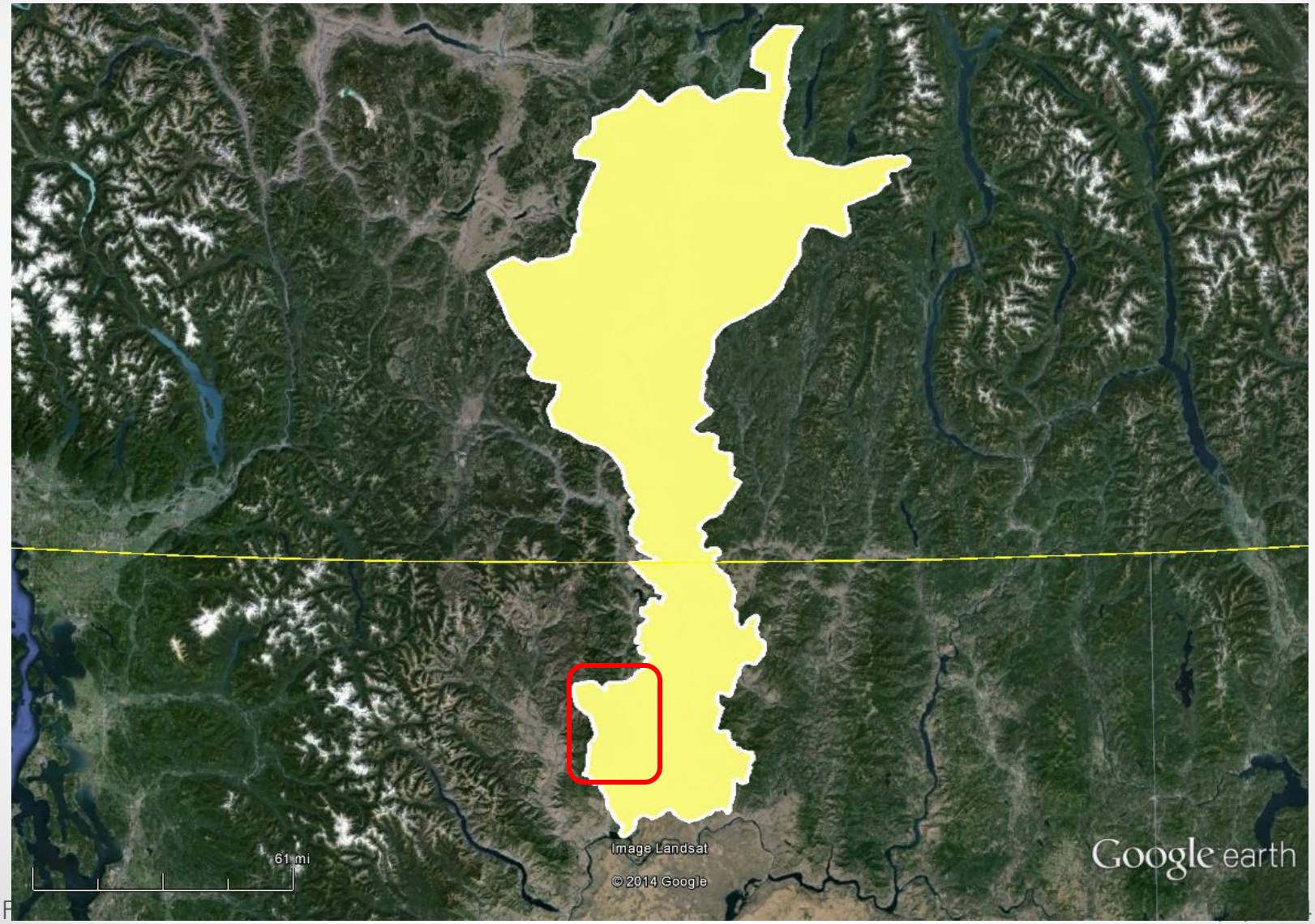
This Diagnostic Unit	Degrades	Is Restored
Okanogan River O2: Salmon to Om		
Okanogan River O3: Omak to River		
Okanogan River O4: Riverside to Ja		
Okanogan River O5: Janis to Siwas		
Okanogan River O6: Siwash to Con		
Okanogan River O7: Confluence to		
Okanogan River O1: Chilliwist to Sa		
Omak Creek Lower		
Salmon Creek Lower		
Salmon Creek Upper		
Similkameen River Lower		
Similkameen River Middle		
Similkameen River Upper		
Siwash Creek		

Habitat Priorities - Theoretical Population Abundance Will Change by This Much if

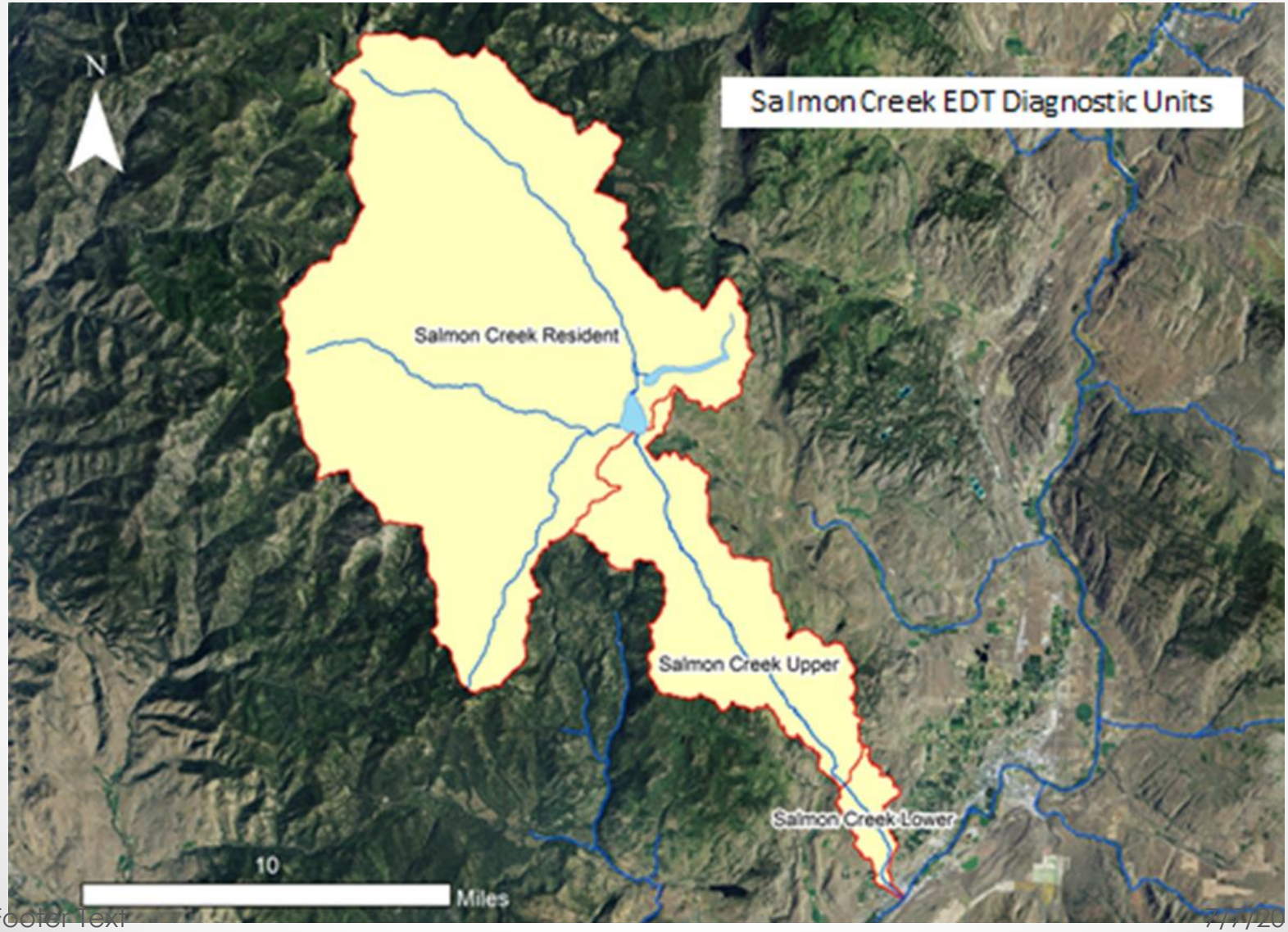
This Reach	Degrades	is Restored
Salmon 10		
Salmon 11		
Salmon 11h (hatchery release)		
Salmon 12		
Salmon 13 (dam)		
Salmon 6		
Salmon 7		
Salmon 8		
Salmon 9		



