Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basins

Part 2: Lower Columbia Chinook

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Paul McElhany[1], Mark Chilcote[2], James Myers[1], Ray Beamesderfer[3]

[1] National Marine Fisheries Service Northwest Fisheries Science Center
[2] Oregon Department of Fish and Wildlife
[3] Cramer Fish Sciences

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I. ESU Overview and Historical Range

Based on TRT analysis, the Oregon portion of the LRC ESU historically contained 12 populations: 9 fall run chinook (tules); 1 late fall run chinook (brights); and 2 spring run chinook (Figure 1 and Figure 2). The stratum composition is shown in Table 1. The Lower Gorge and Upper Gorge populations occur in both Washington and Oregon. In this report, we describe only the status of the Oregon portion of these two populations.

In general, naturally-produced chinook in the lower Columbia basin are thought to be substantially reduced compared to historic levels (Myers, et al. 1998). Coinciding with this decline in total abundance has been a reduction in the number of functioning wild populations, particularly in the case of Tule fall chinook. In addition the significant presence of stray hatchery fish is thought to be common throughout most of the range. Currently, only 2 of the historical 12 populations in the ESU show substantial natural production.

The presentation of our assessment begins with three sections, each of which evaluates one of the viability criteria (i.e., abundance/productivity, spatial structure, and diversity). We have pooled the results from these sections in a synthesis section for each population, where we derive a status rating for each population. We end our presentation with an interpretation of the population results in terms of the overall status of Oregon's LCR chinook populations.

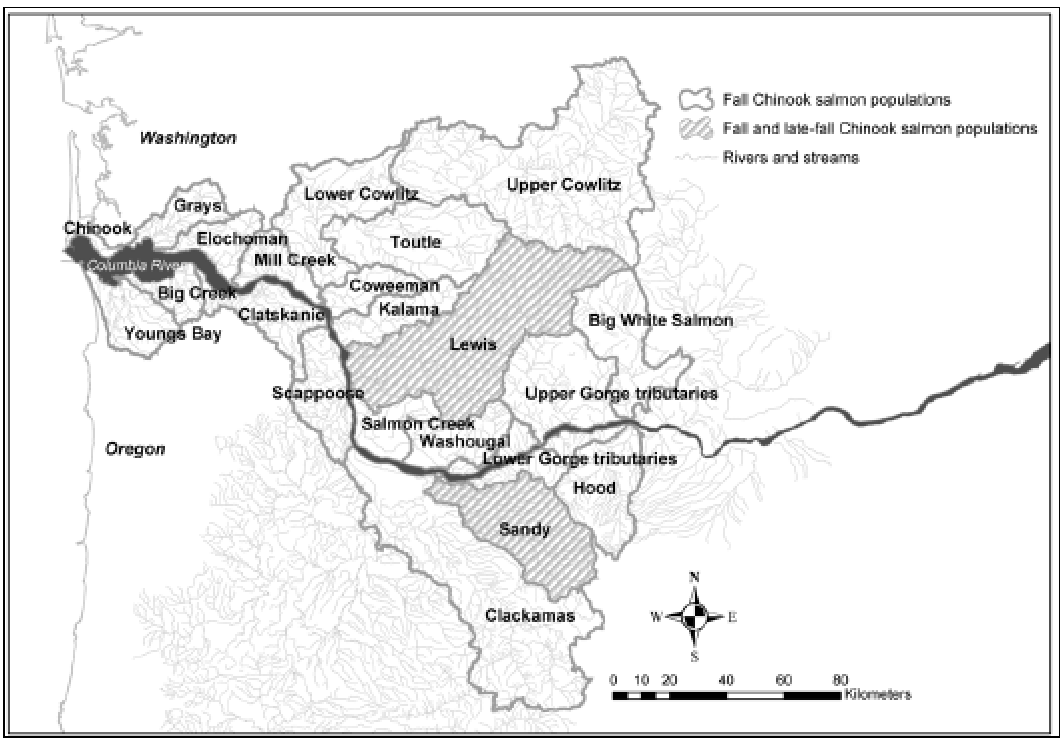

Figure 1: Map of LCR fall chinook salmon populations.

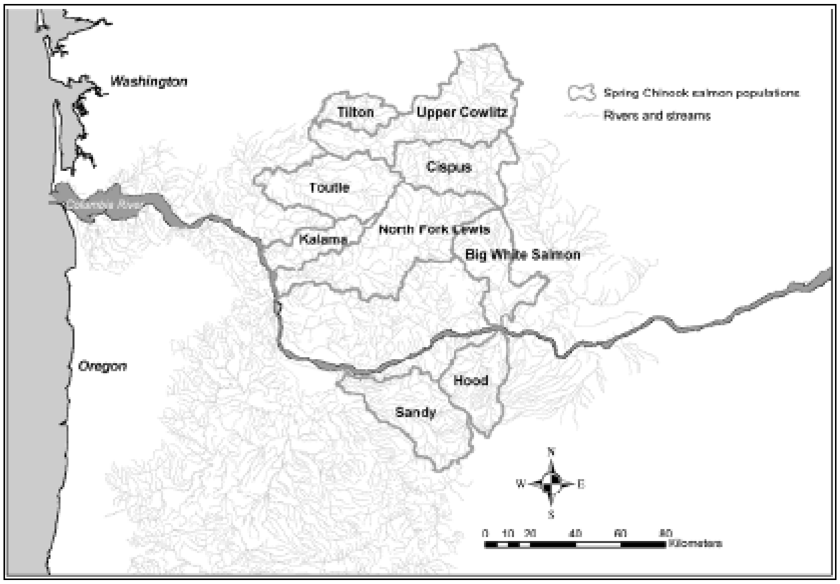

Figure 2: Map of LCR spring chinook salmon populations.

Table 1: Stratum composition of Oregon LCR chinook populations. Each ecozone and life history combination is a separate stratum, which results in six strata in this ESU.

EcoZone	Life History	Populations
Coastal	Fall (tule)	Youngs Bay Big Creek Clatskanie Scappoose
Cascade	Fall (tule)	Clackamas Sandy
	Late Fall (bright)	Sandy
	Spring	Sandy
Gorge	Fall	Lower Gorge Upper Gorge Hood
	Spring	Hood

II. Abundance and Productivity

A&P – Youngs Bay Fall Run (Tule)

A time series of abundance adequate for quantitative viability analysis is not available for the Youngs Bay fall chinook population. A time series of fish per mile for this population was included in the 2005 BRT status update (Good et al. 2005) (Figure 3), but the time series does not distinguish between hatchery and natural origin fish, so it is not very informative about the status of the natural population. However, the time series does indicate that no fish (of either hatchery or natural origin) were observed during some recent years, suggesting that the number of fish can get relatively low (assuming the survey was reasonably efficient at finding fish). A time series of abundance was analyzed for the nearby Clatskanie fall chinook population and that analysis indicated that the Clatskanie is at a high risk of extinction. Conditions in Youngs bay are not expected to be any more favorable to fall chinook than in the Clatskanie. In fact, conditions may be less favorable because of the presence of a large number of out of strata origin hatchery fish (discussed in the diversity section). Data in the 2005 Oregon Native Fish Status Report show a geometric mean return abundance for this populations in years 2000-2004 of 37 fish per mile (ODFW 2005). The report states that the “existing run is likely to be primarily hatchery fish.” There is no abundance and productivity evidence supporting the existence of a viable natural origin population in Youngs Bay, and comparisons with populations in similar habitats suggest the population is at significant risk. The 2005 Oregon Native Fish Status Report listed this population as “failed” for abundance and productivity.

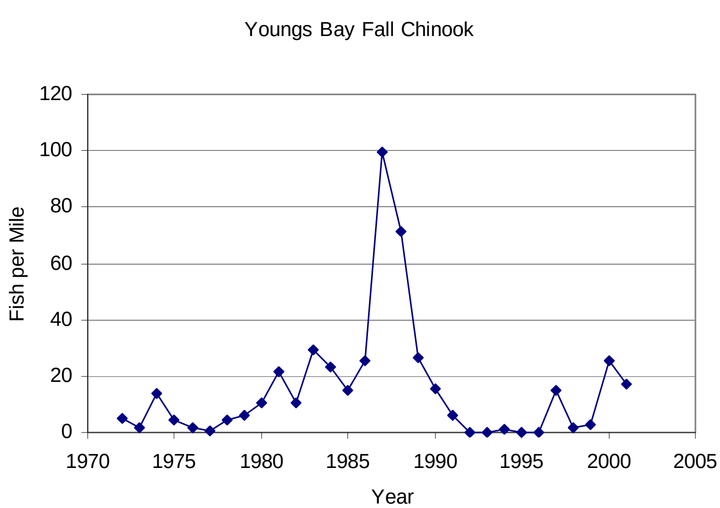

Figure 3: Youngs Bay chinook salmon per mile, 1972-2001.

A&P – Big Creek Fall Run (Tule)

A time series of abundance adequate for quantitative viability analysis is not available for the Big Creek fall chinook population. A time series of fish per mile for this population was included in the 2005 BRT status update (Figure 4), but the time series does not distinguish between hatchery and natural origin fish, so it is not very informative about the status of the natural population. However, the time series does indicate that very few fish (of either hatchery or natural origin) were observed during some recent years, suggesting that the number of fish can get relatively low (assuming the survey was reasonably efficient at finding fish). A time series of abundance was analyzed for the nearby Clatskanie fall chinook population and that analysis indicated that the Clatskanie is at a high risk of extinction. Conditions in Big Creek are not expected to be any more favorable to fall chinook than in the Clatskanie. In fact, conditions may be less favorable because of the presence of a large number of origin hatchery fish (discussed in the diversity section). Data in the 2005 Oregon Native Fish Status Report show a geometric mean return abundance for this population in years 2000-2004 of 413 fish per mile, but the report states that the "existing run is likely to be primarily hatchery fish" (ODFW 2005). There is no abundance and productivity evidence supporting the existence of a viable natural origin population in Big Creek and comparisons with populations in similar habitats suggest the population is at significant risk. The 2005 Oregon Native Fish Status Report listed this population as "failed" for abundance and productivity.

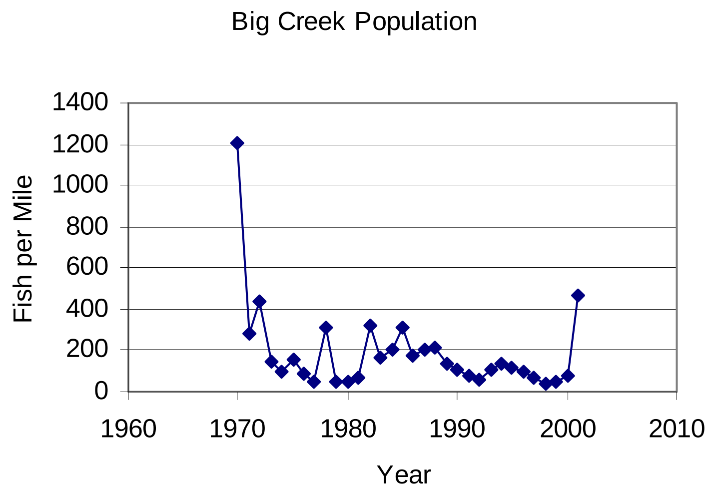

Figure 4: Big Creek chinook salmon per mile, 1970-2001.

A&P – Clatskanie Fall Run

Although there is likely to be substantial measurement error in the data, a time series of abundance was available for the Clatskanie fall chinook population (Appendix B). Descriptive graphs and viability analysis results are provided in Figure 5 to Figure 11 and in Table 2 and Table 5. These analyses suggest that this population is at substantial risk of extinction. As shown in the viability curve graphs, the population has been at a very low abundance of natural origin spawners. In more than half the years, the population was below 100 spawners, and in 9 of the years the abundance was less than 10 fish.

The viability curves suggest a relatively high productivity for this population. However, we believe that is likely a product of measurement error and does not reflect the true productivity of the population. With very low abundances, even small measurement errors in abundance estimates and hatchery fraction estimates or violations of the no migration assumptions will lead to erroneous (and upwardly biased) estimates of productivity. These analyses put the population in the very high risk category. The PopCycle model estimates a 56% risk level, which also puts it in the high risk category.

The CAPM model also indicates that the population is in the high risk category, with a median CRT risk probability of 53%. The escapement viability curve indicates that the population has very low chance of persistence if the pattern of harvest that occurred over the available time series were to continue (average harvest rate 66%). The 2005 Oregon Native Fish Status Report (ODFW 2005) states that the "existing run is likely to be primarily hatchery." However, in 2006 new information became available that the frequency of Fall chinook recovered during spawning surveys known to be hatchery fish as indicated from CWT recoveries was extremely low.

Expansion of these observations based on the CWT tagging rate of hatchery fish released from nearby hatcheries, indicated the likely fraction of all hatchery fish (with and without CWTs) within the Clatstkanie in recent years was in the range of 15%. The geometric mean natural origin spawners is 50 fish (Table 2), which is in the "extirpated or nearly so" minimum abundance threshold category. The 2005 Oregon Native Fish Status Report listed this population as "failed" for abundance and productivity.

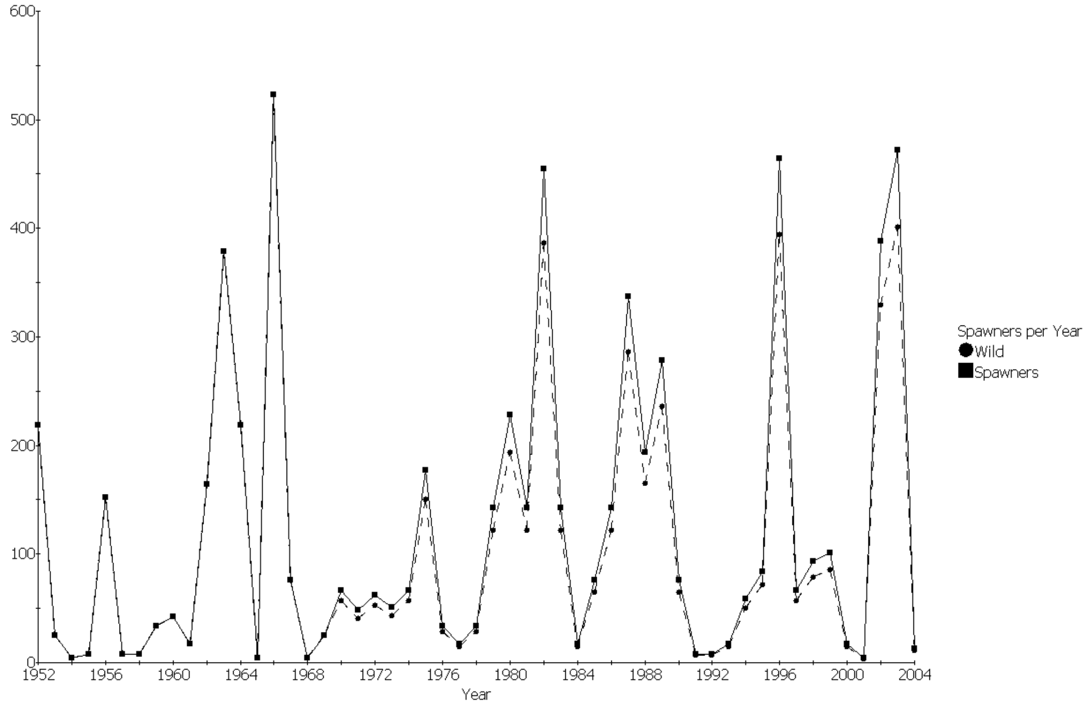

Figure 5: Clatskanie fall chinook abundance.

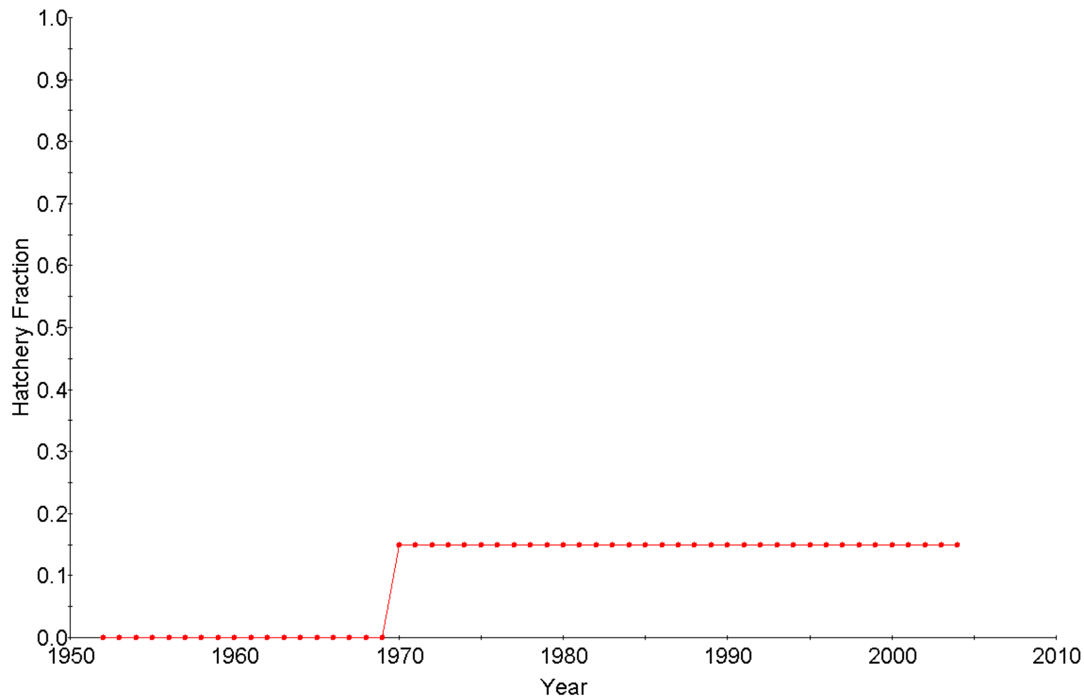

Figure 6: Clatskanie fall chinook hatchery fraction.

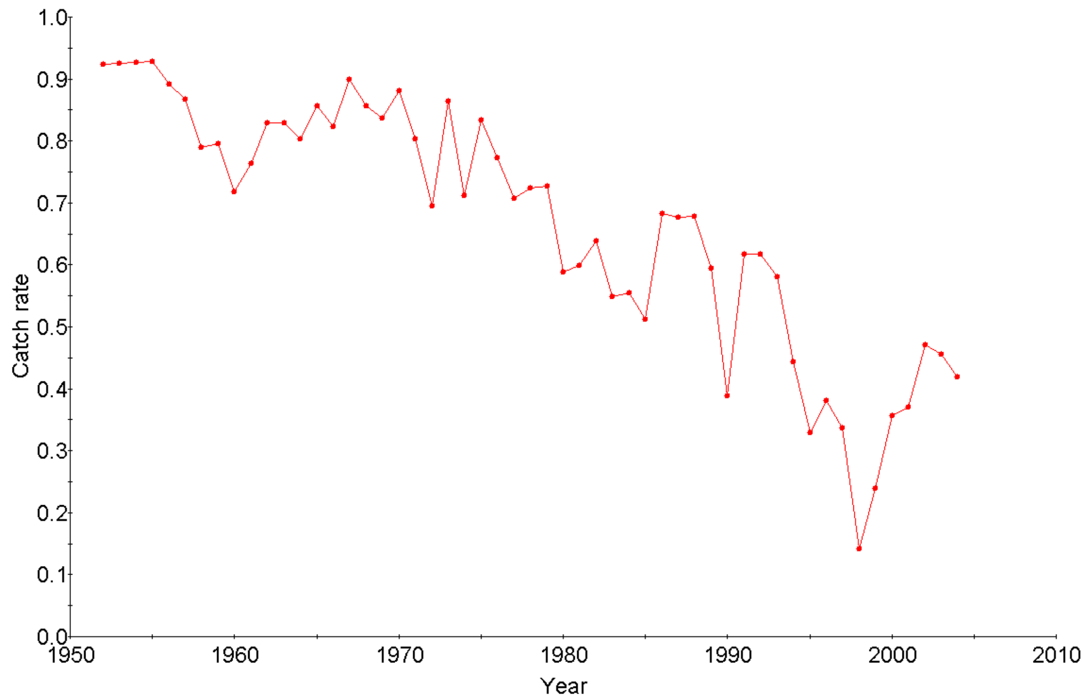

Figure 7: Clatskanie fall chinook harvest rate.

