Required Survival Rate Changes to Meet Technical Recovery Team Abundance and Productivity Viability Criteria for Interior Columbia River Basin Salmon and Steelhead Populations

Interior Columbia Technical Recovery Team

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In this document we describe the "gap" in abundance and productivity between current status and Interior Columbia Technical Recovery Team (ICTRT) abundance and productivity criteria for viable populations. We briefly describe the difference between TRT viability and formal delisting criteria, summarize the analyses we conducted and describe their use in assessing overall ESU status. We also present some general conclusions from these analyses, and finally, provide ESU and population-specific methods and results.

Viability, delisting and recovery

- Technical Recovery Teams (TRTs) define biological viability criteria or recommended biological goals – these describe the biological characteristics of ESUs and their constituent populations that are likely to yield long-term persistence. NOAA Fisheries delisting criteria and broad sense recovery goals are policy constructs that consider biological goals, mitigation of threats, legal obligations, risk tolerance and other considerations.
- TRT viability recommendations have been used and applied by local recovery planners throughout the Pacific Northwest.
- The TRT viability criteria incorporate the four VSP parameters: abundance, productivity, spatial structure and diversity. All four parameters are critical for population and ESU viability.

Quantifying needed changes to meet biological viability criteria

All four VSP parameters contribute to overall population and ESU viability. The ICTRT uses several metrics to describe risk levels associated with spatial structure and diversity. These metrics do not lend themselves well to generating a single summary statistic to quantify a gap, and thus are not included in this document. They are described in current status assessments (nwfsc.noaa.gov/trt/col/trt_current_status_assessments.html).

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- The change from the current condition that is required to meet ICTRT viability criteria for abundance and productivity can be estimated quantitatively. This change has been referred to informally as the "gap", and addresses the VSP parameters abundance and productivity. Preliminary results for six listed ESUs are summarized in the following sections, and are presented to inform ongoing discussions.[1]
- A key part of the "gap" calculation is the productivity of the population. We use a measure of productivity that directly relates to the potential ability for a population to be self-sustaining. The productivity measure used in the gap calculations is expressed in terms of recruits per spawner or the rate at which spawning adults in one generation are replaced by spawning adults in the next generation.

[1] The survival gap analyses were developed to inform Interior Columbia Basin recovery efforts and the Federal Columbia River Hydropower System Biological Opinion Remand process. The quantitative estimates provided in this paper do not in and of themselves constitute a legal determination of current status, recovery or the effect of particular actions under the provisions of the Endangered Species Act.

- This measure of life-cycle productivity is affected by mortality and survival at all life stages, including juvenile mortality (such as the relative number or proportion of juveniles that die while migrating down river) and by adult mortality (such as the relative proportion of adult fish harvested) (Figure 1).
- The gap analyses themselves do not identify or target a particular life stage for actions to achieve viability criteria. Gaps can be addressed by improvements to survival rates at any life stage (e.g., tributary residence, migration, estuarine, early ocean, upstream migration). Formal limiting factors analyses would be the starting point for identifying effective actions.
- As a first step, the ICTRT is engaged in modeling efforts to assess the impact of several factors that may affect the change required from current status, including improvements to survival through the hydropower system, and alternative early ocean survival scenarios which include effects of ocean condition and any delayed or latent mortality attributable to the hydrosystem.
- Studies have indicated lower relative effectiveness of hatchery origin spawners in natural settings in comparison to adults of natural origin. The relative difference in effectiveness has been linked to the degree of difference (level of domestication, etc.) associated with the hatchery stock. For these preliminary gap analyses, we did not directly incorporate relative effectiveness adjustments for hatchery spawners. We do provide examples of the potential impact on gap calculations for Upper Columbia steelhead.

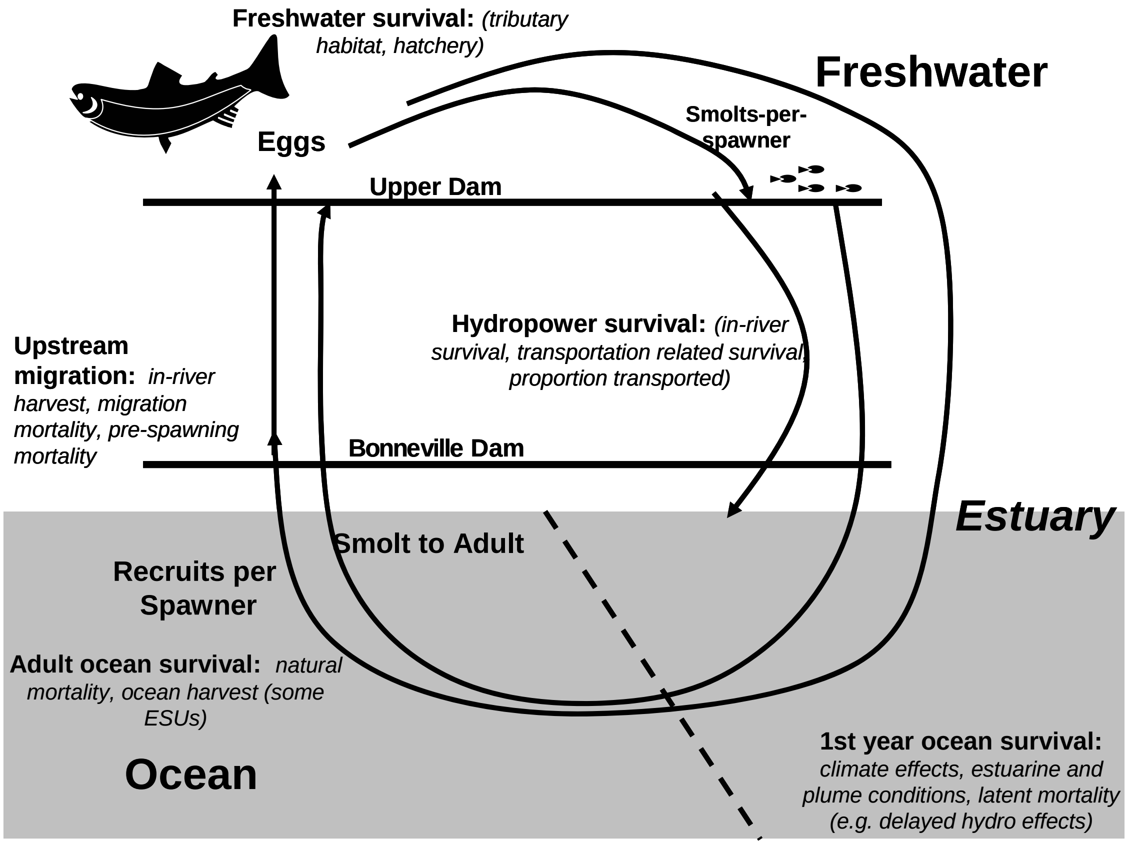

Figure 1: Generalized life cycle for Interior Columbia salmon and steelhead, with factors that contribute to mortality at each stage. The productivity measure (recruits per spawner) that we use encompasses mortality at all stages.

Calculating Observed Survival Gaps

The ICTRT has developed quantitative abundance and productivity criteria for Interior Columbia Basin chinook and steelhead populations using a set of viability curves specific to each Interior Columbia basin listed chinook and steelhead ESU (ICTRT, 2007). Risk levels are expressed in terms of the probability that a population will go extinct over a 100 year time frame (ICTRT, 2005). Draft ICTRT viability criteria for abundance and productivity define a range of risk ratings in terms of the projected probability of extinction over a 100 year period: High (>25% probability of extinction), Moderate (5 to 25% probability), Low risk (< 5%) and Very Low risk (<1%). Theoretically, any combination of abundance and productivity that exceeds a target viability curve would meet the corresponding risk objective.

The current status assessments provide a graphical and narrative comparison of current status relative to the viability curves. Recovery planners would like a method for quantitatively gauging the relative amount of change in survival or capacity required to move a population from current status to a particular viability level. A status assessment includes specific analyses of current levels of abundance, capacity and intrinsic productivity for those populations with sufficient available data (most stream-type Chinook populations and a subset of steelhead populations). Under the ICTRT approach, a population is assigned a current risk level relative to the corresponding viability curves using an estimate of intrinsic productivity (data from the most recent 20 years) and an estimate of recent (10 year geometric mean) natural spawner abundance. The analysis described below provides a quantitative estimate of the gap (if present) between the current abundance and productivity estimates and alternative viability/risk levels for individual populations.

We used results from the abundance and productivity analyses derived for the ICTRT **Current Status Assessments** (ICTRT website) as a starting point in defining Observed gaps at the population level. Observed gaps represent the minimum survival change needed to elevate a particular population from its current status to a point on its target viability curve. We developed estimates for observed productivity gaps using the following analytical steps.

1) Estimate current intrinsic productivity and natural spawner abundance (most recent 20 years of stock-recruit data)

2) Estimate current spawning level associated with achieving juvenile capacity.

3) Assign each population to a category based on its position relative to the viability curve

4) Calculate gap based on the minimum distance from the abundance/productivity point representing current status and the appropriate viability curve.

A detailed description of the methods used in calculating population specific abundance and productivity gaps is provided in Appendix A.

Interpreting the changes needed.

Because the calculations of productivity and abundance we use require several generations of data, the 'observed gap' between those measures and TRT viability criteria do not necessarily reflect survival and productivity under current hydropower management and operations. Similarly, changes in early ocean survival rates or scenarios have the potential to affect strongly the estimate of the gap. Thus, we estimated the gap under three different kinds of scenarios (schematics describing these scenarios are shown in Figures 2 and 3):

- ***Observed Gaps***: These are the empirical estimates of the required change in survival to meet ICTRT abundance and productivity goals (i.e., the gap reflected in data from the most recent 20 years, and identified in the ICTRT's working current status assessments).
- ***Direct Hydro Adjustments***: Estimates of survival through the hydropower system for the past 5 years have been consistently higher than the recent twenty year average. As a result, gaps for affected populations may have been reduced. The Direct Hydro Adjustments scenarios are run under the assumption that the recent improvements in survivals will continue. We also include results incorporating the estimated survival changes associated with projected mainstem hydropower system operational scenarios. For these prospective modeling runs, we used COMPASS results produced in May 2007 for the FCRPS Biological Opinion (COMPASS 2007). The projected survival changes incorporated into the gap modeling analyses described in this summary do not include estimated impacts of proposed habitat and hatchery actions under discussion in the hydro system Biological Opinion Remand process. Future returns will allow us to evaluate whether these improvements have been realized.
- ***Projected Gaps under Alternative Early Ocean Survivals***: Because early ocean survival has a strong effect on life-cycle productivity, we modeled a range of scenarios at this stage (see below).

Ongoing and future degradation in other arenas (e.g. freshwater habitat, etc.) may also alter survival rates. In addition, restoration and protection measures and other actions aimed at salmon recovery could reduce the gap. With respect to harvest, the observed gaps analyses incorporate estimates of annual harvest rates for each modeled population. The projected gaps analyses carry forward the recent average specific to each population. We have not developed scenarios to address the potential impacts of changes in these areas (e.g., further habitat degradation or restoration, changes in harvest management) on population gaps. The matrix modeling tool we used to assess the alternative hydropower and climate scenarios can be used to evaluate the impacts of estimated changes in life stage survivals or capacities as they are developed through recovery planning. Because of all these factors, the effective survival needed to realize ICTRT abundance and productivity goals may be greater or less than the current observed gap. Thus, an adaptive recovery strategy will be important as we move forward in recovery planning.

Early ocean survival scenarios – modeling alternative futures

Early ocean survival is a critical component of overall life-cycle productivity. This stage includes both natural and anthropogenic mortality in the ocean and in the estuary until the fishes' third birthday, and any latent mortality attributable to the hydropower system. We examined a variety of ocean and in-river indices potentially predicting early ocean survival and developed statistical models incorporating multiple indices of environmental conditions during outmigration and early ocean residence (ICTRT & Zabel, 2007). The analyses highlighted relationships between annual survival and combinations involving monthly Pacific Decadal Oscillation (PDO) indices; regional indices of Columbia River water travel time (WTT), indicators of overall freshwater and in-river conditions; and an index of coastal upwelling. We examined a range of scenarios affecting that survival.

Alternate Environmental Scenarios

At this time, it is not technically possible to identify the most likely specific future conditions for any of these alternative predictors. Thus, for those ESUs with sufficient available information, we provide estimates of gaps given three alternative future environmental scenarios that bound a likely plausible range of future scenarios.

- *Recent*: Ocean survivals over the next hundred years have the same characteristics (average and year to year variations) as those experienced over the time period of our current status assessments (brood years 1978-1999; outmigration years 1980-2001).
- *Historical*: Ocean survivals over the next hundred years have the same characteristics (average and year to year variations) as those experienced over the past 60 years (length is determined by availability of specific index data).
- *Pessimistic (Warm PDO):* Ocean survivals over the next hundred years have the same characteristics (average and year to year variations) as those experienced by the 1975-97 brood years. These years corresponded to extremely poor climatic conditions and poor measured early ocean survival rates.

We used outputs from our life cycle modeling assessment of representative populations from listed Interior Columbia ESUs (ICTRT & Zabel, 2007) to estimate the potential impact of alternative climate and hydropower scenarios (Table 1). Survival multipliers (expressed as change in intrinsic productivity) for each alternative future climate or hydropower scenario were calculated as ratios relative to the corresponding estimates generated by the model using the Observed gap inputs.

For Snake Fall Chinook the records available and the lack of pre-existing analyses make it much more difficult to generate estimates of the relative contributions of climate variations vs. recent changes in hydropower system related juvenile survivals on annual return rates. However, we analyzed two variations on the recent time series to illustrate the impact of alternative assumptions regarding the continuation of recent increases in life cycle survivals for Snake River fall chinook.

Table 1.Intrinsic productivity multipliers (return per spawner at low parent escapement abundance) for alternative climate and hydro scenarios. Calculated using modeling results summarized in ICTRT & Zabel, 2007 (Table 7a) expressed as a ratio of model estimated Mean R/S at low density to recent observed estimate. Insufficient data for direct modeling for Upper Columbia steelhead; applied Upper Columbia Chinook hydropower scenario results, average of Snake River and Mid Columbia climate scenario multipliers.

ESU	Climate Scenario		Hydro Scenario	
	Historical	Warm PDO	Current	Projected BiOp
Snake Spring/Summer Chinook	1.37	0.88	1.12	1.18
Upper Columbia Spring Chinook	1.44	0.97	1.18	1.29
Snake River Steelhead	1.19	0.98		
Mid-Columbia Steelhead	1.11	0.98		
4 dams Yakima, Walla Walla, Touchet			1.03	1.09
3 dams Umatilla, Rock Cr.			1.02	1.07
2 dams Deschutes, Fifteen Mile			1.01	1.05
1 dam Klickitat			1.01	1.02
Upper Columbia Steelhead	1.15	0.98	1.18	1.29

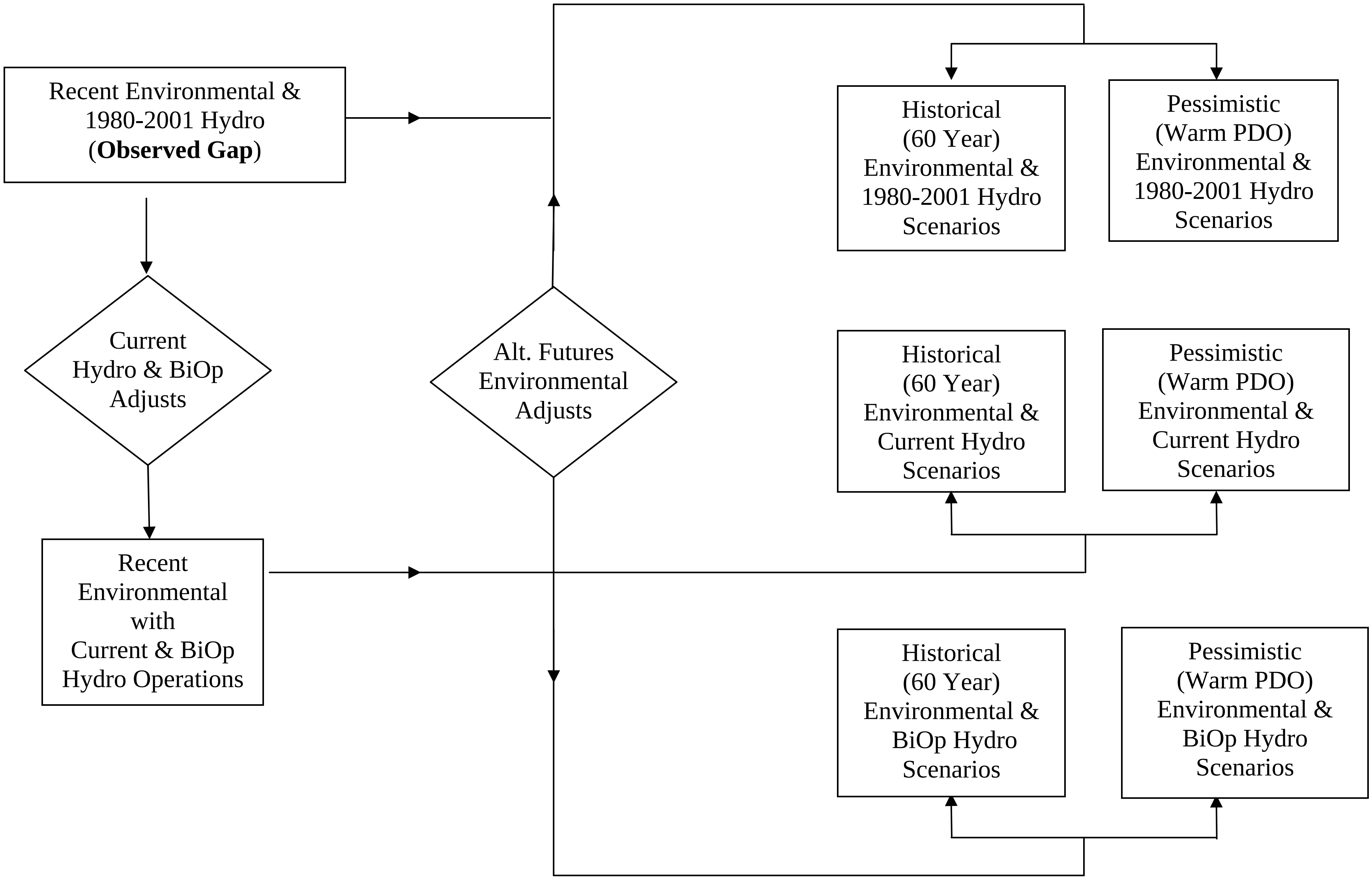

Figure 2. Flow chart demonstrating the adjustments to the Observed Gap, to represent scenarios generated by different combinations of hydropower operational and future environmental scenarios (see text for description of alternatives). All boxes represent entries in the accompanying tables. Diamonds represent model-based adjustments.

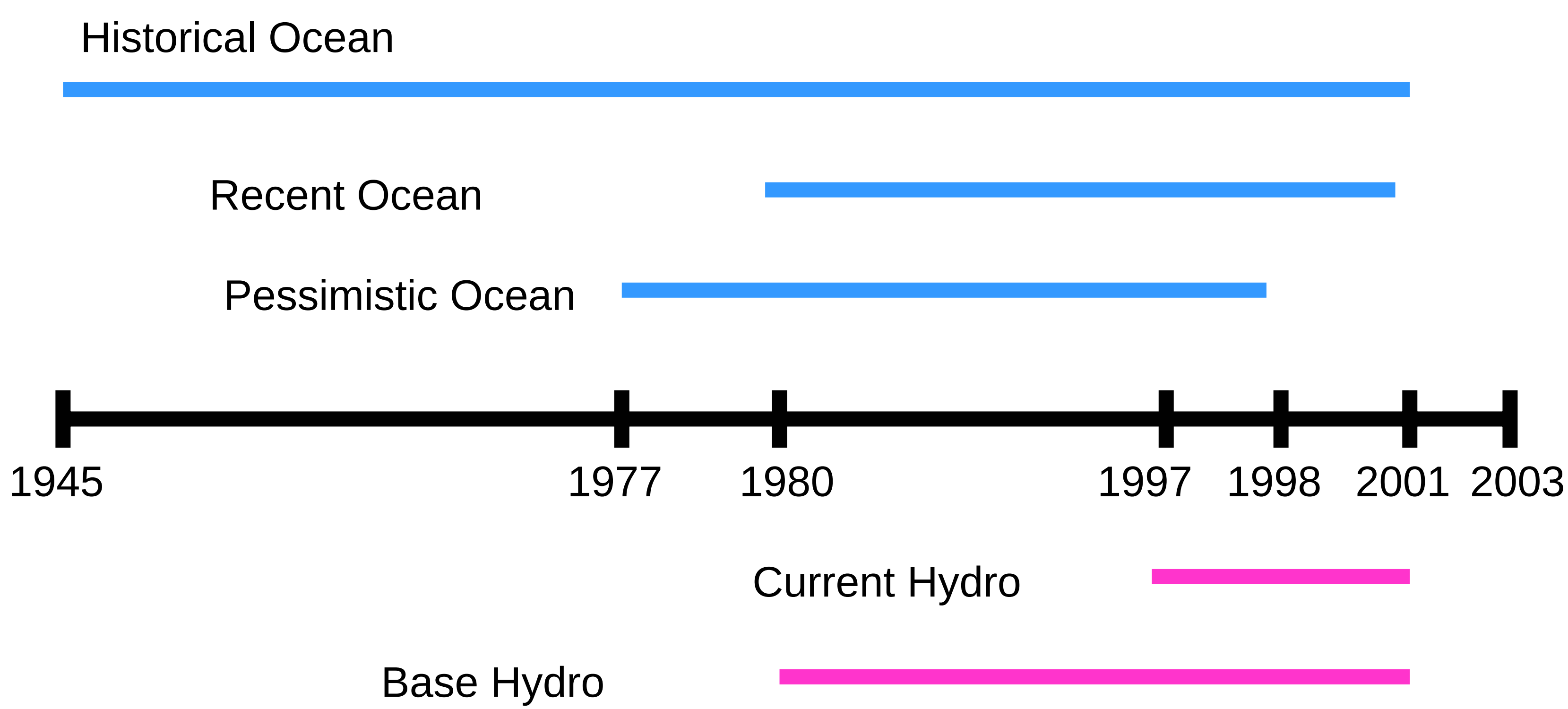

Figure 3. Timeline (not to scale) showing years/conditions incorporated into each early ocean survival and hydro scenario presented in this memo.

