Anadromous Reintroduction Potential for the Sanpoil River and Select Upper Columbia Tributaries on the Colville Reservation using the Ecosystem Diagnosis and Treatment model

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Acronyms and Abbreviations

BOA	Bonneville Dam, adult fish ladder
BON	Bonneville Dam
CCT	Colville Confederated Tribes
EDT	Ecosystem Diagnosis and Treatment Model
EDT3	The current (third generation) version of the EDT Model
FCRPS	Federal Columbia River Power System (now the Columbia River System Operations)
HUC 10	USGS 10th field hydrologic unit (watershed
HUC 12	USGS 12th field hydrologic unit (subwatershed)
km	Kilometer
LCM	EDT life cycle model (represents an individual age class and behavioral form)
MCN	McNary Dam
NMFS	National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council
PRD	Priest Rapids Dam
RIS TLRC	Rock Island Dam tailrace
RIS	Rock Island Dam
RRE TLRC	Rocky Reach Dam tailrace
RRE	Rocky Reach Dam
SAR	Smolt-to-adult return rate
UCUT	Upper Columbia United Tribes
USGS	United States Geological Survey
WLS RES	Wells Reservoir pool
WLS	Wells Dam

Executive Summary

The Colville Confederated Tribes (CCT) have developed an assessment of habitat potential for reintroduction of summer steelhead, summer/fall Chinook salmon and spring Chinook salmon in the Sanpoil River subbasin and four select tributary watersheds to Lake Roosevelt in the Upper Columbia Subbasin, referred to hereafter as the select tributaries. This analysis is consistent with Phase I of the Upper Columbia United Tribes anadromous reintroduction plan (UCUT 2015) and Northwest Power and Conservation Council research objectives (NPCC 2014), and the results presented herein are intended to support the ongoing development of these anadromous reintroduction initiatives.

This assessment was conducted using existing Sanpoil and Upper Columbia Ecosystem Diagnosis and Treatment (EDT) models previously built for the CCT by ICF to support resident fish conservation efforts. The adaptation of these existing EDT models required the development of hypothetical populations of steelhead, summer/fall Chinook and spring Chinook. ICF and the CCT hosted a life history model workshop with regional fisheries experts to define probable age composition, and life stage timing, distribution and behavioral characteristics based on knowledge of remaining extant populations in the Upper Columbia region. The information gained from this workshop was used to parameterize EDT model populations used in the Phase I reintroduction analysis.

ICF relied on the consensus opinion of workshop attendees and National Marine Fisheries Service intrinsic potential model criteria to define the extent of probable habitat for steelhead, spring Chinook salmon and summer/fall Chinook salmon in each subbasin. A summary of total habitat length and area in each subbasin by species is provided in Table E-1.

ICF applied three different sets of assumptions about Grand Coulee Dam and Chief Joseph Dam passage survival to evaluate reintroduction potential. These scenarios use the following passage survival rates for juvenile migrants moving downstream and adult migrants moving upstream:

- Biological opinion (BiOp) survival: 95% juvenile downstream, 98% adult upstream survival at each dam
- Moderate survival: 90% juvenile downstream, 97% adult upstream survival at each dam
- Low survival: 85% juvenile downstream, 95% adult upstream survival at each dam

These passage survival scenarios apply only to Grand Coulee Dam and Chief Joseph Dam. The BiOP survival assumption is consistent with Federal Columbia River Power System biological opinion survival standards for other federally-operated dams on the Columbia River mainstem. The moderate and low survival assumptions are provided to evaluate habitat potential at survival rates below BiOP standards. ICF calibrated juvenile and adult migrant survival in the remainder of the Columbia River migration corridor and Pacific Ocean to match recent observations for extant species, emphasizing data collected after 2008 when significant changes in federal hydropower system operations and other system improvements were implemented to increase juvenile migrant survival.

A summary of EDT-estimated habitat potential for summer steelhead and spring Chinook in the Sanpoil River and Select Tributaries and summer/Fall Chinook in the Sanpoil River is presented in Tables E-2, E-3 andE-4. The take home messages from these results are as follows:

- There is substantial potential for summer steelhead reintroduction in Colville Reservation watersheds:
    - CCT Reservation watersheds could support a population of approximately 1000 adult steelhead with a productivity over 2 returns per spawner under current subbasin habitat conditions and the high Chief Joseph and Grand Coulee dams passage survival scenario, assuming that all manmade passage barriers within potential anadromous habitat are addressed
    - Steelhead abundance could theoretically double with extensive habitat restoration
    - Steelhead life stage survival metrics are consistent with observed survival rates in other functional watersheds in the Columbia Basin

      Egg-to-parr survival[1] in the Sanpoil ranges from 3.4% to 7.8% under current conditions across all subpopulations and life history strategies.
- There is substantial potential for summer/fall Chinook reintroduction in the Sanpoil subbasin:
    - The Sanpoil River could potentially support an equilibrium abundance of nearly 1600 adult summer/fall Chinook with a productivity of 3.6 under current conditions, using the high Chief Joseph and Grand Coulee dams passage survival scenario
    - Even under the most conservative (lowest) hydrosystem passage survival assumption, the model predicted an equilibrium abundance of over 1000 adult spawners with a productivity of 2.9 under current conditions.
    - Summer/fall Chinook habitat potential would likely benefit from restoration of thermal refugia and holding habitat in the Sanpoil mainstem
    - Under current conditions 0-age migrant egg-to-parr survival is 6.0% for 0-age migrants and 0.7% to 1.0% for stream and reservoir-type 1-age migrants, respectively
- Spring Chinook habitat potential is relatively modest under both the template and current conditions scenarios, specifically:
    - Reservation watersheds could support an equilibrium abundance of approximately 500 adult spring Chinook with a productivity over 2.7 under template conditions and the high Chief Joseph and Grand Coulee dams passage survival scenario
    - Abundance potential under current conditions is approximately 330, a decrease of 36% relative to the template scenario
    - The Sanpoil watershed contains the majority of potential spring Chinook habitat, compared to the Select Tributaries
    - EDT-estimated spring Chinook egg-to-parr survival in the Sanpoil ranges from 8.3% to 14.4% under current conditions across all subpopulations and life history strategies.
    - EDT Performance Report and life stage integration results for spring Chinook reflect broader themes observed elsewhere in the Upper Columbia region, suggesting that the Phase I assessment results provide a reasonable interpretation of habitat potential and Spring Chinook performance.

[1] Egg-to-parr survival in this study means survival from the beginning of incubation through the end of the first summer of active rearing.

Table E-1. Summary of potentially suitable anadromous habitat extent by stream environment type in the Sanpoil River and select tributaries in the Upper Columbia subbasin.

Species	Subbasin/ Watershed	Environment Type	Habitat Length (kilometers/miles)	Habitat Area (hectares/acres)
Steelhead	**Sanpoil River**	Small tributary	449.9/279.6	163.2/403.3
		Headwater	176.1/109.4	96.5/238.5
		Low Stream Order	130.1/80.8	120.3/297.2
		Mid-stream Order	61.5/38.2	91.1/225.0
		Total	*817.6/508*	*471.1/1164*
	Select Tributaries	Small tributary	25/15.5	11/27.2
		Headwater	98/60.9	32.4/80
		Low Stream Order	70.6/43.9	73.9/182.7
		Mid-stream Order	10.5/6.5	13.7/33.9
		Total	*204/126.8*	*131/323.8*
	All Habitat	**Grand Total**	**1021.6/634.8**	**602.1/1487.8**
Spring Chinook	**Sanpoil River**	Small tributary	211.6/131.5	84.3/208.3
		Headwater	114/70.9	58.7/145
		Low Stream Order	109.5/68	103.5/255.7
		Mid-stream Order	61.5/38.2	91.1/225
		Total	*496.6/308.6*	*337.5/834.1*
	Select Tributaries	Small tributary	16.7/10.4	7.9/19.6
		Headwater	35.8/22.2	14.6/36
		Low Stream Order	67.4/41.9	73.5/181.7
		Mid-stream Order	10.5/6.5	13.7/33.9
		Total	*130.4/81*	*109.7/271.2*
	All Habitat	**Grand Total**	**627/389.6**	**447.2/1105.3**
Summer/fall Chinook	**Sanpoil River**	Low Stream Order	34.4/21.4	34.4/85
		Mid-stream Order	61.5/38.2	91.1/225
		Grand Total	**95.9/59.6**	**125.5/310**

Environment type descriptions:

Small tributary: Lower elevation tributary streams, Shreve Order 1 to 2

Headwater: High-elevation headwater tributaries, Shreve Order 1 to 4

Low stream order: Tributary and mainstem reaches, Shreve Order 5 to 50

Mid-stream order: Tributary and mainstem reaches, Shreve Order >50

Note: Habitat area summary does not include potential reservoir rearing habitats. Reservoir rearing habitat area used in EDT focused on inundated arms of spawning tributaries. While this habitat assumption does not place a capacity limitation on rearing potential, it is not representative the full extent of potential reservoir rearing habitat in Lake Roosevelt.

Table E-2. Theoretical Sanpoil River and Select Tributaries summer steelhead population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	Subbasin Population	EDT Performance Metric by Watershed Habitat Scenario							
		Diversity		Productivity		Capacity		Equilibrium Abundance	
		Template	Current	Template	Current	Template	Current	Template	Current
BiOp	Sanpoil	81.5%	29.1%	3.7	2.2	2480	1719	1807	947
	Select Tributaries	49.7%	15.2%	2.6	2.0	312	240	193	119
Moderate	Sanpoil	79.3%	24.0%	3.4	2.1	2185	1513	1583	783
	Select Tributaries	43.5%	11.8%	2.4	1.9	275	212	162	99
Low	Sanpoil	75.2%	18.5%	3.1	1.9	1873	1296	1261	622
	Select Tributaries	36.2%	7.7%	2.2	1.8	235	181	129	78

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2014 Sanpoil River habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

Table E-3. Theoretical Sanpoil River summer/fall Chinook population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	EDT Performance Metric by Watershed Habitat Scenario							
	Diversity		Productivity		Capacity		Equilibrium Abundance	
	Template	Current	Template	Current	Template	Current	Template	Current
BiOp	87.7%	79.5%	6.7	3.6	3379	2206	2874	1594
Moderate	87.2%	78.2%	5.9	23.3	3012	1954	2504	1352
Low	87.1%	75.5%	5.1	2.9	2615	1684	2104	1099

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2014 Sanpoil River habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

Table E-4. Theoretical Sanpoil River and Select Tributaries spring Chinook population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	Subbasin Population	EDT Performance Metric by Watershed Habitat Scenario							
		Diversity		Productivity		Capacity		Equilibrium Abundance	
		Template	Current	Template	Current	Template	Current	Template	Current
BiOp	Sanpoil	39.7%	2.0%	2.8	2.25	659	498	420	277
	Select Tributaries	18.5%	2.3%	2.9	2.3	182	128	119	73
Moderate	Sanpoil	31.6%	1.3%	2.7	2.15	578	437	360	234
	Select Tributaries	12.8%	1.8%	2.8	2.2	160	112	104	61
Low	Sanpoil	22.3%	1.0%	2.5	2.0	495	374	300	186
	Select Tributaries	7.6%	1.4%	2.8	2.0	137	96	88	47

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2014 Sanpoil River habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

Note: Results in this table differ from those presented on November 15, 2016 at the Lake Roosevelt Forum Conference. The revised results reflect a calibrated increase in Lake Roosevelt to Wells survival to more closely match Wells to McNary survival (see Appendix A, Table A-1).

Section 1
Introduction

1.1 Purpose and Scope

This technical memorandum presents the results of an Ecosystem Diagnosis and Treatment (EDT) model analysis of anadromous reintroduction potential for summer steelhead, spring Chinook and summer/fall Chinook salmon in Colville Reservation tributaries to the Columbia River in the "blocked area" upstream of Grand Coulee Dam. The analysis was conducted by ICF on behalf of the Confederated Tribes of the Colville Reservation (CCT) Resident Fish Program and is consistent with Phase I of the Upper Columbia United Tribes anadromous reintroduction plan (UCUT 2015) and Northwest Power and Conservation Council research objectives (NPCC 2014). The results of this analysis, referred to hereafter as the Phase I reintroduction analysis, are intended to support the ongoing development of these anadromous reintroduction initiatives.