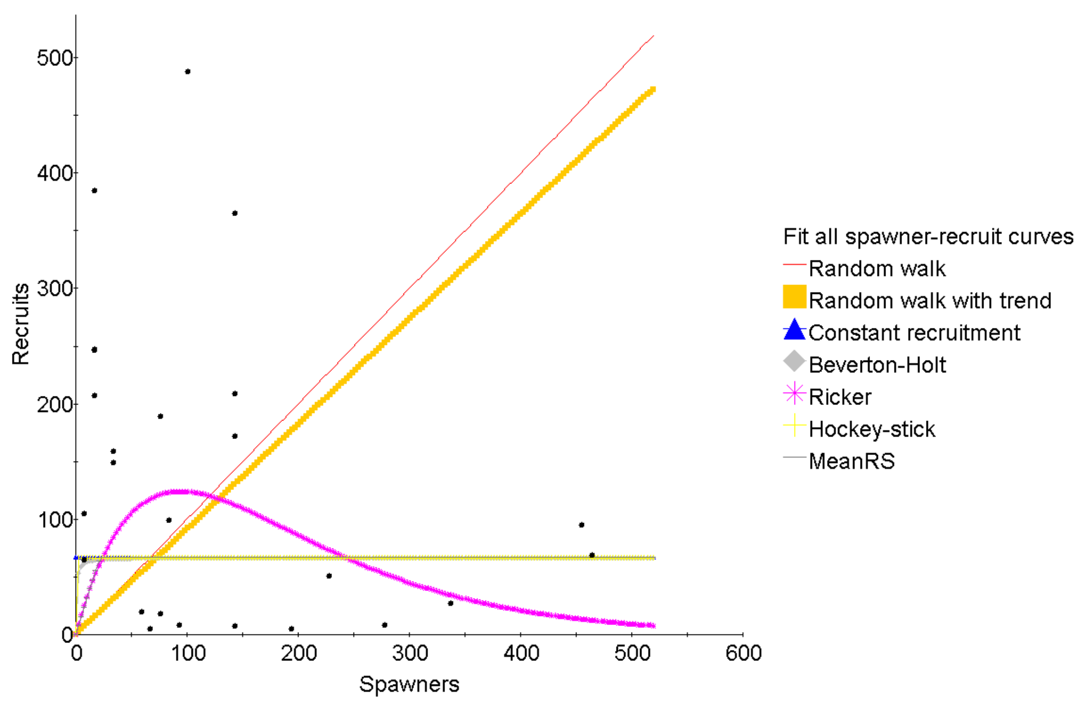

Figure 8: Clatskanie fall chinook escapement recruitment functions.

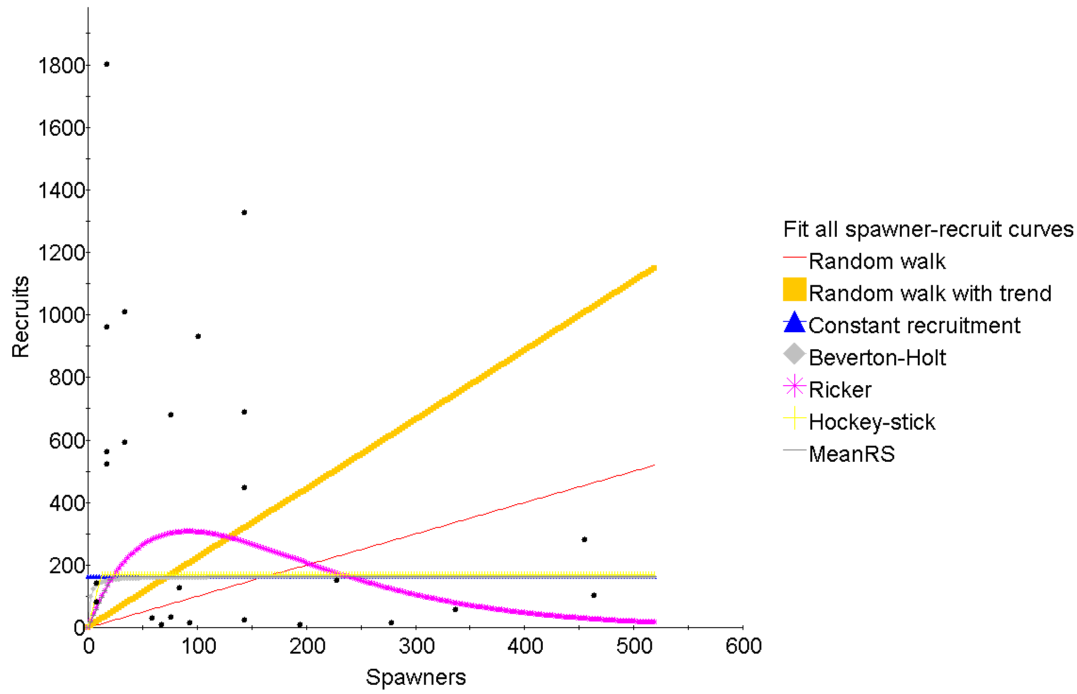

Figure 9: Clatskanie fall chinook pre-harvest recruitment functions.

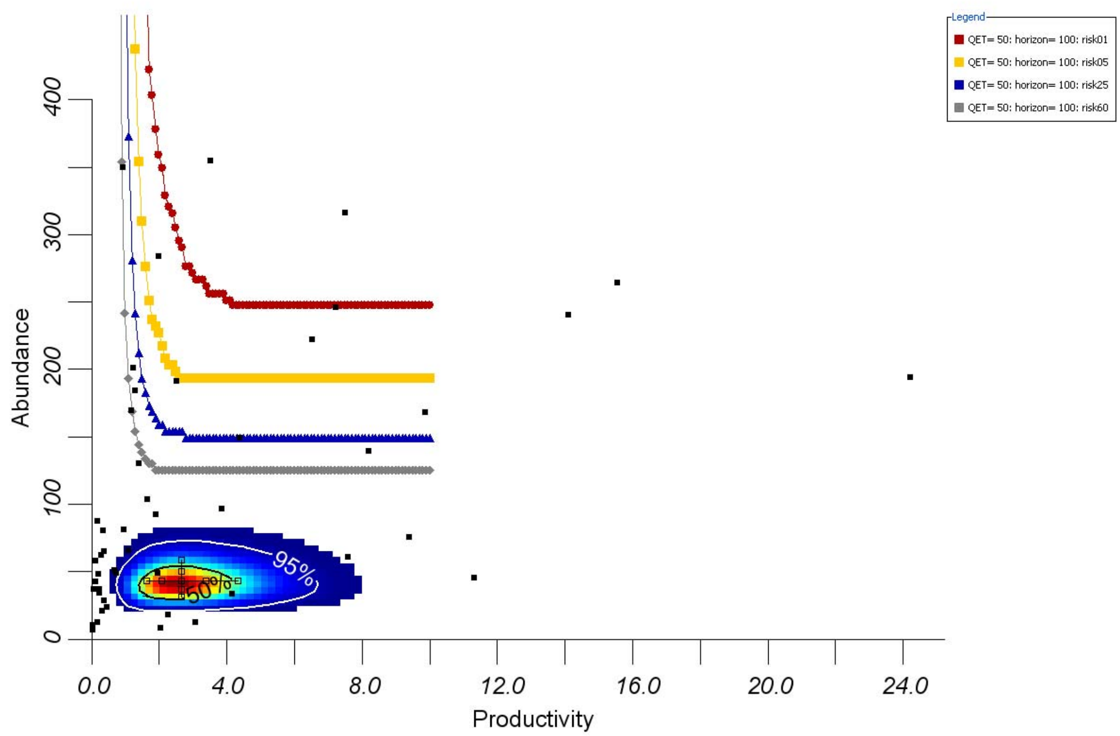

Figure 10: Clatskanie fall chinook escapement viability curve. Measurement error assumptions were: abundance ± 40%; hatchery fraction ± 70%; age structure shape parameter 20; catch abundance ± 40%. CRT = 50.

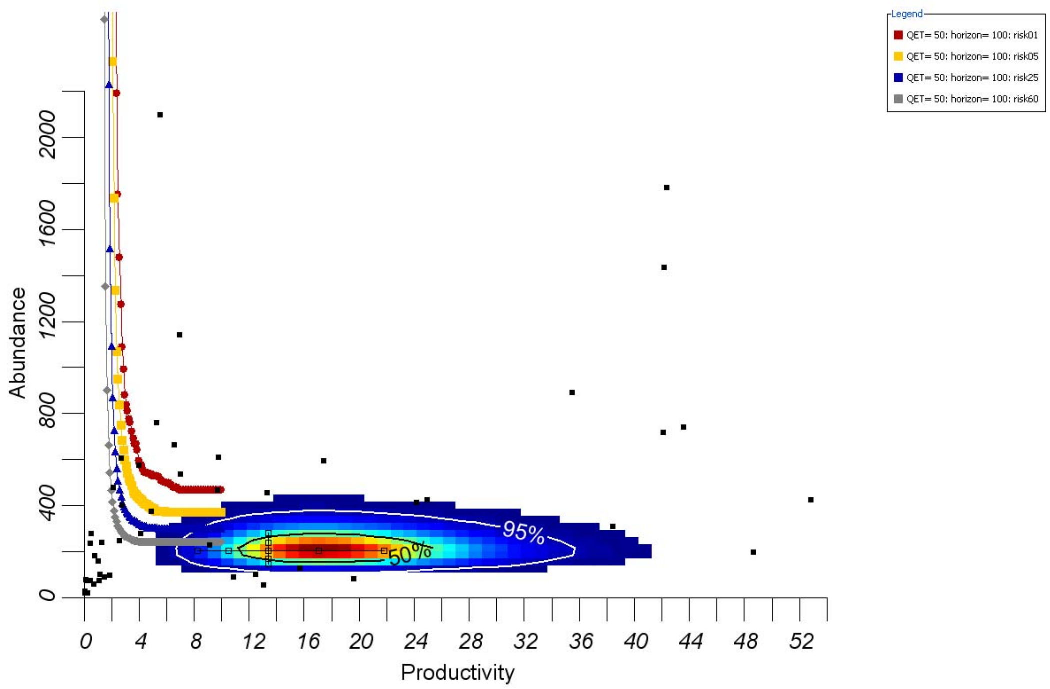

Figure 11: Clatskanie fall chinook pre-harvest viability curve. Measurement error assumptions were: abundance ± 40%; hatchery fraction ± 70%; age structure shape parameter 20; catch abundance ± 40%. CRT = 50.

Table 2: Clatskanie fall chinook summary statistics. The geometric mean natural origin spawner abundance (highlighted in red) is in the "extirpated or nearly so" viability criteria category. The 95% confidence intervals are shown in parentheses.

Statistic	Escapement		Pre-harvest	
	Total Series	Recent Years	Total Series	Recent Years
Time Series Period	1952-2004	1990-2004	1952-2004	1990-2004
Length of Time Series	53	15	53	15
Geometric Mean Natural Origin Spawner Abundance	50 (34-74)	41 (18-96)	NA	NA
Geometric Mean Recruit Abundance	71 (52-96)	83 (40-173)	242 (173-337)	132 (62-280)
Lambda	0.99 (0.824-1.189)	1.152 (0.514-2.582)	1.397 (1.129-1.729)	1.33 (0.564-3.134)
Trend in Log Abundance	1.012 (0.987-1.039)	1.077 (0.882-1.314)	NA	NA
Geometric Mean Recruits per Spawner (all broods)	1.232 (0.763-1.99)	1.628 (0.449-5.908)	4.214 (2.52-7.047)	2.592 (0.697-9.646)
Geometric Mean Recruits per Spawner (broods < median spawner abudance)	4.61 (2.998-7.088)	7.502 (0.861-65.372)	17.503 (11.436-26.789)	11.585 (1.173-114.452)
Average Hatchery Fraction	0.099	0.150	NA	NA
Average Harvest Rate	0.664	0.410	NA	NA
CAPM median extinction risk probability (5th-95th percentiles)	NA	NA	0.53	NA
PopCycle extinction risk	NA	NA	0.56	NA

Table 3: Escapement recruitment parameter estimates and relative AIC values for Clatskanie fall chinook. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted.

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	0 (0-0)	0 (0-0)	2.14 (1.77-2.77)	18.5
Random walk with trend	0.91 (0.54-2.42)	0 (0-0)	2.14 (1.8-2.82)	20.5
Constant recruitment	0 (0-0)	67 (45-123)	1.42 (1.2-1.96)	0
Beverton-Holt	>100 (14.28->100)	68 (45-131)	1.42 (1.22-1.99)	2.2
Ricker	3.61 (1.91-13.44)	126 (94-384)	1.65 (1.44-2.41)	9.6
Hockey-stick	43.03 (9.05->100)	67 (44-123)	1.42 (1.2-1.97)	2
MeanRS	3.32 (1.43-7.11)	67 (41-106)	2.33 (1.48-2.94)	12.1

Table 4: Prehavest recruitment parameter estimates and relative AIC values for Clatskanie fall chinook. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted.

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	0 (0-0)	0 (0-0)	2.43 (2.02-3.25)	17.6
Random walk with trend	2.21 (1.26-6.69)	0 (0-0)	2.3 (1.94-3.22)	16.8
Constant recruitment	0 (0-0)	162 (102-337)	1.64 (1.39-2.28)	0
Beverton-Holt	>100 (17.23->100)	166 (105-392)	1.65 (1.41-2.32)	2.4
Ricker	9.12 (4.41-35.76)	306 (234-1107)	1.81 (1.58-2.7)	7.1
Hockey-stick	14.13 (12.12->100)	168 (102-339)	1.63 (1.39-2.28)	1.9
MeanRS	7.5 (2.94-18.07)	162 (94-276)	2.95 (1.95-3.7)	14.4

Table 5: Clatskanie fall chinook CAPM risk category and viability curve results.

Risk Category	Viability Curves		CAPM
	Escapement	Pre-harvest	
Probability the population is not in "Extirpated or nearly so" category	0.000	0.408	1.000
Probability the population is above "Moderate risk of extinction" category	0.000	0.114	0.158
Probability the population is above "Viable" category	0.000	0.023	0.005
Probability the population is above "Very low risk of extinction" category	0.000	0.000	0.000

A&P – Scappoose Fall Run

No abundance data were available on the Scappoose fall chinook population. While chinook salmon have been observed, the 2005 Oregon Native Fish Status Report states that the "existing run is likely to be primarily hatchery fish" and the population is categorized as "Fail" for abundance and productivity. A time series of abundance was analyzed for the nearby Clatskanie fall chinook population and that analysis indicated that the Clatskanie is at a high risk of extinction. Conditions in Scappoose Creek are not expected to be any more favorable to fall chinook than in the Clatskanie. There is currently no hatchery in this watershed, but there are large fall chinook hatchery releases in neighboring watersheds (discussed in the diversity section). There is no abundance and productivity evidence supporting the existence of a viable natural origin population in Scappoose Creek and comparisons with populations in similar habitats suggest the population is at significant risk.

A&P – Clackamas Fall Run (Tule)

No reliable abundance data were available on the Clackamas River fall chinook population. The 2005 BRT status update report (Good et al. 2005) contained a figure of spawner abundance for this population (Figure 12), but subsequent analysis has suggested that the data are unreliable. The Oregon Native Fish Status Report continued this time series through 2003 and the geometric mean abundance for 2000-2003 is 12 fish, with two of those years having an abundance estimate of 3 fish. Although the specific abundance estimates may not be accurate and there is no estimate of the fraction of spawners that are of hatchery origin, the figure does provide a suggestion of the order of magnitude for population size—present total spawners are likely to be in the single digits, tens or maybe hundreds. These numbers put the population in the "extirpated or nearly so" persistence category based on the minimum abundance threshold. The 2005 Oregon Native Fish Status Report listed the population as "failing" for abundance because of "chronically low returns". There is currently no hatchery in this watershed, but there are large fall chinook hatchery releases in neighboring watersheds (discussed in the diversity section). There is no abundance and productivity evidence supporting the existence of a viable natural origin population in the Clackamas, and comparisons with populations in similar habitats suggest the population is at significant risk.

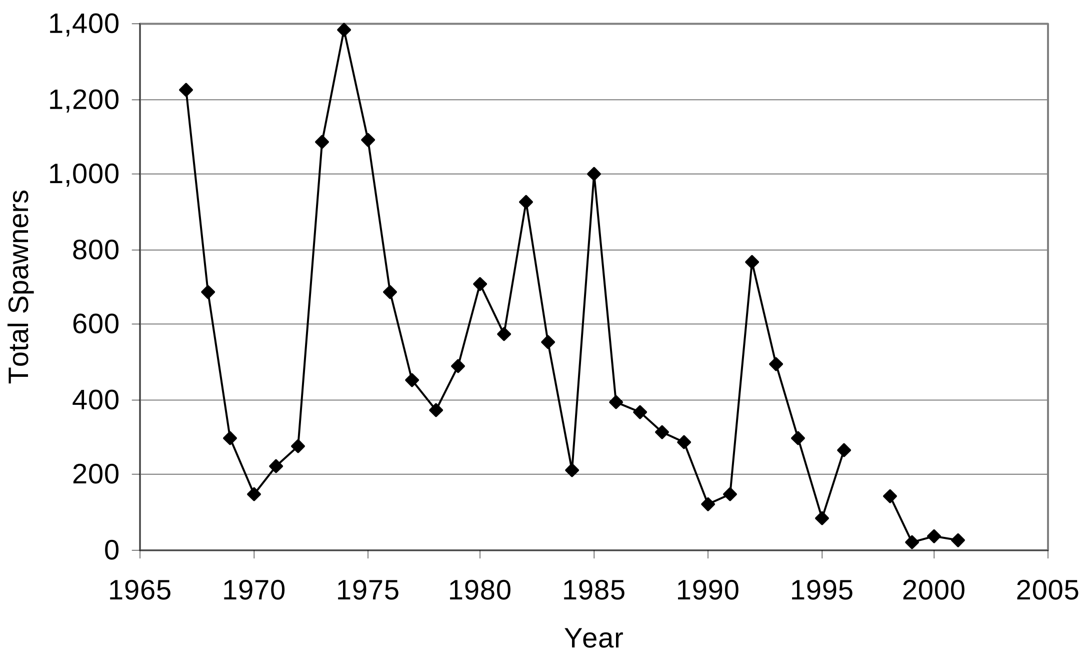

Figure 12: Spawner abundance estimates or Clackamas fall chinook copied from the 2005 BRT status update report. These data are considered unreliable, but are provided as an order of magnitude approximation. There is no estimate of the fraction of the fish that are of hatchery origin.

A&P – Sandy River Fall Run (Tule)

No abundance data were available on the Sandy River tule fall chinook population. The 2005 Oregon Native Fish Status Report does not list this population since there is uncertainty on the historical existence of a tule population in the Sandy River. The TRT list of historical populations adopted a more inclusive approach with populations of uncertain heritage (Myers et al. 2006). There is currently no hatchery in this watershed, but there are large numbers of hatchery-origin fall chinook released into neighboring watersheds (discussed in the diversity section). The neighboring Clackamas tule population is describe as being “chronically low abundance” in the 2005 Native Fish Status Report. There is no abundance and productivity evidence supporting the existence of a viable natural origin population in the Sandy River, and comparisons with populations in similar habitats suggest the population is at significant risk.

A&P – Lower Gorge Fall Run (Tule)

No abundance data were available for the Lower Gorge fall chinook population. The 2005 Oregon Native Fish Status Report did not assess mainstem populations (i.e. Ives Island), which is where much of the spawning for this population currently occurs. Part of the population exists on the Washington side of the Columbia. There are large hatchery releases in this population and it is expected that the majority of spawning fish that return are of hatchery origin. Historically, the nearby Clackamas population would have been much larger than the Lower Gorge population and given that the Clackamas population is currently at low abundance, it is likely that the Lower Gorge is at even lower abundance. There is no abundance and productivity evidence substantiating the existence of a viable natural origin population in the Oregon portion of the Lower Gorge population and the population is considered to be at significant risk.