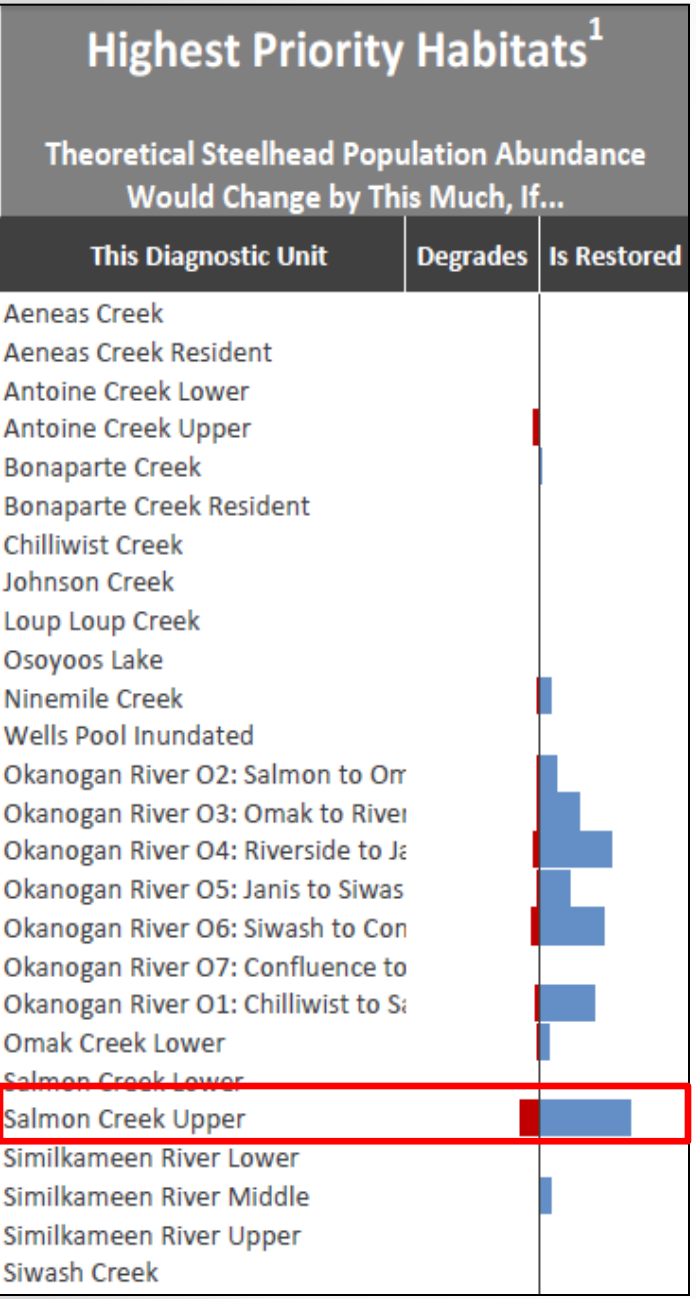
The Salmon Creek Story



Salmon Creek DU's

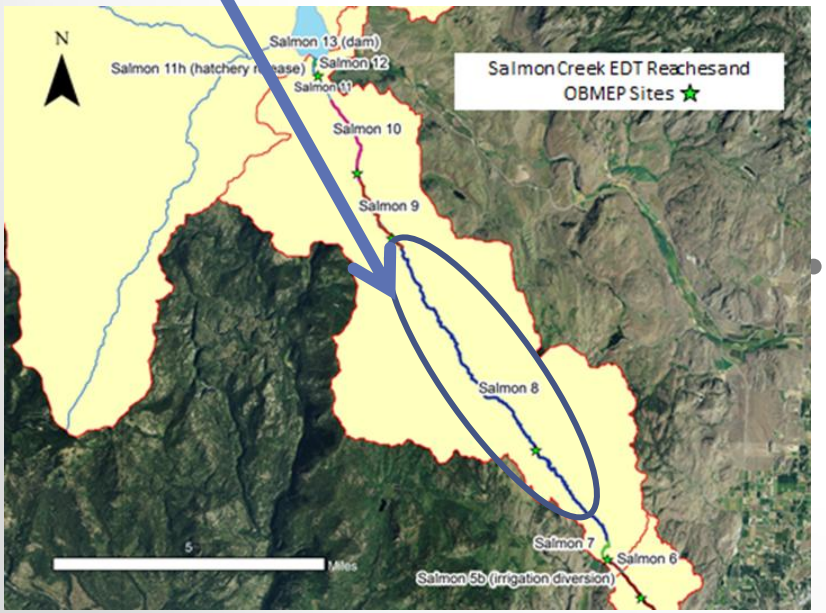


OBMEP/EDT: Salmon Creek Upper has greatest habitat potential in the entire Okanogan Basin



EDT Results Indicate:

Habitat Priorities - Theoretical Population Abundance Will Change by This Much if		
This Reach	Degrades	is Restored
Salmon 10		
Salmon 11		
Salmon 11h (hatchery release)		
Salmon 12		
Salmon 13 (dam)		
Salmon 6		
Salmon 7		
Salmon 8		
Salmon 9		