1.2 Study Area

The study area for the Phase I reintroduction analysis encompasses the Sanpoil River subbasin and select tributaries in the Upper Columbia subbasin draining to Lake Roosevelt from the eastern end of the Colville Reservation (Figure 1-1). The EDT model analysis summarizes anadromous habitat potential at the subbasin and US Geological Survey (USGS) 10th field hydrologic unit watershed (HUC10 watershed) scales.

There are four HUC 10 watersheds in the Sanpoil subbasin, the Lower Sanpoil, Middle Sanpoil, West Fork Sanpoil, and Upper Sanpoil (Figure 1-2). There are seven Colville Reservation HUC 10 watersheds in the Upper Columbia subbasin, but only four of these, including Barnaby Creek, Hall Creek, Stranger Creek/Twin Lakes and Nez Perce Creek provide potential anadromous habitat (Figure 1-3). These are referred to hereafter as the Select Tributaries. The Wilmont Creek, Ninemile Creek, and Sixmile/Threemile Creek watersheds all have impassable natural barriers at or near their mouths and are not considered potential anadromous habitat for the purpose of the Phase I reintroduction analysis.

While not presented in this report, Phase I reintroduction analysis results can also be summarized at the diagnostic unit scale. Diagnostic units are based on and analogous to the USGS 12th field subwatersheds (HUC 12s), there are a total of 49 diagnostic units across the study area.

1.3 Species Considered

This Phase I reintroduction analysis evaluates habitat potential for three anadromous species, summer steelhead, spring Chinook salmon, and summer/fall Chinook salmon. Sockeye salmon were also initially considered but were excluded from the analysis because EDT model life stage-habitat rules have not yet been developed for this species.

Figure 1-1. Location of the Sanpoil River and Select Tributaries in relation to Lake Roosevelt, Grand Coulee Dam and the Colville Indian Reservation.

Figure 1-2. HUC 10 Analysis Watersheds in the Sanpoil River subbasin.

Figure 1-3. HUC 10 Analysis Watersheds in the Upper Columbia subbasin.

Section 2
Methods and Assumptions

This section describes the methods and key assumptions used in the Phase I reintroduction analysis. This analysis relied on the adaptation of existing EDT models developed to support resident fish conservation and enhancement efforts in the Sanpoil River and select Colville Reservation tributaries in the Upper Columbia subbasin under the Lake Roosevelt Habitat Improvement Project (LRHIP). Two specific types of EDT model outputs are reported, standard EDT Performance Report results and a new set of life stage and location integration results that were used to develop the egg-to-parr, parr-to-smolt and prespawn adult survival metrics. The life stage and location integration results are a new feature developed in the EDT3 model platform with support from the Phase I reintroduction analysis and other concurrent EDT model projects. This feature represents a substantial contribution to the EDT model platform that will make it easier to compare and integrate EDT model results with other life cycle modeling efforts in the region.

The typical EDT model analysis is a two-step process, with the first step being the generation of Performance Reports for the focal (e.g. current conditions) and reference (e.g. template and degraded conditions) habitat scenarios used in the model. The second step in a typical EDT analysis is generation of a Diagnostic Splice Report, which is used to identify habitat protection and restoration priorities. The diagnostic splice replaces focal scenario conditions with reference scenario conditions on a reach by reach, habitat parameter by habitat parameter basis and evaluates the resulting effect of that change on habitat performance. The Phase I reintroduction analysis scope did not include the diagnostic splice analysis, but this step could be conducted to identify habitat restoration priorities for anadromous species in future analysis phases if desired.

2.1 Analysis Methods

2.1.1 Application of Existing EDT Models

ICF began working with LRHIP in 2011 to develop EDT models for the Sanpoil River subbasin and Upper Columbia subbasin tributaries on the Colville Reservation (i.e. the Select Tributaries). The primary objective of this early modeling effort was to provide a systematic platform for identifying and prioritizing habitat protection and restoration opportunities for resident redband trout. This included the development of historical template, current, and degraded conditions habitat scenarios using the best available habitat data, including habitat survey data collected by the CCT in the target subbasins specifically to support habitat restoration planning. The redband trout EDT model analysis was completed in early 2016.

The CCT recognized that the existing Sanpoil and Select Tributaries EDT models could be adapted to evaluate habitat potential for reintroduction of summer steelhead, summer/fall Chinook and spring Chinook consistent with UCUT and NPCC Phase I reintroduction analysis objectives. This report reflects the application of the existing Sanpoil and Select Tributaries EDT models to support the Phase I reintroduction analysis.

2.1.2 Configuring Hypothetical Anadromous Populations

ICF and the CCT collaborated with regional fisheries experts to develop hypothetical populations of summer steelhead, summer/fall Chinook and spring Chinook for the Phase I reintroduction analysis. Because the target species were extirpated from the study area several decades ago and information about historical population structure is generally lacking, this approach necessarily relied on expert opinion and extrapolation from existing populations in other Upper Columbia subbasins.

ICF and the CCT hosted a life history model workshop on June 28th, 2016 to define parameters necessary to construct theoretical anadromous populations in the EDT model. The meeting included representatives from the CCT, the Spokane Tribe of Indians, the Washington Department of Fish and Wildlife, and the Upper Columbia United Tribes. Based on the findings of this meeting, ICF and the CCT used the following approach to parameterize anadromous populations in the EDT model:

- Summer steelhead
    - Adapt the existing Okanogan summer steelhead population from the Okanogan EDT model
    - Incorporate additional reservoir rearing life cycle models based on observed redband trout population structure in Upper Columbia tributaries
- Summer/fall Chinook
    - Adapt the existing Okanogan summer/fall Chinook population from the Okanogan EDT model
- Spring Chinook
    - Construct a new population in the EDT3 model platform based on observed population structure in the Methow, Entiat and Wenatchee rivers
    - Incorporate reservoir rearing and holding life history model elements to reflect observed behavior in these populations

Each EDT population is composed of a set of EDT Life Cycle Models (LCM) and a designated set of spawning reaches. Each LCM is composed of a set of constraints used to define spawning, rearing and migratory timing and behavior of an individual age class. Each EDT population is composed of a proportional distribution of LCMs configured to be representative of the age structure and range of life history expression of the modeled species. The LCMs and population configuration for each species are described in the following sections.

Steelhead

Theoretical EDT population structure for Sanpoil and Select Tributaries summer steelhead is summarized in Table 2-1 and outlined in detail in Table 2-1. ICF and the CCT imported the existing population parameters for steelhead used in the Okanogan EDT model and reconfigured these parameters as necessary to work within the Sanpoil and Select Tributaries EDT models. Three new reservoir rearing LCMs were added to the steelhead population to reflect probable use of reservoir habitats by juvenile steelhead based on the observed behavior of adfluvial redband trout originating in the study area (ICF 2013). The CCT anticipates that up to 10% of a reintroduced steelhead population would use the reservoir as primary rearing habitat prior to emigration. The remaining steelhead LCMs are evenly divided between transient, or "mover," and resident rearing, or "stayer" juvenile life history strategies. Mover-type LCMs are allowed to redistribute in the spring and fall to

reflect use of different habitats during winter and summer rearing. Stayer-type LCMs are assumed to remain in essentially the same habitat throughout the entire juvenile rearing period ranging from one to three years.

Table 2-1. Summary of EDT summer steelhead age structure and behavioral-type composition used in the Sanpoil and Select Tributaries EDT models.

Parameter	Age or Behavioral Type	Proportion of Population
Juvenile age at smolting	Age-1	42.25%
	Age-2	35.50%
	Age-3	22.25%
Adult age at migration	1 ocean year	34.75%
	2 ocean years	54.25%
	3 ocean years	11.00%
Rearing behavioral type	Mover	45.0%
	Stayer	45.0%
	Reservoir	10.0%

Juvenile age at smolting: Age when migrant juveniles enter the Columbia River migratory corridor

Adult age at migration: Number of years spent rearing in the ocean before re-entering the Columbia River as migrant adults

Mover: Transient rearing behavioral type, demonstrating substantial movement between summer and winter rearing habitats

Stayer: Resident rearing behavioral type, remains in close proximity to incubation habitat until outmigration

Reservoir: Transient rearing juveniles that emigrate to reservoir habitats, overwinter, and migrate to the ocean at age 1

Table 2-2. EDT summer steelhead Life Cycle Models and population composition used in the Sanpoil and Select Tributaries EDT models.

Life Cycle Model	Juvenile Rearing Strategy	Juvenile Age at Migration	Ocean Age	Percent of Population
Age 1/1 Transient - Reservoir Rearing	Reservoir	1	1	4.5%
Age 1/2 Transient - Reservoir Rearing	Reservoir	1	2	5.0%
Age 1/3 Transient - Reservoir Rearing	Reservoir	1	3	0.5%
Age 1/1 Transient	Mover	1	1	4.8%
Age 1/2 Transient	Mover	1	2	8.5%
Age 1/3 Transient	Mover	1	3	1.8%
Age 2/1 Transient	Mover	2	1	7.0%
Age 2/2 Transient	Mover	2	2	11.0%
Age 2/3 Transient	Mover	2	3	2.0%
Age 3/1 Transient	Mover	3	1	3.5%
Age 3/2 Transient	Mover	3	2	5.0%
Age 3/3 Transient	Mover	3	3	1.5%
Age 1/1 Resident	Stayer	1	1	6.5%
Age 1/2 Resident	Stayer	1	2	9.0%
Age 1/3 Resident	Stayer	1	3	1.8%
Age 2/1 Resident	Stayer	2	1	4.5%
Age 2/2 Resident	Stayer	2	2	9.0%
Age 2/3 Resident	Stayer	2	3	2.0%
Age 3/1 Resident	Stayer	3	1	4.0%
Age 3/2 Resident	Stayer	3	2	6.8%
Age 3/3 Resident	Stayer	3	3	1.5%

Probable spawning reaches for steelhead were identified by the regional fisheries experts who participated in the June 28, 2016 life history model workshop. The workshop participants concluded that steelhead would spawn in suitable habitat in virtually every accessible reach in the Sanpoil and Select Tributaries EDT models. EDT spawning reaches for summer steelhead in the Sanpoil River and Select Tributaries are shown Figures 2-1 and 2-2, respectively. The extent of potential steelhead spawning and rearing habitat in the Sanpoil River and select tributaries is summarized in Table 2-3.

Table 2-3. Summary of potentially suitable habitat for steelhead by stream environment type in the Sanpoil River and Select Tributaries.

Species	Subbasin/ Watershed	Environment Type	Habitat Length (kilometers/miles)	Habitat Area (hectares/acres)
Steelhead	Sanpoil River	Small tributary	449.9/279.6	163.2/403.3
		Headwater	176.1/109.4	96.5/238.5
		Low Stream Order	130.1/80.8	120.3/297.2
		Mid-stream Order	61.5/38.2	91.1/225.0
		Total	817.6/508	471.1/1164
	Select Tributaries	Small tributary	25/15.5	11/27.2
		Headwater	98/60.9	32.4/80
		Low Stream Order	70.6/43.9	73.9/182.7
		Mid-stream Order	10.5/6.5	13.7/33.9
		Total	204/126.8	131/323.8
	All Habitat	Grand Total	1021.6/634.8	602.1/1487.8

Environment type descriptions:

Small tributary: Lower elevation tributary streams, Shreve Order 1 to 2

Headwater: High-elevation headwater tributaries, Shreve Order 1 to 4

Low stream order: Tributary and mainstem reaches, Shreve Order 5 to 50

Mid-stream order: Tributary and mainstem reaches, Shreve Order >50

Note: Habitat area summary does not include potential reservoir rearing habitats. Reservoir rearing habitat area used in EDT focused on inundated arms of spawning tributaries. While this habitat assumption does not place a capacity limitation on rearing potential, it is not representative the full extent of potential reservoir rearing habitat in Lake Roosevelt.