ESU Viability

The “gaps” shown in the attached tables (and summarized in Figures 4 (a, b)) reflect the level of improvement in survivals across the life cycle needed to return a particular population to a level of abundance and productivity the TRT associates with abundance and productivity goals for viability given the corresponding assumption regarding future climate conditions. Under the ESU level viability criteria developed by the ICTRT approximately one-half of the populations within each major population grouping must, at a minimum, exhibit less than a 5% extinction risk. Therefore not all population survival gaps need to be completely filled in order for an ESU to be considered to meet the ICTRT viability criteria.

Achieving biological viability criteria -- general conclusions

- Increases in population productivity required to meet viability criteria vary with
    - ESU and population
    - Early ocean survival patterns
    - Level of risk (e.g. 1% or 5% extinction risk)
- We provide a graphical summary of the population level survival increases required relative to the ICTRT abundance/productivity criteria in Figures 2(a, b).

- Survival increases required to meet the 1% risk level criteria would need to be approximately 1.3 to 1.5 times higher relative to the increases required to achieve the 5% criteria.
- Survivals under current hydropower operations are improved relative to the average levels affecting the returns used in calculating recent average abundance and productivity levels (see details in ICTRT & Zabel, 2007).
- For most populations, improving hydropower survival to levels anticipated by 2014 in the 2004 Biological Opinion will mitigate risk (reduce the total required change), but will not be sufficient by itself to meet viability criteria (projected improvements in hydropower survival is approximately 2% for Snake River spring/summer Chinook and 10% for Upper Columbia spring chinook).
- Early ocean survival is a strong determinant of overall productivity; thus any factor affecting survival at that stage, including prolonged periods of poor ocean conditions, estuarine or plume conditions, or latent mortality attributable to the hydropower system have the potential to change the overall required survival change substantially.
- Current abundance levels for populations in the Snake River and Upper Columbia chinook ESUs are well below the minimum thresholds defined in the ICTRT viability criteria (Tables 3a, 4a). Addressing the deficits in population specific productivity levels identified in the accompanying tables will contribute to rebuilding. Actually achieving abundance and productivity criteria will require a sustained and significant response by the populations.
- The ICTRT has developed alternative methods for buffering against high levels of uncertainty in population abundance and productivity estimates. We used a second

risk test[2] to determine alternative adjusted gap estimates for those populations with sufficiently high productivity standard errors. The second risk test was designed to reduce the probability that the actual population risk was greater than 25% in 100 years to less than 1 in 20 (at 5% risk) and 1 in 100 (1% risk).

Because data available to support this analysis varied from ESU to ESU, and in some cases from population to population, we present a more detailed summary of ESU specific methods and results below. The sections for each ESU contain a brief narrative summarizing the availability of population specific abundance and productivity data along with results of the Observed and Projected A/P Gaps analyses. Those results are described in the context of ICTRT ESU and Major Population Grouping level viability criteria. We also provide a comparative summary of the median and range of the estimated A/P Gaps within each listed Upper Columbia River ESU in Table 2.

[2] Method B1 as described in ICTRT Dec. 2005 Viability Update Memo

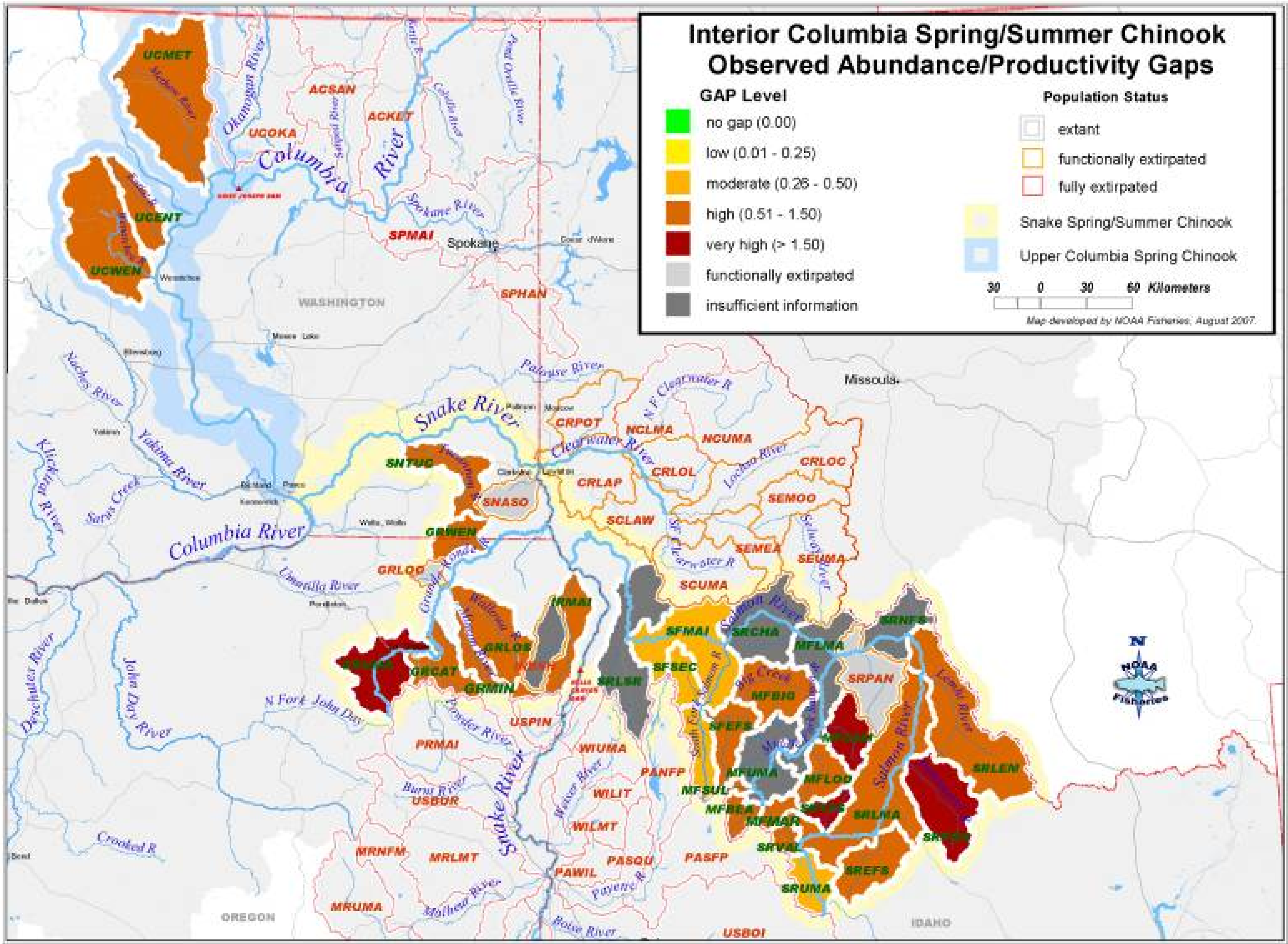
Interior Columbia Spring/Summer Chinook
Observed Abundance/Productivity Gaps
GAP Level
no gap (0.00)
low (0.01 - 0.25)
moderate (0.26 - 0.50)
high (0.51 - 1.50)
very high (> 1.50)
functionally extirpated
insufficient information
Population Status
extant
functionally extirpated
fully extirpated
Snake Spring/Summer Chinook
Upper Columbia Spring Chinook
30 0 30 60 Kilometers
Map developed by NOAA Fisheries, August 2007.
UCMET
UCENT
UCWEN
ACSAN
UCOKA
ACKET
SPMAI
Spokane
SPHAN
WASHINGTON
Columbia River
Okanogan River
Spokane River
Snake River
Clearwater River
Missoula
CRPOT
NCLMA
NCUMA
CRLOL
CRLOC
CRLAP
SEMOO
SCLAW
SEMEA
SEUMA
SCUMA
SNTUC
SNASO
GRWEN
GRLOO
GRCAT
GRLOS
GRMIN
IRMAI
SFMAI
SRCHA
MFLMA
SRNFS
SFSEC
SRLSR
MFBIG
SRPAN
SFEFS
MFUMA
MFLOD
SRLEM
MFSUL
MFBEA
MFMAR
SRLMA
SRVAL
SREFS
SRUMA
USPIN
PRMAI
WIUMA
PANFP
WILIT
WILMT
USBUR
MRNFM
MRLMT
PAWIL
PASQU
PASFP
MRUMA
USBOI
OREGON
IDAHO
Salmon River
Lemhi River
Grande Ronde R
Powder River
John Day River
Deschutes River
Umatilla River
Yakima River
Klickitat River
Malheur River
Payette R
Boise River
Weiser River
Crooked R
NOAA Fisheries

Figure 4a

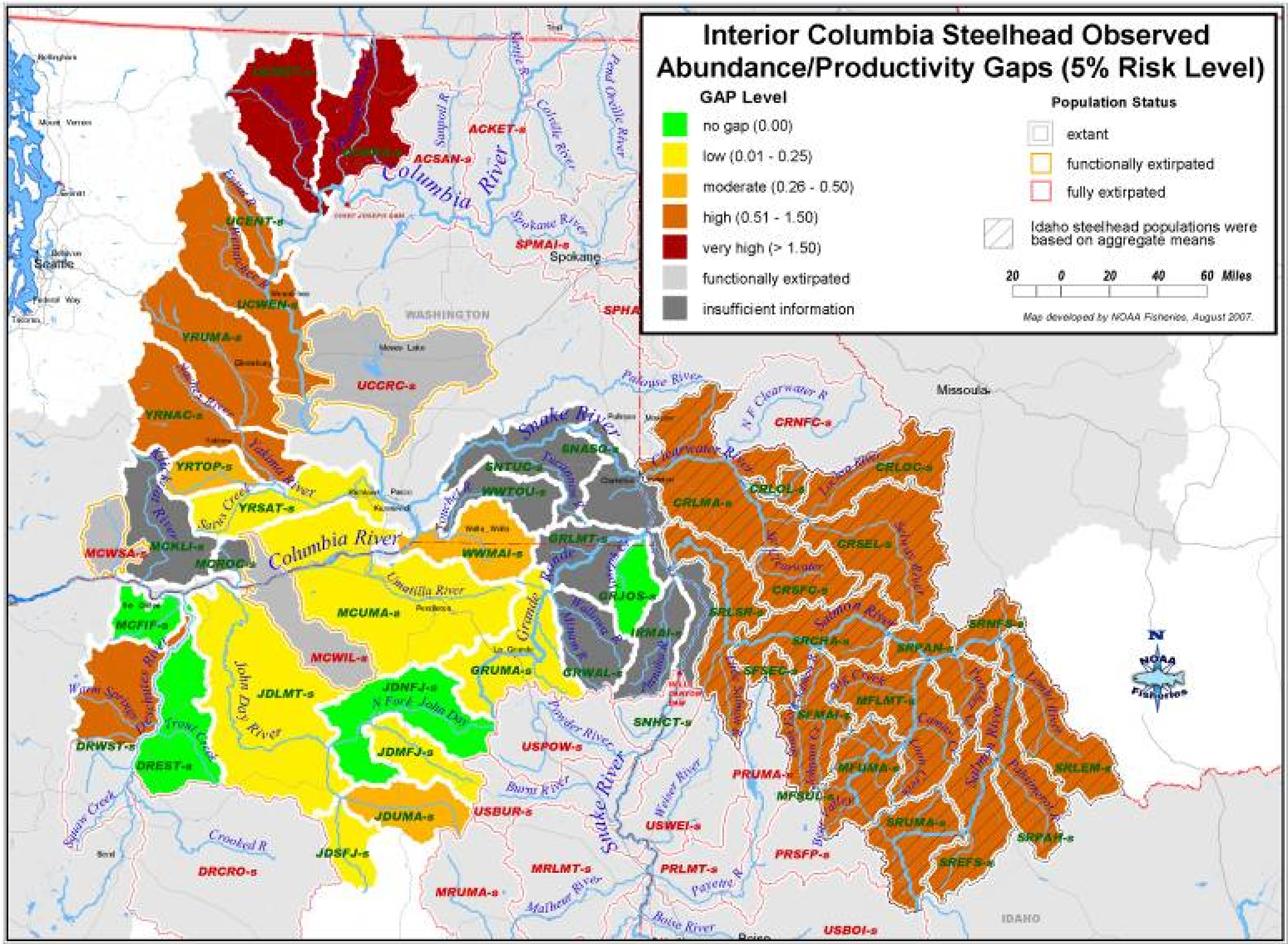
Interior Columbia Steelhead Observed
Abundance/Productivity Gaps (5% Risk Level)
GAP Level
no gap (0.00)
low (0.01 - 0.25)
moderate (0.26 - 0.50)
high (0.51 - 1.50)
very high (> 1.50)
functionally extirpated
insufficient information
Population Status
extant
functionally extirpated
fully extirpated
Idaho steelhead populations were based on aggregate means
20 0 20 40 60 Miles
Map developed by NOAA Fisheries, August 2007.
Columbia River
Snake River
Clearwater River
Salmon River
John Day River
Umatilla River
Grande Ronde
Yakima River
WASHINGTON
IDAHO
Spokane
Seattle
Missoula
UCENT-s
UCWEN-s
YRUMA-s
YRNAC-s
YRTOP-s
YRSAT-s
UCCRC-s
ACKET-s
ACSAN-s
SPMAI-s
MCWSA-s
MCKLI-s
MCROC-s
MCFIF-s
MCUMA-s
MCWIL-s
WWMAI-s
WWTOU-s
SNTUC-s
SNASO-s
GRLMT-s
GRJOS-s
IRMAI-s
GRUMA-s
GRWAL-s
JDLMT-s
JDNFJ-s
JDMFJ-s
JDUMA-s
JDSFJ-s
DRWST-s
DREST-s
DRCRO-s
USPOW-s
USBUR-s
SNHCT-s
USWEI-s
MRLMT-s
MRUMA-s
PRLMT-s
PRUMA-s
PRSFP-s
USBOI-s
CRNFC-s
CRLMA-s
CRLOL-s
CRLOC-s
CRSEL-s
CRSFC-s
SRLSR-s
SRCHA-s
SFSEC-s
SFMAI-s
MFLMT-s
MFUMA-s
MFBIG-s
SRPAN-s
SRNFS-s
SRLEM-s
SRUMA-s
SRPAH-s
SREFS-s
NOAA Fisheries

Figure 4b

Table 2. Survival change necessary for populations to meet IC-TRT abundance and productivity viability goals under alternate scenarios, summarized by ESU. Median values across populations within ESUs are presented in each cell, with the range in parentheses. Negative values indicate that estimated abundance/productivity exceeds the corresponding viability curve. Note: no available climate or hydro scenario estimates are available for Snake River Fall chinook, observed gaps presented for two time periods (1978-2001, 1990-2001). Upper Columbia Steelhead environmental and hydro scenarios generated with Upper Columbia spring chinook survival change estimates. Snake River Steelhead estimates based on limited number of data series (2 Grande Ronde populations and average a and b run surrogate populations).

Scenario	Snake River Spring/Summer Chinook	Upper Columbia Spring Chinook	Snake River Fall Chinook (1978-2001,1990-2001)	Middle Columbia Steelhead	Snake River Steelhead	Upper Columbia Steelhead
Observed (25%)	0.20 (0.01, 1.60)	0.59 (0.39, 0.76)	0.12 , 0.00	-0.01 (-0.58, 0.11)	-0.01 (-.64, 0.22)	1.17 (0.18, 7.67)
Observed (5%)	1.15 (0.32, 3.09)	1.03 (0.73 , 1.44)	0.27, 0.02	0.22 (-0.49, 1.50)	0.42 (-0.59, 0.85)	2.55 (0.66, 9.07)
Observed (1%)	2.02 (0.60, 6.08)	1.25 (1.05, 2.06)	0.38, 0.19	0.22 (-0.38, 1.50)	0.46 (-0.54, 0.85)	3.34 (0.73, 11.09)
Projected Gap (5%) Under Recent Ocean (same as observed above)						
Multiple Index Model						
Observed	1.15 (0.32, 3.09)	1.03 (0.73, 1.44)	xx (xx, xx)	0.22 (-0.48, 1.50)	0.42 (-0.59, 0.85)	2.55 (0.66, 9.07)
Hydro (Adjusted to Current)	0.92 (0.20, 2.65)	0.72 (0.47, 1.07)	xx (xx, xx)	0.19 (-0.49, 1.43)	0.46 (-0.58, 0.90)	2.23 (0.41, 7.84)
Hydro (Adjstd to BiOp est.)	0.82 (0.14, 2.47)	0.57 (0.34, 0.89)		0.12 (-0.52, 1.25)	0.56 (-0.55, 1.03)	1.95 (0.29, 7.09)
Projected Gap (5%) Under Historical Ocean						
Multiple Index Model						
Observed	0.57 (0.05, 1.99)	0.41 (0.20, 0.70)	xx (xx, xx)	0.10 (- 0.54, 1.25)	0.19 (-0.66, 0.55)	2.31 (0.44, 8.07)
Hydro (Adjusted to Current)	0.40 (-0.06, 1.67)	0.19 (0.02, 0.44)	xx (xx, xx)	0.07 (-0.55, 1.19)	0.23 (-0.65, 0.60)	1.81 (0.22, 6.69)
Hydro (Adjstd to BiOp est.)	0.33 (-0.11, 1.53)	0.09 (-0.07, 0.32)		0.01 (-0.57, 1.06)	0.31 (-0.62, 0.70)	1.57 (0.12, 5.03)
Projected Gap (5%) Under Pessimistic Ocean						
Multiple Index Model						
Observed	1.44 (0.50, 3.65)	1.09 (0.79, 1.52)	xx (xx, xx)	0.25 (-0.48, 1.55)	0.45 (-0.58, 0.88)	2.88 (0.70, 9.64)
Hydro (Adjusted to Current)	1.18 (0.36, 3.15)	0.77 (0.51, 1.14)	xx (xx, xx)	0.21 (-0.49, 1.48)	0.49 (-0.57, 0.94)	2.29 (0.44, 8.02)
Hydro (Adjstd to BiOp est.)	1.07 (0.27, 2.94)	0.62 (0.39, 0.95)		0.14 (-0.51, 1.33)	0.59 (-0.54, 1.07)	2.01 (0.31, 7.25)

Population Survival Gaps

Snake River Spring/Summer Chinook ESU

Population specific current abundance/productivity estimates, status ratings and Observed A/P Gaps results are summarized in Table 3a. Recent Hydro Adjusted A/P Gaps and Projected A/P Gaps results relative to 25%, 5% and 1% viability curves are summarized in Table 3b.

Summary by Major Population Grouping

The following summaries, organized by Major Population Grouping (MPG), describe the Observed Gaps and the range in resulting Projected Gaps for Snake River Spring/Summer Chinook populations. The MPG summaries include the all population MPG median A/P Gap estimates from the Observed Gap analysis and for the most optimistic Projected Gap scenario analyzed, the Historical Ocean (PDO Index) combined with Recent Hydro Adjusted. Each MPG narrative also highlights the range in population level A/P gaps for a minimum set corresponding to meeting ICTRT MPG level viability criteria.

Lower Snake MPG

The Tucannon River population is the only extant population in this grouping. Average survival at low to moderate abundance would need to increase by a factor of 1.23 (123%) to meet the 5% risk criteria for the Observed Gap. Exceeding the 1% risk curve from the Observed Gap would require a 2.48 improvement in cumulative life cycle survival.

At the 5% risk level, the Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.40. Under this scenario for the 1% risk level, the Projected A/P Gap was 1.27.

Grande Ronde/Imnaha MPG

Six of the eight historical populations in this grouping are considered extant, the median Observed A/P Gap (relative to the 5% viability curve) is 1.04. Four populations must exceed the 5% risk curve to meet ICTRT MPG objectives. Several combinations of viable individual populations could meet the ICTRT criteria, the set with the lowest gaps would include: Minam R. (0.73), Imnaha R. (1.23), Lostine R. (1.04). We analyzed two alternative scenarios for Catherine Creek. Under the assumption that high contributions of outside origin stock have temporarily depressed productivity, the remaining gap for Catherine Creek would be 0.59. If natural productivities remain at the recent average, the gap would be 1.00. The Minam River population and Catherine Creek (hatchery effect) alternative) would require the least improvement in survival to achieve High Viability (1% risk curve) with an Observed Gaps of 0.70 and 0.24, respectively. .

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.29. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be 0.00 to 1.58. The Minam River population gap relative to the 1% risk criteria under this scenario would be 0.70.

South Fork Salmon MPG

All three of the historical populations in this region are extant and two must meet viability criteria for the MPG to be considered at low risk. The median Observed A/P Gap (relative to the 5% viability curve) is 0.45. ICTRT criteria call for two populations from this group exceeding the 5% risk curve, with one of those achieving the 1% risk level. The Observed Gap relative to the 5% risk level ranged from 0.32 (South Fork Mainstem) to 1.33 (the East Fork/Johnson Creek population). The South Fork population would require the least improvement in survival to achieve High Viability (1% risk curve) with an Observed Gap of 0.92.