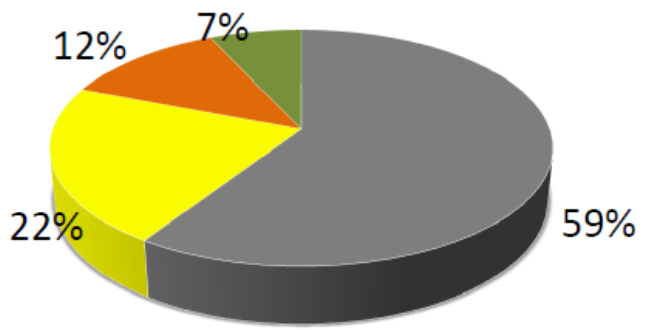


- Lots of available habitat
- Habitat quality is poor
- Critical limiting factor: Flow conditions
  - Seasonal connectivity to the Okanogan River limits upstream and downstream migration
  - Timing of spring water releases negatively impact spawning and incubation
  - Reduced winter base flows limit overwinter cover for juvenile steelhead
- Reach Salmon 8 has the greatest restoration potential

Predictions Match Reality

- Pre-2009, 100% of lower Salmon Creek streamflow stored/diverted
- Action → Colville Tribes secured long-term water lease
  - Restored seasonal access for adult and juvenile steelhead migration
  - Hatchery steelhead stocking initiated 2007
- EDT accurately predicts
  - Severity of flow impacts
  - Observed steelhead abundance under restored flow conditions
  - Need for additional flow improvements
- However:
  - Predicted abundance is below Colville Tribes recovery objectives
  - Observed wild steelhead abundance has been below expectations

Flow Conditions

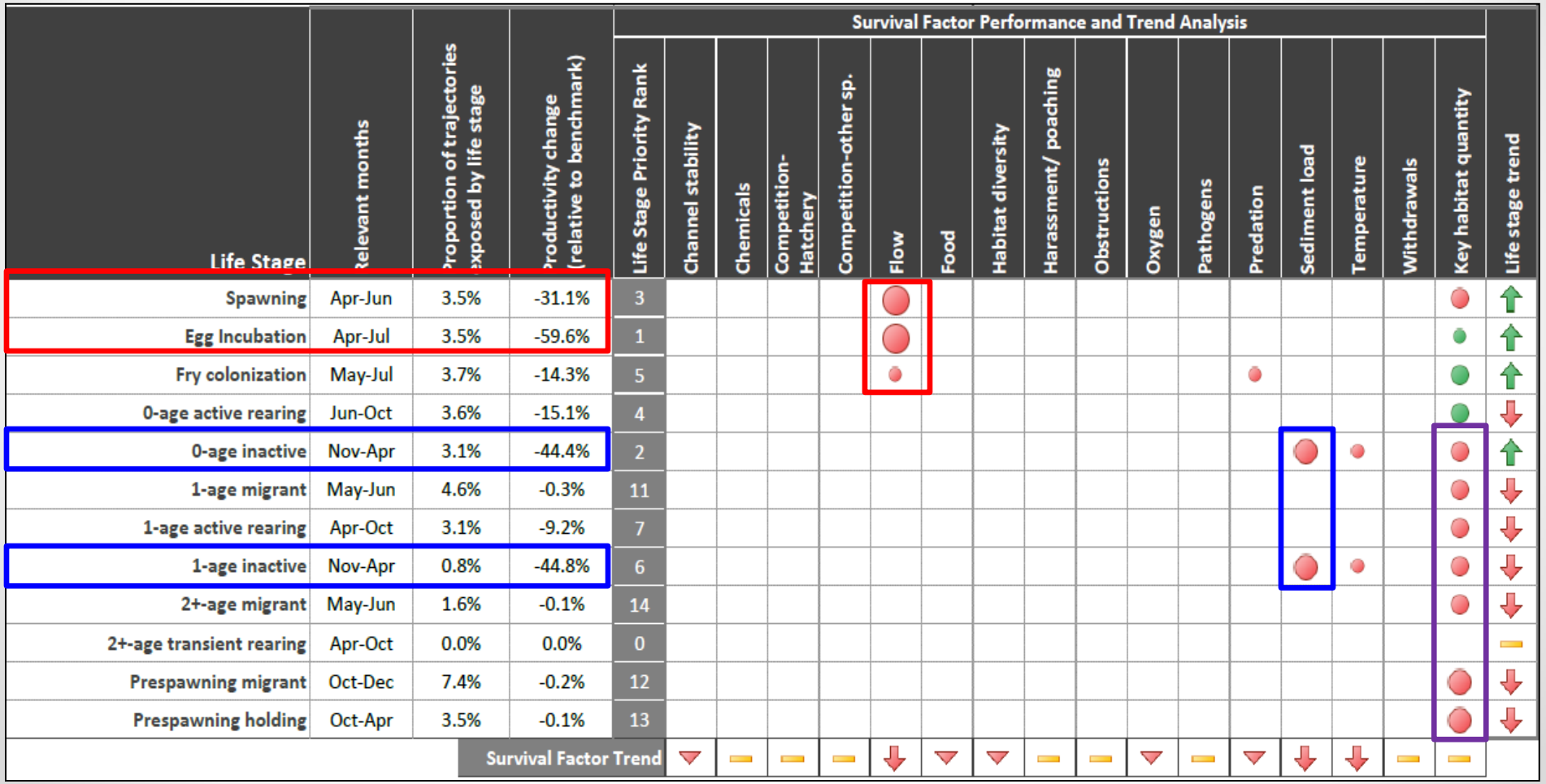


% of Template	50%
Factor Wt.	24%
Factor Trend	↓

Categorical Ranking	Productivity Impact
Not properly functioning	>10.1% reduction
Functioning at High Risk	5.1% to 10% reduction
Functioning at Risk	2.6% to 5% reduction
Properly Functioning	0% to 0% reduction

Salmon Creek Reach 8

Habitat Priorities in Salmon 8



Life Stage	Relevant months	Proportion of trajectories exposed by life stage	Productivity change (relative to benchmark)	Survival Factor Performance and Trend Analysis																	Life stage trend
				Life Stage Priority Rank	Channel stability	Chemicals	Competition-Hatchery	Competition-other sp.	Flow	Food	Habitat diversity	Harassment/ poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity	
Spawning	Apr-Jun	3.5%	-31.1%	3					●											●	↑
Egg Incubation	Apr-Jul	3.5%	-59.6%	1					●											●	↑
Fry colonization	May-Jul	3.7%	-14.3%	5					●							●				●	↑
0-age active rearing	Jun-Oct	3.6%	-15.1%	4																●	↓
0-age inactive	Nov-Apr	3.1%	-44.4%	2													●	●		●	↑
1-age migrant	May-Jun	4.6%	-0.3%	11																●	↓
1-age active rearing	Apr-Oct	3.1%	-9.2%	7																●	↓
1-age inactive	Nov-Apr	0.8%	-44.8%	6													●	●		●	↓
2+-age migrant	May-Jun	1.6%	-0.1%	14																●	↓
2+-age transient rearing	Apr-Oct	0.0%	0.0%	0																	—
Prespawning migrant	Oct-Dec	7.4%	-0.2%	12																●	↓
Prespawning holding	Oct-Apr	3.5%	-0.1%	13																●	↓
			Survival Factor Trend		▼	—	—	—	↓	▼	▼	—	—	▼	—	▼	↓	↓	—	—	