Summer/Fall Chinook

Theoretical EDT population structure for Sanpoil River summer/fall Chinook is summarized in Table 2-4 and outlined in detail in Table 2-5. ICF and the CCT imported the existing population parameters for summer/fall Chinook used in the Okanogan EDT model and reconfigured these parameters as necessary to work in the Sanpoil EDT model. The Okanogan summer/fall Chinook population is composed of a diverse range of life history strategies, including ocean-type, stream-type and reservoir juvenile rearing behavior, and use of mainstem reservoir habitats as thermal refugia during adult holding. Ocean-type LCMs emigrate in their first summer (age-0). Reservoir-type LCMs migrate to reservoir habitats in their first summer, overwinter in the reservoir and migrate in their second summer (age-1). Stream-type LCMs rear in watershed habitats and emigrate in their second summer at age-1.

Probable spawning reaches for Sanpoil summer/fall Chinook were identified by the regional fisheries experts who participated in the June 28, 2016 life history model workshop. The workshop participants concluded that spawning habitat for this species would be restricted to the mainstem of the Sanpoil River downstream of Granite Creek and the lower West Fork Sanpoil River, as shown in Figure 2-3. The extent of potential steelhead spawning and rearing habitat in the Sanpoil River and select tributaries is summarized in Table 2-6.

Table 2-4. Summary of EDT summer/fall Chinook age structure and behavioral-type composition used in the Sanpoil and Select Tributaries EDT models.

Parameter	Age or Behavioral Type	Proportion of Population
Juvenile rearing/ migration behavior type	Ocean-type	86.4%
	Stream-type	4.4%
	Reservoir	9.2%
Adult age at migration	1 ocean year (jacks)	5.0%
	2 ocean years	10.1%
	3 ocean years	49.9%
	4 ocean years	35.0%
Adult holding behavior	Watershed	54.4%
	Reservoir	45.6%

Juvenile rearing/migration behavior type:

Ocean-type: Migrate at age-0 from emergence through summer

Stream-type: Migrate at age-1

Reservoir-type: Emigrate to reservoir habitats, overwinter, and migrate at age 1

Adult age at migration: Number of years spent rearing in the ocean before re-entering the Columbia River as migrant adults

Adult holding behavior type:

Watershed: Migrate to pre-spawn holding habitats in Sanpoil and WF Sanpoil mainstem

Reservoir: Hold in Sanpoil Arm of Lake Roosevelt prior to migrating to spawning habitat

Table 2-5. EDT summer/fall Chinook Life Cycle Models and population composition used in the Sanpoil EDT model.

Life Cycle Model	Adult Holding	Juvenile Rearing	Ocean Age	Percent of Population
Summer Direct/Direct migrant age 0/1	Watershed	Ocean-type	1 (jack)	1.9%
Summer Direct/Direct migrant age 0/2	Watershed	Ocean-type	2	3.9%
Summer Direct/Direct migrant age 0/3	Watershed	Ocean-type	3	19.4%
Summer Direct/Direct migrant age 0/4	Watershed	Ocean-type	4	13.6%
Summer Direct/Delayed migrant age 1/1	Watershed	Reservoir	1 (jack)	0.2%
Summer Direct/Delayed migrant age 1/2	Watershed	Reservoir	2	0.5%
Summer Direct/Delayed migrant age 1/3	Watershed	Reservoir	3	2.3%
Summer Direct/Delayed migrant age 1/4	Watershed	Reservoir	4	1.6%
Summer Direct/Stream-type age 1/1	Watershed	Stream-type	1 (jack)	0.1%
Summer Direct/Stream-type age 1/2	Watershed	Stream-type	2	0.2%
Summer Direct/Stream-type age 1/3	Watershed	Stream-type	3	1.1%
Summer Direct/Stream-type age 1/4	Watershed	Stream-type	4	0.8%
Summer Delayed/Direct migrant age 0/1	Reservoir	Ocean-type	1 (jack)	1.9%
Summer Delayed/Direct migrant age 0/2	Reservoir	Ocean-type	2	3.9%
Summer Delayed/Direct migrant age 0/3	Reservoir	Ocean-type	3	19.4%
Summer Delayed/Direct migrant age 0/4	Reservoir	Ocean-type	4	13.6%
Summer Delayed/Delayed migrant age 1/1	Reservoir	Reservoir	1 (jack)	0.2%
Summer Delayed/Delayed migrant age 1/2	Reservoir	Reservoir	2	0.5%
Summer Delayed/Delayed migrant age 1/3	Reservoir	Reservoir	3	2.3%
Summer Delayed/Delayed migrant age 1/4	Reservoir	Reservoir	4	1.6%
Summer Delayed/stream-type age 1/1	Reservoir	Stream-type	1 (jack)	0.1%
Summer Delayed/stream-type age 1/2	Reservoir	Stream-type	2	0.2%
Summer Delayed/stream-type age 1/3	Reservoir	Stream-type	3	1.1%
Summer Delayed/stream-type age 1/4	Reservoir	Stream-type	4	0.8%
Fall Direct/Direct migrant age 0/1	Watershed	Ocean-type	1 (jack)	0.6%
Fall Direct/Direct migrant age 0/2	Watershed	Ocean-type	2	0.9%
Fall Direct/Direct migrant age 0/3	Watershed	Ocean-type	3	4.3%
Fall Direct/Direct migrant age 0/4	Watershed	Ocean-type	4	3.0%

Table 2-6. Summary of potentially suitable habitat for summer/fall Chinook by stream environment type in the Sanpoil River.

Species	Subbasin/ Watershed	Environment Type	Habitat Length (kilometers/miles)	Habitat Area (hectares/acres)
Summer/fall Chinook	**Sanpoil River**	Low Stream Order	34.4/21.4	34.4/85
		Mid-stream Order	61.5/38.2	91.1/225
		Grand Total	**95.9/59.6**	**125.5/310**

Environment type descriptions:

Low stream order: Tributary and mainstem reaches, Shreve Order 5 to 50

Mid-stream order: Tributary and mainstem reaches, Shreve Order >50

Note: Habitat area summary does not include potential reservoir rearing habitats. Reservoir rearing habitat area used in EDT focused on inundated arms of spawning tributaries. While this habitat assumption does not place a capacity limitation on rearing potential, it is not representative the full extent of potential reservoir rearing habitat in Lake Roosevelt.

Spring Chinook

Theoretical EDT population structure for Sanpoil and Select Tributaries spring Chinook is summarized in Table 2-7 and outlined in detail in Table 2-8. This structure is based on observed population composition in Methow, Wenatchee and Entiat Rivers, with additional modifications to reflect the assumed use of reservoir habitats in Lake Roosevelt for adult holding and juvenile rearing. The adult age distribution spring Chinook assumes approximately 4%, 70%, 21% and 5% of the 6,000 EDT life history trajectories used to model each population will be composed of spawners that spent 1, 2, 3, and 4 years in the ocean, respectively. Each subbasin population is configured to allow for 50% to hold through the summer in reservoir habitats in Lake Roosevelt as prespawn adults. The EDT population configuration also assumes that 26% of juveniles will spend their first winter rearing in reservoir habitats.

Probable spawning reaches for spring Chinook were selected by screening the EDT template conditions habitat scenario using National Marine Fisheries Service (NMFS) intrinsic potential model gradient and bankfull width criteria for stream-type Chinook salmon (Cooney and Holzer 2006). All accessible stream reaches having a gradient of less than 7% and a bankfull width greater than 3.7 meters were considered potential spring Chinook spawning habitat for the purpose of this analysis. Spring Chinook spawning reaches in the Sanpoil River and Select Tributaries EDT models are shown in Figures 2-4 and 2-5, respectively. The extent of potential spring Chinook spawning and rearing habitat in the Sanpoil River and select tributaries is summarized in Table 2-9.

Table 2-7. Summary of EDT spring Chinook age structure and behavioral-type composition used in the Sanpoil and Select Tributaries EDT models.

Parameter	Age or Behavioral Type	Proportion of Population
Juvenile rearing/ migration behavior type	Stream-type	74.0%
	Reservoir	26.0%
Adult age at migration	1 ocean year (jacks)	4.0%
	2 ocean years	70.0%
	3 ocean years	21.0%
	4 ocean years	5.0%
Adult holding behavior	Watershed	50%
	Reservoir	50%

Juvenile rearing/migration behavior type:

Stream-type: Migrate at age-1

Reservoir-type: Emigrate to reservoir habitats, overwinter, and migrate at age 1

Adult age at migration: Number of years spent rearing in the ocean before re-entering the Columbia River as migrant adults

Adult holding behavior type:

Watershed: Migrate to pre-spawn holding habitats in Sanpoil and WF Sanpoil mainstem

Reservoir: Hold in Sanpoil Arm of Lake Roosevelt prior to migrating to spawning habitat

Table 2-8. EDT Spring Chinook Life Cycle Models and population composition used in the Sanpoil and Select Tributaries EDT models.

Life Cycle Model	Adult Holding	Juvenile Rearing	Ocean Age	Percent of Population
Age 1/1 - Reservoir Rearing	Watershed	Reservoir	1 (jack)	0.5%
Age 1/2 - Reservoir Rearing	Watershed	Reservoir	2	9.0%
Age 1/3 - Reservoir Rearing	Watershed	Reservoir	3	2.5%
Age 1/4 - Reservoir Rearing	Watershed	Reservoir	4	1.0%
Age 1/1 - Local Rearing	Watershed	Stream-type	1 (jack)	1.5%
Age 1/2 - Local Rearing	Watershed	Stream-type	2	26.0%
Age 1/3 - Local Rearing	Watershed	Stream-type	3	8.0%
Age 1/4 - Local Rearing	Watershed	Stream-type	4	1.5%
Age 1/1 - Reservoir Rearing and Holding	Reservoir	Reservoir	1 (jack)	0.5%
Age 1/2 - Reservoir Rearing and Holding	Reservoir	Reservoir	2	9.0%
Age 1/3 - Reservoir Rearing and Holding	Reservoir	Reservoir	3	2.5%
Age 1/4 - Reservoir Rearing and Holding	Reservoir	Reservoir	4	1.0%
Age 1/1 - Local Rearing, Reservoir Holding	Reservoir	Stream-type	1 (jack)	1.5%
Age 1/2 - Local Rearing, Reservoir Holding	Reservoir	Stream-type	2	26.0%
Age 1/3 - Local Rearing, Reservoir Holding	Reservoir	Stream-type	3	8.0%
Age 1/4 - Local Rearing, Reservoir Holding	Reservoir	Stream-type	4	1.5%

Table 2-9. Summary of potentially suitable spring Chinook habitat by stream environment type in the Sanpoil River and Select Tributaries.

Species	Subbasin/ Watershed	Environment Type	Habitat Length (kilometers/miles)	Habitat Area (hectares/acres)
Spring Chinook	Sanpoil River	Small tributary	211.6/131.5	84.3/208.3
		Headwater	114/70.9	58.7/145
		Low Stream Order	109.5/68	103.5/255.7
		Mid-stream Order	61.5/38.2	91.1/225
		Total	496.6/308.6	337.5/834.1
	Select Tributaries	Small tributary	16.7/10.4	7.9/19.6
		Headwater	35.8/22.2	14.6/36
		Low Stream Order	67.4/41.9	73.5/181.7
		Mid-stream Order	10.5/6.5	13.7/33.9
		Total	130.4/81	109.7/271.2
	All Habitat	Grand Total	627/389.6	447.2/1105.3

Environment type descriptions:

Small tributary: Lower elevation tributary streams, Shreve Order 1 to 2

Headwater: High-elevation headwater tributaries, Shreve Order 1 to 4

Low stream order: Tributary and mainstem reaches, Shreve Order 5 to 50

Mid-stream order: Tributary and mainstem reaches, Shreve Order >50

Note: Habitat area summary does not include potential reservoir rearing habitats. Reservoir rearing habitat area used in EDT focused on inundated arms of spawning tributaries. While this habitat assumption does not place a capacity limitation on rearing potential, it is not representative the full extent of potential reservoir rearing habitat in Lake Roosevelt.