A&P – Upper Gorge Fall Run (Tule)

No abundance data were available on the Upper Gorge fall chinook population. The 2005 Oregon Native Fish Status Report did not assess mainstem populations, which is where much of the spawning for this population is likely to have occurred. Historical spawning was also likely in the lower reaches of tributaries which have been inundated by Bonneville Dam. Part of the population also occurs on the Washington side of the Columbia. There are large hatchery releases into this population and it is expected that the majority of spawning fish that return are of hatchery origin. Historically, the nearby Hood River population may have been larger than the Upper Gorge population and so, given the Hood River population is currently at low abundance, it is likely that the Upper Gorge is at even lower abundance. There is no abundance and productivity evidence supporting the existence of a viable natural origin population in the Oregon portion of the Upper Gorge population and the population is considered to be at significant risk.

A&P – Hood Fall Run (Tule)

The 2005 Oregon Native Fish Status Report lists an average spawner abundance for the Hood River fall chinook population from 1992-2004 as 26 fish and the geometric mean from 2000-2004 as 36 fish (Figure 13). These numbers put the population in the "extirpated or nearly so" persistence category based on the minimum abundance threshold. The 2005 Oregon Native Fish Status Report puts the population in the "fail" category for abundance and productivity.

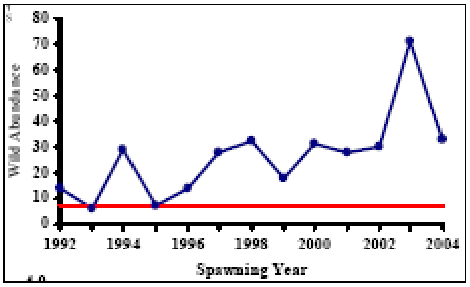

Figure 13: Estimate of Hood River fall chinook wild abundance based on Powerdale Dam count (from Oregon Native Fish Status Report 2005).

A&P – Sandy River late fall Run (Brights)

A time series of abundance sufficient for quantitative analysis is available for the Sandy River late fall run population (Appendix B). Descriptive graphs and viability analysis results are provided in Figure 14 to Figure 21 and in Table 6 and Table 9. The population is relatively large (recent geometric mean > 2,500 spawners). The population is also assumed to be relatively free of hatchery fish. The pre-harvest viability curve analysis, the PopCycle modeling and the CAPM Modeling suggest that the population is currently viable. The pre-harvest viability curves were run considering two different future harvest assumptions, 25% and 50%, in order to bracket the range of observed harvest rates in the population. The viability curve analysis assumes that a 25% future harvest indicates that the population is most likely viable, but there is considerable uncertainty in the assessment. If it is assumed that future harvest will be 50%, the population is most likely not viable. The escapement viability curve suggests that the population would not be sustainable in the long term if the harvest rates over the available time series, which averaged 43%, were extended into the future,. The geometric mean natural origin abundance is approximately 3,000 (Table 6), which is in the "very low risk" minimum abundance threshold category.

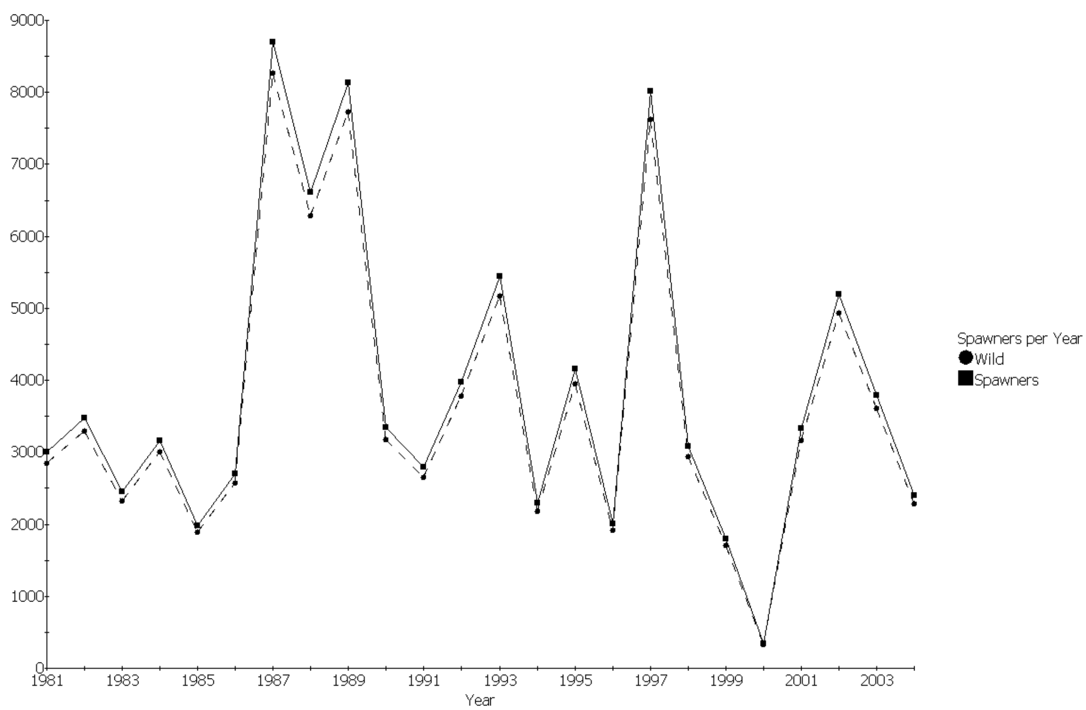

Figure 14: Sandy River late-fall chinook salmon abundance.

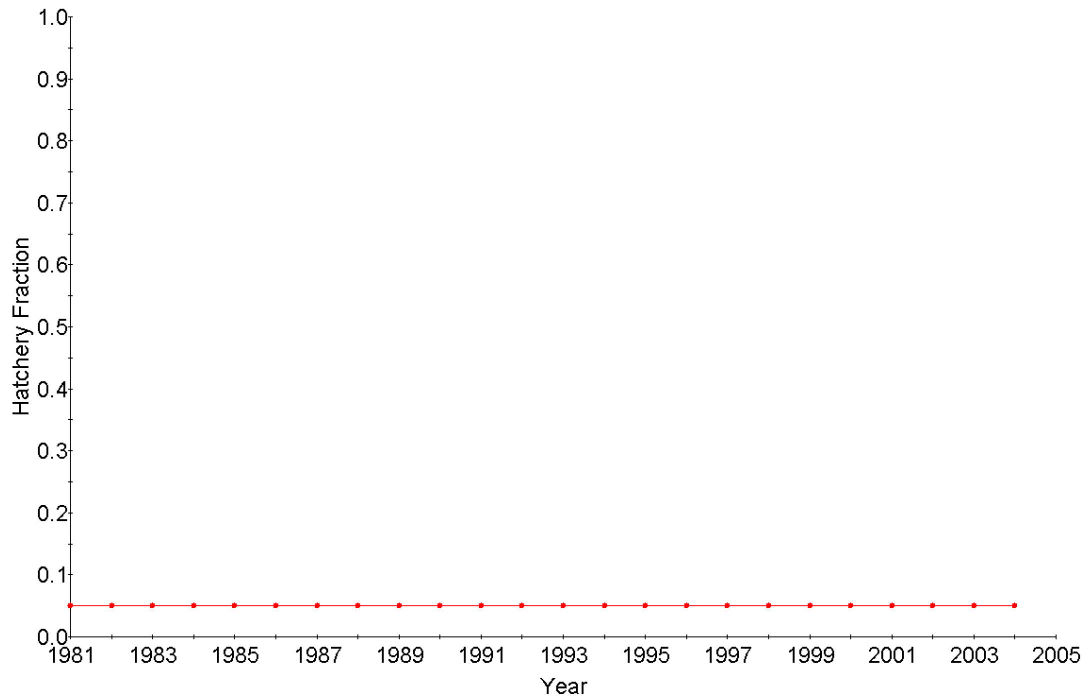

Figure 15: Sandy River late-fall chinook salmon hatchery fraction.

Figure 16: Sandy River late-fall chinook salmon harvest rate.

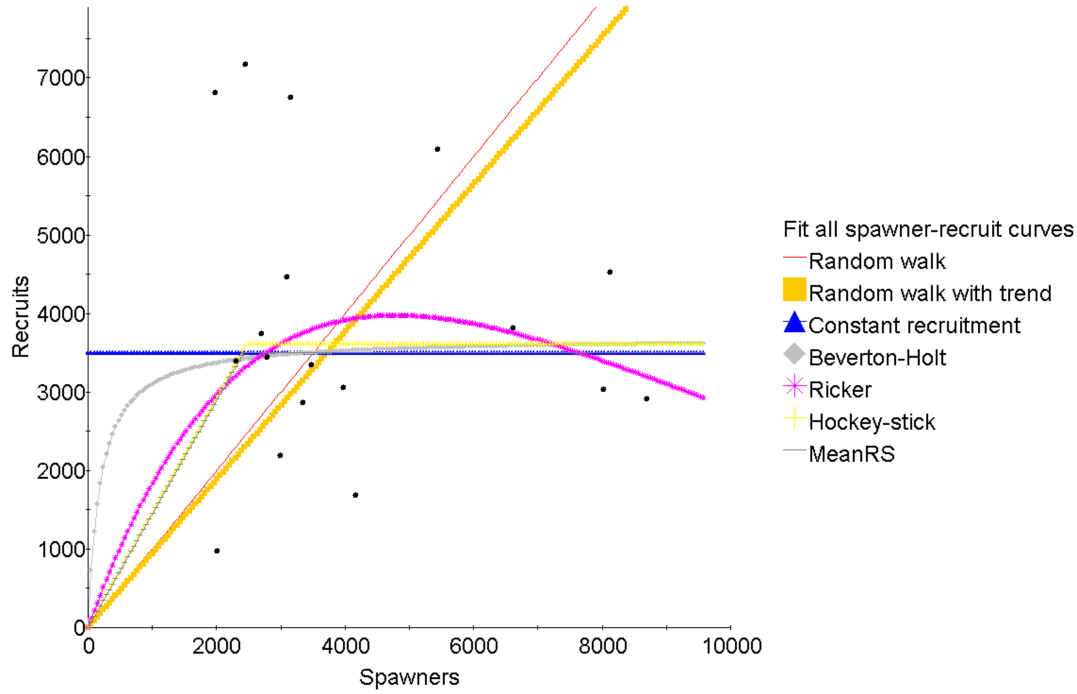

Figure 17: Sandy River late-fall chinook salmon escapement recruitment functions.

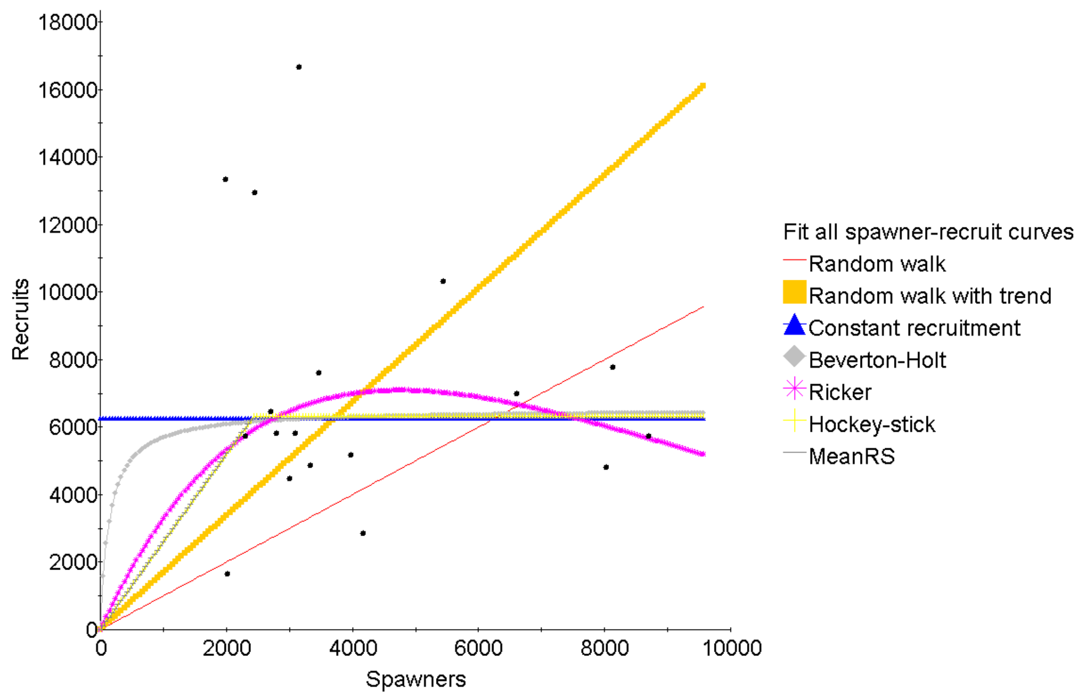

Figure 18: Sandy River late-fall chinook salmon pre-harvest recruitment functions.

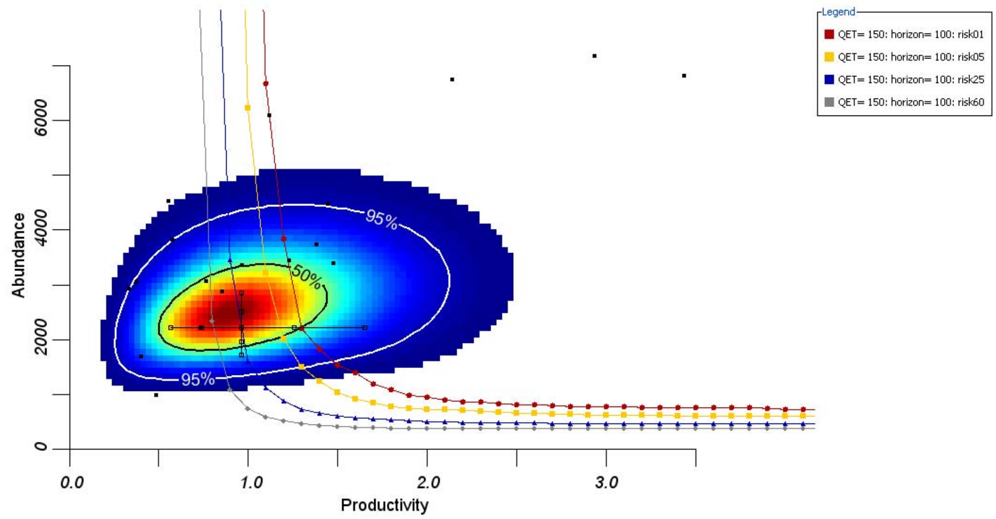

Figure 19: Sandy River late fall chinook escapement viability curves. Measurement error assumptions were: abundance ±40%; hatchery fraction ±70%; age structure shape parameter 20; catch abundance ±40%. CRT = 150.

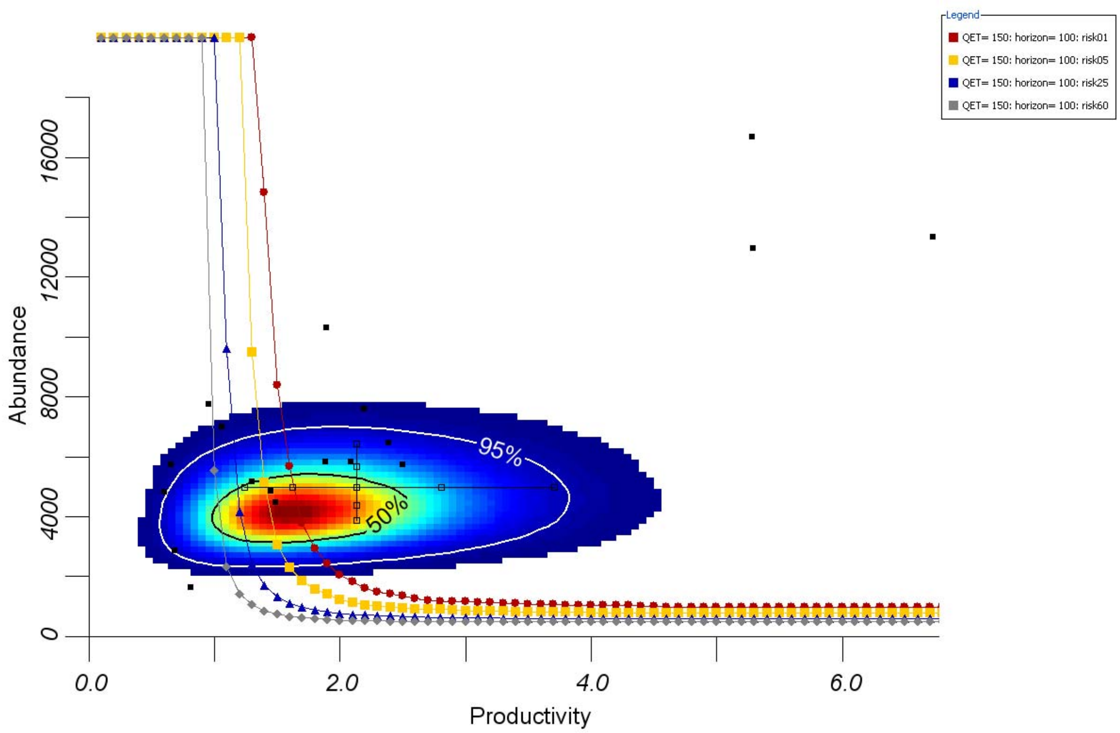

Figure 20: Sandy River late fall chinook pre-harvest viability curves. Measurement error assumptions were: abundance ±40%; hatchery fraction ±70%; age structure shape parameter 20; catch abundance ±40% (Assumes future harvest rate of 25%). CRT = 150.

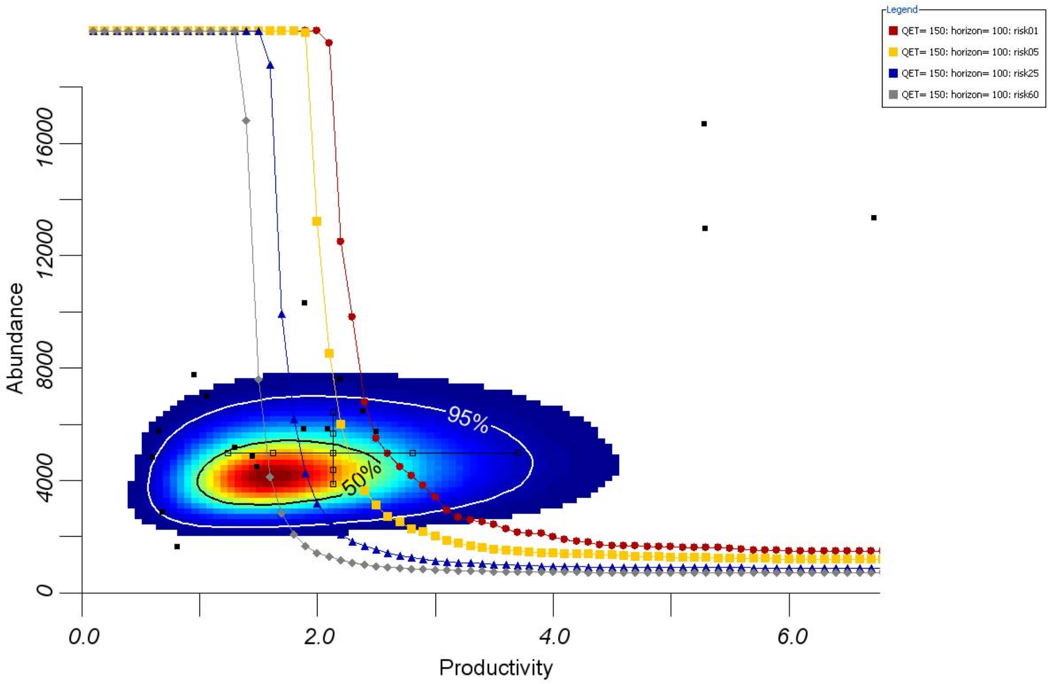

Figure 21: Sandy River late fall chinook pre-harvest viability curves. Measurement error assumptions were: abundance ±40%; hatchery fraction ±70%; age structure shape parameter 20; catch abundance ±40% (Assumes future harvest rate of 50%). CRT = 150.