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was -0.14. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be 0.03 to 0.83. Under this scenario, the South Fork population is projected to achieve the 1% risk curve with a survival improvement of 0.30.

Middle Fork Salmon MPG

All nine of the historical populations in this MPG are currently extant, five would need to meet or exceed the ICTRT viability criteria. The median baseline gap (5% risk curve/threshold) for this grouping is 1.27. Several combinations of viable individual populations could meet the ICTRT criteria, the set with the lowest gaps would include: Bear Valley (0.65), Big Creek (1.34), Loon Creek (1.11), Marsh Creek (1.19). The data set for Chamberlain Creek indicates relatively high productivity, missing years in the series resulted in insufficient data for specifically calculating gaps. The Bear Valley population exhibited the lowest baseline gap relative to the 1% risk criteria (0.99).

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.48. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be 0.08 to 0.76. Under this scenario, the Bear Valley population would project to achieve the 1% risk curve with a survival improvement of 0.30.

Upper Salmon MPG

Eight of the nine historical populations in this MPG are currently extant. A minimum of five would need to meet or exceed the ICTRT viability criteria. The median Observed A/P Gap (relative to the 5% viability curve) is 1.07. The minimum set of populations to meet ICTRT MPG criteria would include: Valley Creek (1.07), Upper Salmon River (0.44), East Fork Salmon River (0.82), Pahsimeroi River (2.17) and Lemhi River (1.07). The Upper Salmon River population exhibited the lowest baseline gap relative to the 1% risk criteria (0.68).

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.30. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be -0.06 to 1.07. Under this scenario, the Upper Salmon River population would project to achieve the 1% risk curve with a survival improvement of 0.10.

Table 3a. SNAKE RIVER SPRING/SUMMER CHINOOK ESU. Population level statistics and observed gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
SR Spring/Summer Chinook														
Tucannon River	750	82	5-667	53%	0.79	0.14	H	H	0.08	0.49	1.23	2.48		
Asotin Creek	500	Functionally Extirpated												
Catherine Creek	750	107	38-420	29%	0.89	0.24	H	M	0.08	0.33	0.98	2.09	1.00	
Catherine (no hatchery yrs)	750	107	38-421	29%	1.28	0.07	H	M	0.08	0.05	0.59	0.97		
Lostine River	1000	276	85-812	28%	0.78	0.22	H	M	0.08	0.50	1.03	1.95	1.04	
Minam River	750	337	142-638	4%	1.02	0.21	H	M	0.08	0.16	0.73	1.70		
Imnaha River	750	380	124-2217	65%	0.79	0.11	H	M	0.08	0.44	1.23	2.48		
Wenaha River	750	376	48-750	5%	0.74	0.19	H	M	0.08	0.54	1.38	2.72		
Upper Grande Ronde	1000	38	4-140	23%	0.42	0.41	H	H	0.08	1.60	2.76	4.48	3.09	4.84
Big Sheep Creek[a]	500	4	0-170	38%	0.29	0.44	H	H	0.08					
Lookingglass Creek	500	Functionally Extirpated												
South Fork Mainstem	1000	601	112-1873	38%	1.20	0.20	H	M	0.08	0.03	0.32	0.92		
Secesh River	750	403	86-1228	4%	1.21	0.13	H	L	0.08	0.05	0.45	1.27		
East Fork Johnson	1000	105	20-579	10%	0.97	0.28	H	L	0.08	0.29	1.33	1.70		
Little Salmon River	500	Insufficient Data												
Big Creek	1000	90	5-662	0%	1.22	0.21	H	M	0.08	0.09	1.34	1.64		
Bear Valley Creek	750	182	15-1232	0%	1.46	0.17	H	L	0.08	0.02	0.65	0.99		
Marsh Creek	500	42	0-599	0%	1.01	0.22	H	L	0.08	0.25	1.19	3.75		
Sulphur Creek	500	21	0-178	0%	1.05	0.38	H	M	0.08	0.21	1.40	3.57	1.42	
Camas Creek	500	28	0-261	0%	0.83	0.32	H	M	0.08	0.42	1.66	4.78	1.70	
Loon Creek	500	51	0-611	0%	1.06	0.31	H	M	0.08	0.20	1.08	3.53	1.11	
Chamberlain Creek	500	223			2.45	0.52								
Lower Middle Fork Salmon	500	Insufficient Data												
Upper Middle Fork Salmon	750	Insufficient Data												
Lemhi River	2000	79	10-582	0%	1.07	0.26	H	L	0.08	0.19	1.03	1.22		
Valley Creek	500	34	0-292	0%	1.07	0.24	H	H	0.08	0.19	1.07	3.49		
Yankee Fork	500	13	0-153	0%	0.68	0.31	H	H	0.08	0.74	2.25	6.06	2.28	
Upper Salmon River	1000	246	91-567	25%	1.51	0.22	H	M	0.08	0.01	0.44	0.68		
North Fork Salmon River	500	Insufficient Data												
Lower Salmon River	2000	103	37-378	0%	1.22	0.18	H	L	0.08	0.08	1.36	1.52		
East Fork Salmon River	1000	148	9-598	8%	1.07	0.27	H	H	0.08	0.18	0.82	1.15		
Pahsimeroi River	1000	127	45-316	42%	0.54	0.37	H	H	0.08	1.04	1.93	3.26	2.17	3.46
Panther Creek	750	Functionally Extirpated												

a. Big Sheep Population (Imnaha River). Viability data are presented, however population is considered functionally extinct.

b. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap.

Table 3b. SNAKE RIVER SPRING/SUMMER CHINOOK ESU. Required change in survival projected to meet abundance and productivity criteria for 25%, 5% and 1% Risk Curves under a range of ocean/hydropower survival scenarios. Projected A/P Gap is the survival improvement projected as necessary to meet particular risk criteria after accounting for survival adjustment at average hydropower and harvest survival levels. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average.

SR Spring/Summer Chinook	Estimated Abundance/Productivity Gap Scenarios (25% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Lower Snake																		
Tucannon River	0.49	0.33	0.27				0.09	-0.03	-0.08				0.70	0.52	0.44			
Asotin Creek																		
Grande Ronde / Imnaha																		
Catherine Creek	0.33	0.18	0.12				-0.03	-0.14	-0.18				0.51	0.35	0.28			
Catherine (no hatchery yrs)	0.05	-0.06	-0.11				-0.23	-0.31	-0.35				0.20	0.07	0.02			
Lostine River	0.50	0.34	0.27				0.09	-0.02	-0.07				0.70	0.52	0.44			
Minam River	0.16	0.03	-0.02				-0.16	-0.25	-0.28				0.31	0.17	0.11			
Imnaha River	0.44	0.29	0.22				0.05	-0.06	-0.11				0.64	0.46	0.39			
Wenaha River	0.54	0.38	0.31				0.12	0.00	-0.05				0.75	0.56	0.48			
Upper Grande Ronde	1.60	1.32	1.20				0.89	0.69	0.61				1.95	1.63	1.50			
Big Sheep Creek																		
Lookingglass Creek																		
South Fork Salmon																		
South Fork Mainstem	0.03	-0.07	-0.12				-0.25	-0.32	-0.36				0.16	0.04	-0.01			
Secesh River	0.05	-0.05	-0.10				-0.23	-0.30	-0.34				0.19	0.06	0.01			
East Fork Johnson	0.29	0.17	0.11				-0.06	-0.14	-0.19				0.46	0.31	0.24			
Little Salmon River																		
Middle Fork Salmon																		
Big Creek	0.09	-0.03	-0.08				-0.20	-0.29	-0.33				0.24	0.11	0.05			
Bear Valley Creek	0.02	-0.09	-0.14				-0.26	-0.33	-0.37				0.16	0.04	-0.02			
Marsh Creek	0.25	0.11	0.06				-0.09	-0.19	-0.23				0.42	0.27	0.20			
Sulphur Creek	0.21	0.08	0.03				-0.12	-0.21	-0.25				0.37	0.23	0.16			
Camas Creek	0.42	0.27	0.20				0.04	-0.07	-0.12				0.62	0.44	0.37			
Loon Creek	0.20	0.07	0.02				-0.13	-0.22	-0.26				0.36	0.22	0.15			
Chamberlain Creek																		
Lower Middle Fork Salmon																		
Upper Middle Fork Salmon																		
Upper Salmon																		
Lemhi River																		
Lemhi River - 2	0.19	0.06	0.01				-0.13	-0.23	-0.27				0.35	0.20	0.14			
Valley Creek	0.19	0.06	0.01				-0.13	-0.23	-0.27				0.35	0.20	0.14			
Yankee Fork	0.74	0.55	0.47				0.27	0.13	0.07				0.97	0.76	0.67			
Upper Salmon River	0.01	-0.10	-0.15				-0.27	-0.34	-0.38				0.14	0.02	-0.03			
North Fork Salmon River																		
Lower Salmon River	0.08	-0.03	-0.08				-0.21	-0.29	-0.33				0.23	0.10	0.04			
East Fork Salmon River	0.18	0.05	0.00				-0.14	-0.23	-0.27				0.34	0.19	0.13			
Pahsimeroi River	1.04	0.82	0.73				0.49	0.33	0.26				1.31	1.07	0.96			
Panther Creek																		

Table 3b. (Continued)

SR Spring/Summer Chinook	Estimated Abundance/Productivity Gap Scenarios (5% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Lower Snake																		
Tucannon River	1.23	0.99	0.89				0.63	0.45	0.38				1.53	1.26	1.15			
Asotin Creek																		
Grande Ronde / Imnaha																		
Catherine Creek*	1.00	0.78	0.69				0.46	0.30	0.23				1.27	1.03	0.92			
Catherine (no hatchery yrs)	0.59	0.42	0.34				0.16	0.03	-0.02				0.80	0.61	0.53			
Lostine River*	1.04	0.82	0.73				0.49	0.33	0.26				1.32	1.07	0.97			
Minam River	0.73	0.54	0.46				0.26	0.12	0.07				0.96	0.75	0.66			
Imnaha River	1.23	0.99	0.89				0.63	0.45	0.38				1.53	1.26	1.15			
Wenaha River	1.38	1.12	1.02				0.74	0.55	0.47				1.70	1.41	1.29			
Upper Grande Ronde*	3.09	2.65	2.47				1.99	1.67	1.53				3.65	3.15	2.94			
Big Sheep Creeka																		
Lookingglass Creek																		
South Fork Salmon																		
South Fork Mainstem	0.32	0.20	0.14				0.14	0.03	-0.04				0.50	0.36	0.27			
Secesh River	0.45	0.32	0.25				0.25	0.14	0.06				0.65	0.50	0.40			
East Fork Johnson	1.33	1.12	1.01				1.01	0.83	0.70				1.65	1.41	1.24			
Little Salmon River																		
Middle Fork Salmon																		
Big Creek	1.34	1.09	0.99				0.71	0.53	0.45				1.66	1.38	1.26			
Bear Valley Creek	0.65	0.47	0.40				0.21	0.08	0.02				0.88	0.68	0.59			
Marsh Creek	1.19	0.95	0.85				0.60	0.43	0.35				1.49	1.22	1.11			
Sulphur Creek*	1.42	1.16	1.05				0.77	0.58	0.50				1.75	1.45	1.33			
Camas Creek*	1.70	1.41	1.29				0.97	0.76	0.67				2.07	1.74	1.60			
Loon Creek*	1.11	0.89	0.79				0.54	0.38	0.31				1.40	1.14	1.03			
Chamberlain Creek																		
Lower Middle Fork Salmon																		
Upper Middle Fork Salmon																		
Upper Salmon																		
Lemhi River	1.03	0.82	0.72				0.48	0.33	0.26				1.31	1.06	0.96			
Valley Creek	1.07	0.84	0.75				0.51	0.35	0.28				1.35	1.10	0.99			
Yankee Fork*	2.28	1.93	1.78				1.39	1.14	1.03				2.73	2.33	2.16			
Upper Salmon River	0.44	0.29	0.22				0.05	-0.06	-0.11				0.64	0.46	0.39			
North Fork Salmon River																		
Lower Salmon River	1.36	1.11	1.00				0.72	0.54	0.46				1.68	1.40	1.27			
East Fork Salmon River	0.82	0.62	0.54				0.33	0.18	0.12				1.06	0.84	0.75			
Pahsimeroi River*	2.17	1.83	1.69				1.32	1.07	0.96				2.61	2.22	2.06			
Panther Creek																		

Table 3b. (Continued)

SR Spring/Summer Chinook	Estimated Abundance/Productivity Gap Scenarios (1% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Lower Snake																		
Tucannon River	2.48	2.11	1.95				1.54	1.27	1.15				2.96	2.53	2.35			
Asotin Creek																		
Grande Ronde / Imnaha																		
Catherine Creek	2.09	1.76	1.62				1.26	1.01	0.91				2.51	2.14	1.98			
Catherine (no hatchery yrs)	0.97	0.76	0.67				0.44	0.29	0.22				1.24	1.00	0.90			
Lostine River	1.95	1.63	1.50				1.15	0.92	0.82				2.35	1.99	1.84			
Minam River	1.70	1.41	1.28				0.97	0.76	0.67				2.06	1.74	1.60			
Imnaha River	2.48	2.11	1.95				1.54	1.27	1.15				2.96	2.53	2.35			
Wenaha River	2.72	2.32	2.15				1.71	1.42	1.30				3.22	2.77	2.58			
Upper Grande Ronde*	4.84	4.21	3.95				3.26	2.81	2.61				5.64	4.92	4.62			
Big Sheep Creeka																		
Lookingglass Creek																		
South Fork Salmon																		
South Fork Mainstem	0.92	0.74	0.65				0.65	0.50	0.40				1.20	1.00	0.90			
Secesh River	1.27	1.07	0.96				0.96	0.78	0.66				1.61	1.37	1.25			
East Fork Johnson	1.70	1.46	1.33				1.33	1.12	0.97				2.11	1.82	1.68			
Little Salmon River																		
Middle Fork Salmon																		
Big Creek	1.64	1.36	1.24				0.93	0.72	0.63				2.00	1.68	1.54			
Bear Valley Creek	0.99	0.78	0.69				0.45	0.30	0.23				1.26	1.02	0.92			
Marsh Creek	3.75	3.24	3.03				2.47	2.10	1.94				4.40	3.82	3.58			
Sulphur Creek	3.57	3.08	2.87				2.34	1.98	1.83				4.19	3.64	3.40			
Camas Creek	4.78	4.16	3.90				3.22	2.77	2.58				5.57	4.87	4.57			
Loon Creek	3.53	3.04	2.84				2.31	1.95	1.80				4.15	3.59	3.36			
Chamberlain Creek																		
Lower Middle Fork Salmon																		
Upper Middle Fork Salmon																		
Upper Salmon																		
Lemhi River	1.22	0.98	0.88				0.62	0.44	0.37				1.52	1.25	1.13			
Valley Creek	3.49	3.01	2.80				2.27	1.92	1.77				4.10	3.55	3.32			
Yankee Fork	6.06	5.30	4.98				4.15	3.60	3.37				7.02	6.16	5.80			
Upper Salmon River	0.68	0.50	0.42				0.23	0.10	0.04				0.91	0.70	0.62			
North Fork Salmon River																		
Lower Salmon River	1.52	1.25	1.14				0.84	0.64	0.56				1.86	1.56	1.43			
East Fork Salmon River	1.15	0.92	0.82				0.57	0.40	0.33				1.45	1.18	1.07			
Pahsimeroi River*	3.46	2.98	2.78				2.26	1.91	1.76				4.07	3.53	3.30			
Panther Creek																		

Upper Grand Ronde and Catherine Creek substantially reduced from historical capacity.
Lostine/Wallowa may require increase in functional spawning/rearing capacity to meet abundance threshold in combination with the survival improvements indicated in this analysis.
Chamberlain Creek; Trend data with missing years, increased escapements in recent years
[1] Lemhi and Pahsimeroi are substantially reduced from historical capacity. Lemhi productivity gap analysis extremely sensitive to current capacity estimate. 1) includes assumption capacity is at 1950/60s level. 2) gap if capacities remain at levels indicated by current analysis.
Data sets insufficient for productivity/abundance assessments for North Fork Salmon River population. Gaps for these likely at mid to high end of range for Upper Salmon populations.

Upper Columbia Spring Chinook ESU

This ESU is currently limited to three extant populations in one Major Population Grouping. The MPG supported a fourth population in the Okanogan River basin, it is functionally extinct. Two additional MPGs likely existed, the tributaries that supported them are now cut off from anadromous access by Grand Coulee and Chief Joseph Dams.

Population specific current abundance/productivity estimates, status ratings and Observed A/P Gaps results are summarized in Table 4a. Recent Hydro Adjusted A/P Gaps and Projected A/P Gaps results relative to 25%, 5% and 1% viability curves are summarized in Table 4b.

The median base period gap (5% risk curve) for the three extant populations in this ESU is 1.03, ranging from 0.73 (0.89 with error buffer) for the Wenatchee to 1.44 (Entiat). The ICTRT has recommended that two populations from this group be targeted for very low risk to compensate, in part, for the loss of the upriver populations in this ESU. The baseline gaps relative to a 1% risk curve for the Wenatchee and the Methow are 1.05 and 1.75, respectively.

Under the Historical ocean scenario and assuming recent average hydropower system related survivals continue, the median 5% risk gap would decrease to 0.19 (0.02 to 0.44). The gaps relative to the 1% risk curve under this scenario would be 0.20 and 0.62 for the Wenatchee and Methow populations, respectively.

Table 4a. UPPER COLUMBIA SPRING CHINOOK ESU. Population level statistics and observed gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
Upper Columbia Chinook														
Wenatchee	2000	222	18-1779	38%	0.93	0.28	H	H	0.08	0.39	0.73	1.05	0.86	1.24
Methow	2000	180	20-1694	48%	0.8	0.25	H	H	0.08	0.59	1.03	1.75	1.09	
Entiat	500	59	10-174	131%	0.72	0.16	H	H	1.08	0.76	1.44	2.06		

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap.

Table 4b. UPPER COLUMBIA SPRING CHINOOK ESU. Required change in survival projected to meet abundance and productivity criteria. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average levels.

Upper Columbia Chinook	Estimated Abundance/Productivity Gap Scenarios (25% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Upper Columbia Chinook																		
Wenatchee	0.39	0.18	0.08				-0.04	-0.18	-0.25				0.43	0.21	0.11			
Methow	0.59	0.35	0.23				0.10	-0.07	-0.15				0.64	0.39	0.27			
Entiat	0.76	0.49	0.37				0.22	0.04	-0.05				0.82	0.54	0.41			

Upper Columbia Chinook	Estimated Abundance/Productivity Gap Scenarios (5% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Upper Columbia Chinook																		
Wenatchee	0.73	0.47	0.34				0.20	0.02	-0.07				0.79	0.51	0.39			
Methow	1.03	0.72	0.57				0.41	0.19	0.09				1.09	0.77	0.62			
Entiat	1.44	1.07	0.89				0.70	0.44	0.32				1.52	1.14	0.95			

Upper Columbia Chinook	Estimated Abundance/Productivity Gap Scenarios (1% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Upper Columbia Chinook																		
Wenatchee	1.05	0.73	0.59				0.42	0.20	0.10				1.11	0.79	0.63			
Methow	1.75	1.33	1.13				0.91	0.62	0.48				1.84	1.40	1.20			
Entiat	2.06	1.59	1.37				1.12	0.80	0.64				2.15	1.67	1.44			

Snake River Fall Chinook ESU

The ICTRT has concluded that the Snake River drainage historically supported three populations of fall chinook. At present, only one of the three historical populations is extant (mainstem and tributaries below Hells Canyon). The extirpated mainstem populations above the Hells Canyon dam complex were relatively large and productive, dominating production for this ESU. The following gaps analysis focuses on productivity and abundance of the extant population (Table 5). Re-establishing natural production in the historical core production areas above the Hells Canyon complex would substantially reduce risks to the long-term persistence of this ESU.

Considerations

A number of factors had the potential to significantly influence return rates during the period examined including:

- relatively short time series of representative data
- lack of a demonstrated surrogate for tracking annual variations in ocean survival
- changes in ocean and in-river exploitation rates over time and significant changes in hydropower/transportation over the past 10-15 years
- increasing presence of multiple life history patterns (Connor, et al. 2005).

Downstream passage survival: Available data clearly indicates that the hydropower system has a major affect on migration and rearing survivals for Snake River fall chinook. At this point we do not have a model for use in partitioning out downstream passage mortalities for Snake River fall chinook. Contributing factors include: the lack of a complete and consistent measure of outmigrating smolts over a substantial period of years, the potential influence of the significant changes in hydropower operations since the listing in the early 1990s, and the increasing presence of multiple life history patterns in fall chinook (Connor, et al. 2005). We are continuing to explore the use of available data sets in simple life cycle and passage models for application to Snake River fall chinook.

Year-to-Year Fluctuations in Ocean Survival: At this time, a direct SAR series representative of naturally produced Snake River fall chinook is not available.

Harvest: We used estimated annual exploitation rates generated by the Columbia River Technical Advisory Committee (TAC) as the basis for a harvest rate index.

Current Productivity and Abundance

We analyzed two time series, brood years 1977-2001 brood and 1990-2001. By definition the longer series captures more of the potential year-to-year variations in survival rates, but it also bridges across two distinctly different sets of in-river conditions and hydropower operations. The more recent period (1990-2001) corresponds to a period of relatively consistent harvest and hydropower operations with reduced impacts on Snake River fall chinook. It is difficult to separate variations in ocean survivals from potential changes in hydropower impacts without comparative measures of juvenile passage survivals under current operations or a representative measure of ocean survival rates. Based on the 1977-2001 brood time series, the average survival gap relative to the 5% viability curve would be 0.27 and the gap relative to the 1% viability curve would be 0.38. Assuming the average productivity estimated derived from the more recent (1990-2001) the estimated survival gap would be 0.02 (0.20 after incorporating error buffer) relative to the 5% viability curve and 0.19 (0.41 after incorporating error buffer) relative to the 1% viability curve. At this time, it is reasonable to assume that the current A/P Gap falls within the range defined by the two recent scenarios.