Figure 2-1. Distribution of steelhead spawning reaches used in the Sanpoil EDT model.

Figure 2-2. Distribution of steelhead spawning reaches used in the Select Tributaries EDT model.

Figure 2-3. Distribution of summer/fall Chinook spawning reaches used in the Sanpoil EDT model.

Figure 2-4. Distribution of spring Chinook spawning reaches used in the Sanpoil EDT model.

Figure 2-5. Distribution of spring Chinook spawning reaches used in the Select Tributaries EDT model.

2.2 Critical Assumptions

The Phase I reintroduction analysis necessarily required a set of critical assumptions about in-basin and out-of-basin habitat and survival parameters used in the EDT model. These assumptions are described below.

2.2.1 In-Basin Analysis Parameters

In-basin parameters include the habitat scenarios used in the Phase I reintroduction analysis and critical assumptions about the status of manmade and natural passage obstructions.

Subbasin Habitat Scenarios

ICF and the CCT selected two sets of EDT habitat scenarios to evaluate anadromous reintroduction potential in the study area:

- Template conditions: An approximation of historical and/or fully functional habitat conditions in the Sanpoil and Select Tributaries, which represent the best available approximation of fully functional habitat conditions
- Current conditions: An approximation of current habitat conditions based primarily on empirical habitat surveys conducted by the CCT in 2013 and 2014 supported by other sources of data from multiple sources

ICF generated EDT Performance Reports for the template and current conditions scenarios, with the current conditions scenario modified using the manmade barrier assumptions described below.

Manmade and Natural Barrier Assumptions

For the purpose of the Phase I anadromous reintroduction analysis ICF and the CCT assumed that all manmade barriers in the study area watersheds, including culverts, weirs and small dams, have been removed or modified as needed to provide uninhibited passage of adult and juvenile salmonids. This assumption is consistent with the hierarchical restoration strategy being pursued for redband trout in the study area and broadly consistent with habitat restoration theory and practice in the Upper Columbia region. There are 102 and 30 identified manmade passage obstructions in the accessible portions of the Sanpoil subbasin and select tributaries, of which 92 and 22 are identified as complete or partial barriers to fish passage, respectively. The extent of potentially suitable habitat for steelhead and spring Chinook in the study area that is partially or completely blocked by these obstructions is summarized in Table 2-10. Potential summer/fall Chinook habitat is restricted to mainstem habitats in the Sanpoil River and West Fork Sanpoil River. There are no natural or manmade obstructions within the subbasin that would restrict access to these habitats.

Table 2-10. Extent of potentially suitable habitat for steelhead and spring Chinook in the Sanpoil River and select tributaries study area that is partially or completely inaccessible due to manmade obstructions.

Species	Subbasin/Watershed	% of Suitable Habitat Upstream of Manmade Barriers	
		By Length	By Area
Steelhead	Sanpoil	26.8%	16.2%
	Select Tributaries	52.5%	49.5%
Spring Chinook	Sanpoil	26.4%	14.2%
	Select Tributaries	52.4%	50.9%

Values reflect habitat area upstream of manmade obstructions identified as complete or partial barriers to fish passage by the CCT. Obstructions that were not rated for the purpose of EDT modeling are assumed to be 100% passable.

ICF and the CCT assumed that areas above identified natural barriers would remain inaccessible to anadromous species for the purpose of the Phase I analysis. These habitats were not included in the Sanpoil and Select Tributaries EDT models and have not been quantified.

2.2.2 Out-of-Basin Assumptions

The EDT model uses two sets of input parameters to calculate life stage survival in the mainstem Columbia River migratory corridor and Pacific Ocean. Performance Values are reach-specific monthly life stage survival parameters assigned to habitat reaches in the mainstem migratory corridor and ocean. Obstruction ratings are structure-specific monthly life stage survival values assigned to each individual Columbia River mainstem dam.

ICF and the CCT collaboratively developed a series of mainstem and ocean survival assumptions for the Phase I reintroduction analysis covering Lake Roosevelt and the Columbia River mainstem downstream to Wells Dam, the Columbia River from Wells Dam to McNary Dam, the Columbia River from McNary Dam to Bonneville Dam, and ocean survival as measured using smolt-to-adult return (SAR) rates measured at Bonneville Dam. These assumptions are described in the following sections.

Grand Coulee and Chief Joseph Dam Passage Scenarios

ICF applied three different sets of assumptions about Grand Coulee Dam and Chief Joseph Dam passage survival to evaluate reintroduction potential. These scenarios use the following passage survival rates for juvenile migrants moving downstream and adult migrants moving upstream:

- Biological opinion (BiOp) survival: 95% juvenile downstream, 98% adult upstream survival at each dam
- Moderate survival: 90% juvenile downstream, 97% adult upstream survival at each dam
- Low survival: 85% juvenile downstream, 95% adult upstream survival at each dam

These passage survival scenarios apply only to Grand Coulee Dam and Chief Joseph Dam. The BiOP survival assumption is consistent with Federal Columbia River Power System biological opinion survival standards for other federally-operated dams on the Columbia River mainstem. The moderate and low survival assumptions are provided to evaluate habitat potential at survival rates

below BiOP standards. Migrant survival in the remainder of the Columbia River mainstem have been calibrated to match observed survival rates as described in the following section.

Columbia River Mainstem Survival Assumptions

ICF calibrated EDT juvenile and adult migrant survival values in each major segment of the Columbia River migratory corridor to match available observations by species and age class. The general objective of this approach was to produce EDT-estimated survival rates in each migratory corridor segment and Pacific Ocean SARs that are at least within the range of recent observations, and ideally within the standard error or confidence interval around the arithmetic mean of these observations. Various data sources were used, with emphasis placed on survival rates observed after 2008 when the Federal Columbia River Power System (FCRPS) implemented significant operational changes to improve migratory survival. A detailed summary of out of basin survival calibration parameters and associated data sources is provided in Appendix A.

In some cases multiple references were available that reported different observed survival values in a given migration corridor segment during the same time period, reflecting differing interpretations of the available data by the reference authors.

Lake Roosevelt to Wells Dam Segment

Insufficient data are currently available to assess juvenile and adult salmonid survival rates in the migration corridor segment extending from Lake Roosevelt downstream to Wells Dam (Lk Roosevelt to WLS for juveniles, WLS to Lake Roosevelt for adults). For the purpose of the Phase I reintroduction analysis, ICF and the CCT assumed that juvenile and adult survival in this segment of the migration corridor would be approximately similar to observed mortality in the mainstem segment extending from Wells Dam to McNary Dam (WLS to MCN). The Lake Roosevelt to WLS segment beginning at the mouth of the Sanpoil Arm is approximately 148 km in length, the WLS to MCN segment is approximately 360 km in length. Therefore, equivalent mortality in the two segments would equate to a morality rate/km in the Lake Roosevelt to WLS segment between 2 and 3 times higher than the rate in the WLS to MCN segment.

EDT juvenile survival rates and mortality rates/km are summarized by species in Table 2-11. As shown, the mortality rates/km in the Lk Roosevelt to WLS segment are approximately 2 to 3 times the calibrated EDT rates in the WLS to MCN segment. ICF and the CCT view these mortality rates to be conservatively high, therefore the Phase I analysis results likely represent a conservatively low estimate of reintroduction potential under both current and restored habitat conditions. Calibrated EDT survival rates and mortality rates/km for adult migrants in the WLS to Lake Roosevelt segment are summarized by species in Table 2-12. As shown, adult survival between the MCN to WLS and WLS to Lake Roosevelt segments are generally similar, with the rate/km in the WLS to Lake Roosevelt segment approximately 2 to 3 times that in the downstream segment.

Table 2-11. Calibrated EDT juvenile migrant survival rates in the Lake Roosevelt to WLS and WLS to MCN mainstem segments.

Species	Migrant Age	Lake Roosevelt to WLS		WLS to MCN	
		Survival Rate	Mortality/km	Survival Rate	Mortality/km
Steelhead	1-3	0.623	0.0025	0.607	0.0011
Summer/Fall Chinook	0-1	0.560	0.0030	0.539	0.0013
Spring Chinook	1	0.595	0.0027	0.642	0.0010

Table 2-12. Calibrated EDT adult migrant survival rates in the WLS to Lake Roosevelt and MCN to WLS mainstem segments.

Species	WLS to Lake Roosevelt		MCN to WLS	
	Survival Rate	Mortality/km	Survival Rate	Mortality/km
Steelhead	0.958	0.00028	0.945	0.00015
Summer/Fall Chinook	0.954	0.00031	0.944	0.00016
Spring Chinook	0.947	0.00036	0.952	0.00013

Wells Dam to McNary Dam Segment

Comparisons of calibrated EDT survival rates to observed juvenile and adult survivals in the WLS to MCN segment are provided in Tables 2-13 and 2-14, respectively. EDT survival rates were calculated for relevant portions of the WLS to MCN segment to match the available data observations by species.

As shown in Table 2-13, EDT juvenile survival rates fell within the standard error and/or the range of recent observations in all cases with the exception of spring Chinook migrants in the RRE TLRC to MCN segment. Notably however, the observations used for comparison were collected from 1999-2000 and pre-date operational changes implemented by the FCRPS and county public utility districts to increase juvenile migration survival. Therefore the more recent observations were used to validate EDT model calibration. In the case of adult survivals, the reference sources used for this analysis provided only the mean of observations and did not report the range or standard deviation metrics (see Appendix A).

Table 2-13. Comparison of calibrated EDT juvenile migrant survival rates to observed survival rates in the WLS to MCN mainstem segment.

Species	Mainstem Segment	EDT Value	Observed Survival Rates			
			Mean	Standard Error	Range	Period
Steelhead	WLS RES to WLS TLRC	0.950	0.945	***0.015***	0.943-0.946	1999-2000
	RIS to MCN	0.703	0.609	0.010	***0.499-0.739***	2009-2015
Summer/Fall Chinook	RIS to MCN	0.659	0.561	0.0585	***0.219-0.891***	2009-2015
	WLS RES to MCN	0.528	0.322	0.0438	0.247-0.527	2008-2014
	PRD to MCN	0.804	0.673	0.0801	***0.500-0.820***	2008-2014
Spring Chinook	RIS to MCN	0.753	0.667	0.0191	***0.489-0.935***	2009-2015
	RRE TLRC to RIS TLRC	0.933	0.942	***0.0157***	0.897-0.973	2000-2010
	RRE TLRC to MCN	0.730	0.671	0.0105	0.656-0.686	1999-2000

Table 2-14. Comparison of calibrated EDT adult migrant survival rates to observed survival rates in the WLS to MCN mainstem segment.

Species	Mainstem Segment	EDT Value	Observed Survival Rates			
			Mean	Standard Error	Range	Period
Spring Chinook	MCN to WLS	0.926	≥0.95	NR	NR	2012-2015
	PRD to WLS	0.948	0.920	NR	NR	2003-2010
	RRE to WLS	0.979	0.986	NR	NR	2015
Summer/Fall Chinook	MCN to WLS	0.946	≥0.95	NR	NR	2015
Spring Chinook	MCN to WLS	0.960	≥0.95	NR	NR	2015
	PRD to WLS	0.972	0.956	NR	NR	2003-2010
	RRE to WLS	0.989	1.000	NR	NR	2015

NR = Not reported

McNary Dam to Bonneville Dam Segment

Comparisons of calibrated EDT survival rates to observed juvenile and adult survival in the MCN to BON segment are provided in Tables 2-15 and 2-16, respectively. As shown, all EDT juvenile survival rates are within the standard error of the mean and/or the range of observed values in this segment. All EDT adult survival rates are within the standard error of the mean of recent observations.