Table 6: Sandy River late fall chinook summary statistics. The geometric mean natural origin spawner abundance (highlighted) is in the "very low risk" viability criteria category. The 95% confidence intervals are shown in parentheses.

Statistic	Escapement		Pre-harvest	
	Total Series	Recent Years	Total Series	Recent Years
Time Series Period	1981-2004	1990-2004	1981-2004	1990-2004
Length of Time Series	24	15	24	15
Geometric Mean Natural Origin Spawner Abundance	3085 (2337-4074)	2771 (1868-4110)	NA	NA)
Geometric Mean Recruit Abundance	3505 (2727-4504)	2887 (1917-4347)	6268 (4770-8235)	4708 (3171-6991)
Lambda	0.997 (0.857-1.16)	0.982 (0.827-1.167)	1.135 (0.938-1.373)	1.088 (0.902-1.311)
Trend in Log Abundance	0.983 (0.945-1.024)	0.971 (0.885-1.066)	NA	NA
Geometric Mean Recruits per Spawner (all broods)	0.94 (0.669-1.321)	0.807 (0.534-1.218)	1.681 (1.174-2.407)	1.316 (0.882-1.962)
Geometric Mean Recruits per Spawner (broods < median spawner abudance)	1.448 (0.898-2.333)	1.063 (0.459-2.463)	2.595 (1.535-4.385)	1.682 (0.763-3.707)
Average Hatchery Fraction	0.05	0.05	NA	NA
Average Harvest Rate	0.4268	0.3771	NA	NA
CAPM median extinction risk probability (5^{th}-95^{th} percentiles)	NA	NA	0.000 (0.000-0.000)	NA
PopCycle extinction risk	NA	NA	<0.01	NA

Table 7: Escapement recruitment parameter estimates and relative AIC values for Sandy River late fall chinook. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted.

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	0 (0-0)	0 (0-0)	0.67 (0.54-0.97)	9.1
Random walk with trend	0.94 (0.73-1.3)	0 (0-0)	0.66 (0.55-1)	10.9
Constant recruitment	0 (0-0)	3505 (2883-4420)	0.49 (0.41-0.74)	0
Beverton-Holt	19.3 (3.86->50)	3705 (3023-5337)	0.49 (0.4-0.74)	2
Ricker	2.25 (1.32-3.81)	3987 (3409-6539)	0.49 (0.42-0.78)	2.2
Hockey-stick	1.46 (3.25->50)	3566 (2887-4432)	0.49 (0.4-0.74)	1.4
MeanRS	1.45 (1.04-1.99)	3505 (2882-4217)	0.25 (0.11-0.37)	

Table 8: Pre-harvest recruitment parameter estimates and relative AIC values for Sandy River late fall chinook. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted.

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	0 (0-0)	0 (0-0)	0.87 (0.71-1.25)	15.7
Random walk with trend	1.68 (1.28-2.39)	0 (0-0)	0.7 (0.58-1.06)	9.9
Constant recruitment	0 (0-0)	6271 (5077-8100)	0.53 (0.44-0.8)	0
Beverton-Holt	>50 (4.83->50)	6535 (5468-10985)	0.53 (0.44-0.8)	2
Ricker	4.07 (2.25-7.36)	7097 (6046-13237)	0.54 (0.46-0.86)	2.1
Hockey-stick	2.66 (3.97->50)	6505 (5078-8166)	0.52 (0.44-0.81)	1.5
MeanRS	2.59 (1.82-3.68)	6268 (5091-7681)	0.29 (0.13-0.45)	

Table 9: Sandy River late fall chinook CAPM risk category and viability curve results.

Risk Category	Viability Curves			CAPM
	Escapement	Pre-harvest (harvest rate 25%)	Pre-harvest (harvest rate 50%)	
Probability the population is not in "Extirpated or nearly so" category	0.737	0.927	0.657	1.000
Probability the population is above "Moderate risk of extinction" category	0.601	0.865	0.487	1.000
Probability the population is above "Viable" category	0.413	0.748	0.282	1.000
Probability the population is above "Very low risk of extinction" category	0.309	0.613	0.157	0.993

A&P – Sandy River spring Run

A time series of abundance sufficient for quantitative analysis is available for the Sandy River spring run population (Appendix B). Descriptive graphs and viability analysis results are provided in Figure 22 to Figure 28 and in Table 10 and Table 13. The total number of spawners in the population has been in the low thousands in recent years, but on average at least half of the fish in some years are estimated to be of hatchery origin. . However, the data suggest general upward population trend that most likely reflects the fact that up until the 1970s spring chinook passage upstream of Marmot Dam was severely restricted due to water diversions that dewatering of the migration channel. The pre-harvest viability curve analysis, PopCycle and the CAPM modeling are in general agreement that the population is not likely to be viable but is in a high to moderate risk category. The escapement viability curve suggests that a population experiencing the pattern of harvest that occurred over the observed time period would not be sustainable in the long term. The long term geometric mean of natural origin spawners for the population is around 300 fish (Table 10), which is in the "extirpated or nearly so" minimum abundance threshold category, but using only the most recent years data, the population would be in the viable category.

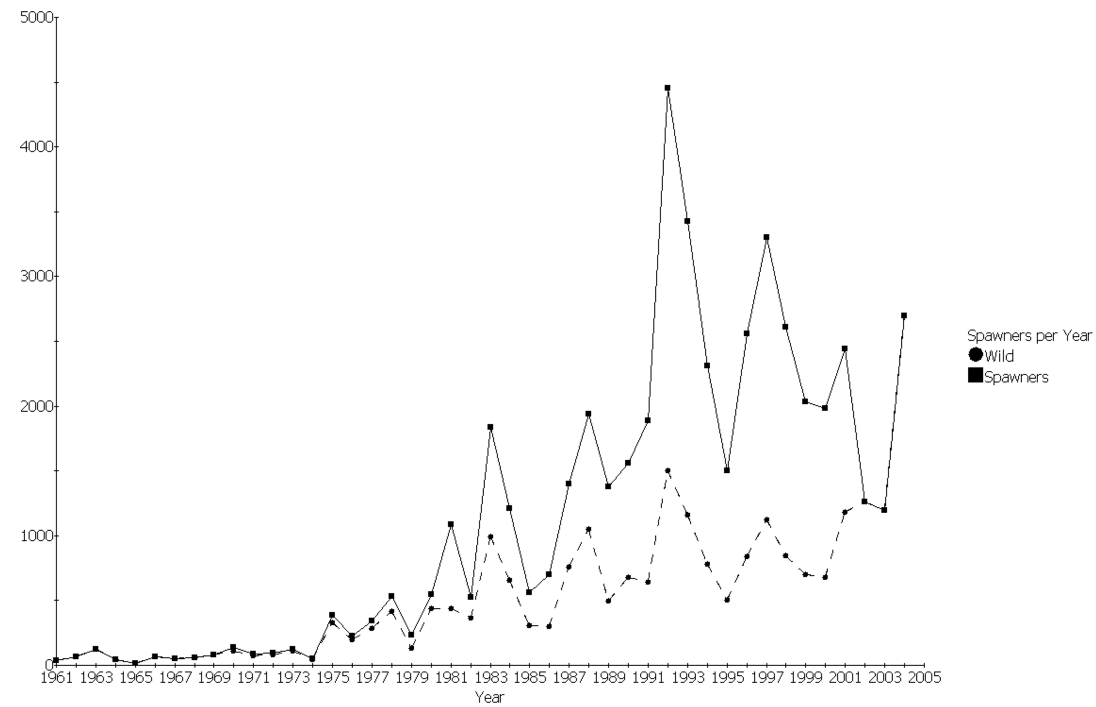

Figure 22: Sandy River spring-run chinook salmon abundance.

Figure 23: Sandy River spring-run chinook salmon hatchery fraction.

Figure 24: Sandy River spring-run chinook salmon harvest rate.

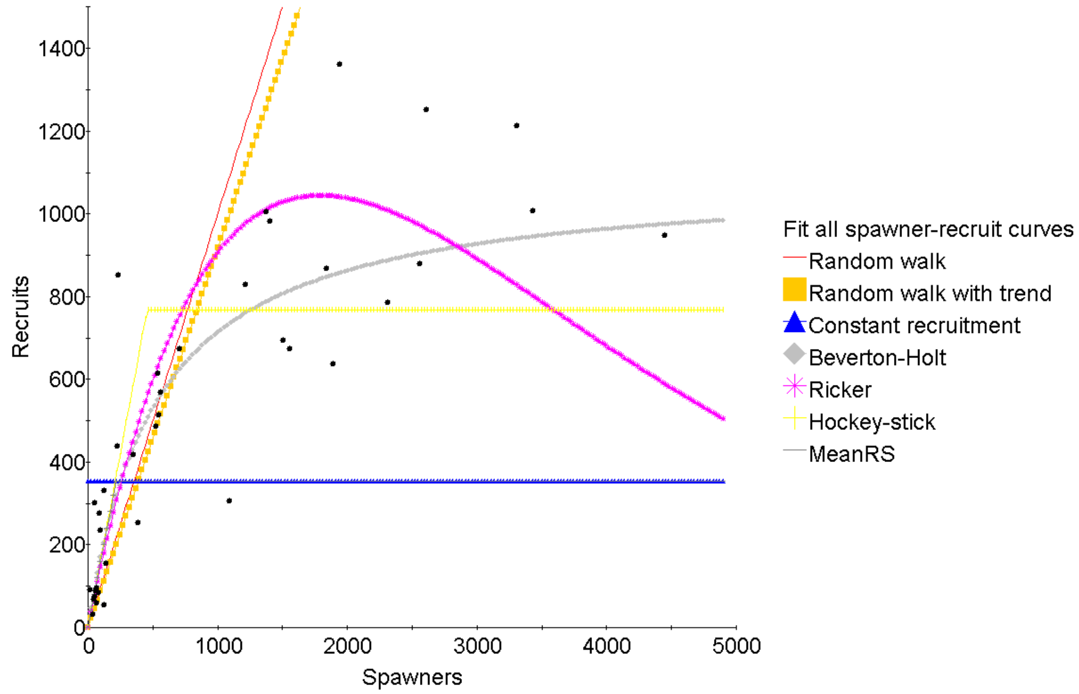

Figure 25: Sandy River spring-run chinook salmon escapement recruitment functions.

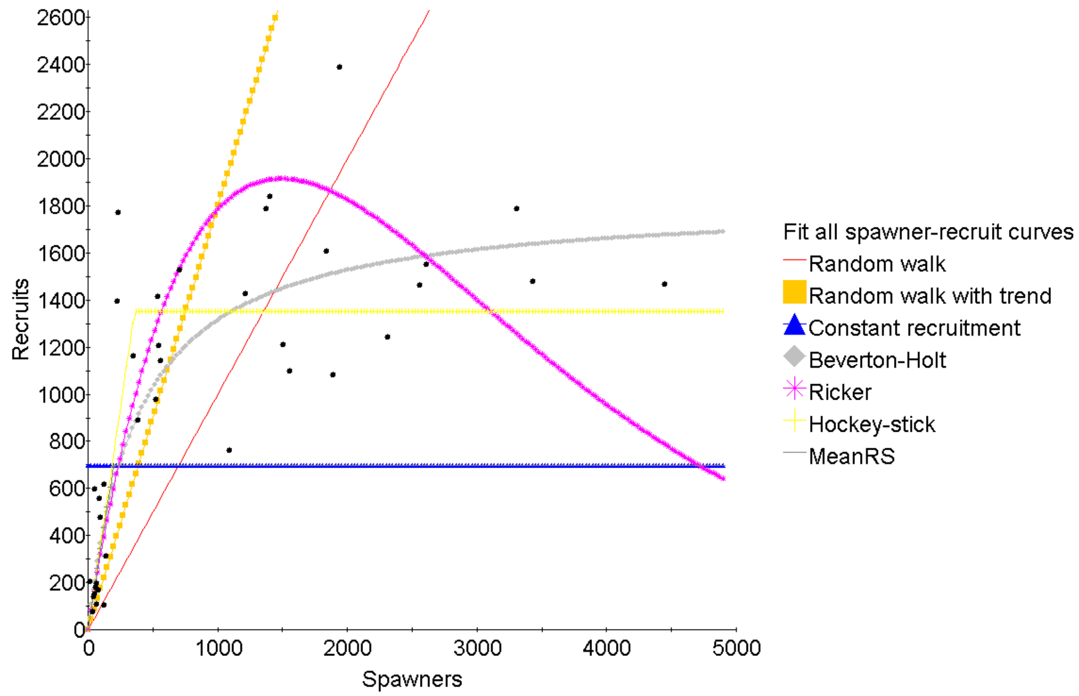

Figure 26: Sandy River spring-run chinook salmon pre-harvest recruitment functions.

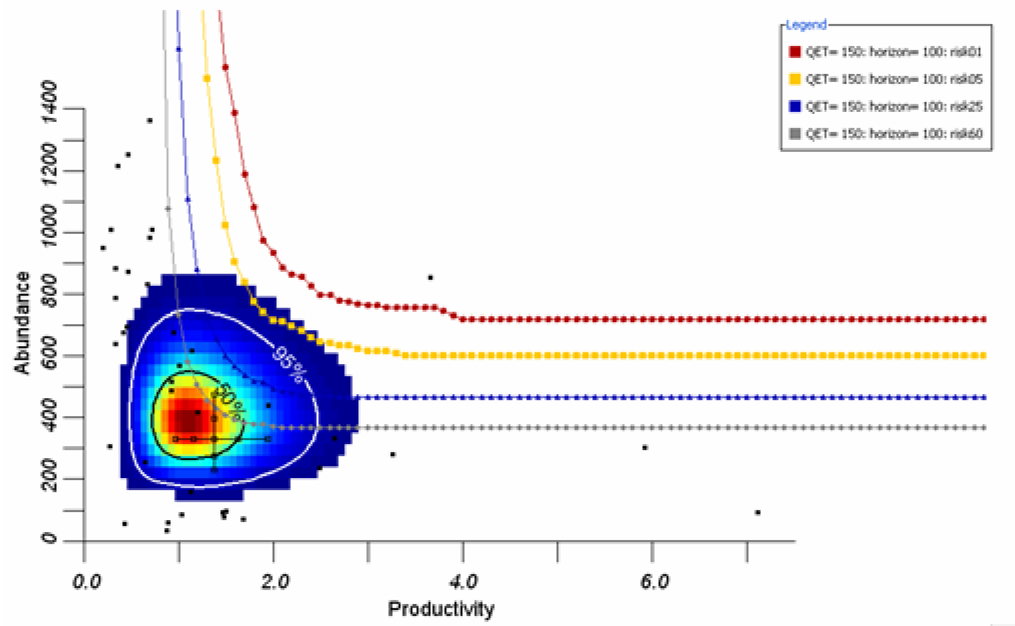

Figure 27: Sandy River spring-run chinook salmon escapement viability curve. Measurement error assumptions were: abundance ±40%; hatchery fraction ±40%; age structure shape parameter 20; catch abundance ±30%. CRT = 150.

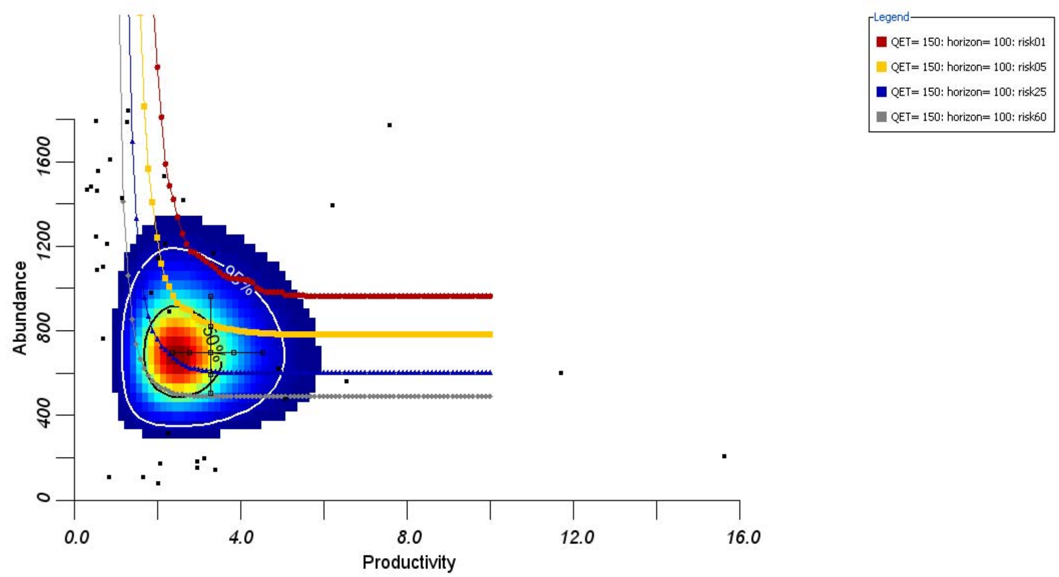

Figure 28: Sandy River spring chinook pre-harvest viability curve. Measurement error assumptions were: abundance ±40%; hatchery fraction ±40%; age structure shape parameter 20; catch abundance ±30%. (Assumes future harvest rate of 25%.) CRT = 150.

Table 10: Sandy River spring chinook summary statistics. The geometric mean natural origin spawner abundance (highlighted) is in the "extirpated or nearly so" viability criteria category for the total time series, but in the "viable" category using only recent year data. The 95% confidence intervals are shown in parentheses.

Statistic	Escapement		Pre-harvest	
	Total Series	Recent Years	Total Series	Recent Years
Time Series Period	1961-2004	1990-2004	1961-2004	1990-2004
Length of Time Series	44	15	44	15
Geometric Mean Natural Origin Spawner Abundance	297 (202-438)	959 (759-1212)	NA	NA
Geometric Mean Recruit Abundance	355 (251-502)	874 (722-1059)	697 (502-968)	1359 (1193-1548)
Lambda	0.961 (0.853-1.083)	0.834 (0.657-1.059)	1.111 (0.957-1.289)	0.901 (0.725-1.119)
Trend in Log Abundance	1.093 (1.079-1.108)	1.047 (0.997-1.1)	NA	NA
Geometric Mean Recruits per Spawner (all broods)	0.915 (0.692-1.209)	0.354 (0.292-0.429)	3.332 (2.463-4.508)	0.55 (0.451-0.671)
Geometric Mean Recruits per Spawner (broods < median spawner abundance)	1.535 (1.13-2.084)	0.407 (0.271-0.613)	3.332 (2.463-4.508)	0.688 (0.451-1.05)
Average Hatchery Fraction	0.323	0.515	NA	NA
Average Harvest Rate	0.476	0.376	NA	NA
CAPM median extinction risk probability (5th and 95th percentiles in parenthesis)	NA	NA	0.090 (0.005-0.435)	NA
PopCycle Extinction Risk	NA	NA	0.8	NA

Table 11: Escapement recruitment parameter estimates and relative AIC values for Sandy River spring chinook. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted.

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	0 (0-0)	0 (0-0)	0.84 (0.72-1.06)	34.1
Random walk with trend	0.92 (0.74-1.19)	0 (0-0)	0.84 (0.72-1.07)	35.7
Constant recruitment	0 (0-0)	354 (273-493)	1.04 (0.9-1.33)	52.4
Beverton-Holt	2.06 (1.59-2.77)	1092 (832-1578)	0.51 (0.45-0.66)	0
Ricker	1.58 (1.29-1.97)	1044 (899-1360)	0.56 (0.49-0.72)	6.5
Hockey-stick	1.69 (1.32-2.26)	769 (616-1049)	0.55 (0.48-0.72)	6.1
MeanRS	1.63 (1.25-2.14)	355 (267-468)	0.41 (0.26-0.55)	81.9

Table 12: Preharvest recruitment parameter estimates and relative AIC values for Sandy River spring chinook. The 95% probability intervals on parameters are shown in parentheses. The model that is the "best" approximation (i.e., relative AIC = 0) is shown in bright green. Models that nearly indistinguishable from best (i.e., relative AIC <2) are shown in darker green. Models that are possible, but less likely, contenders as best (i.e., 2 < relative AIC < 10) are shown in yellow. Models that are very unlikely to be the best approximating model (i.e., relative AIC > 10) are not highlighted.