Table 5. SNAKE RIVER FALL CHINOOK ESU. Required change in survival projected to meet abundance/productivity criteria. No direct SAR or hydropower survival time series. Gap estimates are expressed as a proportion of life stage survivals, and are based on a 1977 to 2004 data series. Two alternative scenarios were used in the assessment of this population: "Baseline" (averages over the 1977-2001 brood year returns), and "Recent" (averages over the 1990-99 brood year returns). The recent period reflects improved transportation, flow and temperature patterns during rearing/migration period, increasing presence of reservoir resident form. Gap estimates for this population are PRELIMINARY.

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
Snake River Fall Chinook														
Fall Chinook (1977-2001)	3000	1273	306-5083	0.54	1	0.11	H			0.12	0.27	0.38	0.27	0.38
Fall Chinook (1990-2001)	3000	1273	306-5083	0.54	1.26	0.22	M			0.00	0.02	0.19	0.20	0.41

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

Mid Columbia Steelhead ESU

This ESU includes four MPGs, each with multiple extant populations. Relative population status varies widely across this ESU. In general, the populations in the Yakima MPG have the largest A/P gaps relative to TRT viability criteria. Several populations in this ESU have relatively high productivities but are falling short of meeting natural abundance criteria. Under the simple algebraic rules we used for estimating survival gaps, these populations are generally driven by achieving threshold abundance levels. The ICTRT is evaluating available information to determine if adjustment factors can be calculated for any recent changes in hydropower survival or for longer term ocean/climate impacts. The following summaries reflect results of the Observed Gap analyses.

Population specific current abundance/productivity estimates, status ratings and Observed A/P Gaps results are summarized in Table 6a. Recent Hydro Adjusted A/P Gaps and Projected A/P Gaps results relative to 25%, 5% and 1% viability curves are summarized in Table 6b. Population specific results are organized by MPG in each table.

Eastern Cascades MPG

This group of populations occupies drainages from the eastern slopes of the Cascade mountain range that enter the mainstem Columbia upstream from the Hood River. Two extant populations in this MPG do not have sufficient data series to calculate abundance and productivity estimates - Klickitat and Rock Creek. Abundance estimates for the Klickitat can be inferred from fishery monitoring information and redd count data (for some years), although the series is not sufficient to estimate a population specific productivity and survival gap. Five of the seven populations in this MPG are currently extant. Under ICTRT guidelines, four of the seven populations in this grouping need to meet low risk viability criteria, the remaining three extant populations must be maintained. The median Observed survival gap (5% risk curve) for the populations in this group with sufficient information to generate productivity estimates is 0.21, ranging from -0.34 (Deschutes Eastside) to 0.78 (Deschutes Westside).

Under the Historical Ocean/Current Hydropower survival scenario, two out of the three populations with sufficient data to allow for gap calculation in the Eastern Cascades MPG would be projected to exceed the 5% and the 1% abundance/productivity criteria.

John Day Basin MPG

The ICTRT identified five populations in this MPG, contained entirely within the John Day River basin. A minimum of three populations in the MPG must meet low risk viability criteria under the proposed ICTRT criteria. The median gap (relative to 5% risk curve) for this grouping is 0.09. The North Fork John Day population is the only steelhead population in the Interior Columbia basin that currently meets the ICTRT Very Low Risk criteria (exceeds 1% risk curve). The largest gaps in this grouping are associated with the South Fork (0.34) and the Lower Mainstem populations (0.11).

Four out of the five populations in this MPG would exceed both the 5% and the 1% abundance/productivity risk criteria under the Historical Ocean/Current Hydropower scenario projections. The exception would be the South Fork John Day population.

Umatilla/Walla Walla MPG

This grouping of three extant and one functionally extirpated populations occupies drainages entering the Columbia downstream of the confluence with the Snake River. Data series for the extant populations are relatively short, therefore gap estimates based on these series should be considered preliminary. The Umatilla (0.09) and Walla Walla mainstem (0.34) are the closest to achieving the 5% risk. Of the two populations in this MPG with sufficient data to estimate gaps, the Umatilla River would require the smallest improvement to achieve 1% risk criteria (gap of 0.12 relative to observed productivity).

Under the Historical climate/Current Hydrosystem scenario, the Umatilla population would project to achieve the 5% and the 1% risk levels.

Yakima River MPG

There are four extant populations in this MPG. The median gap relative to the 5% risk curve for this MPG is 1.04. Gaps range from 0.22 (Satus Creek, considering tributary spawning habitat only) to 1.16 (Upper Yakima). Potential spawning areas in the mainstem lower Yakima are included in the Satus Creek population under the general ICTRT criteria for defining historical populations. These areas do not currently support spawning. Including consideration for the mainstem areas would increase the gap for Satus Creek to 1.51. Two populations are required to meet low risk criteria for the ESU, the other two must be maintained. At a minimum this would require restoring Satus and Naches River (gaps =1.50/0.22 and 0.50 respectively).

The median gap for populations in the Yakima River MPG under the Historical Ocean/Current hydropower scenario would be reduced to 0.79. None of the four populations in this MPG would meet the 5% risk criteria under this scenario, although the gap for the Satus Creek population would be reduced to 1.19/0.07.

Table 6a: Mid Columbia Steelhead ESU. Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncerta
										25%	5%	1%	Adjusted 5% Gap
Middle Columbia Steelhead													
Deschutes (westside)	1000	456	108-1283	0.26	1.05	0.15	M	M		0.14	0.78	0.92	
Deschutes (eastside)	1000	1599	401-8274	0.39	1.89	0.27	L	M		-0.46	-0.34	-0.20	
Klickitat River	1000						M	M					
Fifteenmile Creek	500	703	231-1922	0	1.82	0.2	L	L		-0.01	-0.21	-0.03	
Rock Creek	500	Insufficient Data					H	M					
White Salmon	500	Functionally Extirpated					N/A	N/A					
Upper Yakima River	1500	85	40-265	0.02	1.09	0.22	H	H		0.11	1.15	1.27	
Naches River	1500	472	142-1454	0.06	1.12	0.22	M	M		0.04	1.03	1.16	
Toppenish River	500	322	57-1252	0.06	1.60	0.3	M	M		0.00	0.50	0.50	
Satus Creek	1000	379	138-1032	0.06	1.40	0.15	M	M		-0.01	1.50	1.50	
Satus Creek (Trib only)	500	379	138-1033	0.06	1.73	0.14	M	M		-0.01	0.22	0.22	
John Day Lower Mainstem	2250	1800	911-6257	0.1	2.99	0.24	M	M		0.00	0.11	0.11	
John Day North Fork	1500	1740	961-3444	0.08	2.41	0.22	VL	L		-0.58	-0.49	-0.38	
John Day Upper Mainstem	1000	524	326-1344	0.08	2.14	0.33	M	L		-0.02	0.37	0.37	
John Day Middle Fork	1000	756	195-2639	0.08	2.45	0.16	M	L		0.00	0.08	0.08	
John Day South Fork	500	259	110-830	0.08	2.06	0.27	M	L		-0.02	0.22	0.22	
Umatilla River	1500	1472	771-3542	0.36	1.50	0.15	M	M		-0.32	0.09	0.09	
Walla Walla Mainstem	1000	650	270-1746	0.02	1.34	0.12	M	M		-0.08	0.34	0.45	
Touchet River	1000	Insufficient Data					H	M					
Willow Creek	1000	Functionally Extirpated					N/A	N/A					

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

Table 6b. Mid Columbia Steelhead ESU. Required change in survival projected to meet abundance and productivity criteria for 25%,5% and 1% risk curves under a range of ocean/hydropower survival scenarios. Projected A/P Gap is the survival improvement projected as necessary to meet particular risk criteria after accounting for survival adjustment at average hydropower and harvest survival levels. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average.

Middle Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios (25% Risk Curve)								
	Recent Ocean Survival			Historical Ocean Survival			Pessimistic Ocean Survival		
	PDO/WTT/UPW Model			PDO/WTT/UPW Model			PDO/WTT/UPW Model		
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro
Middle Columbia Steelhead									
Deschutes (westside)	0.14	0.13	0.09	0.03	0.02	-0.02	0.17	0.15	0.11
Deschutes (eastside)	-0.46	-0.47	-0.48	-0.51	-0.52	-0.54	-0.45	-0.46	-0.47
Klickitat River									
Fifteenmile Creek	-0.01	-0.02	-0.05	-0.10	-0.12	-0.14	0.01	0.00	-0.03
Rock Creek									
White Salmon									
Upper Yakima River	0.11	0.08	0.01	0.00	-0.03	-0.09	0.13	0.10	0.03
Naches River	0.04	0.01	-0.05	-0.07	-0.09	-0.15	0.06	0.03	-0.03
Toppenish River	0.00	-0.03	-0.09	-0.10	-0.12	-0.18	0.02	-0.01	-0.07
Satus Creek	-0.01	-0.03	-0.09	-0.11	-0.13	-0.18	0.01	-0.01	-0.07
Satus Creek (Trib only)	-0.01	-0.03	-0.09	-0.10	-0.13	-0.18	0.01	-0.01	-0.07
John Day Lower Mainstem	0.00	-0.02	-0.06	-0.10	-0.11	-0.16	0.02	0.00	-0.04
John Day North Fork	-0.58	-0.59	-0.60	-0.62	-0.63	-0.64	-0.57	-0.58	-0.60
John Day Upper Mainstem	-0.02	-0.04	-0.08	-0.12	-0.13	-0.17	0.00	-0.02	-0.06
John Day Middle Fork	0.00	-0.02	-0.07	-0.10	-0.12	-0.16	0.02	0.00	-0.05
John Day South Fork	-0.02	-0.04	-0.09	-0.12	-0.14	-0.18	0.00	-0.02	-0.07
Umatilla River	-0.32	-0.33	-0.36	-0.39	-0.40	-0.43	-0.31	-0.32	-0.35
Walla Walla Mainstem	-0.08	-0.11	-0.16	-0.17	-0.19	-0.24	-0.06	-0.09	-0.14
Touchet River									
Willow Creek									

Table 6b continued

Middle Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios (5% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Middle Columbia Steelhead																		
Deschutes (westside)	0.78	0.76	0.70				0.60	0.58	0.53				0.82	0.79	0.74			
Deschutes (eastside)	-0.34	-0.35	-0.37				-0.40	-0.41	-0.43				-0.33	-0.33	-0.35			
Klickitat River																		
Fifteenmile Creek	-0.21	-0.22	-0.25				-0.29	-0.30	-0.32				-0.20	-0.21	-0.23			
Rock Creek																		
White Salmon																		
Upper Yakima River	1.15	1.10	0.97				0.94	0.89	0.77				1.20	1.14	1.01			
Naches River	1.03	0.98	0.86				0.83	0.79	0.68				1.08	1.02	0.90			
Toppenish River	0.50	0.46	0.37				0.35	0.32	0.24				0.53	0.49	0.40			
Satus Creek	1.50	1.43	1.28				1.25	1.19	1.06				1.55	1.48	1.33			
Satus Creek (Trib only)	0.22	0.19	0.12				0.10	0.07	0.01				0.25	0.21	0.14			
John Day Lower Mainstem	0.11	0.09	0.04				0.00	-0.02	-0.06				0.14	0.11	0.06			
John Day North Fork	-0.49	-0.50	-0.52				-0.54	-0.55	-0.57				-0.48	-0.49	-0.51			
John Day Upper Mainstem	0.00	-0.02	-0.07				-0.10	-0.12	-0.16				0.02	0.00	-0.05			
John Day Middle Fork	0.09	0.07	0.02				-0.01	-0.03	-0.08				0.12	0.09	0.04			
John Day South Fork	0.34	0.31	0.25				0.21	0.18	0.13				0.37	0.34	0.28			
Umatilla River	0.09	0.07	0.02				-0.01	-0.03	-0.08				0.12	0.09	0.04			
Walla Walla Mainstem	0.34	0.30	0.22				0.21	0.17	0.10				0.37	0.33	0.25			
Touchet River																		
Willow Creek																		

Table 6b continued

Middle Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios (1% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Middle Columbia Steelhead																		
Deschutes (westside)	0.92	0.89	0.83				0.73	0.71	0.65				0.96	0.93	0.87			
Deschutes (eastside)*	0.05	0.04	0.00				-0.06	-0.07	-0.10				0.07	0.06	0.02			
Klickitat River																		
Fifteenmile Creek*	0.09	0.08	0.04				-0.02	-0.03	-0.06				0.11	0.10	0.07			
Rock Creek																		
White Salmon																		
Upper Yakima River	1.27	1.21	1.08				1.05	0.99	0.87				1.32	1.26	1.12			
Naches River	1.16	1.10	0.97				0.94	0.89	0.77				1.20	1.14	1.01			
Toppenish River*	0.57	0.53	0.43				0.41	0.38	0.29				0.60	0.56	0.46			
Satus Creek	1.50	1.43	1.28				1.25	1.19	1.06				1.55	1.48	1.33			
Satus Creek (Trib only)	0.22	0.19	0.12				0.10	0.07	0.01				0.25	0.21	0.14			
John Day Lower Mainstem	0.11	0.09	0.04				0.00	-0.02	-0.06				0.14	0.11	0.06			
John Day North Fork	-0.38	-0.39	-0.42				-0.44	-0.45	-0.48				-0.37	-0.38	-0.41			
John Day Upper Mainstem	0.00	-0.02	-0.07				-0.10	-0.12	-0.16				0.02	0.00	-0.05			
John Day Middle Fork	0.12	0.10	0.05				0.01	-0.01	-0.06				0.15	0.12	0.07			
John Day South Fork	0.45	0.42	0.35				0.30	0.28	0.22				0.48	0.45	0.38			
Umatilla River*	0.12	0.10	0.05				0.01	-0.01	-0.06				0.15	0.12	0.07			
Walla Walla Mainstem	0.45	0.41	0.32				0.30	0.27	0.19				0.48	0.44	0.35			
Touchet River																		
Willow Creek																		

Snake River Steelhead ESU

This ESU includes 20 extant populations occupying drainages to the mainstem Snake River, the Grand Ronde River, the Clearwater River and the Salmon River. Population specific adult abundance trend data sets are generally not available for Snake River steelhead populations. The steelhead populations in this ESU are all summer run, spawning in late spring and early summer. As a result of environmental conditions during the spawning period, it can be difficult to conduct representative surveys of the number of spawners within specific populations using redd counts or fish counts.

We have sufficient information to calculate preliminary gap analyses for two populations in the Grande Ronde MPG (Joseph Creek and Upper Grande Ronde). These populations have relatively high natural abundance and productivity levels. We generated preliminary estimates of average population abundance and productivity for the remaining Snake basin populations using Lower Granite wild dam counts. This analysis assumes that hatchery returns over Lower Granite Dam are generally accounted for as rack returns, harvest, or localized spawning in the vicinity of major release points (Herb Pollard, NOAA Fisheries Boise Office, pers. comm.). We developed estimates for two average populations representing the remaining populations within this ESU, each representing a major run type (A and B). For B run steelhead populations, we estimated productivity and abundance characteristics for an average population, assuming that natural origin returns over Lower Granite Dam were allocated proportionally among populations. The Grand Ronde populations with specific data series are classified as A run steelhead. We subtracted the estimated natural origin returns accounted for in the Grand Ronde populations from the count of natural origin A run steelhead at Lower Granite Dam. We assumed the resulting abundance time series represented the remaining A run populations and calculated abundance and productivity gaps. The majority of populations in both the A run and B run components of this ESU are classified within the Intermediate size grouping, with a minimum abundance threshold of 1,000 adult spawners.

Population specific current abundance/productivity estimates, status ratings and Observed A/P gaps results are summarized in Table 7a. Recent Hydro Adjusted A/P Gaps and Projected A/P Gaps results relative to 25%, 5% and 1% viability curves are summarized in Table 7b.

The range in Observed Gap estimates for Snake River Steelhead populations was -0.59 to 0.85. B-run populations occupying relative high elevation tributaries in the Clearwater and Salmon River drainages would be at the high end of this range. Since the value representing the largest A/P Gap in this range is an average across populations, it is likely that the specific A/P Gaps for some of the A run populations exceed the high end of the range. Weir count based trend data sets representing relatively small components of some upper basin steelhead populations also indicate relatively low natural productivity rates. The range in estimated gaps for Snake River steelhead populations would be reduced to -0.67 to 0.50 under a combination of current hydropower improvements and historical climate assumptions.

Table 7a. SNAKE RIVER STEELHEAD ESU. Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
SR Spring/Summer Sthd.														
Tucannon River														
Asotin River														
Grande Ronde Upper Main.	1500	1226	673-2277	10%	2.29	0.18	VL	L		0.00	0.11	0.11		
Grande Ronde Lower Main.	1000													
Joseph Creek	500	2132	1084-4007	0%	2.62	0.14	VL	L		-0.64	-0.59	-0.54		
Wallowa River	1000	n/a	n/a	0%	1.21	0.25								
Imnaha River	1000	n/a	n/a	0%	1.51	0.15								
CW Lower Mainstem	Insufficient Data													
Selway River	Insufficient Data													
CW South Fork	Insufficient Data													
Lochsa River	Insufficient Data													
Lolo Creek	Insufficient Data													
CW North Fork (blocked)	Extirpated													
Lemhi														
Upper Salmon East Fork	Insufficient Data													
Upper Salmon Mainstem	Insufficient Data													
Upper Middle Fork	Insufficient Data													
Lower Middle Fork	Insufficient Data													
Chamberlain Creek	Insufficient Data													
Pahsimeroi River	Insufficient Data													
Panther Creek	Insufficient Data													
Little Salmon River	Insufficient Data													
Secesh River	Insufficient Data													
Snake R. Hells Canyon Tributaries	Insufficient Data													
Average "b" population	1000	272	101-1558	0%	0.85	0.14	H			0.22	0.73	0.82		
Average other "a" population	1000	456	144-2521	0%	1.32	0.41	M			0.00	0.87	0.87		1.12

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

Table 7b. SNAKE RIVER STEELHEAD ESU. Reguired change in survival projected to meet abundance and productivity criteria for 25%, 5% and 1% risk curves under a range of ocean/hydropower survival scenarios.

Snake River Steelhead	Estimated Abundance/Productivity Gap Scenarios (25% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Lower Snake River																		
Tucannon River																		
Asotin River																		
Grande Ronde River																		
Grande Ronde Upper Main.	0.00	0.04	0.10				-0.16	-0.13	-0.07				0.02	0.06	0.13			
Grande Ronde Lower Main.																		
Joseph Creek	-0.64	-0.63	-0.61				-0.70	-0.69	-0.67				-0.64	-0.62	-0.60			
Wallowa River																		
Imnaha River																		
Imnaha River																		
Clearwater River																		
CW Lower Mainstem																		
Selway River																		
CW South Fork																		
Lochsa River																		
Lolo Creek																		
CW North Fork (blocked)																		
Salmon River																		
Lemhi																		
Upper Salmon Mainstem																		
Lower Middle Fork																		
Chamberlain Creek																		
Pahsimeroi River																		
Panther Creek																		
Little Salmon River																		
CW South Fork																		
Secesh River																		
CW North Fork																		
Hells Canyon																		
Snake R. Hells Canyon Tributaries																		
Average "b" population	0.22	0.26	0.34				0.03	0.06	0.13				0.25	0.29	0.37			
Average other "a" population	0.00	0.03	0.10				-0.16	-0.13	-0.08				0.02	0.05	0.12			

Table 7b, continued.

Snake River Steelhead	Estimated Abundance/Productivity Gap Scenarios (5% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	**Base Hydro**	**Current Hydro**	**Proj. BiOp Hydro**				**Base Hydro**	**Current Hydro**	**Proj. BiOp Hydro**				**Base Hydro**	**Current Hydro**	**Proj. BiOp Hydro**			
Lower Snake River																		
Tucannon River																		
Asotin River																		
Grande Ronde River																		
Grande Ronde Upper Main.	0.11	0.15	0.22				-0.07	-0.04	0.03				0.13	0.17	0.25			
Grande Ronde Lower Main.																		
Joseph Creek	-0.59	-0.58	-0.55				-0.66	-0.65	-0.62				-0.58	-0.57	-0.54			
Wallowa River																		
Imnaha River																		
Imnaha River																		
Clearwater River																		
CW Lower Mainstem																		
Selway River																		
CW South Fork																		
Lochsa River																		
Lolo Creek																		
CW North Fork (blocked)																		
Salmon River																		
Lemhi																		
Upper Salmon Mainstem																		
Lower Middle Fork																		
Chamberlain Creek																		
Pahsimeroi River																		
Panther Creek																		
Little Salmon River																		
CW South Fork																		
Secesh River																		
CW North Fork																		
Hells Canyon																		
Snake R. Hells Canyon Tributaries																		
Average "b" population	0.73	0.78	0.90				0.45	0.50	0.60				0.76	0.82	0.94			
Average other "a" population	0.87	0.93	1.05				0.57	0.62	0.72				0.91	0.96	1.09			

Table 7b, continued.