Table 2-15. Comparison of calibrated EDT juvenile migrant survival rates to observed survival rates in the MCN to BON mainstem segment.

Species	EDT Value	Observed Survival Rates			
		Mean	Standard Error	Range	Period
Steelhead	0.747	0.724	***0.090***	0.487-1.069	2009-2015
		0.795	0.016	***0.587-0.958***	2009-2015
Summer/Fall Chinook	0.699	0.649	0.038	***0.621-0.743***	2009-2013
Spring Chinook	0.758	0.835	***0.092***	0.626-1.056	2008-2015

Table 2-16. Comparison of calibrated EDT adult migrant survival rates to observed survival rates in the BOA to MCN mainstem segment.

Species	EDT Value	Observed Survival Rates			
		Mean	Standard Error	Range	Period
Steelhead	0.909	0.901	***0.074***	0.733-0.981	2008-2015
		0.893	***0.049***	0.823-0.977	
Summer/Fall Chinook	0.926	0.947	***0.065***	0.896-1.00	2008-2015
Spring Chinook	0.941	0.966	***0.033***	0.909-1.00	2008-2015
		0.938	***0.063***	0.876-1.00	

Ocean Survival – Smolt-to-Adult Return Rates

ICF calibrated EDT ocean survival for steelhead, summer/fall Chinook and spring Chinook using available SAR data for Upper Columbia River populations, emphasizing observations between 2008 and 2015 where available. As shown in Table 2-17, the calibrated EDT SARs are within the 90% confidence interval of the arithmetic mean and/or the range of recent observations used in this analysis.

Table 2-17. Comparison of EDT Smolt-to-Adult Return (SAR) values to observed SARs for Upper Columbia River populations of steelhead, summer/fall Chinook and spring Chinook.

Species	Segment	Calibrated EDT Result	Observed Survival Calibration Metric			
			Mean	90% CI of Mean	Range	Period
Steelhead	BON to BOA	0.040	--	--	--	--
	MCN to BOA	**0.030**	0.041	**0.029-0.053**	0.013-0.067	2006-2012
	RRE to BOA	**0.020**	0.027	**0.019-0.036**	0.009-0.048	2008-2012
Summer/Fall Chinook	BON to BOA	0.046	--	--	--	--
	MCN to BOA	**0.032**	0.021	0.018-0.026	**0.012-0.041**	2011-2013
	RIS to BOA	**0.021**	0.012	0.010-0.015	**0.006-0.021**	2009-2013
Spring Chinook	BON to BOA	0.036	--	--	--	--
	MCN to BOA	**0.025**	0.019	0.013-0.024	**0.006-0.028**	2009-2014

2.3 Results Reporting

The Phase I reintroduction analysis results are reported using two related types of EDT model outputs, standard Performance Report metrics and a customized set of life stage and location integration metrics generated using new EDT3 model features developed by ICF in conjunction with this project. These reporting metrics are described in detail below.

All Phase I reintroduction analysis results are summarized at the subbasin and HUC 10 watershed scale as described in Section 1.2.

2.3.1 EDT Performance Report Metrics

The Phase I anadromous reintroduction analysis results were developed by generating EDT Performance Reports for the template and current conditions habitat scenarios under each Grand Coulee and Chief Joseph dam passage scenario.

The Performance Report is the primary set of habitat performance metrics generated by the EDT model. Performance Report results are specific to a specific habitat scenario selected for analysis. Generation of Performance Reports for the focal habitat scenario (e.g. current conditions) and one or more diagnostic reference scenarios (e.g. template conditions) is the first step in a typical EDT model analysis. Performance Report metrics include:

- Habitat capacity – Theoretical maximum number of adults that can be supported by the available habitat, based on the integration of habitat quantity under the selected habitat scenario with life stage-specific density benchmarks and habitat affinity rules across all life stages
- Productivity – Density-independent productivity based on the conditions present under the selected habitat scenario
- Equilibrium abundance – The theoretical population size that can be supported by the selected habitat scenario, calculated from life stage capacity and productivity using recursive properties of the Beverton-Holt equation
- Diversity – An index of life history diversity under the selected habitat scenario based on the proportion of EDT life history trajectories that have a productivity greater than 1 (i.e. are self-sustaining)

2.3.2 EDT Life Stage and Location Integration Metrics

ICF developed a new set of EDT results metrics to support the Phase I reintroduction analysis. The CCT wanted to be able to report egg-to-parr and parr-to-smolt survival by watershed and diagnostic unit. These metrics are not part of the standard EDT model results reporting and were previously derived by hand from the intermediate analysis results produced by the model. With support from the CCT and other concurrent EDT modeling projects, ICF coded new life stage and location integration features into the EDT3 Report Generator that allows the user to generate customized life stage survival results at any location in the focal watershed and the Columbia Basin migratory corridor. These new features were used to calibrate the out of basin survival parameters used in the Phase I reintroduction analysis and to generate the following in-basin life stage survival metrics presented in this report:

- Egg-to-parr survival – Juvenile survival from the beginning of egg incubation through the end of active rearing in October (i.e. end of the EDT 0-age resident rearing life stage)
- Parr-to-smolt survival – Juvenile survival from the end of the first summer through emigration (i.e. beginning of the EDT 0-age inactive rearing life stage through to the point when migrant juveniles pass through the inundated arm of their natal tributary and enter the main body of Lake Roosevelt)
- Prespawn adult survival – In-basin survival of prespawn holding adults

These new EDT reporting metrics represent a valuable addition to the suite of tools and capabilities available to resource managers in the Upper Columbia region. The life stage survival metrics will allow for direct comparison of EDT model and WDFW/NMFS life cycle model outputs, and the use of EDT outputs as life cycle model inputs. This increased compatibility will make it easier to conduct complimentary model analyses supporting species conservation and recovery objectives in the region.

Section 3
Results

This section presents the results of the EDT Phase I reintroduction analysis for summer steelhead, summer/fall Chinook and spring Chinook in the Sanpoil River, and summer steelhead and spring Chinook in the Select Tributaries to the Colville Reservation. Two sets of EDT model results are provided as follows (see Section 2.3 for definitions):

- Standard EDT Performance Report metrics for each Grand Coulee and Chief Joseph dam passage scenario under template and current habitat conditions, including:
    - Habitat capacity
    - Productivity
    - Equilibrium abundance
    - Diversity
- Customized life stage survival metrics calculated using the BiOp survival Grand Coulee and Chief Joseph dam passage scenario, including:
    - Egg-to-parr survival
    - Parr-to-smolt survival
    - Prespawn adult survival

The standard EDT Performance Report metrics are summarized by species in the following sections. The life stage survival metrics are summarized in Appendix B as referenced below. All EDT model results are summarized at the subbasin and HUC 10 watershed scale as described in Section 1.2.

3.1 Summer Steelhead Reintroduction Potential

EDT model results indicate strong potential for steelhead reintroduction in Colville Reservation watersheds upstream of Grand Coulee Dam under current habitat conditions, with the Sanpoil River accounting for the majority of available habitat potential. Template conditions scenario results indicate that targeted restoration actions could substantially increase steelhead habitat potential in both subbasins. EDT habitat performance results for the Sanpoil River and Select Tributaries subbasin are summarized in Tables 3-1 and 3-2, respectively.

EDT results indicate the Sanpoil River could potentially support a return of approximately 622 to 947 adult steelhead under current habitat conditions depending on the passage scenario selected (Table 3-1). The Select Tributaries could potentially support a return of approximately 75 to 120 adult steelhead under current conditions depending on passage scenario (Table 3-2). The theoretical steelhead population size effectively doubles under template conditions across all passage scenarios, suggesting that habitat restoration could yield considerable benefits for this species.

Egg-to-parr survival in the Sanpoil ranges from 3.5% to 6.5% under template conditions and 3.4% to 7.8% under current conditions with some variation depending on the subpopulation and life

history strategy (TableB-1). Egg-to-parr survival in the Select Tributaries was more variable but generally higher, averaging approximately 17% for template and current conditions in the select Tributaries (Table B-2). EDT-estimated steelhead life stage survival rates for the Sanpoil and Select Tributaries are summarized in Appendix B, Tables B-1 and B-2, respectively. The Phase I reintroduction analysis did not include an EDT diagnostic splice so the specific reasons for the increase in egg-to-parr survival are unclear. One probable explanation is that the timing of peak snowmelt flows shifted between the template and current habitat conditions scenarios to earlier in the spring in both subbasin models. The resulting reduction in exposure of the EDT incubation life stage to flow-related bed scour effects would increase incubation survival under the current conditions scenario.

Parr-to-smolt survival rates vary by age at migration and rearing strategy. Survival rates for age-1 reservoir rearing migrants was approximately 8% under template and current conditions in the Sanpoil watershed (Table B1). The select tributaries had a much higher estimate of egg to parr survival (64%). The consistent results between current and template conditions for both populations is a good indicator that the reservoir rearing life history strategy is likely to successful for steelhead.

Parr-to-smolt survival rates for tributary rearing migrants under both habitat scenarios reflect the broader effects of age at migration. Parr-to-smolt survival for stayer-type and mover-type 1-age migrant juveniles ranges was approximately 6-8% in the Sanpoil for both current and template (Table B-1). In the select tributaries, the parr to smolt survival was much higher (48-52%)(Table B2). Survival to emigration decreases with every additional year of exposure to rearing habitat conditions and values for age 2 and 3 migrants can be found in Tables B-1 and B-2.

There is a clear disparity in parr-to-smolt survival rates between the Sanpoil and select tributaries, the reasons for which are not clear. There are several potential explanations but an EDT diagnostic splice and additional analysis of life history trajectory performance in each subbasin would be required to identify the specific factors that are contributing to the observed difference in survival.

In-basin survival of prespawn adult steelhead is generally consistent between the template and current conditions scenarios where life stage comparisons can be made. Adult survival ranged from 79% to 84% under template conditions and 72% to 82% under current conditions. In the Select Tributaries, adult pre-spawn survival was much lower, falling between 41-45% for both current and template conditions. A comparison of results life history strategy shows consistent modest differences in survival of 0.5% to 5% between habitat scenarios (Tables B-1 and B-2). Nez Perce Creek results are skewed by the limited overall habitat potential for adult steelhead (Table 3-2).

Table 3-1. Theoretical Sanpoil River summer steelhead population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	Subpopulation	EDT Performance Metric by Watershed Habitat Scenario									
		Diversity		Eggs per Spawner		Productivity		Capacity		Equilibrium Abundance	
		Template	Current	Template	Current	Template	Current	Template	Current	Template	Current
BiOp	**All Subpopulations**	**81.5%**	**29.1%**	**3019**	**3017**	**3.69**	**2.23**	**2480**	**1719**	**1807**	**947**
	Lower Sanpoil	61.4%	17.6%	3018	3015	3.16	2.22	586	473	400	260
	Middle Sanpoil	82.9%	36.2%	3018	3015	3.81	2.30	322	227	237	128
	West Fork Sanpoil	94.7%	36.7%	3020	3019	3.81	2.24	987	689	728	381
	Upper Sanpoil	74.5%	22.2%	3017	3016	3.75	2.16	586	330	429	177
Moderate	**All Subpopulations**	**79.3%**	**24%**	**3019**	**3017**	**3.38**	**2.07**	**2185**	**1513**	**1583**	**783**
	Lower Sanpoil	60.6%	14.5%	3018	3015	2.94	2.07	516	417	340	215
	Middle Sanpoil	80.9%	31.9%	3018	3015	3.46	2.12	283	200	201	106
	West Fork Sanpoil	92.8%	29.7%	3020	3019	3.48	2.09	870	607	620	316
	Upper Sanpoil	72.4%	18.1%	3017	3016	3.43	2.01	516	290	365	146
Low	**All Subpopulations**	**75.2%**	**18.5%**	**3019**	**3017**	**3.06**	**1.92**	**1873**	**1296**	**1261**	**622**
	Lower Sanpoil	55%	11.9%	3018	3015	2.73	1.92	442	357	280	171
	Middle Sanpoil	78%	24.9%	3018	3015	3.10	1.95	243	171	164	84
	West Fork Sanpoil	88.7%	22.6%	3020	3019	3.14	1.94	746	520	508	251
	Upper Sanpoil	68.6%	13.7%	3017	3016	3.10	1.86	442	248	299	115