Model	Productivity	Capacity	Variance	Relative AIC
Random walk	0 (0-0)	0 (0-0)	1.1 (0.94-1.39)	54.3
Random walk with trend	1.8 (1.43-2.4)	0 (0-0)	0.94 (0.81-1.2)	43.7
Constant recruitment	0 (0-0)	697 (547-947)	0.99 (0.85-1.26)	47.7
Beverton-Holt	4.71 (3.63-6.48)	1825 (1423-2497)	0.52 (0.45-0.67)	0.2
Ricker	3.49 (2.86-4.37)	1915 (1664-2372)	0.55 (0.48-0.72)	5.5
Hockey-stick	3.77 (3.03-4.8)	1352 (1131-1718)	0.51 (0.45-0.67)	0
MeanRS	3.54 (2.73-4.62)	697 (533-898)	0.36 (0.2-0.53)	88.2

Table 13: Sandy River spring chinook CAPM risk category and viability curve results.

Risk Category	Viability Curves		CAPM
	Escapement	Pre-harvest	
Probability the population is not in "Extirpated or nearly so" category	0.302	0.858	0.978
Probability the population is above "Moderate risk of extinction" category	0.070	0.595	0.858
Probability the population is above "Viable" category	0.004	0.164	0.297
Probability the population is above "Very low risk of extinction" category	0.000	0.018	0.075

A&P – Hood Spring Run

The 2005 BRT report describe the Hood River spring run as "extirpated or nearly so" and the 2005 Native Fish Status report describes the population as "extinct." A hatchery population with out-of-ESU brood stock is currently in the watershed, but native fish are not considered to be present.

A&P – Criterion Summary

For the abundance and productivity criterion, the most probable risk category for all but two of these populations is high (Figure 29). The exceptions are most probable classifications of 'moderate risk' for the Sandy River spring chinook populations and 'low risk' for the Sandy River late fall chinook. Although the shape of the diamonds in Figure 29 suggest there is considerable uncertainty as to the status classification of these two Sandy populations, even the most optimistic interpretation would place only one population in the viable category. Conversely, the lower tail of the diamonds for these two populations both drop into the 'high risk' category. From the perspective of this viability criterion LCR chinook in Oregon are clearly at high risk.

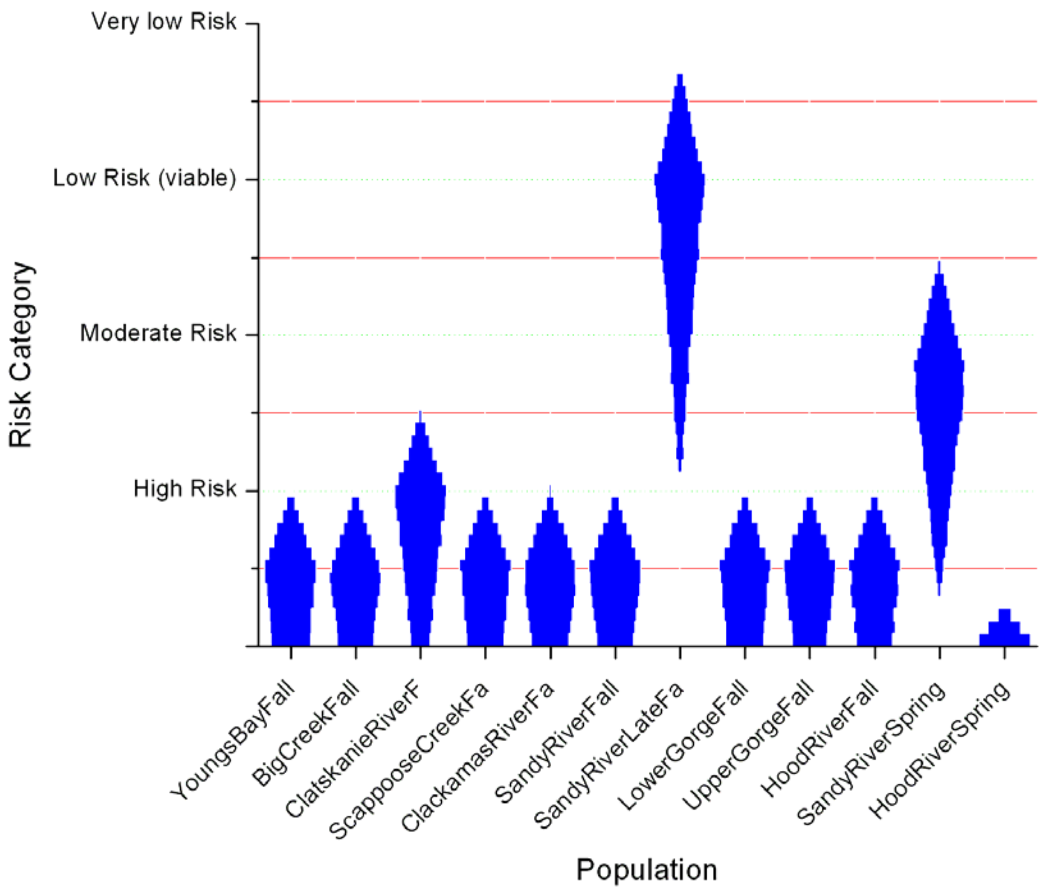

Figure 29: Lower Columbia River chinook salmon risk status summary based on evaluation of abundance and productivity only.

III. Spatial Structure

SS – Youngs Bay

Even under historical conditions, the distribution of fall chinook in this basin was limited. Most tributary streams remain accessible to anadromous fish, particularly in the mainstem areas that were historically suitable for fall chinook (Figure 1)(ODFW 2005). Small areas of marginal habitat for fall chinook are no longer accessible or utilized above a hatchery weir on the NF Klaskanine and in several small valley floor tributaries. ODFW (2005) estimates that 13% of the historical fall chinook habitat is no longer accessible. Habitat degradation in the basin has reduced the spatial distribution of suitable habitats for fall chinook. Habitat changes in the Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores. Access scores were modified for weighted historical productivity of suitable habitats and effects of habitat degradation on currently accessible habitats.

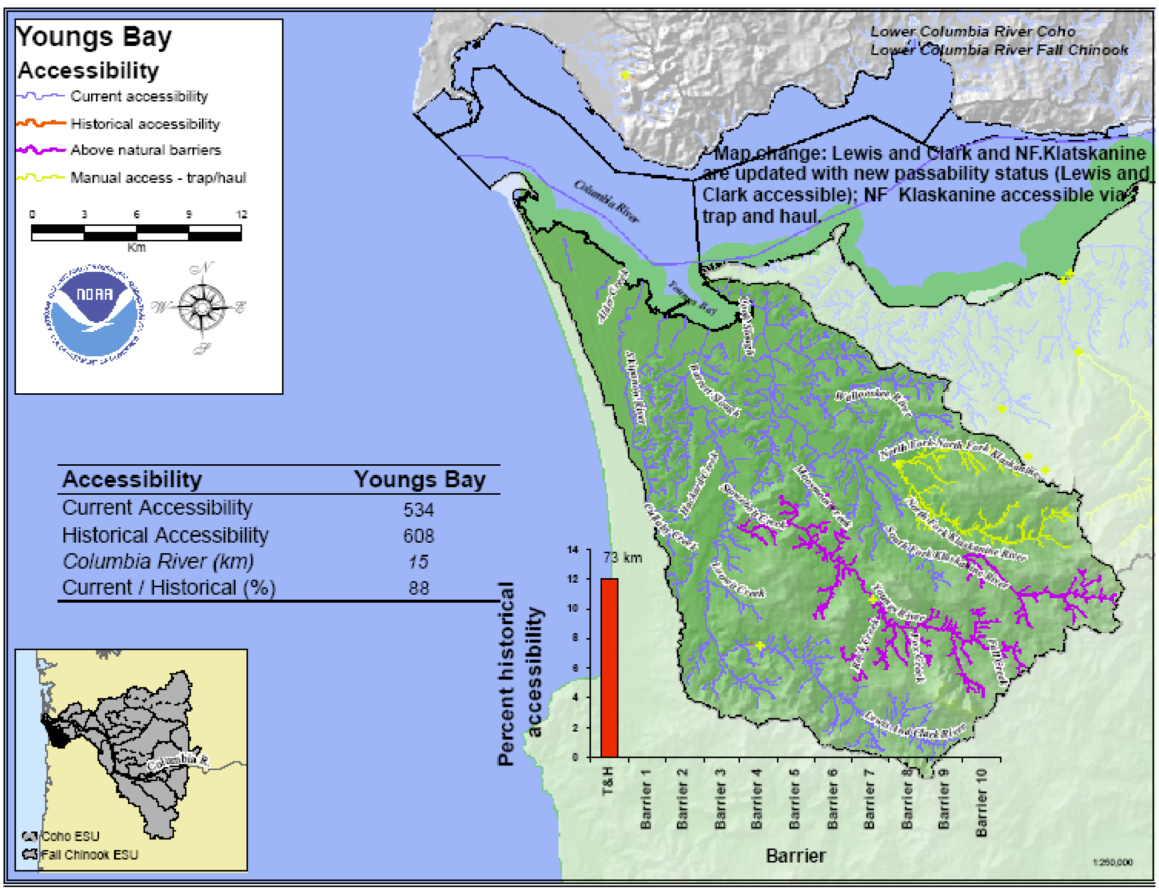

Figure 30: Youngs Bay fall-run chinook salmon current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Big Creek

Even under historical conditions, the distribution of fall chinook in this basin was largely limited to lower mainstem reaches. Most areas that were historically suitable for fall chinook are currently accessible (Figure 31) (ODFW 2005). Hatchery barriers limit access to portions of Gnat Creek but these areas were not productive fall chinook habitats. Habitat degradation in the basin has reduced the spatial distribution of suitable habitats for fall chinook. Habitat changes in the Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores. Access scores were modified for weighted historical productivity of suitable habitats and effects of habitat degradation on currently accessible habitats.

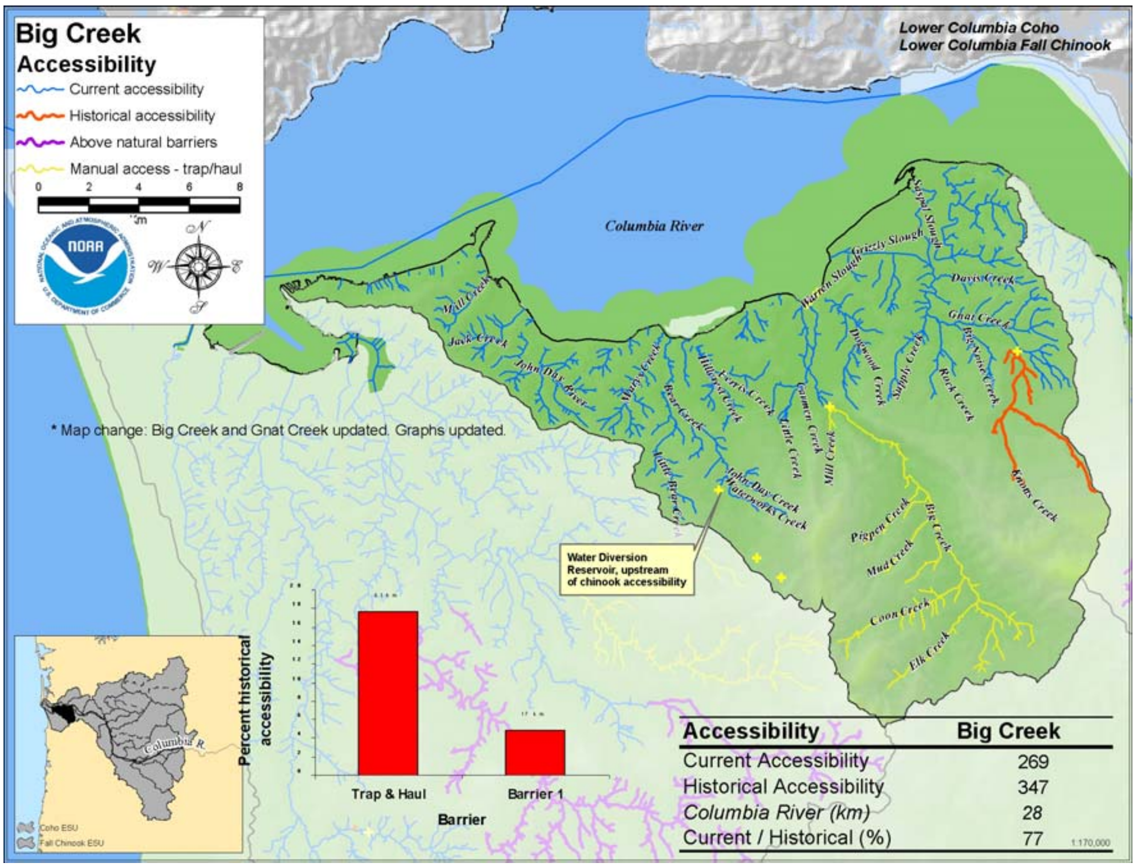

Figure 31: Big Creek fall-run chinook salmon current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Clatskanie

Even under historical conditions, the distribution of fall chinook in this basin was largely limited to lower mainstem reaches. All mainstem areas that were historically suitable for fall chinook are currently accessible (Figure 32)(ODFW 2005). Anadromous access to some smaller streams has been lost but these areas were not productive fall chinook habitats. Habitat changes in the Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores. Access scores were modified for the limited area of suitable habitat and effects of habitat degradation on currently accessible habitats.

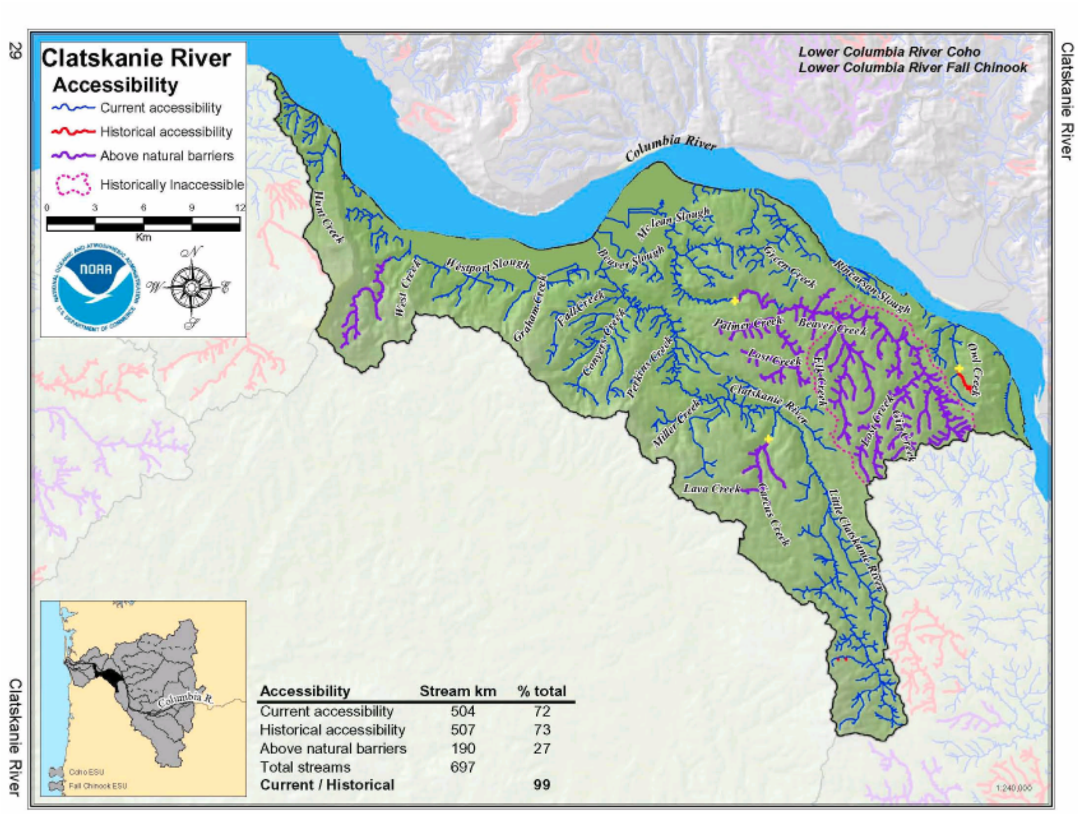

Figure 32: Clatskanie fall chinook current and historical accessibility (from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Scappoose

Even under historical conditions, the distribution of fall chinook in this basin was largely limited to lower mainstem reaches. All mainstem areas that were historically suitable for fall chinook are currently accessible (Figure 33)(ODFW 2005). Anadromous access to some smaller streams has been lost but these areas were not productive fall chinook habitats. Habitat changes in the Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores. Access scores were modified for the limited area of suitable habitat and effects of habitat degradation on currently accessible habitats.

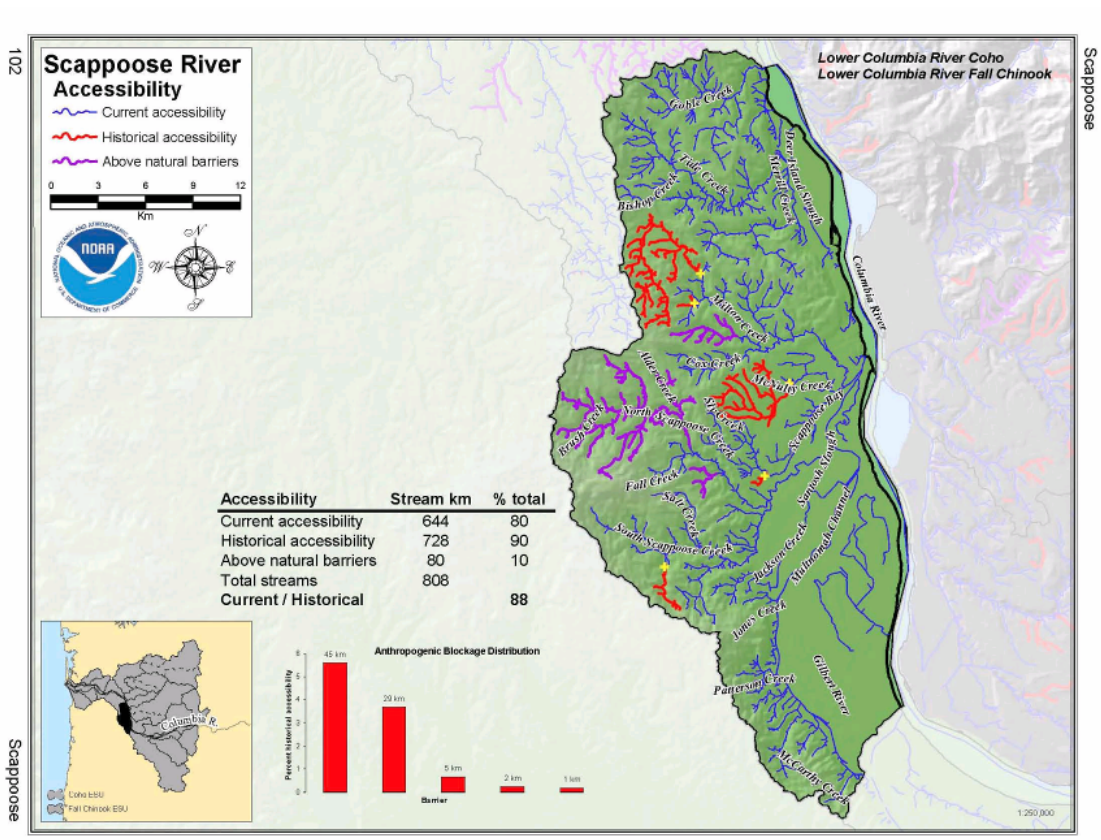

Figure 33: Scappoose Creek fall-run chinook salmon current and historical accessibility (from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Clackamas

Historical fall chinook production areas were limited to the lower mainstem and portions of the mainstem tributaries. All mainstem areas that were historically suitable for fall chinook are currently accessible (Figure 34) (ODFW 2005). Access to some smaller streams in the basin has been lost, but these areas were not productive fall chinook habitats. Habitat degradation in the basin has reduced the spatial distribution of suitable habitats for fall chinook. Habitat changes in the Willamette and Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores. Access scores were modified for weighted historical productivity of suitable habitats and effects of habitat degradation on currently accessible habitats.