Snake River Steelhead	Estimated Abundance/Productivity Gap Scenarios (1% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO/WTT/UPW Model						PDO/WTT/UPW Model						PDO/WTT/UPW Model					
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro				Base Hydro	Current Hydro	Proj. BiOp Hydro			
Lower Snake River																		
Tucannon River																		
Asotin River																		
Grande Ronde River																		
Grande Ronde Upper Main.	0.11	0.15	0.22				-0.07	-0.04	0.03				0.13	0.17	0.25			
Grande Ronde Lower Main.																		
Joseph Creek	-0.54	-0.52	-0.49				-0.61	-0.60	-0.57				-0.53	-0.51	-0.48			
Wallowa River																		
Imnaha River																		
Imnaha River																		
Clearwater River																		
CW Lower Mainstem																		
Selway River																		
CW South Fork																		
Lochsa River																		
Lolo Creek																		
CW North Fork (blocked)																		
Salmon River																		
Lemhi																		
Upper Salmon Mainstem																		
Lower Middle Fork																		
Chamberlain Creek																		
Pahsimeroi River																		
Panther Creek																		
Little Salmon River																		
CW South Fork																		
Secesh River																		
CW North Fork																		
Hells Canyon																		
Snake R. Hells Canyon Tributaries																		
Average "b" population	0.82	0.87	1.00				0.53	0.57	0.68				0.85	0.91	1.04			
Average other "a" population	0.87	0.93	1.05				0.57	0.62	0.72				0.91	0.96	1.09			

Upper Columbia Steelhead ESU

This ESU is currently limited to four extant populations in one Major Population Grouping. The MPG historically included a fifth population in the Crab Creek drainage, it is believed to be functionally extinct. Two additional MPGs likely existed, the tributaries that supported them are now cut off from anadromous access by Grand Coulee and Chief Joseph Dams.

The ICTRT has recommended that two populations from this group be targeted for very low risk to compensate, in part, for the loss of the upriver populations in this ESU. The median Observed A/P Gap (5% risk curve) for the four extant populations in this ESU is 2.55, ranging from 0.66 (Wenatchee adjusted from 0.47 to account for uncertainty) to 9.0 (the Okanogan River population).

Population specific current abundance/productivity estimates, status ratings and Observed A/P Gaps results are summarized in Table 8a. Recent Hydro Adjusted A/P Gaps and Projected A/P Gaps results relative to 25%, 5% and 1% viability curves are summarized in Table 8b.

We generated alternative climate and hydropower scenarios for Upper Columbia Steelhead populations based on modeling results for other Interior Basin ESUs. We calculated Historical and Warm PDO climate adjustments by averaging the results for the other two steelhead ESUs (Snake River and Mid-Columbia). We applied the Recent and Projected BioOp hydro survival factors developed for Upper Columbia Spring Chinook to generate Projected Gaps scenarios for Upper Columbia Steelhead populations. Under the Historical ocean scenario and assuming recent average hydropower system related survivals continue, the median 5% risk gap would decrease to 1.81 (0.22 to 6.69). The gaps relative to the 1% risk curve under this scenario would be 3.15 and 0.41 for the Methow and the Wenatchee populations, respectively.

Returns from large scale hatchery programs have dominated natural spawning in these systems for more than 30 years. The recent 10 year average percentage hatchery origin on the spawning grounds for the Upper Columbia populations has been high: Okanogan (94%), Methow (90%), Entiat (80%) and Wenatchee (60%). As a result there is a significant possibility that current productivity of natural spawning steelhead in the upper Columbia has been affected and is depressed from historical levels. For example, assuming that the relative effectiveness of an average hatchery origin spawner is 0.3 and that natural productivity could be restored over time, the Observed A/P Gap relative to the 5% risk criteria would drop from 0.66 to 0.53 for the Wenatchee population, and from 3.64 to 1.53 for the Methow steelhead population.

Table 8a. UPPER COLUMBIA STEELHEAD ESU. Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
Upper Columbia Steelhead														
Wenatchee (hatchery eff.=1)	1000	900	269-2163	0.60	0.84	0.21	H	H	0.08	0.18	0.43	0.73	0.66	0.91
Wenatchee (hatchery eff.=0.3)	1000	900	269-2163	0.60	0.87	0.19	H	H	0.08	0.15	0.38	0.67	0.53	0.90
Methow (hatchery eff.=1)	1000	281	76-615	0.90	0.28	0.29	H	H	0.1	2.68	3.29	4.18	3.64	4.63
Methow (hatchery eff.=0.3)	1000	281	76-615	0.90	0.49	0.14	H	H	0.1	1.10	1.45	1.96	1.51	2.05
Entiat (hatchery eff.=1)	500	94	34-292	0.80	0.48	0.23	H	H	0.08	1.23	1.81	2.50	1.97	2.64
Okanogan (hatchery eff.=1)	1000	104	22-212	0.94	0.12	0.35	H	H	0.1	7.67	9.00	11.08	9.43	11.54

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

Table 8b. UPPER COLUMBIA STEELHEAD ESU. Required change in survival projected to meet abundance and productivity criteria for 25%,5% and 1% Risk Curves under a range of ocean/hydropower survival scenarios. Projected A/P Gap is the survival improvement projected as necessary to meet particular risk criteria after accounting for survival adjustment. Average hydropower and harvest survival levels. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average.

Upper Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios (25% Risk Curve)								
	Recent Ocean Survival			Historical Ocean Survival			Pessimistic Ocean Survival		
	PDO/WTT/UPW Model			PDO/WTT/UPW Model			PDO/WTT/UPW Model		
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro
Upper Columbia Steelhead									
Wenatchee (hatchery eff.=1)	0.18	0.00	-0.09	0.02	-0.13	-0.21	0.20	0.02	-0.07
Wenatchee(hatchery eff.=0.3)	0.15	-0.03	-0.11	0.00	-0.15	-0.23	0.17	-0.01	-0.09
Methow (hatchery eff.=1)	2.68	2.12	1.85	2.20	1.71	1.48	2.75	2.18	1.91
Methow (hatchery eff.=0.3)	*1.23*	*0.89*	*0.73*	*0.94*	*0.64*	*0.50*	*1.27*	*0.93*	*0.76*
Entiat (hatchery eff.=1)	1.23	0.89	0.73	0.94	0.64	0.50	1.27	0.93	0.76
Okanogan (hatchery eff.=1)	7.67	6.34	5.72	6.54	5.39	4.84	7.84	6.49	5.86

Upper Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios (5% Risk Curve)								
	Recent Ocean Survival			Historical Ocean Survival			Pessimistic Ocean Survival		
	PDO/WTT/UPW Model			PDO/WTT/UPW Model			PDO/WTT/UPW Model		
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro
Upper Columbia Steelhead									
Wenatchee (hatchery eff.=1)*	0.66	0.41	0.29	0.44	0.22	0.12	0.70	0.44	0.31
Wenatchee(hatchery eff.=0.3)	*0.53*	*0.29*	*0.18*	*0.33*	*0.13*	*0.03*	*0.56*	*0.32*	*0.21*
Methow (hatchery eff.=1)*	3.64	2.93	2.60	3.03	2.42	2.13	3.73	3.01	2.67
Methow (hatchery eff.=0.3)	*1.97*	*1.52*	*1.31*	*1.59*	*1.19*	*1.01*	*2.04*	*1.57*	*1.35*
Entiat (hatchery eff.=1)*	1.97	1.52	1.31	1.59	1.19	1.01	2.04	1.57	1.35
Okanogan (hatchery eff.=1)*	9.43	7.84	7.09	8.07	6.69	6.03	9.64	8.02	7.25

Upper Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios (1% Risk Curve)								
	Recent Ocean Survival			Historical Ocean Survival			Pessimistic Ocean Survival		
	PDO/WTT/UPW Model			PDO/WTT/UPW Model			PDO/WTT/UPW Model		
Populations	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro
Upper Columbia Steelhead									
Wenatchee (hatchery eff.=1)*	0.91	0.62	0.48	0.66	0.41	0.29	0.95	0.66	0.51
Wenatchee(hatchery eff.=0.3)	*0.90*	*0.61*	*0.47*	*0.65*	*0.40*	*0.28*	*0.94*	*0.64*	*0.50*
Methow (hatchery eff.=1)*	4.63	3.77	3.37	3.90	3.15	2.80	4.75	3.87	3.45
Methow (hatchery eff.=0.3)	*2.64*	*2.08*	*1.82*	*2.16*	*1.68*	*1.45*	*2.71*	*2.15*	*1.88*
Entiat (hatchery eff.=1)*	2.64	2.08	1.82	2.16	1.68	1.45	2.71	2.15	1.88
Okanogan (hatchery eff.=1)*	11.54	9.63	8.72	9.91	8.24	7.45	11.80	9.85	8.92

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Appendix A: Methods for Calculating Observed Population Survival Gaps

We used results from the abundance and productivity analyses derived for the ICTRT **Current Status Assessments** (ICTRT website) as a starting point in defining Observed gaps at the population level. Observed gaps represent the minimum survival change needed to elevate a particular population from its current status to a point on its target viability curve. We developed estimates for observed productivity gaps using the following analytical steps.

5) Estimate current intrinsic productivity and natural spawner abundance (most recent 20 years of stock-recruit data)

6) Estimate current spawning level associated with achieving juvenile capacity.

7) Assign each population to a category based on its position relative to the viability curve

8) Calculate gap based on the minimum distance from the abundance/productivity point representing current status and the appropriate viability curve.

Step 1: Current Population Abundance and Productivity

Current Abundance: We initiated our observed gap analyses using the recent 10-year geomean natural abundance levels as reported for specific populations in the Current Status Assessments.

Current Productivity: We used a simple hockey stick function as a basic population stock recruit model in our observed gap calculations (Figure A-1). For an estimate of current intrinsic productivity, we used the population-specific estimates generated for the Current Status Assessments. The estimated productivity for each population was calculated as the geomean adult natural return per spawner over low to moderate parent spawner years from the most recent 20 year data series (usually 1979-1999 brood years). We limited the analysis to low to moderate parent spawning levels to reduce the influence of density dependence. We calculated the geomean productivity limiting the data pairs to those parent escapements that were below 75% of the assigned abundance threshold for the population. In some cases a substantial proportion of the parent spawning levels in the recent series exceeded 75% of the threshold (e.g., some Mid-Columbia steelhead populations). We calculated an alternative estimate of current population productivity, limiting the dataset to return per spawner pairs where the parent escapement was less than the median escapement for the 20-year series. For the method yielding the higher productivity, if greater than 75% of the return per spawner values were positive, then that productivity was used in the gap calculation. If less than 75% of these values were positive, the alternate productivity was used.

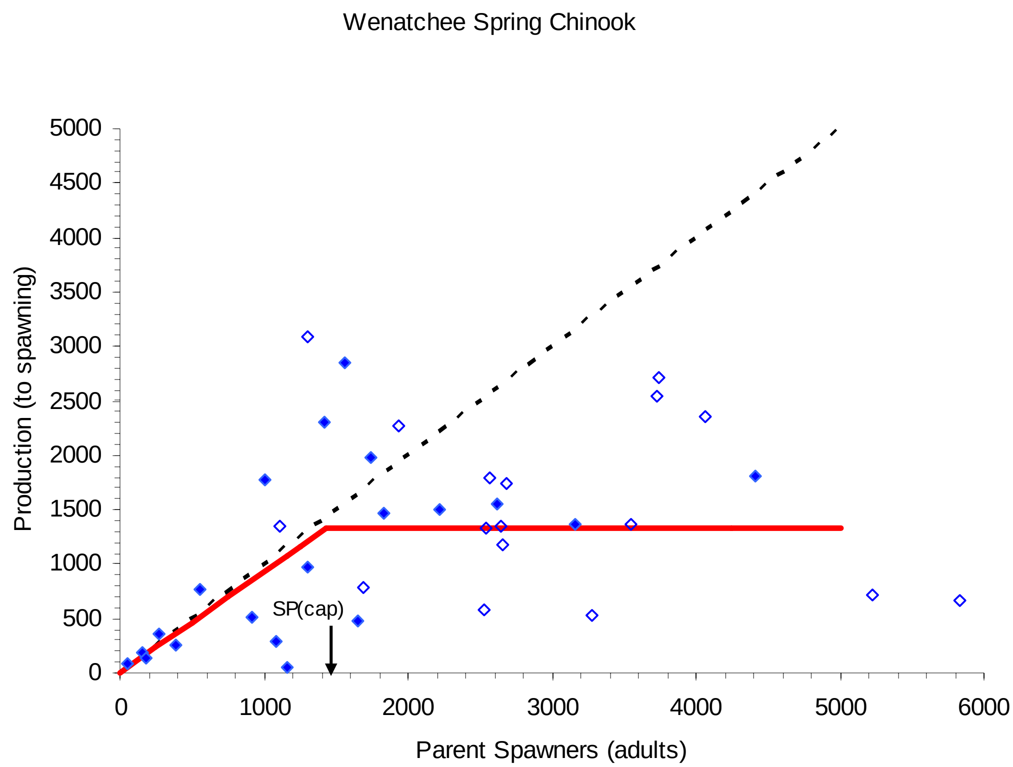


Figure A-1. Example of current spawner/spawner relationship (Wenatchee Spring Chinook population). Dashed line represents equilibrium replacement. Solid line represents derived stock/recruit function where:. Intrinsic productivity (a = 0.93) calculated from 1978-1999 brood data set (solid diamond symbols); spawner level at which capacity is reached (SP@cap = 1427) calculated from 1960-99 brood data set (open diamond symbols represent 1960-77 brood data pairs); SPcur = recent 10 year geomean natural escapement. Data compiled in draft ICTRT Wenatchee Spring Chinook Current Status chapter.

<u>Step 2: Spawners at Capacity:</u>

We expanded the stock recruitment data sets for each population to use the full range of available data to determine an estimate of the minimum number of spawners associated with capacity for each population. We used a simple cohort analysis to generate brood year specific estimates of the cumulative number of returns to the spawning grounds. We standardized return rates to reflect recent average SARs and harvest levels in order to remove the large scale variations associated with annual fluctuations in ocean survival rates and trends in harvest rates. The standardized values were calculated by 1) determining the geometric mean SAR and harvest rate for a fixed period (1978-1999 brood years), 2) expressing each brood year SAR and Harvest Rate relative to the corresponding 1978-99 brood year average (1983 through 2004 return years); and 3) calculating adjusted returns as:

$$R_{(t,adj)} = (\sum R_{(t+i)} / (HR_{(t+i,adj)})) / SAR_{(t,adj)}$$

Where: $R_{(t,adj)}$ = Adjusted returns resulting from brood year t spawners
$R_{(t+i)}$ = Returns from brood year t spawners in year t+i, i = 3,4,5,6
$HR_{(t+i,adj)}$ = Expressed as a proportional difference in harvest survival rate = (1 - 1981-2004 HR)/ (1- Estimated Harvest Rate in year t+i)
$SAR_{(t,adj)}$ = Estimated smolt to adult survival rate for brood year t, expressed in proportion to the 1978-99 geomean.

We assumed that the average Lower Granite Dam wild chinook SAR series applied to individual Snake River spring/summer chinook populations. An expansion of the Chiwawa wild production SAR series combined with an index of hatchery smolt survivals was used for Upper Columbia spring chinook populations.

We used the expanded data sets to generate population specific estimates of the minimum spawners at capacity, assuming a Hockey Stick production function. We assumed that the current productivity estimates derived from the 1978-most recent year data sets were the best available estimates given they were derived at relatively low escapements and represent current hydropower and harvest regimes. We incorporated these productivities with the PopTools routine (Excel add-in tool) to 'fit' estimates of the number of spawners associated with the breakpoint to constant production (Hockey Stick 'b' parameter).

The resulting population specific estimates of spawners at capacity (Hockey Stick 'b' parameter) were highly variable. We applied the following approach to reduce the effects of sampling variability on the estimated gaps and to allow for the estimation of capacity for populations with insufficient spawner/recruit information. We grouped populations by species and regressed the estimated capacity against our independently derived estimates of accessible habitat capacity for the subset of populations with sufficient spawner/return data series (Figures A-2a & A-2b). We did not include populations with substantial habitat degradation and/or chronic large-scale hatchery contributions (e.g., Catherine Creek and the Upper Grande Ronde chinook populations) in the regression data sets. For each population we averaged the spawner/return based capacity estimate with the corresponding regression-based estimate to reduce the influence of sampling variation.

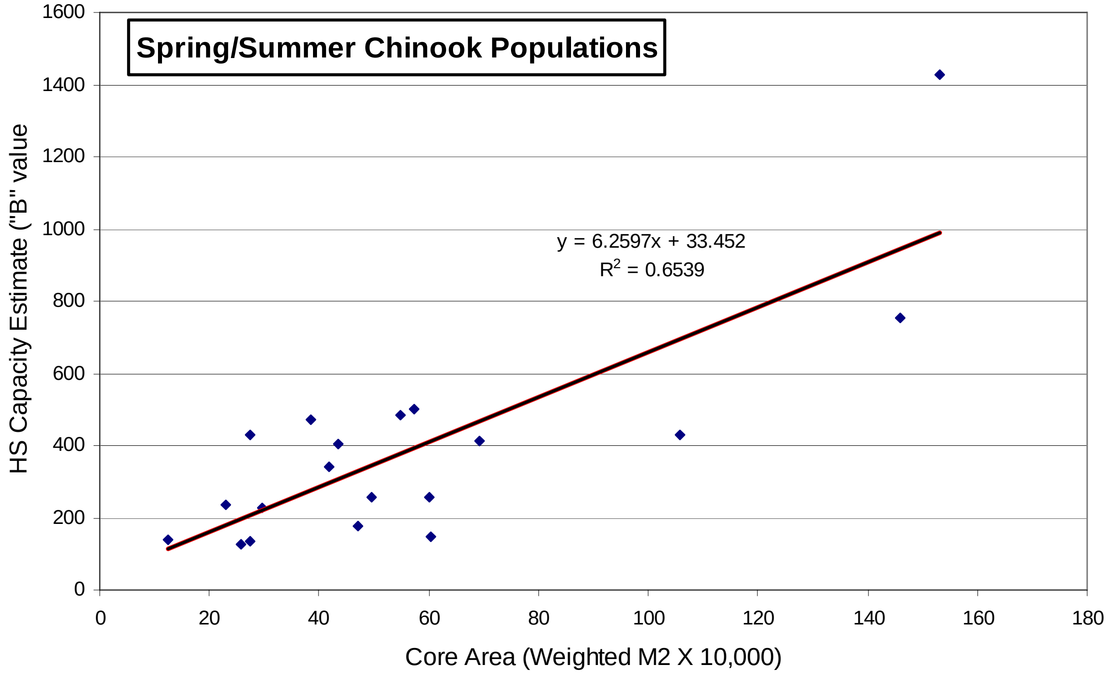


Figure A-2a. Interior Columbia stream type chinook populations. Regression of estimated number of spawners at capacity to available habitat (weighted intrinsic potential).

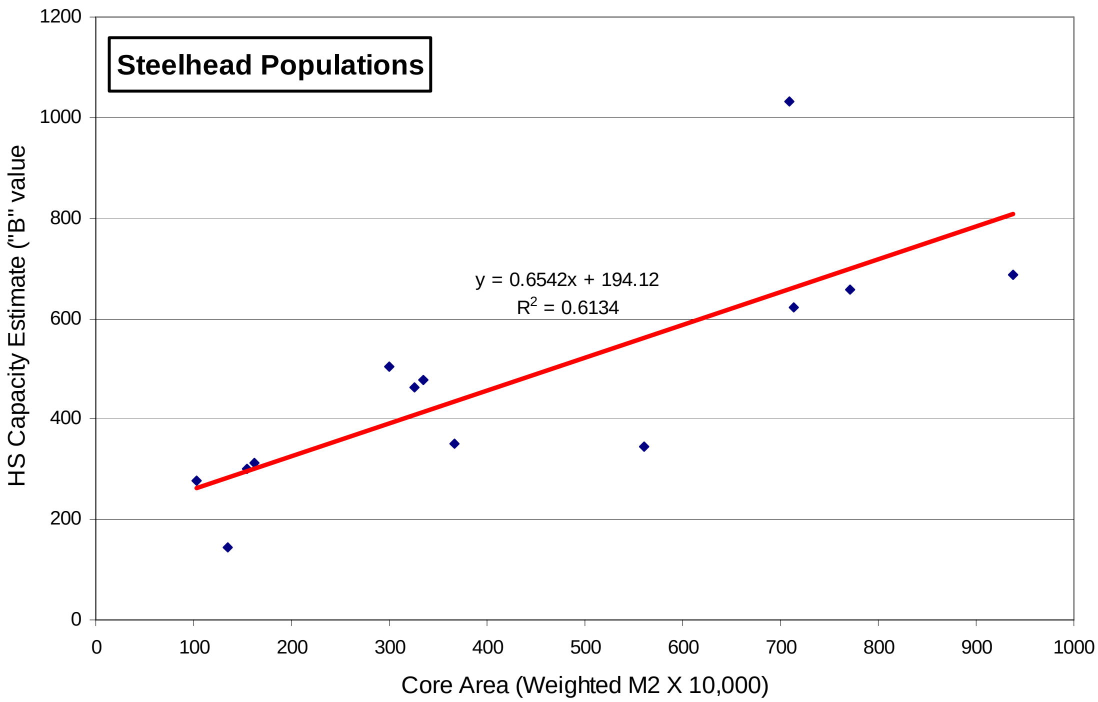


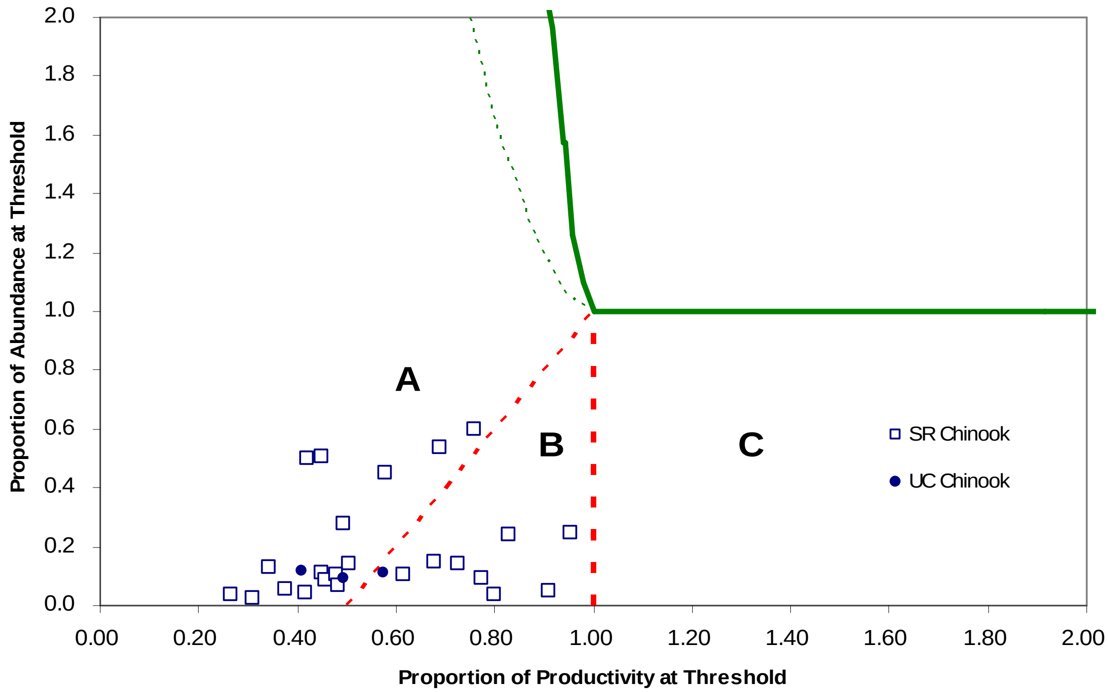
Figure A-2b. Interior Columbia steelhead populations. Regression of estimated number of spawners at capacity to available habitat (weighted intrinsic potential).