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2014 Sanpoil River habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

Table 3-2. Theoretical Select Tributary summer steelhead population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	Subpopulation	EDT Performance Metric by Watershed Habitat Scenario									
		Diversity		Eggs per Spawner		Productivity		Capacity		Equilibrium Abundance	
		Template	Current	Template	Current	Template	Current	Template	Current	Template	Current
BiOp	**All Subpopulations**	**49.7%**	**15.2%**	**3024**	**3022**	**2.6**	**2.0**	**312**	**240**	**193**	**119**
	Barnaby Creek	33.3%	11.5%	3018	3026	3.1	1.9	22	20	15	10
	Stranger Creek	57.3%	19.4%	3028	3026	2.9	2.1	82	60	54	32
	Hall Creek	51.9%	15.1%	3023	3021	2.4	1.9	204	157	120	75
	Nez Perce Creek	12.0%	4.3%	3023	3014	2.3	1.9	3	3	2	1
Moderate	**All Subpopulations**	**43.5%**	**11.8%**	**3024**	**3022**	**2.4**	**1.9**	**275**	**212**	**162**	**99**
	Barnaby Creek	29.4%	9.7%	3018	3026	2.8	1.7	20	18	13	8
	Stranger Creek	51.3%	15.9%	3028	3026	2.7	2.0	72	53	45	27
	Hall Creek	45.1%	11.3%	3023	3021	2.3	1.8	180	138	100	63
	Nez Perce Creek	10.2%	4.0%	3023	3014	2.2	1.7	3	2	2	1
Low	**All Subpopulations**	**36.2%**	**7.7%**	**3024**	**3022**	**2.2**	**1.8**	**235**	**181**	**129**	**78**
	Barnaby Creek	25.4%	6.5%	3018	3026	2.5	1.5	17	15	10	5
	Stranger Creek	44.9%	11.2%	3028	3026	2.4	1.9	62	45	36	22
	Hall Creek	36.7%	7.1%	3023	3021	2.1	1.7	154	118	80	50
	Nez Perce Creek	8.0%	2.9%	3023	3014	1.9	1.6	3	2	1	1

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2013 Select Tributaries habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

3.2 Summer/Fall Chinook Reintroduction Potential

EDT habitat performance results for summer/fall Chinook reintroduction in the Sanpoil River are summarized in Table 3-3. These results indicate good potential for establishing a viable population of summer/fall Chinook in the Sanpoil River. The model estimated that under current conditions the Sanpoil River could support a return of 1099 to 1594 summer/fall Chinook salmon depending on passage scenario. Habitat potential is somewhat higher under template conditions, indicating that habitat restoration could lead to an even more robust population (Table 3-3).

EDT-estimated summer/fall Chinook life stage survival rates for the Sanpoil River are summarized in Appendix B, Table B-3. Under current conditions, egg-to-parr survival in the entire Sanpoil population is approximately 6% for 0-age migrant life history forms and about 1% for reservoir and stream-type 1-age migrant life history forms (Table B-3).

Parr-to-smolt survival rates vary by age at migration and rearing strategy. Survival rates for 0-age migrants are quite high (approximately 92%), (Appendix B, Table B-3). The high survival rates reflect the short amount of time 0-age migrants spend in the system, with the majority of trajectories out-migrating in less than a month. Interestingly reservoir-type and stream-type juveniles emigrating from the West Fork Sanpoil and Middle Sanpoil perform poorly, with no trajectories surviving past the fry colonization stage (Table B-3). The reasons for this are unclear in the absence of a diagnostic splice analysis. Reservoir-type 1-age migrants emerging from the Lower Sanpoil and Upper Sanpoil survive at a relatively high rate of 60%, or 59.3% across the entire population. The Upper Sanpoil was the only watershed to produce stream-type life history trajectories that survived to the parr life stage. Parr-to-smolt survival from this watersheds was 14.9, or 16.2% when integrated to the population scale. The lower juvenile survival rate for this life history form is consistent with extended rearing in less productive stream habitats. Prespawn adult survival was approximately 70% under current conditions for all life history forms, approximately 14 percentage points lower than template conditions (Table B-3).

Table 3-3. Theoretical Sanpoil River summer/fall Chinook population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	Subpopulation	EDT Performance Metric by Watershed Habitat Scenario									
		Diversity		Eggs per Spawner		Productivity		Capacity		Equilibrium Abundance	
		Template	Current	Template	Current	Template	Current	Template	Current	Template	Current
BiOP	**All Subpopulations**	**87.7%**	**79.5%**	**2652**	**2664**	**6.70**	**3.60**	**3379**	**2206**	**2874**	**1594**
	Lower Sanpoil	87.5%	70.6%	2684	2697	6.52	3.63	1568	1036	1327	750
	Middle Sanpoil	87.7%	81.4%	2632	2647	6.97	3.61	826	619	707	447
	West Fork Sanpoil	88.7%	86.3%	2777	2788	6.64	3.95	153	89	130	67
	Upper Sanpoil	87.6%	86.2%	2607	2613	6.82	3.49	832	462	710	330
Moderate	**All Subpopulations**	**87.2%**	**78.2%**	**2652**	**2664**	**5.93**	**3.25**	**3012**	**1954**	**2504**	**1352**
	Lower Sanpoil	87.2%	68.3%	2684	2697	5.77	3.28	1405	921	1162	641
	Middle Sanpoil	87.0%	79.9%	2632	2647	6.20	3.25	733	546	614	378
	West Fork Sanpoil	88.2%	85.1%	2777	2788	5.86	3.51	135	79	112	56
	Upper Sanpoil	87.2%	85.7%	2607	2613	6.03	3.14	739	408	616	278
Low	**All Subpopulations**	**87.1%**	**75.5%**	**2652**	**2664**	**5.12**	**2.88**	**2615**	**1684**	**2104**	**1099**
	Lower Sanpoil	87.1%	64.8%	2684	2697	4.98	2.92	1227	797	981	525
	Middle Sanpoil	86.9%	77.3%	2632	2647	5.32	2.88	633	469	514	306
	West Fork Sanpoil	88.2%	84.3%	2777	2788	5.04	3.06	116	68	93	46
	Upper Sanpoil	86.9%	83.6%	2607	2613	5.20	2.79	638	350	516	224

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2014 Sanpoil River habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

3.3 Spring Chinook Reintroduction Potential

EDT model results indicate modest spring reintroduction potential in Colville Reservation watersheds, with a model estimated equilibrium abundance between 186 and 277 adult spawners under current conditions in the Sanpoil River (depending on the hydro-survival scenario) (Table 3-4). The other smaller tributaries had equilibrium abundances between zero and 51 adult spawners (Table 3-5), indicating that these habitats may be able to support spring Chinook during periods of high habitat productivity but the likelihood of a viable population persisting over long periods is low.

EDT-estimated spring Chinook life stage survival rates for the Sanpoil and Select Tributaries are summarized in Appendix B, Tables B-4 and B-5, respectively. As shown in Table B-4, egg-to-parr survival in the Sanpoil ranges from 8.3% to 14.4% depending on watershed of origin and life history strategy.

Parr-to-smolt survival rates vary by spawning location and rearing strategy, with reservoir-rearing juveniles generally surviving at a substantially higher rate than stayer-type juveniles that rear in proximity to their natal reaches. Parr-to-smolt survival for Sanpoil River reservoir-type juveniles averaged 54.2% under current conditions, while stayer-type survival was only 35.2% (Table B-4). There is an interesting divergence in survival rates between template and current conditions in both subbasins, with the stayer-type rearing strategy having slightly lower survival and reservoir-type juveniles higher survival under template conditions relative to current (Tables B-4 and B-5). This pattern is most prominent, and significant, in the Sanpoil subbasin given that the results in the select tributaries may be confounded by the low overall abundance potential for spring Chinook.

Prespawn survival in the Sanpoil River under current conditions was approximately 69% compared to a template condition of 79% (Table B-4). The select tributaries had a much lower prespawn survival estimate of only 46-52%, which is consistent with their small size and limited habitat suitability for spring Chinook adult holding through the summer.

Table 3-4. Theoretical Sanpoil River spring Chinook population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	Subpopulation	EDT Performance Metric by Watershed Habitat Scenario									
		Diversity		Eggs per Spawner		Productivity		Capacity		Equilibrium Abundance	
		Template	Current	Template	Current	Template	Current	Template	Current	Template	Current
BiOp	**All Subpopulations**	**39.7%**	**2.0%**	**2493**	**2488**	**2.76**	**2.25**	**659**	**498**	**420**	**277**
	Lower Sanpoil	22.1%	0.8%	2466	2449	2.46	2.49	208	162	124	97
	Middle Sanpoil	37.1%	1.1%	2517	2555	2.77	1.69	70	56	45	23
	West Fork Sanpoil	52.8%	3.1%	2523	2505	2.66	2.01	193	147	121	74
	Upper Sanpoil	36.0%	1.8%	2429	2422	3.02	2.55	178	126	119	76
Moderate	**All Subpopulations**	**31.6%**	**1.3%**	**2493**	**2488**	**2.65**	**2.15**	**578**	**437**	**360**	**234**
	Lower Sanpoil	15.9%	0.5%	2467	2449	2.40	2.35	183	143	107	82
	Middle Sanpoil	28.5%	0.8%	2517	2555	2.69	1.54	61	49	39	17
	West Fork Sanpoil	41.9%	2.2%	2523	2506	2.54	1.91	169	129	103	62
	Upper Sanpoil	29.9%	1.2%	2429	2422	2.88	2.41	156	110	102	65
Low	**All Subpopulations**	**22.3%**	**1.0%**	**2493**	**2488**	**2.54**	**1.99**	**495**	**374**	**300**	**186**
	Lower Sanpoil	10.1%	0.4%	2467	2449	2.24	2.04	157	122	87	62
	Middle Sanpoil	18.5%	0.7%	2517	2555	2.62	1.41	53	42	32	12
	West Fork Sanpoil	30.4%	1.6%	2523	2506	2.44	1.77	145	111	86	48
	Upper Sanpoil	22.0%	0.8%	2429	2422	2.77	2.18	133	94	85	51

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2014 Sanpoil River habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

Note: Results in this table differ from those presented on November 15, 2016 at the Lake Roosevelt Forum Conference. The revised results reflect a calibrated increase in Lake Roosevelt to Wells survival to more closely match Wells to McNary survival (see Appendix A, Table A-1).

Table 3-5. Theoretical Select Tributaries spring Chinook population performance under template and current conditions based on three hypothetical passage survival scenarios at Chief Joseph and Grand Coulee Dams.

Passage Scenario	Subpopulation	EDT Performance Metric by Watershed Habitat Scenario									
		Diversity		Eggs per Spawner		Productivity		Capacity		Equilibrium Abundance	
		Template	Current	Template	Current	Template	Current	Template	Current	Template	Current
BiOp	**All Subpopulations**	**18.5%**	**2.3%**	**2467**	**2449**	**2.9**	**2.3**	**182**	**128**	**119**	**73**
	Barnaby Creek	1.1%	0.0%	2693	2706	2.4	--	11	10	6	--
	Hall Creek	23.3%	2.7%	2466	2448	2.8	2.4	125	87	81	51
	Stranger Creek	12.1%	2.1%	2455	2428	3.1	1.9	44	27	29	13
	Nez Perce Creek	0.8%	0.0%	2473	2569	1.2	--	3	3	1	--
Moderate	**All Subpopulations**	**12.8%**	**1.8%**	**2467**	**2448**	**2.8**	**2.2**	**160**	**112**	**104**	**61**
	Barnaby Creek	0.7%	0.0%	2692	2706	2.2	--	10	9	5	--
	Hall Creek	16.5%	2.0%	2466	2447	2.8	2.3	110	77	71	43
	Stranger Creek	6.9%	1.8%	2454	2427	2.9	1.8	38	24	25	11
	Nez Perce Creek	0.5%	0.0%	2474	2572	1.1	--	3	3	--	--
Low	**All Subpopulations**	**7.6%**	**1.4%**	**2467**	**2448**	**2.8**	**2.0**	**137**	**96**	**88**	**47**
	Barnaby Creek	0.4%	0.0%	2692	2705	1.8	--	8	8	4	--
	Hall Creek	9.9%	1.6%	2466	2447	2.8	2.0	94	66	60	33
	Stranger Creek	3.8%	1.4%	2454	2427	2.6	1.7	33	20	20	8
	Nez Perce Creek	0.0%	0.0%	2475	2572	--	--	2	2	--	--

Passage Scenario: Grand Coulee Dam and Chief Joseph Dam passage assumptions.