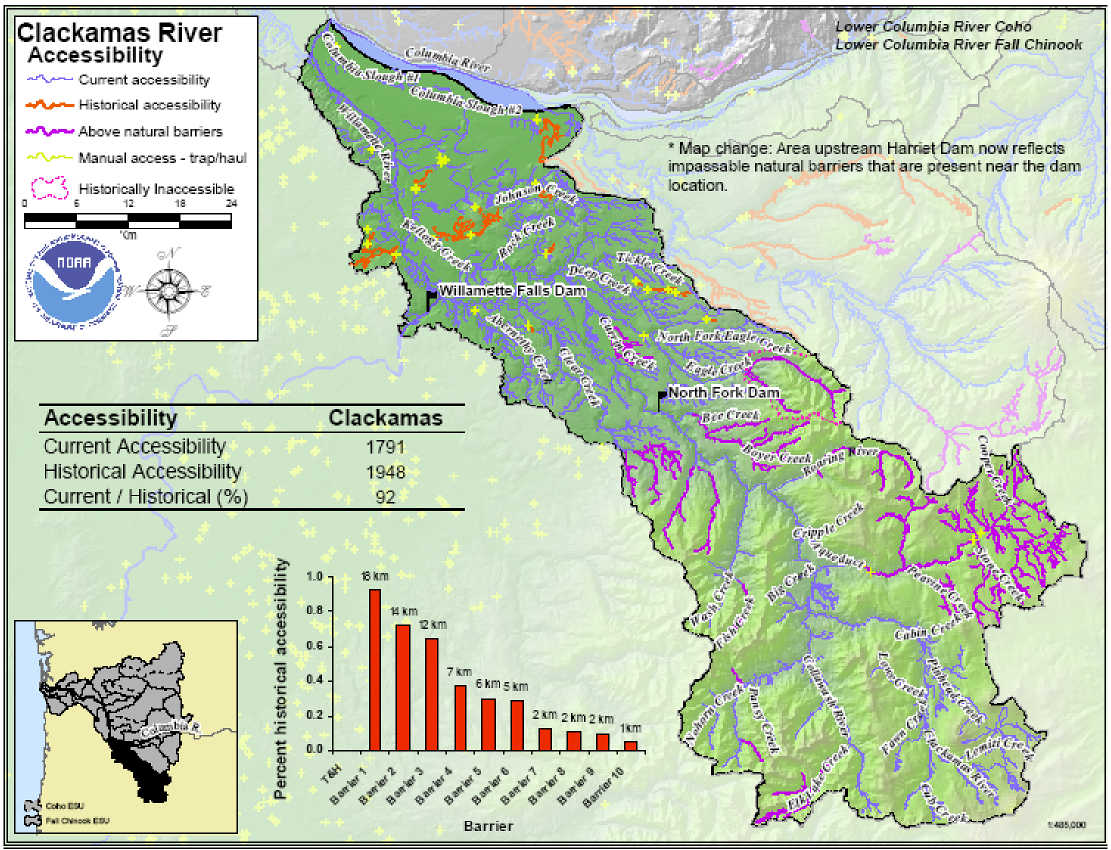

Figure 34: Clackamas fall chinook current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Sandy

Historical fall chinook production areas were limited to the lower mainstem and portions of the mainstem tributaries. Most of the core production area remains accessible (Figure 35). Portions of the historical distribution in the Bull Run River are blocked by a dam. Habitat quality remains adequate to support spawning throughout a significant portion of the accessible range. Habitat changes in the Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores. Access scores were modified for weighted historical productivity of suitable habitats and effects of habitat degradation on currently accessible habitats. Although a significant amount of historically *accessible* habitat is no longer accessible, the majority of habitat historically *used* (because of habitat preference) is still available, so scores were adjusted upward from the base accessibility score.

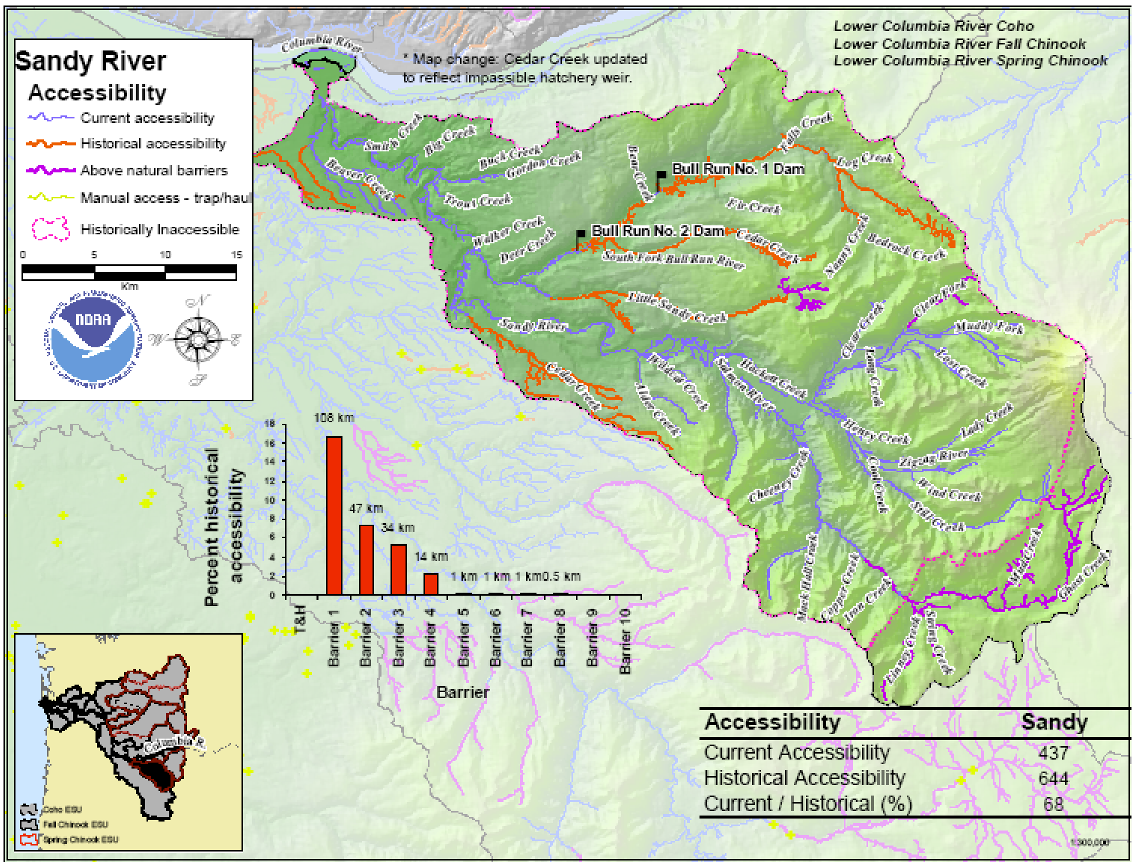

Figure 35: Sandy River fall and spring chinook and coho current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Lower Gorge Tributaries

Most of the small Columbia River gorge streams between the Sandy River and Eagle Creek remain accessible to anadromous fish but habitat availability is limited by the topography (ODFW 2005), specifically impassable waterfalls (Figure 36). Significant historical chinook production was likely limited to low gradient reaches in the lower portions of these streams (ODFW 2005). Significant chinook production occurs in nearby locations of the mainstem Columbia River and in some Washington tributaries. Habitat changes in the Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores. Other local habitat alternations and development have likely reduced habitat quality in some streams. Access scores were modified for the limited area of suitable habitat and effects of habitat degradation on currently accessible habitats.

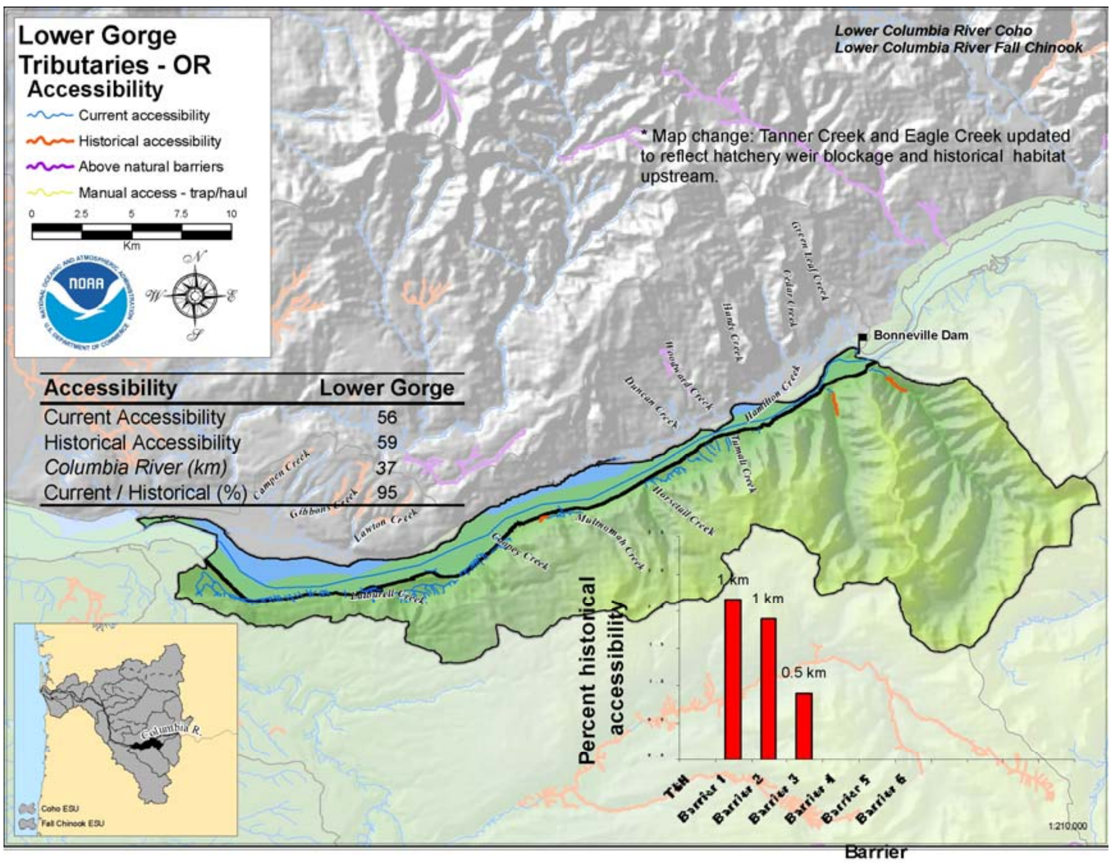

Figure 36: Lower Gorge fall chinook current and historical accessibility (updated by Sheer 2007 from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Upper Gorge Tributaries

The small Columbia River gorge streams upstream from Eagle Creek remain largely accessible but habitat is limited to the lower portions of these streams by topography and portions of the lower reaches have been inundated by the Bonneville Dam reservoir (Figure 37). Other local habitat alternations and development have likely reduced habitat quality in some streams. Access scores were modified for the limited area of suitable habitat and effects of habitat degradation on currently accessible habitats.

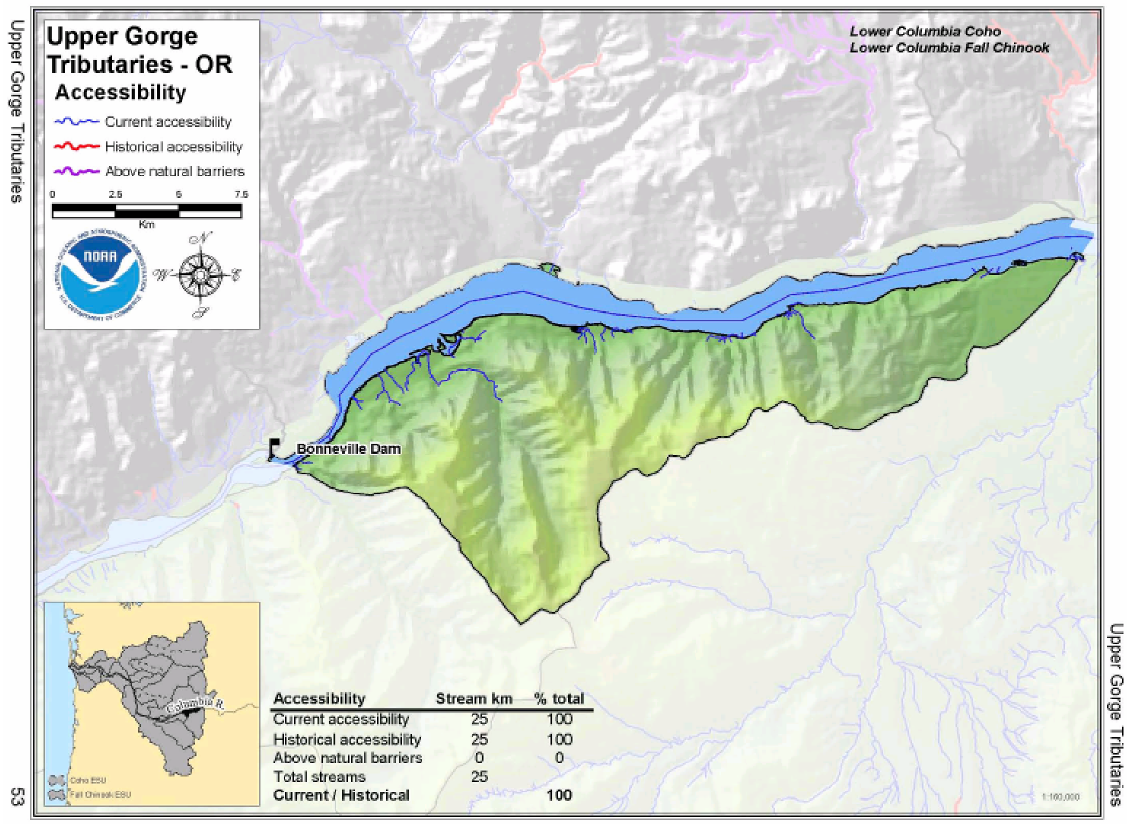

Figure 37: Upper Gorge fall-run chinook salmon current and historical accessibility (from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Hood River

Historical fall chinook production areas were limited to the lower mainstem and portions of the mainstem tributaries. All mainstem areas that were historically suitable for fall chinook are currently accessible (Figure 38)(ODFW 2005). Access to some smaller streams in the basin has been lost but these areas were not productive fall chinook habitats. Habitat degradation in the basin has reduced the spatial distribution of suitable habitats for fall chinook. Portions of the lower reaches have been inundated by the Bonneville Dam reservoir. Habitat changes in the Columbia mainstem and estuary would likely have a significant effect on fall chinook salmon and contributed to adjustments to the spatial structure scores.

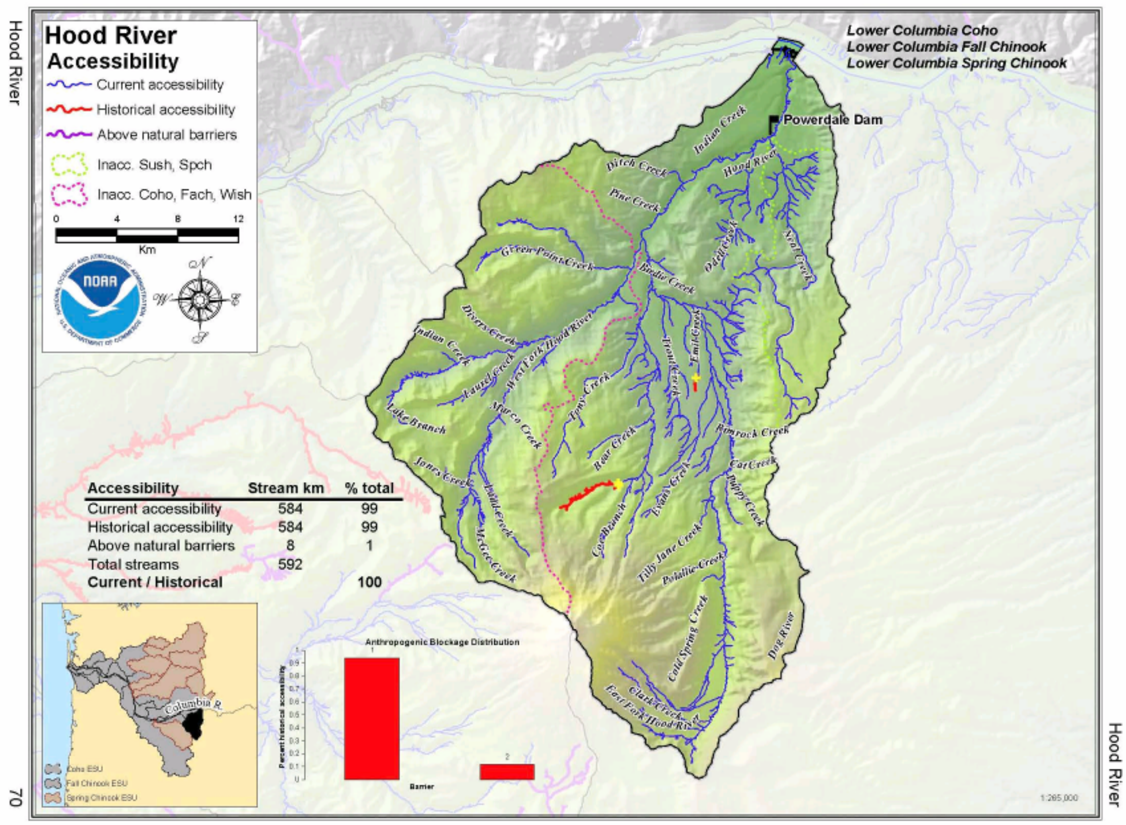

Figure 38: Hood River fall-run chinook and spring-run chinook salmon current and historical accessibility (from Maher et al. 2005). As described in the Introduction (Section 1), these graphs depict access (i.e., where fish could swim) and not necessarily habitat that fish would use.

SS – Hood River (Spring)

Virtually the entire habitat accessible to spring chinook in the Hood River remains accessible today (Figure 38) (ODFW 2005). Blockages are limited to only a few headwater reaches and these streams do not represent significant historical spring chinook production areas. Habitat in this basin was likely not productive for spring chinook prior to development. The native spring chinook run was extirpated and reintroduction attempts are currently underway. Access scores were modified for the effects of habitat limitations in areas of accessible habitat. Habitat declines in the estuary were not factored into spring chinook spatial structure scores because of their life history.

SS – Sandy River (Spring)

Portions of the historical spring chinook range in the Sandy River have been blocked by dam construction in the Bull Run and Little Sandy watersheds (Figure 35). ODFW (2005) estimates that 16% of the historical chinook habitat is no longer accessible. Large areas of productive high quality habitat remain accessible to spring chinook in the remainder of the basin, particularly in the forested upper basin. Production areas are distributed among several tributaries, all of which are in Mt. Hood drainages.

SS – Criterion Summary

Populations in Sandy basin have experienced more than a 30% loss of the habitat historically accessible to chinook due to anthropogenic blockages, primarily dams on the Bull Run River (Figure 39). For the Big Creek and Scappoose Creek populations this loss is approximately 13%. For the other basins, the percent loss has been less than 10%. SS scores for each population were adjusted, where applicable, on the basis of two factors: 1) the suitability/quality of the blocked habitat with respect to chinook production and 2) the degree to which the remaining accessible habitat has been degraded from historical conditions. The adjustments and final SS scores for each population are presented in Table 15.

For the SS criterion the most probable risk category for a majority of the populations was 'low' as evidenced by the SS rating in Table 15 and illustrated by the placement of the widest portion of the diamonds in Figure 40. However, these diamonds also show that there is considerable assessment uncertainty. As the top and bottom of the diamond symbols illustrate, it is possible (but not probable) that all of the populations could fall into the 'low risk' category. Conversely, it is also possible that all populations could fall into the 'moderate risk' category. However, forced to make a most probable call on the overall picture for LCR chinook in Oregon with respect to this criterion we would pick the 'low risk' category.