Step 3: Observed Gaps

We developed a simple approach for expressing the 'distance' from the point defined by the current estimate of abundance and productivity to the corresponding viability curve for each population. We expressed distance in terms of an increase in survival over the life cycle. This allows for a consistent, although relatively coarse scale, initial comparison of the level of action required to meet specific recovery targets across the range of populations within a particular ESU. Many recovery planning actions, if successful, would translate directly into improved survivals for a particular component life stage (e.g., improvements to juvenile summer rearing habitat, downstream smolt migration, or adult holding stage habitat). Other actions may have a more complex linkage to life stage survivals and/or habitat carrying capacities. Importantly, this distance does not target any particular life stages for improvement; more complete limiting factors analyses and life-cycle modeling will be necessary to identify priorities across actions and life stages.

As a first step, we sorted populations into categories based on their current status relative to the viability curves. We standardized across population size categories (and species) by expressing the population specific current abundance and productivity estimates as a proportion of the applicable threshold abundance and the minimum productivity value associated with the threshold (Figures A-3a&b). We divided the surface beneath the curve into three basic zones corresponding to the general characteristics described above (Figures A-3a&b). Point estimates falling below and substantially to the left of the transition point on the curve to threshold abundance levels (zone A) have demonstrated a combination of relatively low productivity and abundance over the past 20 years. It is unlikely that density dependent effects are substantially influencing the productivity values for these populations. Point estimates for some populations, primarily from the Mid-Columbia steelhead ESU, fall below their viability curves but substantially to the right of the minimum productivity values associated with the threshold (zone C). It is likely that these population-specific estimates are influenced by density-dependent effects. Some populations fall in a transition zone between the two general regions described above—they reflect an increasing probability of density dependent effects at higher relative productivity levels (zone B).

A.



B.

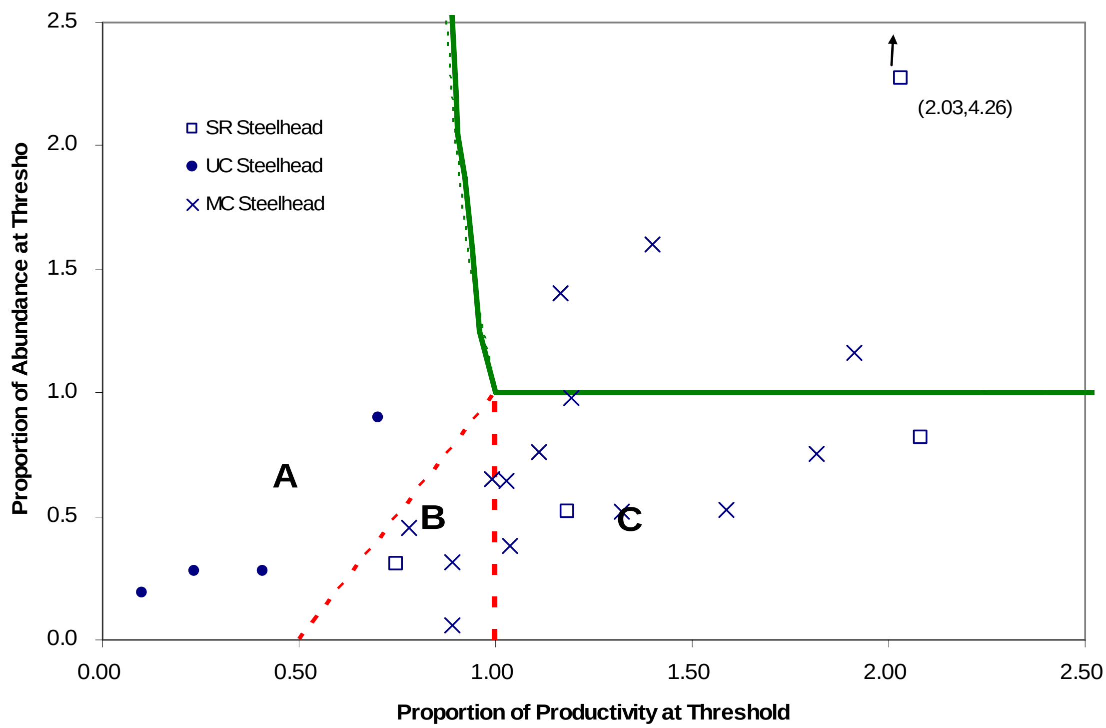


Figure A3a&b: Current abundance and productivity estimates for Upper Columbia and Snake River yearling type Chinook (a) and steelhead (b) populations. Estimates from ICTRT draft Current Status Assessments expressed as proportions. Current abundance relative to the threshold value, productivity relative to the minimum productivity value on the viability curve corresponding to threshold abundance.

Zone A: Very Low/Low productivity

The right-most boundary for this grouping was defined by a line extending from a relative productivity value of 0.5 on the x axis to the point representing the minimum productivity/threshold combination on the viability curve (relative productivity = 1.0, abundance = threshold level). We estimated the observed survival gap for populations falling to the left of this line by determining the shortest distance from the point defining current status for a particular population to its corresponding viability curve (e.g., Figure A-4). To simplify the calculation for populations in this category, we assumed that nearest point on the viability/threshold curve was the inflection associated with threshold abundance. The relative change along the productivity (x) axis was used to define the survival change required for populations in this zone. We included a check to ensure that the capacity required to meet the target level abundance generated by this approach was within a reasonable range: if the target abundance/productivity pair required a number of spawners at capacity exceeding the threshold level, we increased the target productivity to the value on the viability curve corresponding to a spawner capacity equal to the threshold for the population size category.

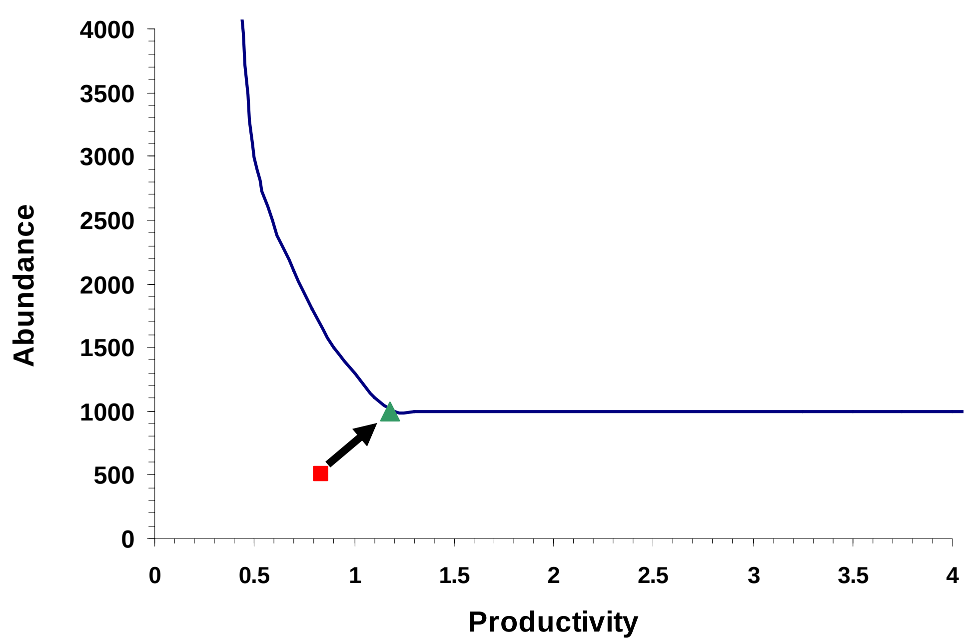


Figure A-4. Illustration of approach for calculating the “zone A” gap between current status (abundance/productivity) and a selected viability curve. This example is a large sized population (minimum abundance threshold of 1000 spawners). The 5% viability curve (line) represents minimum combinations of abundance (at equilibrium) and productivity (expected spawner/spawner ratio from spawning levels below capacity for the population) projecting to no more than a 5% risk of extinction over 100 years. The square represents estimates of current abundance and productivity. The triangle represents combination of abundance and productivity on the viability curve that is the shortest linear distance from the current status point.

Zone B: Transition zone

Populations with current productivity/abundance estimates plotting out above the upper boundary for zone A but with relative productivities less than 1.0 (i.e., productivity estimate below the minimum associated with the threshold for the particular population size group) were included in this zone. The nearest point on the viability/threshold curve for populations in this category was the inflection associated with threshold abundance. As noted above, the potential for carrying capacity limitations is increased in this zone. Accordingly, we directly incorporated an element in the gap calculations that would increase the survival change needed to achieve recovery objectives to counter the potential dampening effects of capacity limits (see formula in Table A1). We started by calculating proportional change in productivity needed to increase from the current level to the minimum level associated with threshold abundance on the target viability curve. We generated an estimate of current capacity (see description below) and calculated the production associated with spawner capacity (spawners at capacity X current productivity. In most cases the theoretical equilibrium point for populations in this grouping falls below the viability/threshold curve at current productivity levels. We calculated the gap for Zone B populations as the average of the estimated productivity and capacity gaps for the specific population. This approach gives an increasing weight to the estimated capacity deficit as current productivity estimates approach the minimum value associated with the population threshold abundance.

Table A-1. Equations for calculating relative population survival gaps as a function of current abundance/productivity estimates.

Zones	Abundance	Productivity	Survival Gap Calculation	Notes
A	***Below Threshold***	***Very Low to Moderate***	Survival Gap = $Prod_{gap}$ = $(Prod_{threshold}/Prod_{current})$ - 1	Assume that density dependent effects are secondary at these levels.
B	***Below Threshold***	***Low to Moderate***	Survival Gap = $(Prod_{gap} + Cap_{gap})$ / 2	Added gap component reflecting potential capacity limitations
C	***Below Threshold***	***Exceeds minimum at Threshold***	Survival Gap = Cap_{gap} =(Threshold/Avg. Equil. Spwners). – 1 Where Avg. Equil. Spwners = Average of $EQ_{capacity}$ and Current $Abund._{10\ yr\ gm}$)	Assume strong density dependent effects. Equal weight to calculated equilibrium, recent performance
D	***Above Threshold***	***Exceeds Viability Curve***	Negative survival gap = proportion current exceeds viability curve	Focus on risk given uncertainty of productivity estimate.

Zone C: Moderate to High Relative Productivity

Populations in this category have exhibited average productivity values above the minimums associated with threshold abundance levels. However, recent average abundance levels in this zone have been relatively low compared to the corresponding viability curve. We assumed that populations in this category were strongly affected by density dependent factors. The gap estimates for populations in this category were generated based on the estimated shortfalls in observed abundance and estimated capacity relative to the threshold abundance level applicable to that particular population (see formula in Table 1). The resulting gaps are expressed as a proportional increase in productivity, but could potentially also be addressed by increasing the effective capacity of the population.

Zone D: Abundance/Productivity Combination Exceeds Curve

Population level abundance and productivity combinations in this zone exceed the particular viability curve and translate into negative gaps in this analysis. The relative distance below 0.0 reflects the proportional reduction in survival that could occur before that population rating would drop below the target viability curve. Very few populations in the Interior Columbia fall into this category, based on performance over the most recent 20-25 years.

Example Gap Calculations

The gaps are expressed as multipliers against recent life cycle survival rates. We assumed that each population functions according to a Hockey Stick stock production function. The Wenatchee Spring Chinook population is classified in Zone B based on current natural abundance and productivity estimates. Based on run reconstructions for the 1978-98 broods, the estimated intrinsic productivity for the Wenatchee spring chinook population is 0.93, with an estimated capacity of approximately 2050 spawners (Figure A-5a).

As described above, the working assumption in estimating gaps for populations falling in zone B is that both productivity and capacity shortfalls should be explicitly considered in calculating the relative change required for the population to meet or exceed the viability curve. For the Wenatchee Spring chinook population, an average survival improvement of 73% (over the life cycle) would be required to increase the geometric mean productivity to the minimum value on the viability curve associated with the abundance threshold for large populations (2,000). The capacity gap is calculated as the threshold minimum abundance level divided by the estimated return level at current capacity. For the Wenatchee population, the capacity gap is estimated as 0.74, nearly identical to the gap estimated based solely on productivity.

Survival Gap = 0.93 X (1.0 + 0.73) = 1.61

The resulting equilibrium escapement estimate is calculated by multiplying the improved productivity times the escapement at capacity:

Equilibrium Escapement (adj) = 1.61 X 1,159 = 2,005

The intent of the survival gap analyses is to express the gap between current status and a selected viability curve in terms of change in overall life cycle survival. In this case, changes in effective capacity – for example, increases in the parr production potential of a particular reach resulting from habitat restoration, could also contribute to shifting the population production function towards levels consistent with the target viability curve (Figure A-5a). .

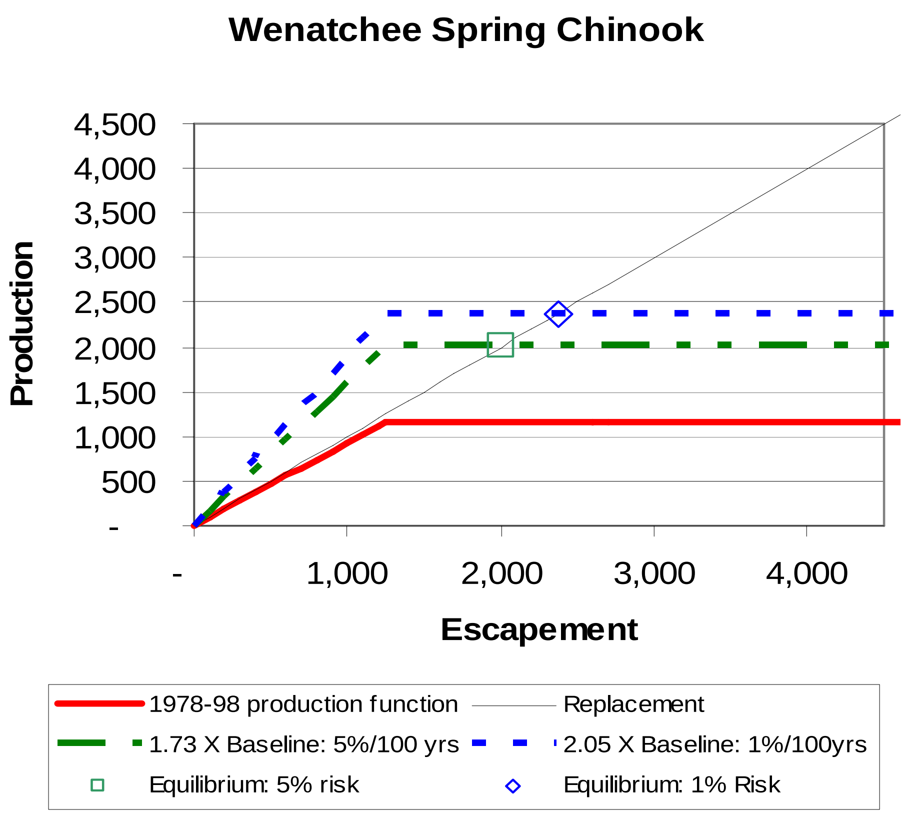


Figure A-5a: Simple hockey stock models corresponding to base conditions (1978-98 broods), the 5% risk scenario and the 1% risk scenario. Symbols indicate the projected equilibrium escapement levels associated with the required proportional survival increases.

The second example (Figure A-5b), using information for the Upper John Day steelhead population, illustrates the gaps calculation for populations classified in zone C. Populations in this category have recent average abundances below minimum thresholds, although their current productivities exceed the minimum value associated with threshold abundance on the corresponding viability curve. Gaps calculated for populations in falling into zone C are based on the assumption that changes in productivity or capacity could contribute to elevating the status of the population relative to the viability curve. Given that the observed productivity exceeds the minimum value associated with the abundance thresholds for both the 5% and 1% risk levels, the proportional increase in life cycle survival or effective capacity required is the same to achieve either criterion.

We calculated gaps for these populations based on the proportional improvement in equilibrium abundance required to exceed the threshold. The following equations illustrate the gap calculations for zone C type populations. Equilibrium capacity estimates based on curve fits to relatively limited data sets can have high uncertainty levels. We incorporated alternative estimates into the gap calculations in order to reduce the impact of sampling variation.

As a first step, we averaged the direct estimate of the minimum number of spawners associated with capacity/equilibrium with a second estimate generated using a simple regression model. The regression incorporated estimates of spawners at capacity and corresponding estimates of the quantity of available spawning habitat for all populations in the analysis. The resulting estimate for Upper John Day steelhead population was 457 spawners.

Step 2 in the calculation of gaps for the zone C type populations requires multiplying the current productivity against the estimated spawners at capacity to generate an estimate of equilibrium abundance.

Cap (current) = Spawners at capacity(avg) * Productivity
= 437 X 2.14
= 936

We assumed that recent 10 year geomean abundance also represented an estimate of equilibrium abundance for zone C type populations. For the Upper John Day steelhead population the recent 10 year geomean abundance was 470 spawners. The average of the two estimates of an equilibrium spawner level for the Upper John Day steelhead population was 730 spawners.

The third and final step in calculating a quantitative gap estimate for a zone C type population is to express the capacity estimated in step 2 relative to the threshold abundance level for the population.

Gap = Threshold / Cap(current) - 1.
= 1,000 / 730 - 1
= 0.37

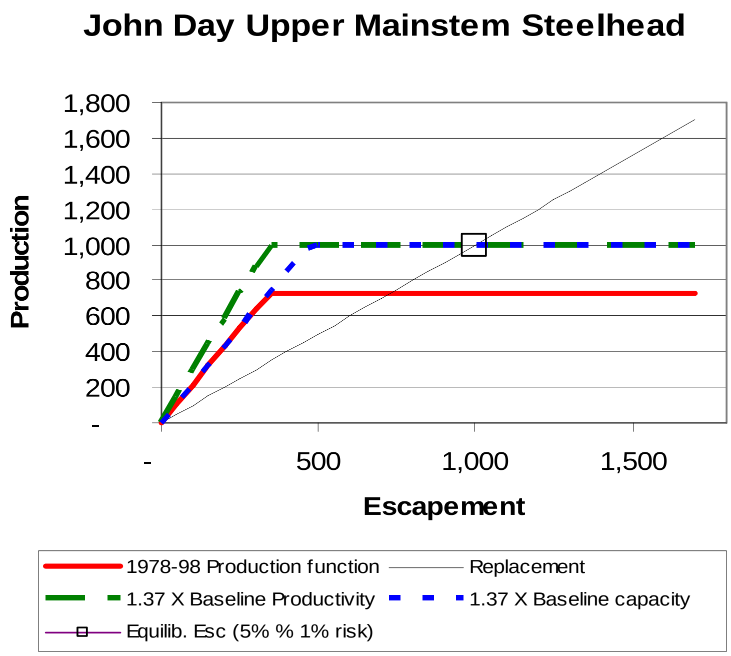


Figure A-5b: Simple hockey stock models illustrating base conditions (1978-98 broods), the 5% risk scenario achieved through increased productivity, and the 5% risk scenario achieved through increase in habitat capacity.

Two different viability scenarios for the John Day Upper Mainstem steelhead population are illustrated in Figure A-5b. Under one strategy, the gap would be addressed by improvements in productivity achieved through increases in life stage survivals. Alternatively, a combination of abundance and productivity exceeding the 5% viability curve could be achieved by increases in functional spawner capacity. In addition to the scenarios illustrated in Figure A-4b, viability objectives for the Upper John Day steelhead population could also be met by alternative combinations of sufficient proportional increases in survival and in capacity.