BiOp = 95% juvenile downstream/98% adult upstream survival at each dam

Moderate = 90%/97% juvenile/adult survival at each dam

Low = 85%/95% juvenile/adult survival at each dam

Watershed Habitat Scenario:

Template = Restoration ideal based on approximation of historical habitat function in Sanpoil subbasin

Current = Current scenario based on habitat conditions observed in 2013 Select Tributaries habitat surveys, modeled habitat attributes, and extrapolation of conditions from similar watersheds.

Note: Results in this table differ from those presented on November 15, 2016 at the Lake Roosevelt Forum Conference. The revised results reflect a calibrated increase in Lake Roosevelt to Wells survival to more closely match Wells to McNary survival (see Appendix A, Table A-1).

References

Bickford, S.A, T. Kahler, J.R. Skalski, R.L. Townsend, R. Richmond, S. McCutcheon, and R. Fechhelm. 2011. *Project survival estimates for yearling Chinook migrating through the Wells Hydroelectric Project, 2010*. Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. 154 p.

Bickford, S.A., J.R. Skalski, R.L. Townsend, S. McCutcheon, R. Richmond, R. Frith, and R. Fechhelm. 2011. *Project survival estimates for yearling summer steelhead migrating through the Wells Hydroelectric Project, 2000.* Public Utility District No. 1 of Douglas County, East Wenatchee, Washington. 117 p.

Cooney, T. and D. Holzer. 2006. *Interior Columbia Basin Stream-type Chinook and Steelhead Populations: Habitat Intrinsic Potential Analysis.* Appendix C in Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs – Technical Review Draft. Interior Columbia Basin Technical Recovery Team. March 2007.

Crozier L., E. Dorfmeier, T. Marsh, B. Sandford, D. Widener. 2016. *Refining our understanding of early and late migration of adult Upper Columbia spring and Snake River spring/summer Chinook salmon: passage timing, travel time, fallback and survival.* National Marine Fisheries Service, Northwest Fisheries Science Center, Fish Ecology Division, Seattle, WA. 57 p.

Douglas Public Utility District No. 1 (Douglas PUD). 2011. Wells Hydroelectric Project – FERC Project No. 2149 Annual Report – Anadromous Fish Agreement and Habitat Conservation Plan. 2010 Annual Report. Prepared by Douglas PUD for the Federal Energy Regulatory Commission. East Wenatchee, WA. 1107 p.

Douglas PUD. 2016. *Annual Report Calendar Year 2015 of Activities Under the Anadromous Fish Agreement and Habitat Conservation Plan Wells Hydroelectric Project FERC License No. 2149.* Prepared by Anchor QEA and Douglas PUD for the Federal Energy Regulatory Commission. East Wenatchee, WA. 1765 p.

Fish Passage Center (FPC). 2016a. 2015 Annual Report. Fish Passage Center, Portland, OR. 915 p.

FPC. 2016b. *Update of juvenile survival estimates and SARs of Upper Columbia River stocks.* Technical memorandum prepared for the Colville Confederated Tribes, Chief Joseph Hatchery Program by M. DeHart. May 26, 2016. 14 p.

Hillman, T., M. Miller, M. Johnson, C. Moran, J. Williams, M. Tonseth, A. Murdoch, C. Willard, S. Hopkins, B. Ishida, C. Kamphaus, T. Pearsons, and P. Graf. 2016. *Monitoring and evaluation of the Chelan and Grant County PUDs hatchery programs: 2015 annual report.* Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, WA.

ICF International (ICF). 2013. *Technical Memorandum - Proposed modifications of EDT summer steelhead benchmarks and habitat sensitivity curves for redband trout model development*. Prepared for the Colville Confederated Tribes Lake Roosevelt Habitat Improvement Project by ICF. ICF project 00442.12. August 29, 2013.

Keefer, M.L., M.A. Jepson, T.S. Clabough, E.L. Johnson, C.C. Caudill, B. J. Burke, and K. E. Frick. 2015. *Reach conversion rates of radio-tagged Chinook and sockeye salmon and steelhead in the Lower Columbia River, 2013-2014.* Technical Report 2015-8 for the USACE, Portland, OR. 88 pages.

National Marine Fisheries Service (NMFS). 2016. *PIT tag based estimates of FCRPS adult conversion rates adjusted for harvest and straying*. Excel spreadsheet based on analytical data summarized by the National Marine Fisheries Service, Protected Resources Division. Obtained by Chuck Peven, ICF. November 18, 2016.

Northwest Power and Conservation Council (NPCC). 2014. *2014 Columbia River Basin Fish and Wildlife Program.* Available at: http://www.nwcouncil.org/fw/program/2014-12/Program

Peven, C., C. Paulsen and C. Baldwin. 2016. *Progress towards addressing RPA 52. Final 2015 annual report. For period 1/1/15-12/31/15.* Prepared for the Bonneville Power Administration under Project 2008-908-00. 40 p.

Skalski, J. R., R. L. Townsend, T. W. Steig, J. W. Horchik, G. W. Tritt, and A. Grassell. 2003. *Estimation of Rock Island Project passage survival of yearling Chinook salmon smolts in 2003 using acoustic and PIT-tag release-recapture methods.* PUD No. 1 of Chelan County, Wenatchee, WA.

Skalski, J. R., R. L. Townsend, T. W. Steig, P.A. Nealson, K. Kumagai, and A. Grassell. 2005. *Estimation of survival of yearling and subyearling chinook, and sockeye salmon smolts, and steelhead at Rocky Reach and Rock Island projects in 2004 using acoustic and PIT-tag release-recapture methods.* PUD No. 1 of Chelan County, Wenatchee, WA.

Snow, C., C. Frady, D. Grundy, B. Goodman, and A. Murdoch. 2015. *Monitoring and evaluation of the Wells Hatchery and Methow Hatchery programs: 2014 annual report.* Prepared by the Washington Department of Fish and Wildlife for Douglas PUD, Grant PUD, and the Wells HCP Hatchery Committee, East Wenatchee, WA.

Tonseth, M. 2016. *Final Upper Columbia River 2016 BY Salmon and 2017 BY Steelhead Hatchery Program Management Plan and Associated Protocols for Broodstock Collection, Rearing/Release, and Management of Adult Returns.* Technical Memorandum prepared by the Washington Department of Fish and Wildlife for the Chelan, Douglas and Grant County Public Utility Districts, and U.S. Army Corps of Engineers. April 7, 2016.

Upper Columbia United Tribes (UCUT). 2015. *Fish Passage & Reintroduction into the U.S. and Canadian Upper Columbia River Basin.* Joint Paper of The Columbia Basin Tribes and First Nations. Available at: https://ucut.org/wp-content/uploads/2016/09/Fish_Passage_and_Reintroduction_into_the_US_And_Canadian_Upper_Columbia_River4-1.pdf

Zabel, R. 2016. *Preliminary survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2016.* Technical memorandum prepared for Richie Graves, National Marine Fisheries Service by the National Marine Fisheries Service, Northwest Fisheries Science Center, Fish Ecology Division. September 26, 2016. 22 p.

Appendices

Appendix A – Out of Basin Survival Calibration

Table A-1. Comparison of calibrated EDT results to observed juvenile and adult survival rates in the Columbia River migration corridor and Pacific Ocean.

Species	Life Stage	Segment	Calibrated EDT Result	Observed Survival Calibration Metric				Comment
				Mean	Standard Error or (90% CI)	Range	Data Source (time series)	
Steelhead	SAR (Ocean Survival)	BON to BOA	0.040	--	--	--	--	EDT value within observed range for selected time period and conservative relative to mean for available points of comparison
		MCN to BOA	0.030	0.041	(0.029-0.053)	0.013-0.067	FPC 2015 (2006-2012)	
		RRE to BOA	0.020	0.027	(0.019-0.036)	0.009-0.048	FPC 2016b (2008-2012)	
	Adult	BOA to MCN	0.909	0.901	0.074	0.733-0.981	Peven et al. 2016 (2008-2015)	
				0.893	0.049	0.823-0.977	NMFS 2016 (2008-2015)	
		MCN to WLS	0.926	≥0.95	--	--	PUD Pers. Comm.	EDT value comparable to or conservative relative to mean of observed conversion rates
		PRD to WLS	0.948	0.920	--	--	Douglas PUD 2011 (2003-2010)	
		RRE to WLS	0.979	0.986	--	--	Douglas PUD 2016 (2015)	
	Juvenile	Lk Roosevelt to WLS	0.623	--	--	--	--	EDT Lk Roosevelt to WLS survival calibrated to be approximately equal to WLS to MCN survival
		WLS to MCN	0.607	--	--	--	--	
		WLS RES to WLS TLRC	0.950	0.945	0.015	0.943-0.946	Bickford et al. 2001 (1999-2000)	EDT value within SE of observed 1999-2000 mean, likely conservative compared to current survival
		RIS to MCN	0.703	0.609	0.010	0.499-0.739	FPC 2016 (2009-2015)	EDT value within observed range, offsets conservative MCN to BON survival
		MCN to BON	0.747	0.724	0.090	0.487-1.069	Zabel 2016 (2009-2015)	EDT value within SE of Zabel 2009-2015 mean but conservative relative to FPC-calculated mean
		MCN to BON	0.747	0.795	0.016	0.587-0.958	FPC 2016 (2009-2015)	
Summer/Fall Chinook	SAR	BON to BOA	0.046	--	--	--	--	
		MCN to BOA	0.032	0.021	(0.018-0.026)	0.012-0.041	FPC 2016 (2011-2013)	EDT SAR includes jacks, observed SAR has been corrected to account for jacks
		RIS to BOA	0.021	0.012	(0.010-0.015)	0.006-0.021	FPC 2016 (2009-2013)	
	Adult	BOA to MCN	0.926	0.815	--	--	Keefer et al. 2015 (2013-2014)	Observed data record limited to two years.
		BOA to MCN		0.947	0.065	0.896-1.00	NMFS 2016 (2008-2015)	Adult conversion rates for Snake River summer/fall Chinook adjusted for straying and harvest
		MCN to WLS	0.946	≥0.95	--	--	PUD Pers. Comm.	PUDs consider upstream survival to be 98-100% at each project (C. Peven, personal communication)
	Juvenile	Lk Roosevelt to WLS	0.560	--	--	--	--	EDT Lk Roosevelt to WLS survival calibrated to be approximately equal to WLS to MCN survival
		WLS to MCN	0.539	--	--	--	--	
		RIS to MCN	0.659	0.561	0.0585	0.219-0.891	FPC 2016 (2009-2015)	
		WLS RES to MCN	0.528	0.322	0.0438	0.247-0.527	FPC 2016 (2008-2014)	Accuracy of the mean and SE of observed subyearling survival is questionable due to small sample size (C. Peven, personal communication)
		PRD to MCN	0.804	0.673	0.0801	0.500-0.820	FPC 2016 (2008-2014)	
		MCN to BON	0.699	0.649	(0.549-0.843)	0.621-0.743	FPC 2016 (2009-2014)	Mix of data for all stocks, specific data are lacking for comparison of subyearling Upper Columbia summer/fall Chinook survivals