Actions Needed to Achieve Tribal Recovery Goals

- Objectives for Salmon Creek
  - NMFS ESA recovery: 100 wild steelhead
  - Colville Tribes recovery: 200 wild steelhead
  - OBMEP/EDT: Watershed can support 113 wild steelhead under 2009 conditions
  - Habitat potential is good but more work is needed to realize this potential
- OBMEP population monitoring
  - Total steelhead returns sufficient to fully seed available habitat
  - Wild returns below expectations
  - Negative impacts from hatchery/wild fish interactions?
- Planned Actions:
  - Improve stream discharge and snow pack monitoring
  - Design new reservoir refill curve, improve flow management
  - Relocate withdrawals, provide instream flows in lower watershed
  - Increase winter base flow
  - Reduce number of hatchery fish on spawning grounds

Conclusions

- EDT integration:
  - Makes OBMEP data useful for decision making
  - Makes habitat status and trends understandable and meaningful
  - Allows the Colville Tribes to meet our regional reporting requirements
- EDT can be compatible with other regional monitoring efforts (CHaMP, ISEMP & AMIP)
  - Use EDT to integrate monitoring data, adding value and utility
  - Use monitoring research to validate and improve EDT rules
- Expanding OBMEP/EDT approach to Upper Columbia Recovery Domain a logical next step
- An opportunity for mutually beneficial collaboration!

Questions and Discussion

Important OBMEP references:

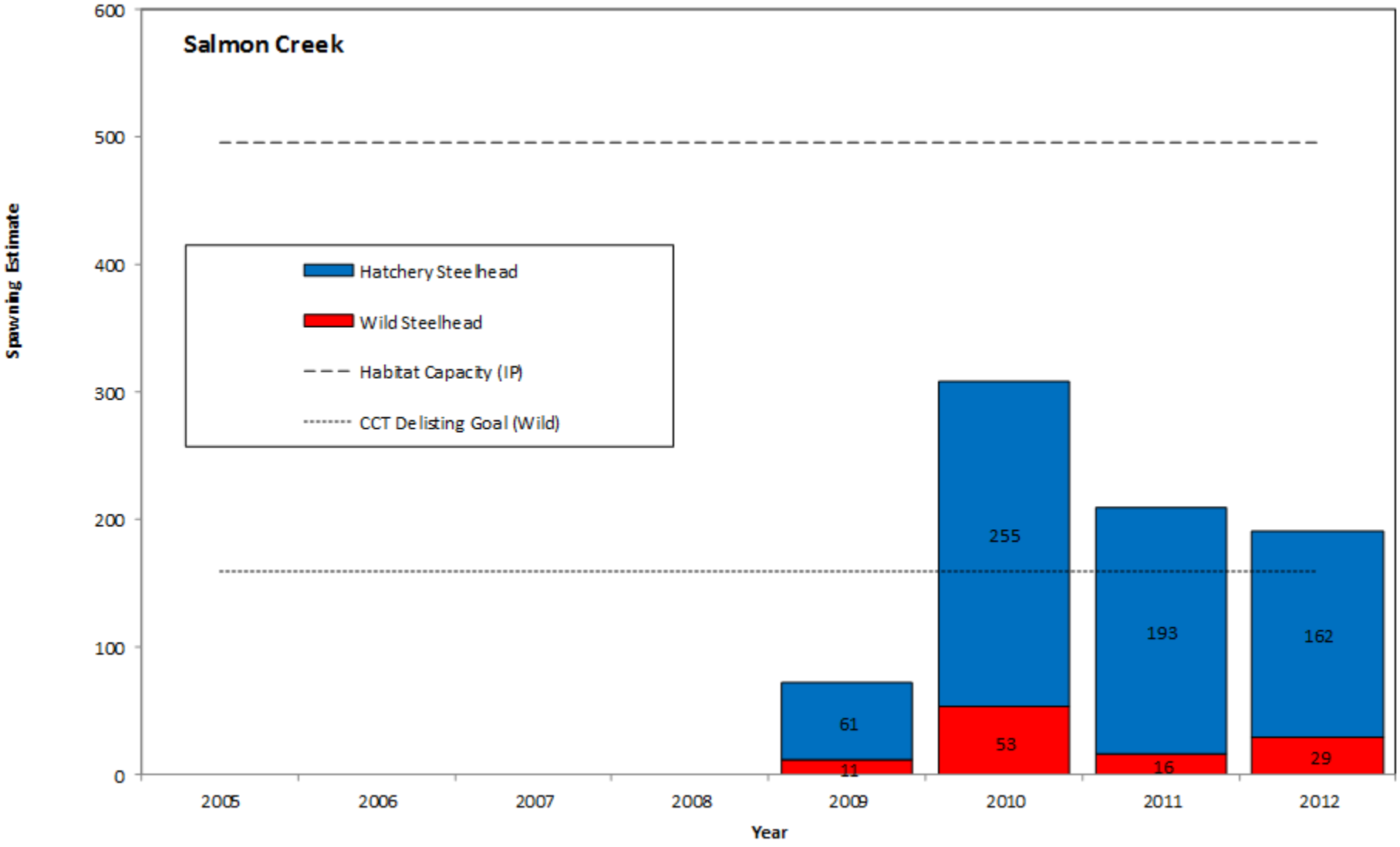
Can be found by googling:

"cctobmep"

Copies of the 2009 OBMEP/EDT Habitat Status and Trend report for both Summer/Fall Chinook and Summer Steelhead

Can be downloaded from our publication page.