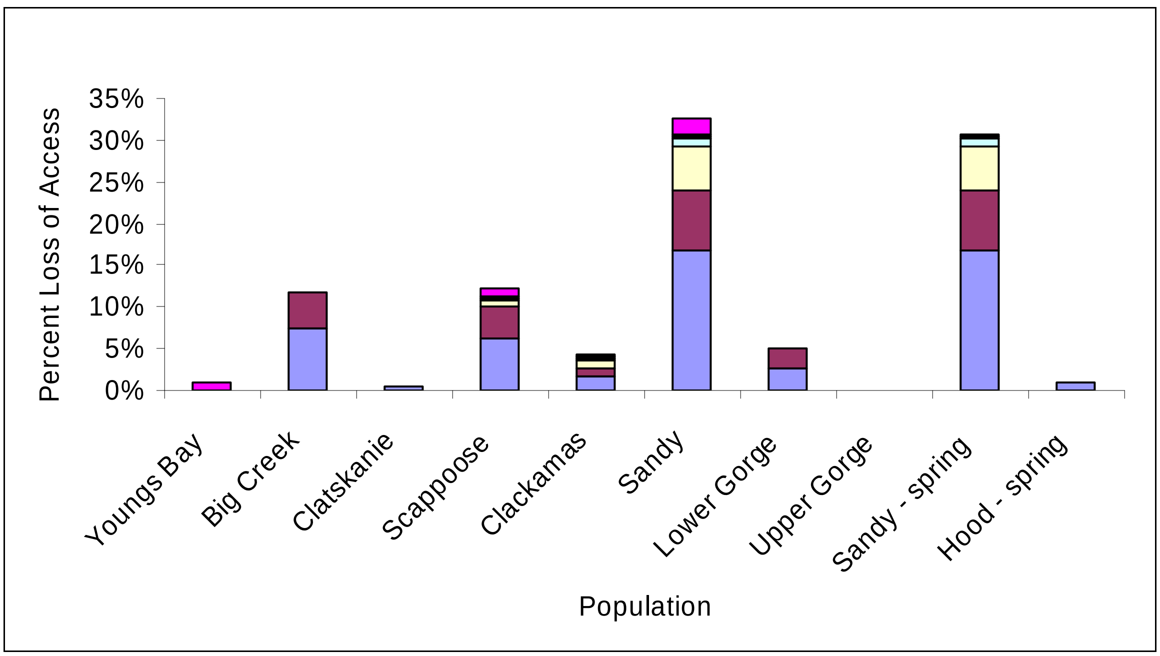

Figure 39: Percent loss in LCR spring and fall chinook accessibility due to anthropogenic blockages (based on Maher et al. 2005 with update by Sheer 2007). Each color represents a blockage ordered from largest to smallest (bottom-up). The topmost blockages, for example the blue segment of the Sandy bar, are a collection of many smaller blockages. The bar graph has been updated to reflect the removal of the largest blockage in Big Creek, still shown in the Atlas maps. Note that the pool of smaller blockages can be greater than larger single blockages.

Table 14: Spatial structure persistence category scores for LCR chinook populations.

Population	Base Access Score	Adjustment for Large Single Blockage	Adjusted Access Score	SS Rating*	Confidence in SS rating
Youngs Bay Fall	4	No	4	3	Low
Big Creek Fall	3	No	3	2.5	Low
Clatskanie Fall	4	No	4	3	Low
Scappoose Creek Fall	3	No	3	2.5	Low
Clackamas Fall	4	No	4	3	Low
Sandy River Fall	2	Yes	1.5	3	Low
Sandy River Late Fall	2	Yes	1.5	2	Low
Lower Gorge Tributaries Fall	3	No	3	2.5	Low
Upper Gorge Tributaries Fall	4	No	4	2.5	Low
Hood River Fall	4	No	4	3	Low
Sandy River spring	2	Yes	1.5	1.75	Low
Hood River spring	4	No	4	3	Low

* SS Rating considers Access Score, Historical Use Distribution, and Habitat Degradation.

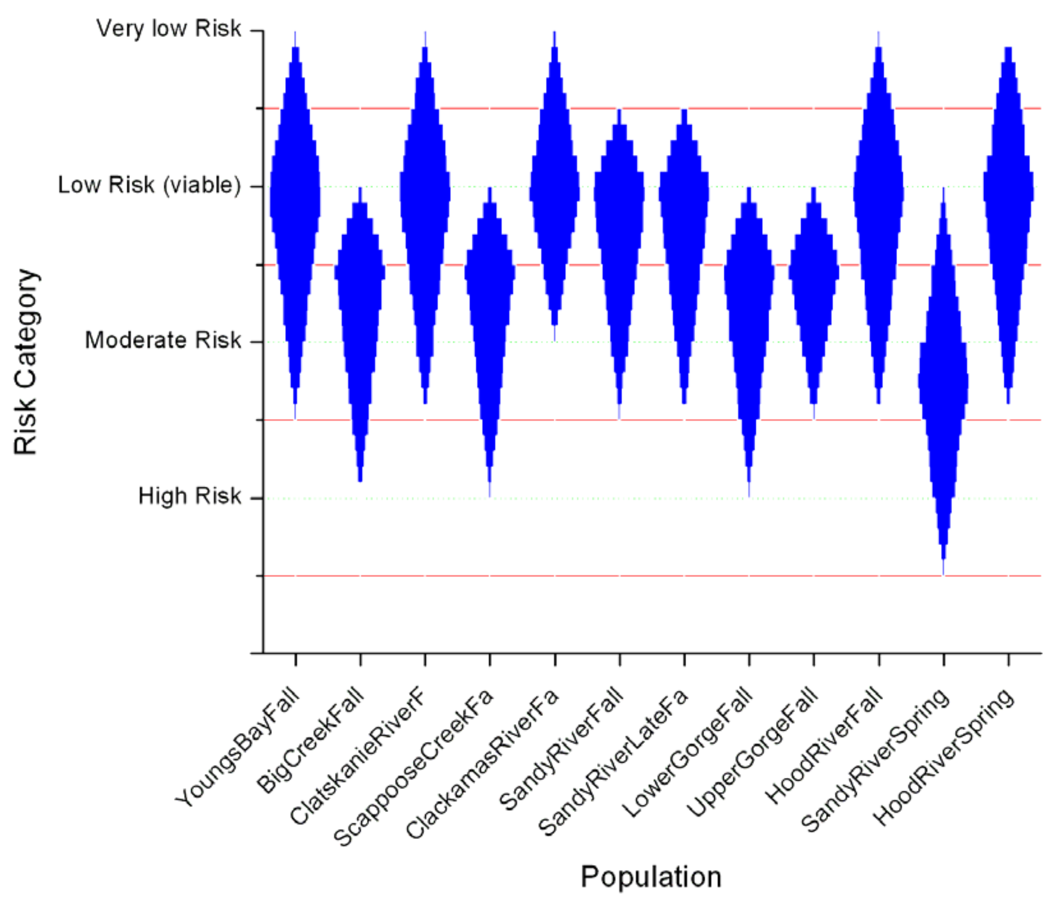

Figure 40: Lower Columbia River chinook salmon risk status summary based on the evaluation of spatial structure.

IV. Diversity

DV – Background and Overview

Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life-history strategies. Healey (1986) described 16 age categories for chinook salmon, 7 total ages with 3 possible freshwater ages. Two generalized freshwater life-history types were initially described by Gilbert (1912): stream-type chinook salmon reside in freshwater for a year or more following emergence, whereas ocean-type chinook salmon migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for ocean type and stream type to describe two distinct races of chinook salmon. Using Healey's definition, chinook salmon native to the Lower Columbia and Upper Willamette Rivers are considered to be ocean type (Myers et al. 1998). Below this stream/ocean level of diversity, run timing and geographic distribution are the most prominent life history characters used to distinguish populations. Of the five recognized run times, only three are currently observed in the Lower Columbia River: spring, fall, and late fall (it is possible that a winter run existed in the Sandy River Basin, but was extirpated). Each of these run timings is associated with a suite life history characters related to spawning site selection, age at emigration, and age at maturation.

The fall run is currently predominant in the Lower Columbia River, although historically, spring-run fish may have been as numerous as the fall run, if not more so. Fall-run fish return to the river in mid-August and spawn within a few weeks (WDF et al. 1993, Kostow 1995). These fall-run chinook salmon are often called tules and are distinguished by their dark-skin coloration and advanced state of maturation at the time of freshwater entry. Tule fall-run chinook salmon populations historically spawned in tributaries from the mouth of the Columbia River to the White Salmon and Hood Rivers and possibly farther upstream. It is also likely that fish spawned in the mainstem Columbia River above the confluence with the Willamette River. A later returning component of the fall run exists in the Lewis and Sandy Rivers (WDF et al. 1993, Kostow 1995, Marshall et al. 1995). Because of the longer time interval between freshwater entry and spawning, Lewis River and Sandy River late-fall-run chinook salmon are less mature at freshwater entry than tule fall chinook salmon at river entry and are commonly termed lower river "Brights" (Marshall et al. 1995). Confusingly, there are presently a number of other non-native fall-run chinook salmon in the Lower Columbia River that are also generally referred to as brights or "up river brights". Hatchery records and genetic analysis indicate that these fish are the descendants of introduced fall-run chinook salmon from the Rogue River (Oregon coast) and the Upper Columbia River (Priest Rapids Hatchery). With the exception of the late fall-run chinook salmon in the Lewis and Sandy Rivers we know of no information to indicate that this life-history form was historically present anywhere else in the ESU.

The majority of naturally produced fall-run chinook salmon from the Lower Columbia and Lower Willamette Rivers emigrate to the marine environment as subyearlings (Reimers and Loeffel 1967, Howell et al. 1985, Hymer et al. 1992, Olsen et al. 1992, WDF et al. 1993), although much of the current information is confounded by the inclusion of a large number of hatchery reared fish.

Historically, adult fish migrations (especially spring run migrations) were synchronized with periods of high rainfall or snowmelt to provide access to upper reaches of most tributaries where fish would hold until spawning (Fulton 1968, Olsen et al. 1992, WDF et al. 1993). The relationship between flow and run timing was recognized by early fishery biologists: "Another peculiarity in connection with the habits of this species [spring run chinook salmon] of salmon is that they will not enter any stream which is not fed by snow water . . ." (ODF 1900). Fall-run chinook salmon generally spawn in the lower reaches of larger rivers and are less dependent on flow, although early autumn rains and a drop in water temperature often provide a cue for movements to spawning areas.

Marine CWT recoveries for Lower Columbia River stocks tend to occur off the British Columbia and Washington coasts, with a small proportion of tags recovered from Alaska (Myers et al. 1998). With the exception of fish populations not native the ESU (i.e. Rogue River fall-run and Carson National Fish Hatchery (NFH) spring-run chinook salmon) and to a lesser extent the late-fall run chinook salmon there is little variation in the distribution of ocean recoveries.

DV – Youngs Bay Fall Run

Life History Traits **–** There is little information on the life history traits of fall-run chinook salmon spawning in tributaries to Young's Bay. Spawner surveys conducted in late September and early October (a timing associated with "tule" fall-run fish), have observed spawners and redds (Theis and Melcher 1995, (Takata 2005)). This spawn timing is similar to other populations in adjacent Lower Columbia River DIPs. Estimation of spawn timing is complicated by the presence of Rogue River late-fall chinook salmon released from Youngs Bay net pens and late-fall fish from coastal chinook salmon populations. Takata (2005) reported that the majority of spawning in the North Fork and South Fork Klaskanine River were Rogue River stock. Score = 3.0

Effective Population Size **–** Abundance estimates for this DIP have been based on single peak count surveys. Counts have varied from zero to several hundred fish, the majority of which are thought to be of hatchery origin. Score = 2-3

Hatchery Impacts

> *Hatchery Domestication (PNI)* **–** There is no hatchery program in the Youngs Bay DIP that releases fall-run chinook salmon that originate from the Coastal Stratum. ODFW (2003) estimated that in the 1990s over 90% of the naturally spawning fish in this stratum were of hatchery origin. Due to the non-local origin of most hatchery fish, hatchery effects were calculated using the hatchery introgression metric. Score = NA
>
> *Hatchery Introgression* **–** Hatchery programs for select area fisheries in Youngs Bay have focused on the release of Upper Willamette River spring run and Rogue River late-fall run chinook salmon. Hatcheries in adjacent watershed release a mixture of stocks, for example the Big Creek hatchery broodstock was founded with fish from the Spring Creek NFH (Gorge Stratum). Estimates of hatchery contribution to natural escapement ranges from 50-91% (ODFW 2003, Goodson 2005). Goodson (2005) suggests 90% of the fall-run chinook salmon present were Rogue River (aka Select Area Bright) fish, although it is unclear how run timing differences might limit genetic introgression. Score = 0.5.
>
> *Synthetic Approach* – There is a very low genetic similarity between the fish released into this DIP and the local naturally-spawning fish. Additionally, the proportion of hatchery fish spawning naturally is very high (pHOS >> 0.50). Diversity persistence score = 0.0.

Anthropogenic Mortality – Harvest impacts on fall-run chinook salmon in the Lower Columbia River, have been and continue to be relatively high. Recent total harvest for LRH stocks was 47.4% (1999-2002), with nearly half of that taking place in inshore and in-river fisheries, where there is some potential for gear-related selection (especially with gillnets). Habitat changes in the estuary and mainstem Columbia River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2.0.

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions. Score = 3 - 4

***Overall Score* = 1.0.** The large proportion of out-of-ESU and out-of-stratum hatchery fish and the extremely low numbers of potentially native fish observed spawning strongly influenced the score. Previously: 2004 TRT 0.96; 2004 ODFW Fail < 4 criteria meet

DV – Big Creek Fall Run

Life History Traits **–** Run timing and age structure information is available for Big Creek chinook salmon, unfortunately in the absence of a pre-hatchery baseline it is difficult to identify any changes in life history diversity. Currently, fish begin freshwater entry in late August and September with spawning taking place from late-September through early/mid October (Howell et al. 1985, Olsen et al. 1992). Scale analysis indicates that the majority of the fish return as 3 and 4-year olds, with a fair number of 2-year-old males (jacks) and a limited number of 5-year-old fish (Olsen et al. 1992). These life history characteristics are similar to other fall-run chinook salmon in the Coastal stratum. Score = 4.0

Effective Population Size – Goodson (2005) and Theis and Melcher (1995) estimate that the spawning escapement to Big Creek and other streams in the DIP numbers in the thousands of fish, although most are thought to be of hatchery origin. Score = 3-4

Hatchery Impacts

Hatchery Domestication (PNI) **–** The Big Creek hatchery was established in 1941 using locally returning fish as broodstock. Since 1941, 8 different stocks of fall-run chinook salmon have been released from this hatchery in addition to a number of spring-run chinook salmon (primarily from the Upper Willamette River ESU). Over 200 million fall-run chinook salmon have been released into the Big Creek Basin. For several years, releases of Rogue River bright fall-run chinook salmon were made from the Big Creek Hatchery, but were terminated because of concerns regarding the straying of these non-native fish into basins throughout the Lower Columbia River. A weir placed in the river for the collection of broodstock blocks access to much of the basin. Passage provided above the weir has been intermittent. Given existing conditions, it is unlikely that the naturally spawning fall-run chinook salmon in this basin are self-sustaining or independent. Genetically, the Big Creek Hatchery population most closely resembles fall-run chinook salmon from the Spring Creek NFH (Gorge fall-run stratum) from which it is descended. It is unclear to what degree these Spring Creek fish could have adapted to local conditions. Recently releases from Big Creek hatchery have been reduced from 10 million to 5-6 million. In 2003, 16,785 chinook returned to the hatchery rack.

PNI ≤ 0.1. , Fitness = 0.45 Score = 1.0

Hatchery Introgression **–** The PNI metric (#2) was utilized to account for hatchery effects Score = NA

Synthetic Approach – Although there is a moderate genetic similarity between the fish released into this DIP and the local naturally-spawning fish, the proportion of hatchery fish spawning naturally is very high (Ph >> 0.50). Diversity persistence score = 1.0.

Anthropogenic Mortality **–** Mortality: Harvest impacts on fall-run chinook salmon in the Lower Columbia River, have been and continue to be rather high. Recent total harvest for LRH stocks was 47.4% (1999-2002), with nearly half of that taking place in inshore and in river fisheries, where there is some potential for gear-related selection (especially with gillnets). Habitat changes in the estuary and mainstem Columbia River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2.0**.**

Habitat Diversity – Although the quality of habitat may be severely degraded the proportion of accessible stream size reflects historical conditions, while much of the elevation diversity has been lost. Score = 3/1.

***Overall Score* = 1.0**. The large proportion of out-of-ESU and out-of-stratum hatchery fish and the extremely low numbers of potentially native fish observed spawning strongly influenced the score. Previously: 2004 TRT 0.96; 2004 ODFW Fail < 4 criteria meet.

DV – Clatskanie River Fall Run

Life History Traits – Naturally spawning fall-run chinook salmon still occur in these streams; however, the majority of these fish appear to be first generation hatchery strays (Theis and Melcher 1995). Merrill (1957) observed chinook salmon spawning just above the tidewater (Rkm 6) during October (at the time of the first survey, October 17th, there were already 7 carcasses on site). Genetic analysis of fall-run fish from these streams is not available; however, based on the marked hatchery strays recovered and geographic proximity it is likely that there would be a strong similarity to stocks released from the Big Creek hatchery and other local facilities. Score = NA

Effective Population Size **–** Index spawner surveys estimate fish density at several hundred fish per mile, which would expand to a few thousand for the whole DIP (Goodson 2005). Score = 3-4

Hatchery Impacts

> *Hatchery Domestication (PNI)* – There is no hatchery program currently operating in this DIP. Goodson (2005) reports >50% of spawning escapement is of hatchery origin, many of which originate from Big Creek (233/240 CWTs) and Elochoman (3/240 CWTs) hatchery programs (Takata 2005). PNI and fitness estimates calculated assuming that hatchery contribution has been at least this high since the initiation of the Big Creek hatchery program. PNI ≤ 0.5. Fitness = 0.75**.** Score = 2.0
>
> *Hatchery Introgression* **–** The majority of hatchery stray fall-run chinook salmon in this DIP originated from the Big Creek Hatchery (BCH) program. Although BCH fish are closely related to Spring Creek NFH fish (Gorge Strata), we have used the PNI calculated to estimate hatchery effects. Score = NA
>
> *Synthetic Approach* – The Big Creek fall-run chinook salmon that represent the majority of naturally spawning hatchery fish are probably moderately genetic similarity between the fish released into this DIP and the local naturally-spawning fish, the proportion of hatchery fish spawning naturally is high (Ph = 0.50). Diversity persistence score = 2.0.

Anthropogenic Mortality **–** Harvest impacts on fall-run chinook salmon in the Lower Columbia River, have been and continue to be relatively high. Recent total harvest for LRH stocks was 47.4% (1999-2002), with nearly half of that taking place in inshore and in-river fisheries, where there is some potential for gear-related selection (especially with gillnets). Habitat changes in the estuary and mainstem Columbia River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2.0**.**

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions. Score = 4/4.

***Overall Score* = 1.5.** The influence of stray hatchery fish from out-of-basin programs was a major consideration estimating a diversity score. The absence of a hatchery program directly releasing fish into the DIP may provide some opportunity for local adaptation.

Previously: 2004 TRT estimate 1.31; 2004 ODFW Fail < 4 criteria met.

DV – Scappoose Creek Fall Run

Life History Traits – There is little information on historical or current life history traits or genetic characteristics. Spawner surveys have been done intermittently and give little indication of run size or trends in abundance. Parkhurst et al. (1950) observed 60-70 spawning chinook salmon on the 8th of October 1945. Spawner surveys are currently carried out in late September and early October. Score = NA

Effective Population Size – Willis (1960) estimated that the run of chinook salmon in Scappoose Creek averaged 100 fish. Goodson (2005) does not present any abundance information for this DIP, but does state that chinook salmon are present. Abundance is presumed to be low, even considering the presence of hatchery strays. Score = 1-2

Hatchery Impacts

Hatchery Domestication (PNI) **–** There is no hatchery program in this DIP; however, there are a number of large fall-run chinook salmon hatcheries in nearby basins (fore example: Cowlitz Salmon Hatchery, Kalama Falls/Fallert Creek Hatchery, Lewis River Hatchery). In the absence of carcass recoveries, specific hatchery influence cannot be established. Score = NA

Hatchery Introgression **–** Goodson (2005) does not present any quantitative estimate of the hatchery contribution to escapement, and simply states that the hatchery influence is "excessive". Score = 2.0

Synthetic Approach– The majority of hatchery fish that are likely to stray into this DIP probably have a low level of genetic similarity. The proportion of hatchery fish spawning naturally is unknown, but thought to be high (0.75>Ph>0.30). Diversity persistence score = 1.0.