Considering Parameter Uncertainty

One of the main tasks assigned to each of the regional Technical Recovery Teams is to develop criteria for use in assessing the status of listed ESUs. The ICTRT has proposed a set of biologically based criteria for use in judging the relative status of a particular listed ESU, based on the current status of its component populations. As a result of the high year to year variability in survival rates and inherent uncertainties in key biological assumptions, the abundance/productivity elements of a population assessment require evaluating performance over a substantial period of time—a minimum of 15-20 years for most populations. The ICTRT has developed some options for dealing with relatively high levels of uncertainty that can be associated with point estimates of abundance and productivity for policy consideration (ICTRT, 2005b). Those methods were specifically designed to be used in assessing status at a particular point in time - looking at performance over a recent 20 period for example. However, the same methods can be adapted for planning purposes to illustrate the potential need for 'buffering' expected survival changes to reflect parameter uncertainties. The following examples illustrate the use of one of the optional buffering methods. Applying this approach for planning purposes requires the assumption that the future magnitude of uncertainty in productivity will be similar to current estimates (expressed here as sample standard error).

In some cases the standard errors for current population productivity estimates were high, leading to a substantial probability that the actual underlying risk level exceeded 25% in 100 years. We identified those situations and adapted one of the alternative uncertainty buffers (Dec. ICTRT Viability Update memo; alternative B1) to adjusted observed gaps.

We chose two populations to represent the range in uncertainty at relatively low productivity. The Imnaha spring chinook data set (productivity SE of 0.12) represents populations with relatively low statistical uncertainty about the geomean productivity estimate. Deschutes (Eastside) steelhead, with a standard error of 0.31, represents the high end of the range. We generated a set of graphs for each population (Figures A-6 & A-7).

The curved line in each figure represents the probability distribution of the estimated geomean return/spawner at low to moderate abundance. The distribution was generated using the excel function NORMINV. We assumed that error distribution was lognormal and used the calculated geomean and standard error for each population data series. We did not specifically allocate any of the variability to measurement error.

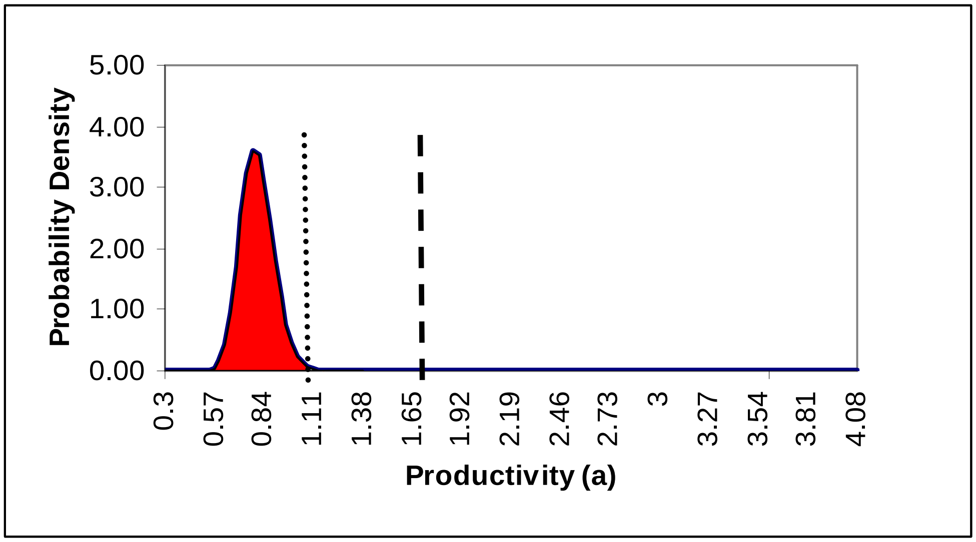
We simplified the target productivity/abundance combinations to illustrate the potential effect of incorporating an uncertainty buffer in calculating gaps. The minimum average productivity values highlighted on each graph (Figure A-6) as a vertical dashed line and correspond to the lowest productivity associated with threshold abundance. The dotted vertical line on each graph represents the productivity associated with a recent average abundance at the threshold level and a 100 year risk of 25%. The relative proportion of the distribution to the left of a particular line represents the probability that the 'true' productivity is less than the value represented by the vertical line.

The distribution depicted in the first graph in each set represents current status (Figures A-6a & A-7a). The distribution in the second graph for the Imnaha chinook example (Figure A-6b) represents an increase from the current average productivity to the level just meeting the 5% risk objective, assuming the current standard error would still reflect the uncertainty level. Since the Deschutes (Eastside) population exceeds the 5% risk curve criteria at current level, for this population the second graphic represents an incremental improvement in productivity sufficient to meet the uncertainty buffer test—no less than a 1 in 20 chance that the 'true' productivity value is less than the level corresponding to a 25% risk of extinction in 100 years (Figure A-7b).

The Imnaha River population would need a 88% increase over current levels to meet the 5% risk viability curve. Assuming that the standard error associated with estimated productivity remains at 0.19, the increase to get geomean productivity to the 5% curve, the test incorporating relative uncertainty indicates that with that increase the probability that the actual productivity value is associated with a 25% risk of extinction or greater is less than 1 in 20. In this case, no increase over the basic gap analysis would be required.

The basic gaps analysis indicates that the current point estimate of productivity for the Deschutes (Eastside) population exceeds the required level to meet the 5% risk test. However, given the relatively broad error bounds on this estimate, productivity would need to be increased by 14% to reduce the chances to less than 1 in 20 that the actual risk is greater than 25% in 100 years.

A.



B.

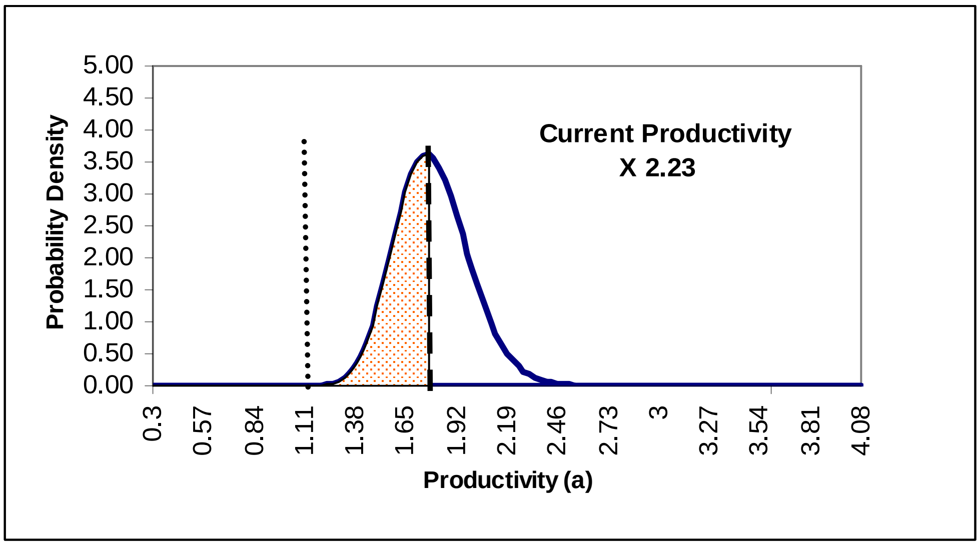
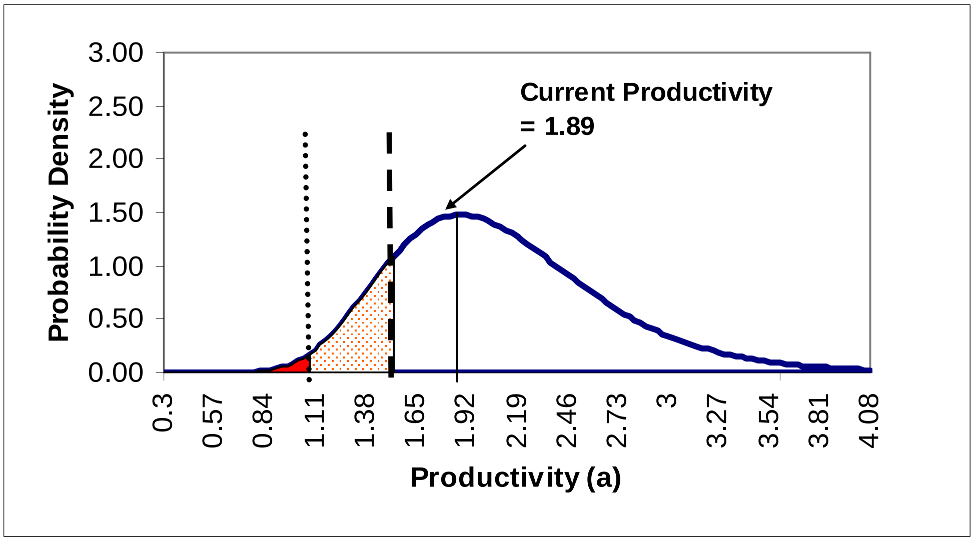


Figure A-6a&b. Example #1: low standard error data series. Probability distribution of estimated productivity for Imnaha Spring Chinook Population. A) geomean and distribution (SE =0 .11) relative to productivities corresponding to 25% and 5% risk levels at threshold abundance. B) With productivity increased to meet 5% risk at threshold abundance. Solid filled area represents probability that the 'true' productivity is low enough that A/P risk rating would be High (exceeds 25% in 100 years). Light shaded area represents probability that the 'true' productivity is at a level corresponding to a Moderate A/P rating. Clear area under the curve represents probability that risk rating is Low.

A.



B.

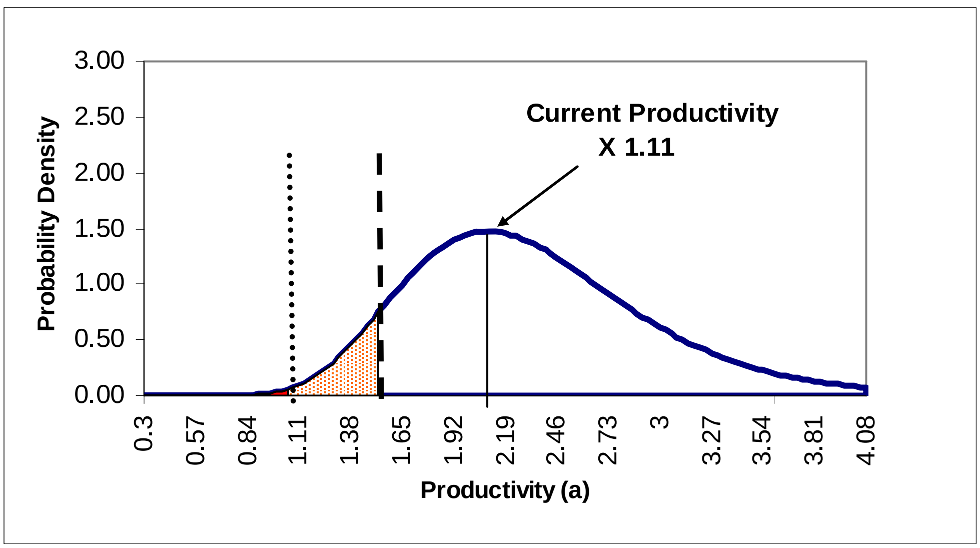


Figure A-7a&b. Example #2: high standard error data series. Probability distribution of estimated productivity for the Deschutes (Eastside) Steelhead population. A) geomean and distribution (SE =0 .31) relative to productivities corresponding to 25% and 5% risk levels at threshold abundance. B) Productivity DECREASED to minimum for 5% risk criteria. Solid filled area represents probability that the 'true' A/P risk rating would be High (exceeds 25% in 100 years). Light shaded area represents probability that the 'true' A/P risk is Moderate (5-25%). Clear area under the curve represents probability that risk rating is Low.

<u>Calculations Summary</u>

The following tables include the population specific input data, calculation step results and Observed Gap estimates (relative to 1%, 5% and 25% risk viability curves). The last columns in these tables are the population specific Observed Gap estimates carried over and discussed by ESU in the ICTRT Interim Gaps Report (ICTRT, 2006b).

Table Column Contents

1. *<u>10 yr Geomean Abund</u>*.: Geomean (most recent 10 years) of natural origin spawners in natural spawning areas (from population specific Current Status Assessments).

2. *<u>20 yr. Productivity</u>*: Geomean productivity at low to moderate total spawning numbers.

3. *<u>Productivity SE</u>*: standard error of the mean (natural log) Productivity estimate for the population.

4. *<u>SE multiplier (0.95)</u>* : Multiplier (upper critical value from t distribution corresponding to sample size n) to Productivity SE, used in calculating productivity value at the lower 5% confidence bound (1 tailed test).

5. *<u>SE multiplier (0.99)</u>*: Multiplier (upper critical value from t distribution corresponding to sample size n) to Productivity SE, used in calculating productivity value at the lower 5% confidence bound (1 tailed test).

6. *<u>Threshold</u>*: Minimum abundance level corresponding to the corresponding population size category (based on historical intrinsic potential habitat).

7. *<u>Averaged Capacity Estimate</u>*: Average of specific estimate derived for population and an estimated generated from regression of capacity vs. historical weighted intrinsic potential habitat.

8. *<u>Average Equilibrium Spawners (Current):</u>* Expected average maximum adult natural return level. For populations with *productivity* above 1.0, is equivalent to estimated equilibrium spawning level.

9. *<u>Gap Zone</u>*: Assigned Gap zone based on abundance and productivity relative to the corresponding population abundance/productivity viability curve (see Figure A-3).

10. *<u>Abundance Prop. of Threshold</u>*: Current natural abundance expressed as a proportion of the corresponding population threshold.

11. *<u>Abund. Needed</u>*: The abundance on the Viability curve associated with *Min. Productivity @ Threshold* (Tables A-2a and A-3a only).

12. *<u>Prod. at Curve</u>*: (Tables A-2a and A-3a only). Productivity at closest point on the 25%

viability curve relative to the current abundance/productivity for a specific population.

13. *Min. Productivity @ Threshold*: (1% and 5% Risk tables only) The minimum productivity value on the Viability curve associated with the population's size threshold.

14. *Min. Prod. @ Current Abund*.: Used in calculating negative gap where current abundance estimate exceeds the threshold (zone D only)—this is the minimum productivity value associated with the current abundance estimate (Tables A-2b, A-2c, A-3b, and A-3c only).

15. *Abundance Check*: Calculated as a check that the capacity required to meet the target level abundance generated by this approach is within a reasonable range relative to the amount of available tributary habitat (Tables A-2b, A-2c, A-3b, and A-3c only).

16. *Prod. Gap*: Refers to the gap between current productivity and *Min. Prod. @ Threshold*. This is the gap reported for zone A populations (Tables A-2b, A-2c, A-3b, and A-3c only).

17. *Capacity Adjusted Productivity Gap*: Used in zone B populations where the gap reflects the combined effect of capacity and productivity shortfalls (Tables A-2b, A-2c, A-3b, and A-3c only).

18. *Observed Gap*: Proportional change in survival required to meet or exceed viability curve for the corresponding risk level (1%, 5%, 25% risk in 100 years).

Table A-2. Chinook population gaps to the 25% risk curve (A), 5% risk curve (B), and 1% risk curve (C).

A. Chinook Populations	Population Statistics										25% Gap		
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Abund. Needed	Prod. @ Curve	Observed 25% Gap
Tucannon River	82	0.79	0.14	1.74	2.57	750	312	197	**A**	0.11	738	1.18	**0.49**
Asotin Creek	Functionally Extirpated												
Catherine Creek	107	0.89	0.24	1.78	2.68	750	422	265	**A**	0.14	738	1.18	**0.33**
Catherine (no hatchery yrs)	107	1.28	0.07	1.89	3.00	750	417	262	**B**	0.14	456	1.35	**0.05**
Lostine River	276	0.78	0.22	1.73	2.55	1000	515	396	**A**	0.28	766	1.17	**0.50**
Minam River	337	1.02	0.21	1.75	2.60	750	322	329	**A**	0.45	738	1.18	**0.16**
Imnaha River	380	0.79	0.11	1.81	2.76	750	978	679	**A**	0.51	866	1.14	**0.44**
Wenaha River	376	0.74	0.19	1.74	2.57	750	312	344	**A**	0.50	866	1.14	**0.54**
Upper Grande Ronde	38	0.42	0.41	1.86	2.90	1000	397	218	**A**	0.04	1023	1.09	**1.60**
Big Sheep Creek	4	0.29	0.44	1.75	2.60	500							
Lookingglass Creek	Functionally Extirpated												
South Fork Mainstem	601	1.20	0.20	1.78	2.68	1000	478	539	**A**	0.60	645	1.23	**0.03**
Secesh River	403	1.21	0.13	1.72	2.53	750	271	337	**A**	0.54	557	1.27	**0.05**
East Fork Johnson	105	0.97	0.28	1.81	2.76	1000	330	217	**B**	0.11	595	1.25	**0.29**
Little Salmon River	Insufficient Data												
Big Creek	90	1.22	0.21	1.73	2.55	1000	295	192	**B**	0.09	484	1.33	**0.09**
Bear Valley Creek	182	1.46	0.17	1.73	2.55	750	358	270	**B**	0.24	377	1.49	**0.02**
Marsh Creek	42	1.01	0.22	1.73	2.55	500	208	125	**A**	0.08	575	1.26	**0.25**
Sulphur Creek	21	1.05	0.38	1.75	2.58	500	128	74	**A**	0.04	557	1.27	**0.21**
Camas Creek	28	0.83	0.32	1.74	2.57	500	150	89	**A**	0.06	738	1.18	**0.42**
Loon Creek	51	1.06	0.31	1.75	2.58	500	174	113	**A**	0.10	557	1.27	**0.20**
Chamberlain Creek	223	2.45	0.52	2.13	3.75	500							
Lower Middle Fork Salmon	Insufficient Data												
Upper Middle Fork Salmon	Insufficient Data												
Lemhi River	79	1.07	0.26	1.72	2.53	2000	710	395	**B**	0.04	557	1.27	**0.19**
Valley Creek	34	1.07	0.24	1.73	2.55	500	331	183	**A**	0.07	557	1.27	**0.19**
Yankee Fork	13	0.68	0.31	1.76	2.62	500	170	91	**A**	0.03	738	1.18	**0.74**
Upper Salmon River	246	1.51	0.22	1.73	2.55	1000	544	395	**B**	0.25	361	1.52	**0.01**
North Fork Salmon River	Insufficient Data												
Lower Salmon River	103	1.22	0.18	1.72	2.53	2000	552	327	**B**	0.05	495	1.32	**0.08**
East Fork Salmon River	148	1.07	0.27	1.72	2.53	1000	464	306	**B**	0.15	575	1.26	**0.18**
Pahsimeroi River	127	0.54	0.37	1.75	2.60	1000	485	306	**A**	0.13	996	1.10	**1.04**
Panther Creek	Functionally Extirpated												
Fall Chinook 1977-	1273	1.00	0.11	1.71	2.50	3000	2400	1837	**B**	0.42	1448	1.12	**0.12**
Fall Chinook 1990-	1273	1.26	0.22	1.81	2.76	3000	4142	2707	**A**	0.42	1261	1.15	**0.00**
Wenatchee	222	0.93	0.28	1.78	2.68	2000	1159	691	**B**	0.11	880	1.29	**0.39**
Methow	180	0.80	0.25	1.75	2.58	2000	775	478	**A**	0.09	926	1.27	**0.59**
Entiat	59	0.72	0.16	1.72	2.53	500	192	125	**A**	0.12	926	1.27	**0.76**

Chinook Populations B.	Population Statistics										5% Gap					
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 5% Gap
Tucannon River	82	0.79	0.14	1.74	2.57	750	312	197	**A**	0.11	1.76		0.00	1.23		**1.23**
Asotin Creek	Functionally Extirpated															
Catherine Creek	107	0.89	0.24	1.78	2.68	750	422	265	**A**	0.14	1.76		0.01	0.98		**0.98**
Catherine (no hatchery yrs)	107	1.28	0.07	1.89	3.00	750	417	262	**B**	0.14	1.76		0.45	0.38	0.59	**0.59**
Lostine River	276	0.78	0.22	1.73	2.55	1000	515	396	**A**	0.28	1.58		0.00	1.03		**1.03**
Minam River	337	1.02	0.21	1.75	2.60	750	322	329	**A**	0.45	1.76		0.16	0.73		**0.73**
Imnaha River	380	0.79	0.11	1.81	2.76	750	978	679	**A**	0.51	1.76		0.00	1.23		**1.23**
Wenaha River	376	0.74	0.19	1.74	2.57	750	312	344	**A**	0.50	1.76		0.00	1.38		**1.38**
Upper Grande Ronde	38	0.42	0.41	1.86	2.90	1000	397	218	**A**	0.04	1.58		0.00	2.76		**2.76**
Big Sheep Creek	4	0.29	0.44	1.75	2.58	500										
Lookingglass Creek	Functionally Extirpated															
South Fork Mainstem	601	1.20	0.20	1.78	2.68	1000	478	539	**A**	0.60	1.58		0.52	0.32		**0.32**
Secesh River	403	1.21	0.13	1.72	2.53	750	271	337	**A**	0.54	1.76		0.38	0.45		**0.45**
East Fork Johnson	105	0.97	0.28	1.81	2.76	1000	330	217	**B**	0.11	1.58		0.23	0.63	1.33	**1.33**
Little Salmon River	Insufficient Data															
Big Creek	90	1.22	0.21	1.73	2.55	1000	295	192	**B**	0.09	1.58		0.54	0.30	1.34	**1.34**
Bear Valley Creek	182	1.46	0.17	1.73	2.55	750	358	270	**B**	0.24	1.76		0.66	0.21	0.65	**0.65**
Marsh Creek	42	1.01	0.22	1.73	2.55	500	208	125	**A**	0.08	2.21		0.00	1.19		**1.19**
Sulphur Creek	21	0.92	0.38	1.75	2.58	500	128	74	**A**	0.04	2.21		0.00	1.40		**1.40**
Camas Creek	28	0.83	0.32	1.74	2.57	500	150	89	**A**	0.06	2.21		0.00	1.66		**1.66**
Loon Creek	51	1.06	0.31	1.75	2.58	500	174	113	**A**	0.10	2.21		0.00	1.08		**1.08**
Chamberlain Creek	223	2.45	0.52	2.13	3.75	500										
Lower Middle Fork Salmon	Insufficient Data															
Upper Middle Fork Salmon	Insufficient Data															
Lemhi River	79	1.07	0.26	1.72	2.53	2000	710	395	**B**	0.04	1.34		0.60	0.25	1.03	**1.03**
Valley Creek	34	1.07	0.24	1.73	2.55	500	331	183	**A**	0.07	2.21		0.00	1.07		**1.07**
Yankee Fork	13	0.68	0.31	1.76	2.62	500	170	91	**A**	0.03	2.21		0.00	2.25		**2.25**
Upper Salmon River	246	1.51	0.22	1.73	2.55	1000	544	395	**B**	0.25	1.58		0.91	0.05	0.44	**0.44**
North Fork Salmon River	Insufficient Data															
Lower Salmon River	103	1.22	0.18	1.72	2.53	2000	552	327	**B**	0.05	1.34		0.82	0.10	1.36	**1.36**
East Fork Salmon River	148	1.07	0.27	1.72	2.53	1000	464	306	**B**	0.15	1.58		0.35	0.48	0.82	**0.82**
Pahsimeroi River	127	0.54	0.37	1.75	2.60	1000	485	306	**A**	0.13	1.58		0.00	1.93		**1.93**
Panther Creek	Functionally Extirpated															
Fall Chinook 77-present	1273	1.00	0.11	1.71	2.50	3000	2400	1837	**B**	0.42	1.28		0.56	0.28	0.27	**0.27**
Fall Chinook 90-present	1273	1.26	0.22	1.81	2.76	3000	4142	2707	**A**	0.42	1.28		0.97	0.02		**0.02**
Wenatchee	222	0.93	0.28	1.78	2.68	2000	1159	691	**B**	0.11	1.62		0.15	0.74	0.73	**0.73**
Methow	180	0.80	0.25	1.75	2.58	2000	775	478	**A**	0.09	1.62		0.00	1.03		**1.03**
Entiat	59	0.72	0.16	1.72	2.53	500	192	125	**A**	0.12	1.76		0.00	1.44		**1.44**