Salmon Creek Adult Returns



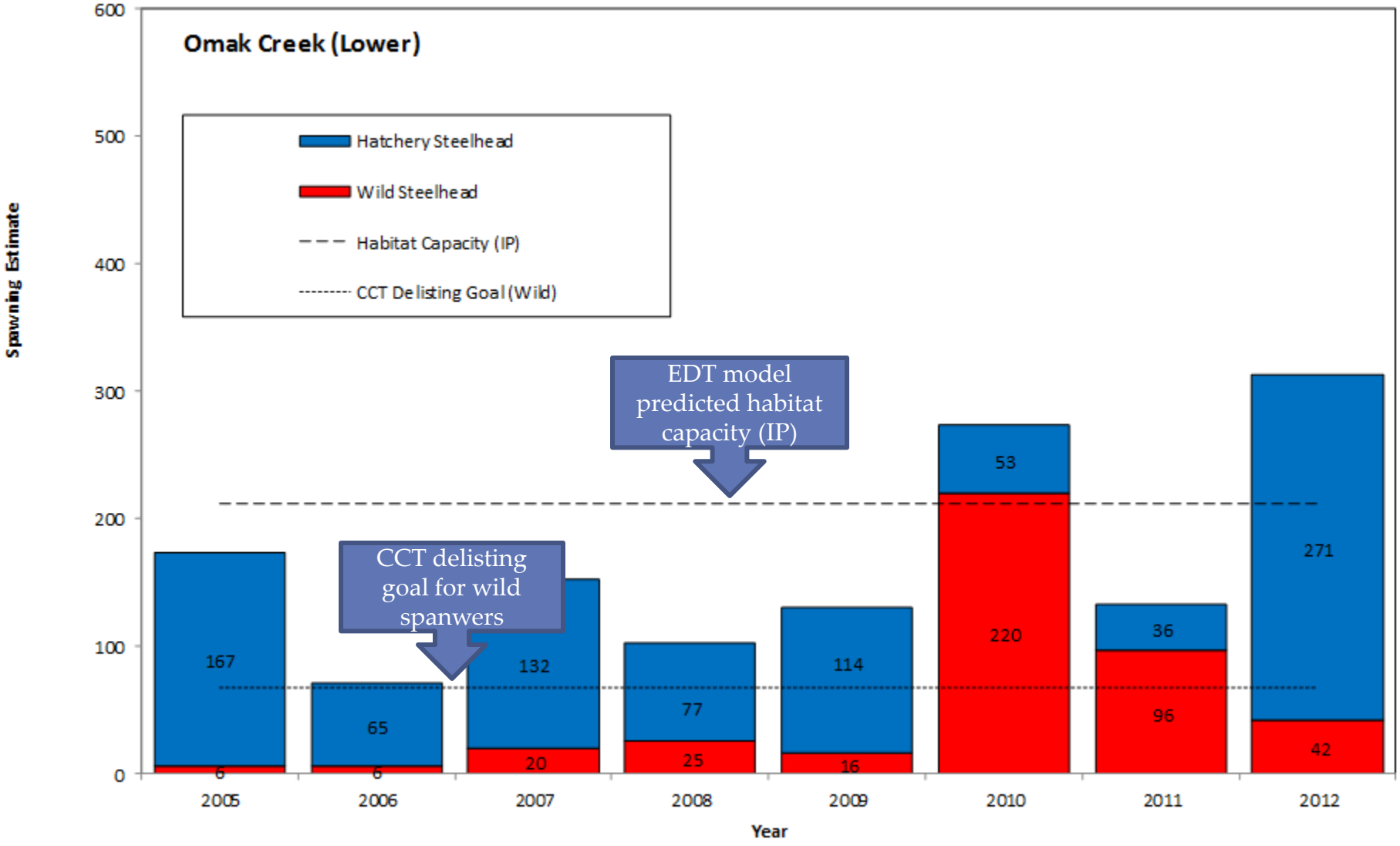
OBMEP Begins

- United States habitat data collection began in 2004 only at a subset of annual panels to test protocols.
  - Designed to mirror Wenatchee ISEMP
  - Followed the Upper Columbia Monitoring Strategy
- Full Fish and Habitat Monitoring begins in 2005.
  - Protocols in place and cross border coordination and training begins
- Completed barrier assessment and defined anadromous barriers
  - Documents still in use today but are in need of updating.
- 2007, First iteration of OBMEP Database is completed to archive data.
- Rolled into the MOA in 2008 to stabilize funding for 13 full time tribal employees (6 Biologists and 7 Technician).
- First complete rotation through all GRST design panel sites 2009.
- Adult enumeration data are used widely by NOAA, WDFW, Colville Tribes and others.
- OBMEP web page considered the "goto" resource for information on the Okanogan River.
  - **cctobmep.com**

Diagnostic Units (DU) / Spawning Areas	Length (m)	Bank full area (m^2)	Weighted Intrinsic Potential (IP) Area (m^2)	Proportion of IP in each DU within the U.S.	Steelhead spawner capacity from IP	Proportional contribution to minimum recovery threshold (IP% * 500)	EDT Capacity	Number of spawners with 4 redds/km	CCT adult steelhead spawner escapement objectives	Number of redds/km for CCT objective
Salmon Creek	26,090	311,434	247,580	23.5%	495	117	301	209	200	3.8
Similkameen River	14,206	724,470	171,281	16.2%	343	81	487	114	100	3.5
Omak Creek (Lower)	9,002	112,008	106,198	10.1%	212	50	94	72	100	5.6
Antoine Creek	18,997	154,099	105,534	10.0%	211	50	70	152	100	2.6
Johnson Creek	16,160	112,304	45,498	4.3%	91	22	TBD	129	100	3.1
Ninemile Creek	8,402	59,235	39,496	3.7%	79	19	85	67	50	3.0
Loup Loup Creek	3,401	27,686	23,229	2.2%	46	11	26	27	50	7.4
Okanogan River	125,595	8,170,205	19,550	1.9%	39	9	2,684	N/A	40	N/A
Bonaparte Creek	1,600	19,359	19,359	1.8%	39	9	15	13	30	9.4
Omak Creek (Upper)*	34,812	267,960	234,738	22.2%	469	111	225	278	200	2.9
Tonasket Creek	3,401	27,545	18,226	1.7%	36	9	25	27	10	1.5
Tunk Creek	1,200	9,963	6,643	0.6%	13	3	9	10	10	4.2
Wild Horse Spring	1,200	8,280	5,520	0.5%	11	3	5	10	10	4.2
Siwash Creek	2,801	20,724	4,946	0.5%	10	2	5	22	10	1.8
Aeneas Creek	1,000	6,902	4,601	0.4%	9	2	16	8	10	5.0
Wannacut Creek	1,801	9,722	2,320	0.2%	5	1	6	14	5	1.4
Chilliwist Creek	600	4,140	998	0.1%	2	0	2	5	0	0.0
Total or Average	270,268	10,046,036	1,055,717	100%	2,111	500	4055	1,157	1,025	3.7

Flow diagram of hatchery management actions to be implemented in tributaries of the Okanogan River based on the pHOS and adult escapement status over a 3-5 year period.