Species	Life Stage	Segment	Calibrated EDT Result	Observed Survival Calibration Metric				Comment
				Mean	Standard Error or (90% CI)	Range	Data Source (time series)	
Spring Chinook	SAR	BON to BOA	0.036	--	--	--	--	EDT SAR includes jacks, observed SAR has been corrected to account for jacks
		MCN to BOA	0.025	0.019	(0.013-0.024)	0.006-0.028	FPC 2016 (2009-2014)	
		RRE to BOA	0.018	0.011	(0.007-0.014)	0.002-0.015	FPC 2016 (2009-2014)	
	Adult	BOA to MCN	0.941	0.966	0.033	0.909-1.00	Peven et al. 2016 (2008-2015)	Within SE of 2008-2015 mean
				0.938	0.063	0.876-1.00	NMFS 2016 (2008-2015)	
		MCN to WLS	0.960	≥0.95	--	--	PUD Pers. Comm.	PUDs consider upstream survival to be 98-100% at each project (C. Peven, personal communication)
		PRD to WLS	0.972	0.956	--	--	Douglas PUD 2011 (2003-2010)	
		RRE to WLS	0.989	1.000	--	--	Douglas PUD 2016 (2015)	EDT value is consistent with high per-project conversion rate estimates
	Juvenile	Lk Roosevelt to WLS	0.595	--	--	--	--	EDT Lk Roosevelt to WLS survival calibrated to be approximately equal to WLS to MCN survival
		WLS to MCN	0.642	--	--	--	--	
		RIS to MCN	0.753	0.667	0.0191	0.489-0.935	FPC 2016 (2009-2015)	RIS to MCN overestimate offset by MCN to BON underestimate
		RRE TLRC to RIS TLRC	0.933	0.942	0.0157	0.897-0.973	Skalski et al. 2010 (2000-2010)	EDT value within SE of 2000-2010 mean
		RRE TLRC to MCN	0.730	0.671	0.0105	0.656-0.686	Bickford et al. 2001 (1999-2000)	Dated study does not reflect post-2008 operational changes, current survival rates higher
		MCN to BON	0.758	0.835	0.092	0.626-1.056	Zabel 2016 (2008-2015)	Within SE of 2009-2015 mean

Appendix B – EDT Life Stage Survival Metrics

Table B-1. EDT life stage survival metrics for Sanpoil River summer steelhead by subpopulation and juvenile rearing strategy.

	Rearing Type	Smolt Age	EDT Life Stage Survival					
			Egg-to-parr		Parr-to-smolt		Prespawn Adult	
			Template	Current	Template	Current	Template	Current
All Subpopulations	Mover	1	0.052	0.051	0.079	0.064	0.826	0.809
		2	0.059	0.060	0.019	0.016	0.838	0.791
		3	0.047	0.051	0.007	0.005	0.792	0.720
	Stayer	1	0.055	0.055	0.088	0.073	0.834	0.811
		2	0.052	0.054	0.016	0.011	0.843	0.821
		3	0.051	0.053	0.007	0.005	0.822	0.809
	Reservoir	1	0.048	0.050	0.088	0.087	0.881	0.867
Lower Sanpoil	Mover	1	0.047	0.049	0.098	0.094	0.776	0.768
		2	0.053	0.071	0.031	0.043	0.773	0.733
		4	0.045	0.071	0.018	0.021	0.705	0.660
	Stayer	1	0.054	0.061	0.092	0.090	0.751	0.716
		2	0.048	0.053	0.020	0.018	0.786	0.777
		3	0.049	0.076	0.014	0.019	0.787	0.796
	Reservoir	1	0.047	0.064	0.099	0.108	0.858	0.852
Middle Sanpoil	Mover	1	0.046	0.042	0.068	0.055	0.854	0.853
		2	0.053	0.048	0.014	0.011	0.841	0.824
		3	0.035	0.034	0.004	0.002	0.849	0.822
	Stayer	1	0.047	0.043	0.074	0.063	0.847	0.843
		2	0.047	0.043	0.013	0.010	0.843	0.850
		3	0.041	0.038	0.004	0.003	0.808	0.776
	Reservoir	1	0.055	0.057	0.083	0.083	0.877	0.877
West Fork Sanpoil	Mover	1	0.052	0.050	0.070	0.050	0.941	0.920
		2	0.060	0.060	0.016	0.010	0.946	0.921
		3	0.046	0.055	0.004	0.003	0.947	0.922
	Stayer	1	0.054	0.051	0.087	0.064	0.943	0.925
		2	0.050	0.050	0.015	0.009	0.946	0.922
		3	0.050	0.059	0.004	0.002	0.945	0.919
	Reservoir	1	0.049	0.059	0.083	0.081	0.933	0.914
Upper Sanpoil	Mover	1	0.060	0.061	0.092	0.080	0.714	0.688
		2	0.065	0.078	0.017	0.017	0.781	0.722
		3	0.056	0.072	0.004	0.002	0.836	0.757
	Stayer	1	0.065	0.066	0.097	0.081	0.754	0.727
		2	0.064	0.070	0.018	0.011	0.768	0.709
		3	0.059	0.065	0.006	0.002	0.756	0.725
	Reservoir	1	0.052	0.057	0.091	0.095	0.837	0.815

Table B-2. EDT life stage survival metrics for Select Tributaries summer steelhead by subpopulation and juvenile rearing strategy.

HUC 10 Subpopulations	Rearing Type	Smolt Age	EDT Life Stage Survival					
			Egg-to-parr		Parr-to-smolt		Prespawn Adult	
			Template	Current	Template	Current	Template	Current
All Subpopulations	Mover	1	0.177	0.183	0.529	0.501	0.448	0.433
		2	0.175	0.185	0.138	0.141	0.441	0.426
		3	0.173	0.199	0.049	0.047	0.430	0.425
	Stayer	1	0.183	0.189	0.516	0.488	0.446	0.429
		2	0.172	0.204	0.155	0.143	0.440	0.420
		3	0.168	0.178	0.065	0.061	0.437	0.419
	Reservoir	1	0.110	0.104	0.640	0.634	0.457	0.447
Barnaby Creek	Mover	1	0.135	0.135	0.498	0.497	0.483	0.467
		2	0.134	0.122	0.058	0.072	0.483	0.466
		3	0.115	0.000	0.026	--	0.483	--
	Stayer	1	0.153	0.141	0.452	0.443	0.484	0.477
		2	0.134	0.149	0.125	0.107	0.482	0.467
		3	0.103	0.115	0.045	0.030	0.486	0.471
	Reservoir	1	0.097	0.075	0.628	0.624	0.483	0.475
Hall Creek	Mover	1	0.188	0.196	0.547	0.503	0.446	0.440
		2	0.183	0.206	0.156	0.143	0.441	0.434
		3	0.184	0.185	0.057	0.059	0.428	0.428
	Stayer	1	0.195	0.196	0.528	0.482	0.441	0.432
		2	0.182	0.209	0.165	0.146	0.439	0.430
		3	0.173	0.202	0.070	0.063	0.432	0.441
	Reservoir	1	0.113	0.112	0.648	0.632	0.440	0.431
Stranger Creek	Mover	1	0.153	0.155	0.470	0.484	0.456	0.421
		2	0.153	0.156	0.098	0.120	0.461	0.426
		3	0.142	0.196	0.029	0.028	0.469	0.446
	Stayer	1	0.160	0.179	0.489	0.516	0.462	0.434
		2	0.148	0.190	0.122	0.153	0.458	0.410
		3	0.157	0.164	0.057	0.063	0.459	0.417
	Reservoir	1	0.104	0.108	0.643	0.639	0.464	0.451
Nez Perce Creek	Mover	1	0.281	0.214	0.677	0.688	0.215	0.238
		2	0.248	0.244	0.338	0.313	0.233	0.235
		3	0.257	0.000	0.160	--	0.153	--
	Stayer	1	0.265	0.242	0.672	0.648	0.265	0.265
		2	0.227	0.153	0.380	0.404	0.225	0.259
		3	0.191	0.000	0.224	--	0.178	--
	Reservoir	1	0.000	0.000	--	--	--	--

Table B-3. EDT life stage survival metrics for Sanpoil River Summer/Fall Chinook salmon by subpopulation and juvenile rearing strategy.

HUC 10 Subpopulation	Rearing Type	Smolt Age	EDT Life Stage Survival					
			Egg-to-parr		Parr-to-smolt		Prespawn Adult	
			Template	Current	Template	Current	Template	Current
All Subpopulations	Ocean-type	0	0.054	0.060	0.892	0.921	0.818	0.700
	Stream-type	1	0.009	0.007	0.183	0.162	0.864	0.742
	Reservoir	1	0.010	0.010	0.595	0.593	0.834	0.666
Lower Sanpoil	Ocean-type	0	0.053	0.059	0.867	0.882	0.808	0.693
	Stream-type	1	0.006	0.00	0.253	--	0.857	--
	Reservoir	1	0.011	0.015	0.585	0.600	0.825	0.701
Middle Sanpoil	Ocean-type	0	0.055	0.063	0.953	0.969	0.836	0.707
	Stream-type	1	0.008	0.00	0.259	--	0.894	--
	Reservoir	1	0.011	0.00	0.607	--	0.864	--
West Fork Sanpoil	Ocean-type	0	0.053	0.054	0.928	0.960	0.817	0.720
	Stream-type	1	0.013	0.00	0.177	--	0.839	--
	Reservoir	1	0.00	0.00	--	--	--	--
Upper Sanpoil	Ocean-type	0	0.057	0.060	0.875	0.935	0.823	0.707
	Stream-type	1	0.017	0.020	0.116	0.149	0.863	0.753
	Reservoir	1	0.010	0.010	0.607	0.603	0.830	0.683

Table B-4. EDT life stage survival metrics for Sanpoil River spring Chinook salmon by subpopulation and juvenile rearing strategy.

HUC 10 Subpopulation	Rearing Type	EDT Life Stage Survival					
		Egg-to-parr		Parr-to-smolt		Prespawn Adult	
		Template	Current	Template	Current	Template	Current
All Subpopulations	Stayer	0.098	0.123	0.281	0.352	0.786	0.696
	Reservoir	0.074	0.099	0.584	0.542	0.785	0.697
Lower Sanpoil	Stayer	0.076	0.144	0.496	0.508	0.777	0.742
	Reservoir	0.068	0.087	0.615	0.579	0.816	0.760
Middle Sanpoil	Stayer	0.091	0.134	0.353	0.347	0.834	0.726
	Reservoir	0.077	0.101	0.571	0.546	0.839	0.619
West Fork Sanpoil	Stayer	0.115	0.120	0.210	0.226	0.806	0.714
	Reservoir	0.080	0.083	0.581	0.553	0.796	0.710
Upper Sanpoil	Stayer	0.117	0.129	0.206	0.263	0.787	0.700
	Reservoir	0.081	0.089	0.572	0.553	0.783	0.681

Table B-5 EDT life stage survival metrics for Select Tributaries spring Chinook salmon by subpopulation and juvenile rearing strategy.

HUC 10 Subpopulation	Rearing Type	EDT Life Stage Survival					
		Egg-to-parr		Parr-to-smolt		Prespawn Adult	
		Template	Current	Template	Current	Template	Current
All Subpopulations	Stayer	0.184	0.166	0.373	0.382	0.566	0.464
	Reservoir	0.169	0.167	0.600	0.596	0.628	0.521
Barnaby Creek	Stayer	0.000	0.000	--	--	--	--
	Reservoir	0.057	0.000	0.582	--	0.924	--
Hall Creek	Stayer	0.185	0.184	0.378	0.347	0.614	0.445
	Reservoir	0.175	0.171	0.601	0.595	0.620	0.513
Stranger Creek	Stayer	0.183	0.168	0.347	0.456	0.586	0.460
	Reservoir	0.125	0.131	0.589	0.601	0.740	0.593
Nez Perce Creek	Stayer	0.265	0.00	0.518	--	0.910	--
	Reservoir	0.00	0.00	--	--	--	--