Chinook Populations C.	Population Statistics										1% Gap					
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 1% Gap
Tucannon River	82	0.79	0.14	1.74	2.57	750	312	312	**A**	0.11	2.75		0.00	2.48		**2.48**
Asotin Creek	Functionally Extirpated															
Catherine Creek	107	0.89	0.24	1.78	2.68	750	422	422	**A**	0.14	2.75		0.00	2.09		**2.09**
Catherine (no hatchery yrs)	107	1.28	0.07	1.89	3.00	750	417	417	**B**	0.14	2.75		0.00	1.15	0.97	**0.97**
Lostine River	276	0.78	0.22	1.73	2.55	1000	515	515	**A**	0.28	2.30		0.00	1.95		**1.95**
Minam River	337	1.02	0.21	1.75	2.60	750	322	322	**A**	0.45	2.75		0.00	1.70		**1.70**
Imnaha River	380	0.79	0.11	1.81	2.76	750	978	978	**A**	0.51	2.75		0.00	2.48		**2.48**
Wenaha River	376	0.74	0.19	1.74	2.57	750	312	312	**A**	0.50	2.75		0.00	2.72		**2.72**
Upper Grande Ronde	38	0.42	0.41	1.86	2.90	1000	397	397	**A**	0.04	2.30		0.00	4.48		**4.48**
Big Sheep Creek	4	0.29	0.44	1.75	2.60	500										
Lookingglass Creek	Functionally Extirpated															
South Fork Mainstem	601	1.20	0.20	1.78	2.68	1000	478	478	**A**	0.60	2.30		0.04	0.92		**0.92**
Secesh River	403	1.21	0.13	1.72	2.53	750	271	271	**A**	0.54	2.75		0.00	1.27		**1.27**
East Fork Johnson	105	0.97	0.28	1.81	2.76	1000	330	330	**B**	0.11	2.30		0.00	1.37	1.70	**1.70**
Little Salmon River	Insufficient Data															
Big Creek	90	1.22	0.21	1.73	2.55	1000	295	295	**B**	0.09	2.30		0.06	0.89	1.64	**1.64**
Bear Valley Creek	182	1.46	0.17	1.73	2.55	750	358	358	**B**	0.24	2.75		0.06	0.88	0.99	**0.99**
Marsh Creek	42	1.01	0.22	1.73	2.55	500	208	208	**A**	0.08	4.80		0.00	3.75		**3.75**
Sulphur Creek	21	1.05	0.38	1.75	2.58	500	128	128	**A**	0.04	4.80		0.00	3.57		**3.57**
Camas Creek	28	0.83	0.32	1.74	2.57	500	150	150	**A**	0.06	4.80		0.00	4.78		**4.78**
Loon Creek	51	1.06	0.31	1.75	2.58	500	174	174	**A**	0.10	4.80		0.00	3.53		**3.53**
Chamberlain Creek	223	2.45	0.52	2.13	3.75	500										
Lower Middle Fork Salmon	Insufficient Data															
Upper Middle Fork Salmon	Insufficient Data															
Lemhi River	79	1.07	0.26	1.72	2.53	2000	710	710	**B**	0.04	1.73		0.24	0.62	1.22	**1.22**
Valley Creek	34	1.07	0.24	1.73	2.55	500	331	331	**A**	0.07	4.80		0.00	3.49		**3.49**
Yankee Fork	13	0.68	0.31	1.76	2.62	500	170	170	**A**	0.03	4.80		0.00	6.06		**6.06**
Upper Salmon River	246	1.51	0.22	1.73	2.55	1000	544	544	**B**	0.25	2.30		0.31	0.52	0.68	**0.68**
North Fork Salmon River	Insufficient Data															
Lower Salmon River	103	1.22	0.18	1.72	2.53	2000	552	552	**B**	0.05	1.73		0.41	0.42	1.52	**1.52**
East Fork Salmon River	148	1.07	0.27	1.72	2.53	1000	464	464	**B**	0.15	2.30		0.00	1.15	1.15	**1.15**
Pahsimeroi River	127	0.54	0.37	1.75	2.60	1000	485	485	**A**	0.13	2.30		0.00	3.26		**3.26**
Panther Creek	Functionally Extirpated			0.00	0.00											
Fall Chinook 77-present	1273	1.00	0.11	1.71	2.50	3000	2400	2400	**B**	0.42	1.50		0.33	0.50	0.38	**0.38**
Fall Chinook 90-present	1273	1.26	0.22	1.81	2.76	3000	4142	4142	**A**	0.42	1.50		0.68	0.19		**0.19**
Wenatchee	222	0.93	0.28	1.78	2.68	2000	1159	1159	**B**	0.11	2.20		0.00	1.37	1.05	**1.05**
Methow	180	0.80	0.25	1.75	2.58	2000	775	775	**A**	0.09	2.20		0.00	1.75		**1.75**
Entiat	59	0.72	0.16	1.72	2.53	500	192	192	**A**	0.12	2.20		0.00	2.06		**2.06**

Table A-3. Steelhead population gaps to the 25% risk curve (A), 5% risk curve (B), and 1% risk curve (C).

Steelhead Populations **A.**	Population Statistics										25% Gap		
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Abund. Needed	Prod. @ Curve	Observed 25% Gap
Wenatchee (hatch=1)	900	0.84	0.21	2.13	2.76	1000	553	726	**A**	0.90	1059	0.99	**0.18**
Wenatchee (hatch=0.3)	*900*	*0.87*	*0.19*	*1.80*	*3.36*	*1000*	*553*	*726*	***A***	*0.90*	*984*	*1.00*	***0.15***
Methow (hatch=1)	281	0.28	0.29	2.13	3.36	1000	241	261	**A**	0.28	764	1.03	**2.68**
Methow (htch. Eff. =0.3)	*281*	*0.49*	*0.14*	*1.75*	*3.36*	*1000*	*241*	*261*	***A***	*0.28*	*764*	*1.03*	***1.10***
Entiat (hatch=1)	94	0.48	0.23	1.74	2.57	500	346	220	**A**	0.19	535	1.07	**1.23**
Okanogan (hatch=1)	104	0.12	0.35	2.13	2.82	1000	79	91	**A**	0.10	696	1.04	**7.67**
Deschutes (westside)	456	1.05	0.15	1.78	2.68	1000	439	448	**B**	0.46	459	1.20	**0.14**
Deschutes (eastside)	1599	1.89	0.27	2.02	3.36	1000	1404	1501	**D**	1.60	1435	1.02	**-0.46**
Klickitat River						1000							
Fifteenmile Creek	703	1.82	0.20	1.94	3.14	500	561	632	**D**	1.41	164	1.81	**-0.01**
Rock Creek	Insufficient Data					500							
White Salmon	Functionally Extirpated					500							
Upper Yakima River	85	1.12	0.22	1.75	2.60	1500	472	278	**B**	0.06	387	1.24	**0.11**
Naches River	472	1.12	0.22	1.75	2.60	1500	509	491	**B**	0.31	541	1.16	**0.04**
Toppenish River	322	1.60	0.30	1.75	2.60	500	344	333	**C**	0.64	189	1.60	**0.00**
Satus Creek	379	1.40	0.15	1.81	2.76	1000	421	400	**C**	0.38	250	1.39	**-0.01**
Satus Creek (Trib only)	379	1.73	0.14	1.89	3.00	500	439	409	**C**	0.76	167	1.72	**-0.01**
John Day Lower Mainstem	1800	2.99	0.24	1.86	2.90	2250	2238	2019	**C**	0.80	134	3.00	**0.00**
John Day North Fork	1740	2.41	0.22	1.81	2.76	1500	1637	1689	**D**	1.16	1435	1.02	**-0.58**
John Day Upper Mainstem	524	2.14	0.33	1.89	3.00	1000	936	730	**C**	0.52	145	2.10	**-0.02**
John Day Middle Fork	756	2.45	0.16	1.89	3.00	1000	1099	928	**C**	0.76	140	2.45	**0.00**
John Day South Fork	259	2.06	0.27	1.83	2.82	500	560	409	**C**	0.52	145	2.01	**-0.02**
Umatilla River	1472	1.50	0.15	2.02	3.36	1500	1270	1371	**C**	0.98	1435	1.02	**-0.32**
Walla Walla Mainstem	650	1.34	0.12	2.02	3.36	1000	599	625	**B**	0.65	405	1.23	**-0.08**
Touchet River	Insufficient Data					1000							
Willow Creek	Functionally Extirpated					1000							
Tucannon River	Insufficient Data												
Asotin River	Insufficient Data												
Grande Ronde Upper Main.	1226	2.29	0.22	1.83	2.82	1500	1475	1350	**C**	0.82	119	2.30	**0.00**
Grande Ronde Lower Main.	Insufficient Data					1000							
Joseph Creek	2132	2.58	0.14	1.81	2.76	500	1371	1752	**D**	4.26	1834	0.92	**-0.64**
Wallowa River	n/a	1.73	0.25	1.81	2.76	1000							
Imnaha River	n/a	1.51	0.15	1.81	2.76	1000							
Clearwater Populations (4)	Insufficient Data												
CW North Fork (blocked)	Fully Extirpated												
Salmon R. Populations (12)	Insufficient Data												
Wild Horse / Powder River	Insufficient Data												
Generic "B" run steelhead	306	0.85	0.14	1.8	2.72	1000	473	354	**B**	0.31	521	1.04	**0.22**
Generic "A" run steelhead	518	1.35	0.42	1.89	3.00	1000	419	542	**C**	0.52	186	1.32	**-0.02**

Steelhead Populations **B.**	Population Statistics										5% Gap					
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 5% Gap
Wenatchee (hatch=1)	900	0.84	0.21	2.13	2.76	1000	553	726	**A**	0.90	1.20		0.40	0.43		**0.43**
Wenatchee (hatch=0.3)	*900*	*0.87*	*0.19*	*1.80*	*3.36*	*1000*	*553*	*726*	***A***	*0.90*	*1.20*		*0.45*	*0.38*		***0.38***
Methow (hatch=1)	281	0.28	0.29	2.13	3.36	1000	241	261	**A**	0.28	1.20		0.00	3.29		**3.29**
Methow (htch. Eff. =0.3)	*281*	*0.49*	*0.14*	*1.75*	*3.36*	*1000*	*241*	*261*	***A***	*0.28*	*1.20*		*0.00*	*1.45*		***1.45***
Entiat (hatch=1)	94	0.48	0.23	1.74	2.57	500	346	220	**A**	0.19	1.35		0.00	1.81		**1.81**
Okanogan (hatch=1)	104	0.12	0.35	2.13	2.82	1000	79	91	**A**	0.10	1.20		0.00	9.00		**9.00**
Deschutes (westside)	456	1.05	0.15	1.78	2.68	1000	439	448	**B**	0.46	1.35		0.56	0.29	0.78	**0.78**
Deschutes (eastside)	1599	1.89	0.27	2.02	3.36	1000	1404	1501	**D**	1.60	1.35	1.25	1.80	-0.29		**-0.34**
Klickitat River						1000					1.35					
Fifteenmile Creek	703	1.82	0.20	1.94	3.14	500	561	632	**D**	1.41	1.56	1.43	1.33	-0.14		**-0.21**
Rock Creek	Insufficient Data					500					1.56					
White Salmon	Functionally Extirpated					500					1.56					
Upper Yakima River	85	1.12	0.22	1.75	2.60	1500	472	278	**B**	0.06	1.26		0.78	0.13	1.15	**1.15**
Naches River	472	1.12	0.22	1.75	2.60	1500	509	491	**B**	0.31	1.26		0.78	0.13	1.03	**1.03**
Toppenish River	322	1.60	0.30	1.75	2.60	500	344	333	**C**	0.64	1.56		1.05	-0.03		**0.50**
Satus Creek	379	1.40	0.15	1.81	2.76	1000	421	400	**C**	0.38	1.35		1.07	-0.04		**1.50**
Satus Creek (Trib only)	379	1.73	0.14	1.89	3.00	500	439	409	**C**	0.76	1.56		1.22	-0.10		**0.22**
John Day Lower Mainstem	1800	2.99	0.24	1.86	2.90	2250	2238	2019	**C**	0.80	1.19		4.03	-0.60		**0.11**
John Day North Fork	1740	2.41	0.22	1.81	2.76	1500	1637	1689	**D**	1.16	1.26	1.23	2.83	-0.48		**-0.49**
John Day Upper Mainstem	524	2.14	0.33	1.89	3.00	1000	936	730	**C**	0.52	1.35		2.17	-0.37		**0.37**
John Day Middle Fork	756	2.45	0.16	1.89	3.00	1000	1099	928	**C**	0.76	1.35		2.63	-0.45		**0.08**
John Day South Fork	259	2.06	0.27	1.83	2.82	500	560	409	**C**	0.52	1.56		1.64	-0.24		**0.22**
Umatilla River	1472	1.50	0.15	2.02	3.36	1500	1270	1371	**C**	0.98	1.26		1.38	-0.16		**0.09**
Walla Walla Mainstem	650	1.34	0.12	2.02	3.36	1000	599	625	**B**	0.65	1.35		0.99	0.01	0.34	**0.34**
Touchet River	Insufficient Data					1000										
Willow Creek	Functionally Extirpated					1000										
Tucannon River	Insufficient Data															
Asotin River	Insufficient Data															
Grande Ronde Upper Main.	1226	2.29	0.22	1.83	2.82	1500	1475	1350	**C**	0.82	1.10		3.16	-0.52		**0.11**
Grande Ronde Lower Main.	Insufficient Data					1000										
Joseph Creek	2132	2.58	0.14	1.81	2.76	500	1371	1752	**D**	4.26	1.27	1.05	3.06	-0.51		**-0.59**
Wallowa River	n/a	1.73	0.25	1.81	2.76	1000										
Imnaha River	n/a	1.51	0.15	1.81	2.76	1000										
Clearwater Populations (4)	Insufficient Data															
CW North Fork (blocked)	Fully Extirpated															
Salmon R. Populations (12)	Insufficient Data															
Wild Horse / Powder River	Insufficient Data															
Generic "B" run steelhead	306	0.85	0.14	1.80	2.72	1000	473	354	**B**	0.31	1.14		0.49	0.34	0.73	**0.73**
Generic "A" run steelhead	518	1.35	0.42	1.89	3.00	1000	419	542	**C**	0.52	1.14		1.37	-0.16		**0.85**

Steelhead Populations **C.**	Population Statistics										1% Gap					
	10-year Geomean Abund.	20-yr Prod.	Prod SE	SE Mult. (95% cert.)	SE Mult. (99% cert.)	Threshold	Averaged Capacity Estimate	Average Equilibrium Spawners (Current)	Gap Zone	Abund. Prop. of Threshold	Min. Prod. @ Threshold	Min. Prod. @ Current Abund.	Abundance Check	Prod. Gap	Capacity Adjusted Productivity Gap	Observed 1% Gap
Wenatchee (hatch=1)	900	0.84	0.21	2.13	2.76	1000	553	726	**A**	0.90	1.45		0.16	0.73		**0.73**
Wenatchee (hatch=0.3)	*900*	*0.87*	*0.19*	*1.80*	*3.36*	*1000*	*553*	*726*	***A***	*0.90*	*1.45*		*0.20*	*0.67*		***0.67***
Methow (hatch=1)	281	0.28	0.29	2.13	3.36	1000	241	261	**A**	0.28	1.45		0.00	4.18		**4.18**
Methow (htch. Eff. =0.3)	*281*	*0.49*	*0.14*	*1.75*	*3.36*	*1000*	*241*	*261*	***A***	*0.28*	*1.45*		*0.00*	*1.96*		***1.96***
Entiat (hatch=1)	94	0.48	0.23	1.74	2.57	500	346	220	**A**	0.19	1.68		0.00	2.50		**2.50**
Okanogan (hatch=1)	104	0.12	0.35	2.13	2.82	1000	79	91	**A**	0.10	1.45		0.00	11.08		**11.08**
Deschutes (westside)	456	1.05	0.15	1.78	2.68	1000	439	448	**B**	0.46	1.64		0.28	0.56	0.92	**0.92**
Deschutes (eastside)	1599	1.89	0.27	2.02	3.36	1000	1404	1501	**D**	1.60	1.64	1.52	1.30	0.00		**-0.20**
Klickitat River						1500					1.53					
Fifteenmile Creek	703	1.82	0.20	1.94	3.14	500	561	632	**D**	1.41	2.00	1.76	0.82	0.10		**-0.03**
Rock Creek	Insufficient Data					500					2.00					
White Salmon	Functionally Extirpated					1000					1.64					
Upper Yakima River	85	1.12	0.22	1.75	2.60	1500	472	278	**B**	0.06	1.53		0.46	0.37	1.27	**1.27**
Naches River	472	1.12	0.22	1.75	2.60	1500	509	491	**B**	0.31	1.53		0.46	0.37	1.16	**1.16**
Toppenish River	322	1.60	0.30	1.75	2.60	500	344	333	**C**	0.64	2.00		0.60	0.25		**0.50**
Satus Creek	379	1.40	0.15	1.81	2.76	1000	421	400	**C**	0.38	1.64		0.71	0.17		**1.50**
Satus Creek (Trib only)	379	1.73	0.14	1.89	3.00	500	439	409	**C**	0.76	2.00		0.73	0.16		**0.22**
John Day Lower Mainstem	1800	2.99	0.24	1.86	2.90	2250	2238	2019	**C**	0.80	1.41		3.24	0.00		**0.11**
John Day North Fork	1740	2.41	0.22	1.81	2.76	1500	1637	1689	**D**	1.16	1.53	1.49	2.15	0.00		**-0.38**
John Day Upper Mainstem	524	2.14	0.33	1.89	3.00	1000	936	730	**C**	0.52	1.64		1.61	0.00		**0.37**
John Day Middle Fork	756	2.45	0.16	1.89	3.00	1000	1099	928	**C**	0.76	1.64		1.99	0.00		**0.08**
John Day South Fork	259	2.06	0.27	1.83	2.82	500	560	409	**C**	0.52	2.00		1.06	0.00		**0.22**
Umatilla River	1472	1.50	0.15	2.02	3.36	1500	1270	1371	**C**	0.98	1.53		0.96	0.02		**0.09**
Walla Walla Mainstem	650	1.34	0.12	2.02	3.36	1000	599	625	**B**	0.65	1.64		0.63	0.22	0.45	**0.45**
Touchet River	Insufficient Data					1000					1.64					
Willow Creek	Functionally Extirpated					1000										
Tucannon River	Insufficient Data															
Asotin River	Insufficient Data															
Grande Ronde Upper Main.	1226	2.29	0.22	1.83	2.82	1500	1475	1350	**C**	0.82	1.22		2.75	0.00		**0.11**
Grande Ronde Lower Main.	Insufficient Data					1000										
Joseph Creek	2132	2.58	0.14	1.81	2.76	500	1371	1752	**D**	4.26	1.49	1.19	2.46	0.00		**-0.54**
Wallowa River	n/a	1.73	0.25	1.81	2.76	1000										
Imnaha River	n/a	1.51	0.15	1.81	2.76	1000										
Clearwater Populations (4)	Insufficient Data															
CW North Fork (blocked)	Fully Extirpated															
Salmon R. Populations (12)	Insufficient Data															
Wild Horse / Powder River	Insufficient Data															
Generic "B" run steelhead	306	0.85	0.14	1.80	2.72	1000	473	354	**B**	0.31	1.29		0.32	0.52	0.82	**0.82**
Generic "A" run steelhead	518	1.35	0.42	1.89	3.00	1000	419	542	**C**	0.52	1.29		1.09	0.00		**0.85**