Hatchery Management Results



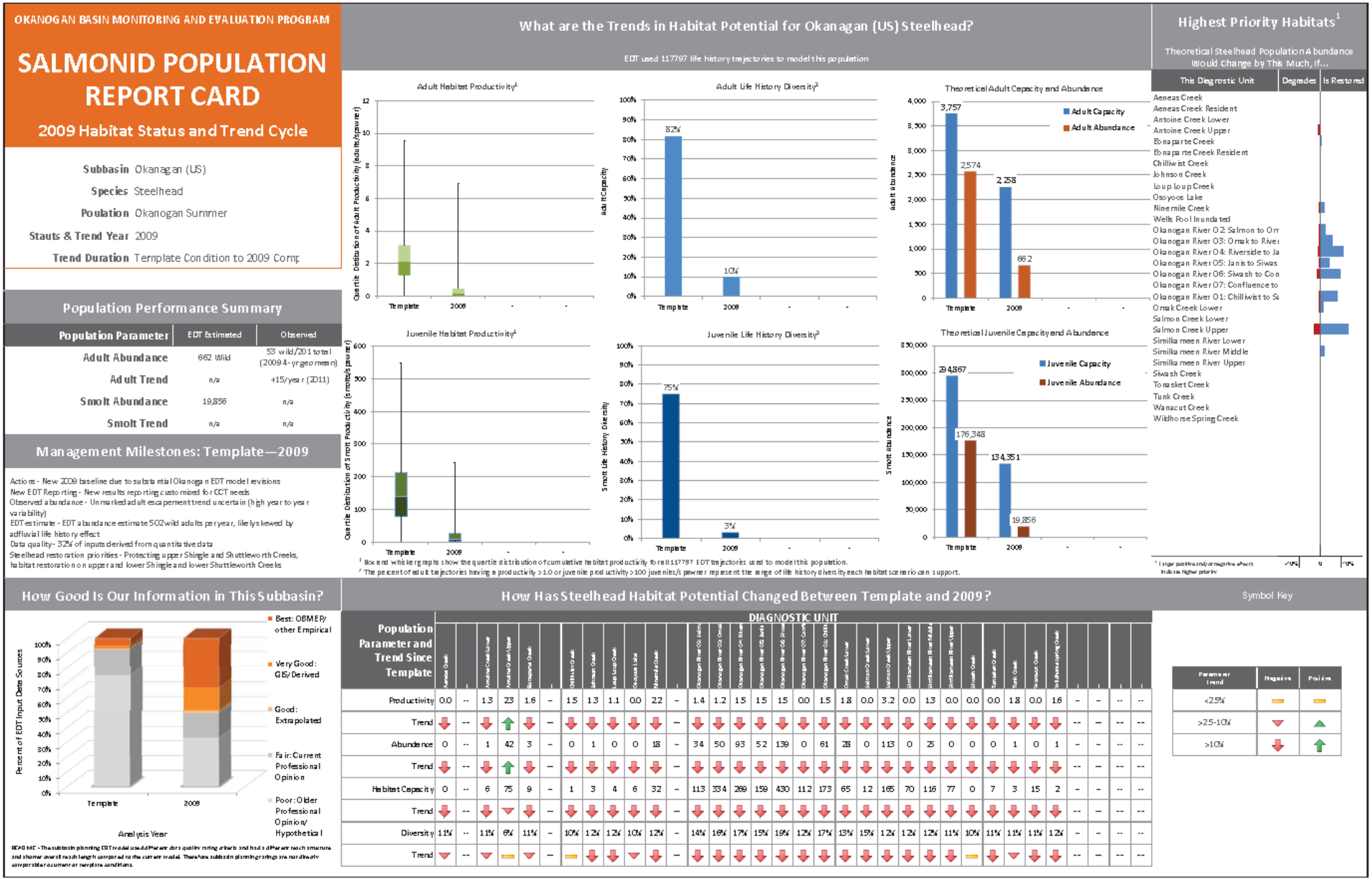


Figure 4. OBMEP/EDT Population Report: Okanogan River Summer Steelhead, U.S. Subpopulation

OKANOGAN BASIN MONITORING AND EVALUATION PROGRAM

REACH REPORT CARD

Subbasin	Okanogan
Diag. Unit	Salmon Creek Upper
Species	Steelhead
Population	Okanogan (U.S.)

Reach	Salmon 8
Reach Length (mi)	7.85
Average Gradient	1.1%
Habitat Area (ac)	25.4

OBMEP Sites

OBMEP-036

Reach Restoration Priority

Effect of Restoration on		Reach Priority	2
Productivity	+ 63%	Out of	186
Diversity	+ 18%	Diagnostic Unit Priority	5
Abundance	+ 43%	Out of	30

Current Habitat Potential

Capacity	80
Productivity	0.0
Diversity	12%
Abundance	0

Reach Preservation Priority

Effect of Degradation on		Reach Priority	21
Productivity	- 1%	Out of	186
Diversity	- 1%	Diagnostic Unit Priority	2
Abundance	- 5%	Out of	30

Survival Factor Performance and Trend Analysis

Life Stage	Relevant months	Proportion of trajectories exposed by life stage	Productivity change (relative to benchmark)	Life Stage Priority Rank	Channel stability	Chemicals	Competition-Hatchery	Competition-other sp.	Flow	Food	Habitat diversity	Harassment/ poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity	Life stage trend
Spawning	Apr-Jun	3.5%	-31.1%	3					●											●	↑
Egg Incubation	Apr-Jul	3.5%	-59.6%	1					●											●	↑
Fry colonization	May-Jul	3.7%	-14.3%	5					●							●				●	↑
0-age active rearing	Jun-Oct	3.6%	-15.1%	4																●	↓
0-age inactive	Nov-Apr	3.1%	-44.4%	2													●	●		●	↑
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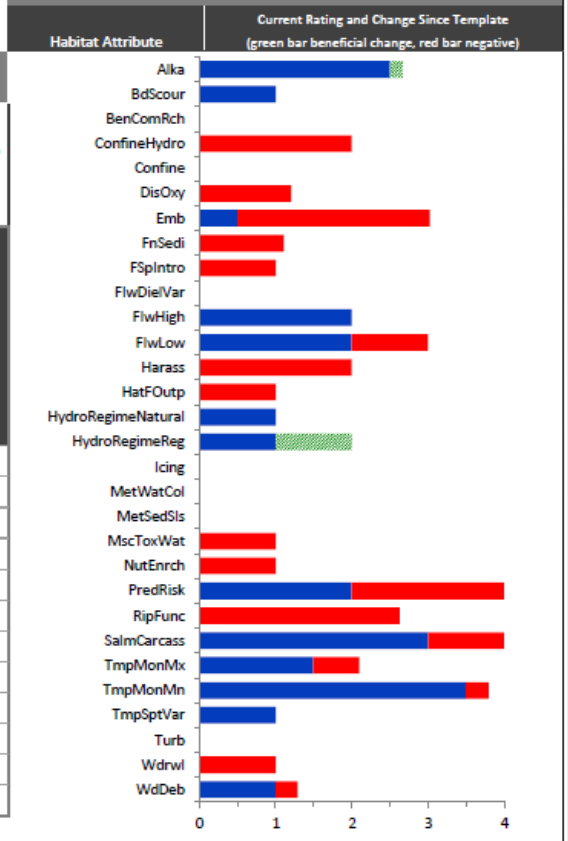
2+-age migrant	May-Jun	1.6%	-0.1%	14																●	↓
2+-age transient rearing	Apr-Oct	0.0%	0.0%	0																	▬
Prespawning migrant	Oct-Dec	7.4%	-0.2%	12																●	↓
Prespawning holding	Oct-Apr	3.5%	-0.1%	13																●	↓
Survival Factor Trend					▼	▬	▬	▬	↓	▼	▼	▬	▬	▼	▬	▼	↓	↓	▬	▬	

EDT Level 2 Attribute Ratings



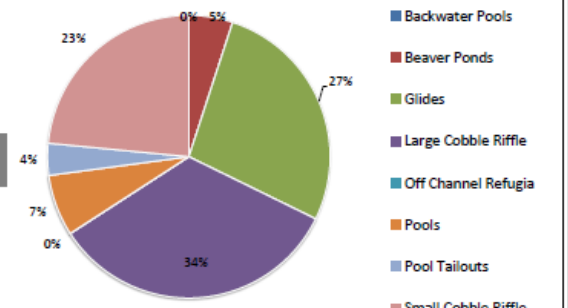
Habitat Productivity Impact Key

Impact	Extreme	High	Moderate	Small	None
Loss	●	●	●	●	-
Gain	●	●	●	●	-

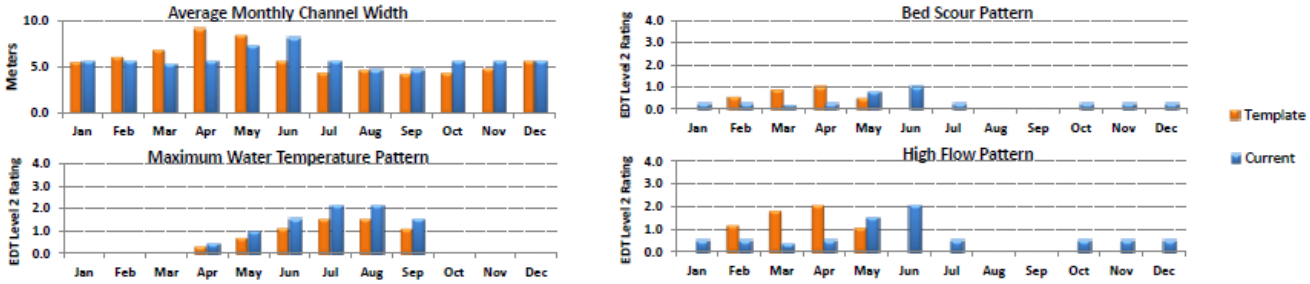
Trend Key

Trend	Neg.	Pos.
<2.5%	▬	▬
>2.5-10%	▼	▲
>10%	↓	↑

EDT Habitat Composition Ratings



Temporal Patterns for Selected EDT Level 2 Attributes



Lifestage	Key Habitat Area[1]	Trend
Spawning	11.6%	↑
Fry Colonization	17.0%	▬
Active Rearing	28.6%	▬
Inactive Rearing	28.6%	▬
Prespawn Holding	14.3%	↓

[1] Percent of reach providing key habitat function for this life stage in EDT

Diagnostic Unit Report Card

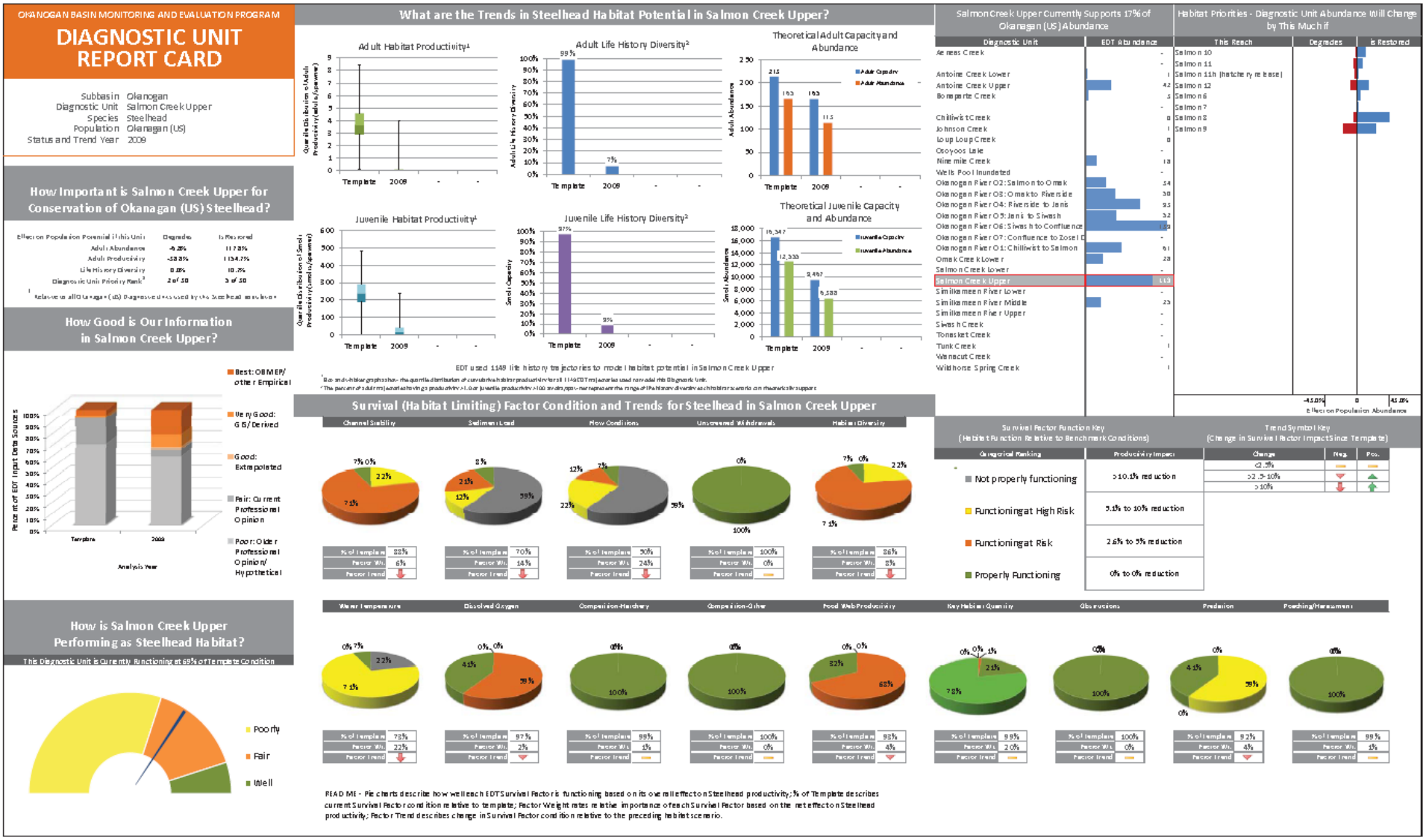


Figure 23. OBMEP/EDT Diagnostic Unit Report: Salmon Creek Upper

How to Report Habitat Data?

- Mean, median, mode are traditional ways to report on habitat but this is hard to use for fish management or recovery.
- 2010, Began working on the idea of using a multivariate model to relate habitat to fish.
- 2011, ICFI and Colville Tribes attempt to use 2004 subbasin planning baseline as template and 2009 OBMEP data as patient but run into problems and identify a need to construct a new reach layer.
  - Preliminary results suggest that changes in habitat sites over time can be detected.
- 2012 New Okanogan River Basin Reach layer completed (10-12 digit HUC, DU and approximately 20 digit HUC, reach scales).
  - Rapidly adopted by the UCSRB, UCRTT, and Expert Panel Process
  - Openly shared on our web page (goggle: **cctobmep**)

Linkage to the Expert Panel Process

- The DU report card limiting factors indicators:
  - Are comparable to information used as inputs for the expert panels based upon best available data.
  - Rely on best available data rather than expert opinion.
  - Represent the same spatial units as the expert panel
  - Are rated for information quality
  - Are weighted for ecological impact
  - Provide the % of template function
  - Provide the % of habitat function
- In 2013 the percent change from 2009 will provide the percent change between reporting intervals.

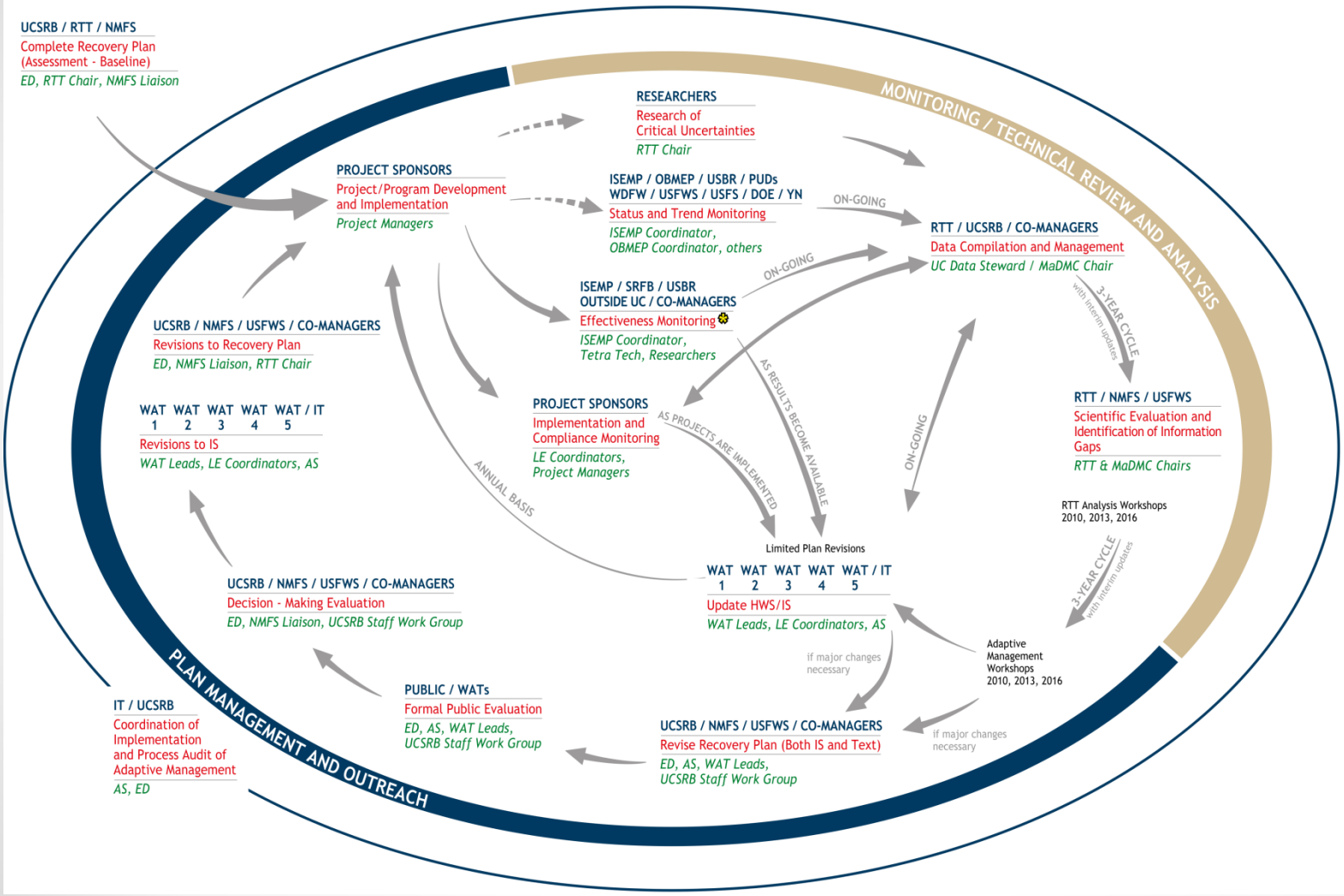

WHAT IF JON SNOW
REALLY KNOWS SOMETHING?

Nested Spatial Structure

- Population: Okanogan Subbasin scale
  - Okanogan steelhead divided into 2 sub-populations
- Diagnostic Unit: Primary management scale
  - Tributaries and mainstem channel segments
  - 30 US and 34 Canada
  - US: 10 mainstem and 20 tributary diagnostic units
- Reach: Finest measurement scale
  - 435 reaches total (186 US, 249 Canada)
  - OBMEP monitoring occurs at reach scale
  - Most habitat actions implemented at this scale
- OBMEP/EDT model built around this spatial structure

HABITAT ADAPTIVE MANAGEMENT FRAMEWORK

- FOR UPPER COLUMBIA SALMON RECOVERY -



LEGEND

- Responsible Entities
- Activity
- Facilitator/Coordinator
- From outside UC as well

The WATs of the Upper Columbia:

Wenatchee Subbasin
Wenatchee Habitat Subcommittee of the Wenatchee Watershed Planning Unit (WWPU)

Entiat Subbasin
Entiat Habitat Subcommittee of the Entiat Watershed Planning Unit (EWPU)

Methow Subbasin
Methow Restoration Council (MRC)

Okanogan Subbasin
Similkameen Okanogan Watershed Action Team (SOWAT)

Douglas County Watersheds
Douglas County Watershed Planning Unit (DCWPU)

Acronyms

AS	Associate Director
DOE	Department of Ecology
ED	Executive Director
HWS	Habitat Work Schedule
IS	Implementation Schedule
ISEMP	Integrated Status and Effectiveness Monitoring Program
IT	Implementation Team
LE	Lead Entity
MaDMC	Monitoring and Data Management Committee
NMFS	National Marine Fisheries Service
OBMEP	Okanogan Basin Monitoring and Evaluation Program
PUD	Public Utility District
RTT	Regional Technical Team
SRFB	Salmon Recovery Funding Board
TRT	Technical Review Team
UCSRB	Upper Columbia Salmon Recovery Board
USBR	United States Bureau of Reclamation
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WAT	Watershed Action Team
WDFW	Washington Department of Fish and Wildlife
YN	Yakama Nation

Costs

- Full OBMEP including both transect based and Rapid Assessment based data collection plus data analysis and reporting for a 4 year cycle.
  - Total Costs $764,000
  - Annual cost $191,000/year
- Rapid Assessment only data collection plus data analysis and reporting for a 4 year cycle.
  - Estimated total cost per subbasin <$500,000
  - Estimated annual cost per subbasin <$125,000/year
- Keep in mind that the Okanogan Subbasin including Canada is one of the largest subbasins in the entire Columbia River basin and smaller subbasins should cost less due to fewer reaches needing data.
- All Cost in 2014 dollars.