Anthropogenic Mortality **–** Harvest impacts on fall-run chinook salmon in the Lower Columbia River, have been and continue to be relatively high. Recent total harvest for LRH stocks was 47.4% (1999-2002), with nearly half of that taking place in inshore and in-river fisheries, where there is some potential for gear-related selection (especially with gillnets). Habitat changes in the estuary and mainstem Columbia River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2.0**.**

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions. Score = 4/3

Overall Score **= 1.5.** Small population size and the influence of a relatively large contribution by hatchery origin fish influenced this score. Due to the poor quantity and quality of information available this score should be considered an interim estimate. Previously: 2004 TRT estimate 1.18; 2004 ODFW Fail < 4 criteria meet

DV – Clackamas River Fall Run

Life History Traits **–** Fall-run chinook salmon were native to the lower Willamette River and its principal tributary, the Clackamas River, and likely other tributaries below Willamette Falls. A tule fall-run existed in the lower Clackamas River until the 1930s (Parkhurst et al. 1950, Gleeson 1972). Dimick and Merryfield (1945) reported that these fish entered the Willamette River in September and October and spawned soon after entering the Clackamas River. Murtagh et al. (1992) indicate that historical records suggest that fall-run chinook salmon may have spawned from September to November. There is little current information available on life history traits, in part because of the inability to distinguish between fall-run and late-spawning spring run chinook salmon. Score = NA.

Effective Population Size **–** Recent spawning escapement estimates indicate that less than 100 fall-run chinook salmon spawn in the lower Clackamas River. Additionally, it is not clear if the existing population is sustainable. Score = 1-2

Hatchery Impacts

Hatchery Domestication (PNI) **–** There is currently no hatchery program for fall run fish in the Clackamas or lower Willamette River. Fall-run chinook salmon from Lower Columbia River hatchery stocks were released from 1952 to 1981 to reestablish the run. Hatchery releases of fall chinook salmon last occurred in the 1980s allowing the existing population as least five generations to adapt to local conditions. Presently, the run appears to be maintained through natural reproduction, ODFW (1998) estimated that there were few if any fall-run hatchery fish spawning in the Clackamas River. Score = NA.

Hatchery Introgression **–** With the termination of fall run releases into the Clackamas and Willamette River, the level of hatchery influence is thought to be low. There is some potential for interbreeding between spring and fall-run fish in the lower Clackamas River. Score = 3.0.

Synthetic Approach – There are no releases of hatchery fall-run fish into the Clackamas River, although a number of spring-run chinook salmon are recovered in the lower river. Genetic similarity between the hatchery fish in this DIP and the local naturally-spawning fish, the proportion of hatchery fish spawning naturally is low or very low. While the number of stray fish may be low, the population of naturally-spawning fish is also very low. The relative proportion of hatchery fish could be high, perhaps in the range of 25% to 50%. Diversity persistence score = 0-2.

Anthropogenic Mortality – Harvest impacts on fall-run chinook salmon in the Lower Columbia River, have been and continue to be rather high. Recent total harvest for LRH stocks was 47.4% (1999-2002), with nearly half of that taking place in inshore and in river fisheries, where there is some potential for gear-related selection (especially with gillnets). Habitat changes in the estuary and mainstem Columbia River and lower Willamette River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2.0.

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions. Score = 4/4.

***Overall Score* = 2.0.** Small effective population size is the primary concern for this DIP, continued low escapements may result is a substantial genetic bottleneck. 2004 TRT estimate 1.34; 2004 ODFW Fail < 4 criteria meet

DV – Sandy River Fall Run

Life History Traits **–** There is considerable debate regarding the historical presence of early (tule) fall-run chinook salmon in the Sandy River. Howell et al. (1985) and Olsen et al. (1992) indicate that although tule fall run have not been stocked since 1977, early spawning fall-run chinook salmon established from those releases and/or strays from current releases continue to spawn below Marmot Dam. Score = NA

Effective Population Size **–** Surveys of “early” fall-run fish in the Sandy River Basin have been intermittent, but it is likely that on average one to a few hundred fish spawn in the basin each year (Theis and Melcher 1995). Score = 2.0

Hatchery Impacts

> *Hatchery Domestication (PNI)* **–** There is currently no hatchery program for fall-run chinook salmon in this DIP. It has been suggested that this is a feral population, founded from releases of LCR fall-run hatchery fish from 1930s to the 1970s. Score = NA
>
> *Hatchery Introgression* **–** Uncertainty regarding the origin of fall-run chinook salmon in the Sandy River complicates estimates of out-of-stratum introgression. Few carcasses are recovered and information on the origin of spawning fish is unavailable Score = 2.0
>
> *Synthetic Approach* – Hatchery fall-run chinook salmon have not been released into this basin for some time – it is unclear whether the fish presently spawning are native or feral. Fall-run (early) fish currently straying into this basin are likely to have a level of genetic similarity relative to naturally-spawning fish, the proportion of hatchery fish spawning naturally is very high ($0.10 < Ph < 0.30$). Diversity persistence score = 2.0.

Anthropogenic Mortality **–** Harvest impacts on fall-run chinook salmon in the Lower Columbia River, have been and continue to be rather high. Recent total harvest for LRH stocks was 47.4% (1999-2002), with nearly half of that taking place in inshore and in river fisheries, where there is some potential for gear-related selection (especially with gillnets). Habitat changes in the estuary and mainstem Columbia River and lower Willamette River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = NA**.**

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions. Score = 4/3.

***Overall Score* = 1.0.** Although the effective population size of this population is relatively low, it does appear to be self-sustaining with little hatchery introgression. The origin of this population remains to be clarified. Previously: 2004 TRT 1.16; 2004 ODFW not rated/introduced.

DV – Lower Gorge Fall Run

Life History Traits **–** There is some historical information available for Lower Gorge tributaries. Evermann and Meek (1898) observed "considerable numbers" of chinook in Eagle and Tanner Creeks. Bowers (1902) reported that chinook salmon had entered Eagle and Tanner Creeks by 18 September 1901. Currently, there are fall-run chinook salmon that spawn off of Ives Island, in the mainstem Columbia River below Bonneville Dam (Van Der Naald et al. 2001). These fish appear to have a typical fall-run spawn timing (late September and October). Score = NA.

Effective Population Size – Lower Gorge tributaries are only intermittently surveyed, returns to the hatcheries number in the thousands, but the origin of many of these broodstocks is uncertain. Several hundred full-run fish spawn in the Ives Island vicinity. Score = 2.0

Hatchery Impacts

Hatchery Domestication (*PNI*) – Populations in the Lower Gorge tributaries are likely heavily influenced by hatchery fish straying from Bonneville Hatchery and Spring Creek NFH. In 2003, some 2,852 fall-run fish returned to the Bonneville Hatchery, this was in addition to the 21,297 Upriver Bright fall-run chinook salmon that returned to the hatchery. Spring Creek NFH fall-run returns normally range from 5,000 to 15,000 fish. In addition, there are a number of other hatchery programs that release both Lower Columbia River fall run and URB fall run fish. Although no estimate is available it is likely that the hatchery contribution to natural spawning escapement is over 50%.2.

PNI ≤ 0.1. Fitness = 0.45. Score = NA

Synthetic Approach – Fall-run hatchery fish straying into this area could be from either local tule hatchery programs or upriver bright programs. There is likely a low or very low level of genetic similarity between the fish released into this DIP and the local naturally-spawning fish, the proportion of hatchery fish spawning naturally is very high (Ph >> 0.50). Diversity persistence score = 0.0.

Hatchery Introgression – Several million URB fall-run fish are released into the mainstem Columbia River near Bonneville Dam. Although there is some temporal separation in spawn timing, there is potential for interbreeding. It is not known the degree to which URB fish stray and spawn in Lower Gorge tributaries, although there is a sizable aggregation (several hundred fish) that spawn off of Ives Island. Score = NA

Anthropogenic Mortality – Harvest impacts on fall-run chinook salmon in the Lower Columbia River, have been and continue to be rather high. Recent total harvest for LRH stocks was 47.4% (1999-2002), with nearly half of that taking place in inshore and in river fisheries, where there is some potential for gear-related selection (especially with gillnets). Habitat changes in the estuary and mainstem Columbia River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2.0**.**

Habitat Diversity – The proportion and character (elevation and stream size) of accessible habitat is somewhat reduced from historical conditions. Score = 4/3

***Overall Score* = 2.0.** There are a number of potential factors that could negatively influence diversity; unfortunately, there are few estimates available to quantify the effects of these factors. This evaluation focused on the Oregon side of the DIP. Previously: 2004 TRT 0.83, 2004 ODFW fail, 4-5 criteria met – combined with Hood River and Upper Gorge Tributaries

DV – Upper Gorge Fall Run

Life History Traits – There is some information available for Upper Gorge tributary chinook salmon, most of which comes from the Washington side of this DIP. Chinook salmon were observed migrating up the Big White Salmon River on 4 September 1896. Hatchery records from the Wind River Hatchery (1928-1938) indicate that eggs were collected from early September to mid-October, with a peak in late September. There is little information on the existing fall-run chinook salmon life history characteristics. Score = NA

Effective Population Size **–** Tributaries in the Upper Gorge are only intermittently surveyed. Observed fish counts range from 0 to a few hundred fish. Score = 1-2

Hatchery Impacts

> *Hatchery Domestication (PNI)* **–** Populations in the Upper Gorge tributaries are likely heavily influenced by hatchery fish straying from Bonneville Hatchery, Little White Salmon NFH, and Spring Creek NFH. In 2003, some 2,852 fall-run fish returned to the Bonneville Hatchery, this was in addition to the 21,297 Upriver Bright fall-run chinook salmon that returned to the hatchery. Spring Creek NFH fall-run returns normally range from 5,000 to 15,000 fish. In addition, there are a number of other hatchery programs that release both Lower Columbia River fall run and URB fall run fish. Although no estimate is available it is likely that the hatchery contribution to natural spawning escapement is well over 50%.
>
> PNI $\leq$ 0.1, Fitness = 0.45 Score = 1.0
>
> *Hatchery Introgression* **–** Several million URB fall-run fish are released into the mainstem Columbia River near Bonneville Dam. Although there is some temporal separation in spawn timing, there is potential for interbreeding. URB fish are known to spawn in tributaries on the Washington side of this DIP, and it is likely that they do likewise on the Oregon side. Score = 2.0
>
> *Synthetic Approach* – Fall-run hatchery fish straying into this area could be from either local tule hatchery programs (Spring Creek NFH) or upriver bright programs. There is likely a low or very low level of genetic similarity between the fish released into this DIP and the local naturally-spawning fish, the proportion of hatchery fish spawning naturally is very high (Ph >> 0.50). Diversity persistence score = 0.0.

Anthropogenic Mortality **–** Fish returning to the Upper Gorge tributaries are subject to both ocean and in-river fisheries. Total harvest rate averaged 66% (1999-2002), with approximately half of the catch being from net fisheries. Habitat changes in the estuary and mainstem Columbia River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2-3**.**

Habitat Diversity **–** Habitat diversity in this DIP has been most strongly affected by the filling of the Bonneville Pool and the loss of much of the spawning rearing habitat for fall-run chinook salmon. Currently, the habitat model is being modified to account for this loss. Score = 3/2

***Overall Score* = 1.0.** There are a number of potential factors that could negatively influence diversity, unfortunately there are few estimates available to quantify the effects of these factors.

Previously: 2004 TRT 0.83, 2004 ODFW fail, 4-5 criteria met – combined with Hood River and Upper Gorge Tributaries.

DV – Hood River Fall Run

Life History Traits **–** Direct Measures: No information available. Score = NA.

Effective Population Size **–** Based on counts at Powerdale Dam (RKm 6), the average escapement for the past 13 years has been 26 fish. Since some spawning habitat exists below the dam, it is possible that the escapement is somewhat higher. Score = 1.0
Hatchery Impacts

> *Hatchery Domestication (PNI)* **–** There is no hatchery program in the Hood River basin for fall-run chinook salmon. Score = NA
>
> *Hatchery Introgression* **–** Estimates of the hatchery-origin fish contribution to escapement varies considerably from year to year, but on average represents 12% of the run. Since this estimate is based on visual detection of adipose fin marks it is likely that the actual percentage is somewhat higher. Score = 2.0
>
> *Synthetic Approach* – Hatchery fish straying into the Hood River are probably upriver bright fall-run chinook salmon, although it is possible that some Spring Creek fish also stray into the Hood River. There is likely a very low level of genetic similarity between the fish released into this DIP and the local naturally-spawning fish. The proportion of hatchery fish spawning naturally is relatively low ($0.10<Ph<0.30$)). Diversity persistence score = 1.0.

Anthropogenic Mortality **–** Fish returning to the Upper Gorge tributaries and Hood River are subject to both ocean and in-river fisheries. Total harvest rate averaged 66% (1999-2002); with approximately have of the catch being from net fisheries. Habitat changes in the estuary and mainstem Columbia River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 1.0**.**

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions. Score = 4/4

***Overall Score* = 0.5.** Small Ne, hatchery impacts, and high harvest rates all contribute to a poor diversity score for this DIP. Previously: 2004 TRT 1.24, 2004 ODFW fail, 4-5 criteria met – combined with Hood River and Upper Gorge Tributaries

DV – Sandy River Late Fall Run

Life History Traits **–** Late-fall chinook salmon return in September and October and spawn from late-November to February (Howell et al. 1985). Late-fall fish also appear to mature at an older age than early-run fish, with the majority of fish maturing at 4 or 5 years of age (Fulop 2000). There are reports of a winter-run in the Sandy River, although Kostow (1995) suggests that they have been extirpated. It is also possible that the winter-run chinook salmon observed are the "tail-end" of the late returning fall-run fish. Late returning bright fish in the Lewis River have been observed spawning as late as April. Late-fall run fish appear to emigrate as subyearlings. Little is know about the distribution of outmigration timing within the first year. Score = 3.0.

Effective Population Size – This population varies from several hundred to a few thousand. The average abundance for the last 30 years has been over 900 fish (Goodson 2005). There have been a number of years when abundance has declined to below 100 fish. The run of late-returning fall run fish may have historically been over 5,000 fish. Surveys during 2003/2004 resulted in a peak count of 281 fish, 54% of the 10-year average (Takata 2005). Score = 2-3.

Hatchery Impacts

> *Hatchery Domestication (PNI)* – There has been no artificial supplementation of the late-returning fall run. Genetic analysis indicates a strong association between Lewis and Sandy River late-returning fall-run chinook salmon, and these two populations cluster with other Lower Columbia River populations. Score = NA
>
> *Hatchery Introgression* – There is no hatchery program for late-fall run chinook salmon. Although there is a spring-run program in the Sandy River Basin and fall-run programs in neighboring basins there is little chance of introgression due to differences in run and spawn timing. Score = 4.0
>
> *Synthetic Approach* – There is no hatchery program in the Sandy River for late-fall run chinook salmon. Hatchery strays are likely to be local tule fall run fish with a low level of genetic similarity relative to the local naturally-spawning fish. Additionally, the proportion of hatchery fish spawning naturally is very low ($Ph < 0.05$).
>
> Diversity persistence score = 4.0.

Anthropogenic Mortality **–** Late-run fall chinook salmon are captured in many of the same ocean fisheries as their early fall-run counterparts. Overall, inshore sport and net harvest impacts are somewhat less for late-fall run fish. From 1999-2002, the average harvest rate for late-fall run fish was 30.7%, using Lewis River fish as a proxy. Habitat changes in the estuary and mainstem Columbia River and lower Sandy River may also have had an influence on juvenile outmigration strategies due to the loss of specific habitats or a reduction in the capacity of existing habitat. Score = 2-3**.**

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions.

Score = 3/3.

Overall Score = 3. Recurring low abundance bottlenecks and the potential for habitat-influenced changes in life history categories were considered to be major factors influencing the diversity score. Previously: 2004 TRT 1.68, 2004 ODFW fail, 4-5 criteria met.

DV – Sandy River Spring Run

Life History Traits **–** Hatchery records indicate that Sandy River spring-run chinook spawned from July to September (ODF 1903). Recent observation indicates that adult spring-run chinook return to the freshwater from May to August and spawn from September to October (Olsen et al. 1992, ODFW 2003). This change in spawn timing is thought to be related to introductions of Upper Willamette River spring-run hatchery fish. Score = 2.0.

Effective Population Size **–** The Sandy River historically had a very large run of spring run chinook salmon. Run size for the Sandy River Basin may have been in excess of 12,000 fish (Mattson 1955). Goodson (2005) estimated the 28-year average abundance at 1,579 fish. Score = 3.0.

Hatchery Impacts

Hatchery Domestication (PNI) **–** Hatchery programs have produced spring-run chinook salmon in the Sandy River Basin since the early 1900s. A number of out-of-basin sources have been integrated into the hatchery broodstock (especially from the Upper Willamette River). Hatchery fish that are now being released are externally marked and will be intercepted at Marmot Dam when they return (ODFW 1998). Hatchery fish are not allowed to pass above Marmot Dam (Rkm 43), although examination of otoliths from "unmarked" fish indicated that nearly 20% of the fish being passed over were of hatchery origin (Goodson 2005). Below Marmot Dam, over half of the naturally spawning fish were of hatchery origin, although it is not known how successful these spring-run fish were in the lower river. ODFW is currently replacing the existing Upper Willamette River derived spring-run chinook salmon with naturally produced spring-run adults returning to Marmot Dam. Genetic analysis of naturally spawning fish from the Sandy River suggested that the Sandy River population was genetically intermediate between Upper Willamette River populations and Lower Columbia River spring-run populations. Furthermore, there was little genetic resemblance between the spring-run and late "bright" fall-run fish in the Sandy River Basin. In other Lower Columbia River and coastal basins there is a tendency for different run times in a basin to have evolved from a common source. The Sandy River Basin would be a deviation from this pattern. Microsatellite DNA data indicated that the Sandy River spring-run was genetically distinguishable for the Clackamas Hatchery spring-run broodstock; however, the degree of differentiation was much less than that between spring runs in the Sandy and Yakima Rivers. Bentzen et al. (1998) concluded that although some interbreeding between the Upper Willamette River and Sandy River stocks had occurred, the Sandy River population still retained some of its original genetic characteristics. PNI $\leq$ 0.65 (above dam), 0.25 (below dam), Fitness = 0.85 (above dam), Score = 2.5

Hatchery Introgression **–** Introductions of Upper Willamette River spring-run chinook salmon increased considerably during the 1960s and 1970s. Releases of hatchery fish in the upper Sandy River (above Marmot Dam) have been terminated, it is unclear to what degree the introduction of Willamette River fish into the Sandy River basin has left a genetic legacy of non-local life history characters. Score = 2.0.

Synthetic Approach – The current Sandy River spring-run hatchery broodstock was recently derived from naturally-spawning native spring run fish. There is likely a moderate level of genetic similarity between the fish released into this DIP and the local naturally-spawning fish. Although a higher level of similarity is normally applied, because of the legacy of non-native Upper Willamette spring run the level was held at "moderate.", the proportion of hatchery fish spawning naturally is low (0.10<Ph <0.30). Diversity persistence score = 4.0.

Anthropogenic Mortality **–** Harvest rates for Sandy River spring-run chinook salmon are thought to be similar to Upper Willamette River spring run populations (ODFW 2003). For the period 1999-2002 the harvest rate averaged 40.7%, with a small proportion of that occurring in in-river net fisheries. As with other ocean-type populations, changes in habitat conditions in the Sandy River and mainstem Columbia river and estuary may have an impact on juvenile life histories. Score = 3-4.

Habitat Diversity **–** Although the quality of habitat may be severely degraded the proportion and character (elevation and stream size) of accessible habitat reflects historical conditions. Score = 3/3.

***Overall Score* = 2.5.** Habitat changes and the legacy of non-local hatchery introductions most dramatically affected the diversity score. Previously: 2004 TRT estimate 1.64; 2004 ODFW fail, 4-5 criteria met.

DV – Hood River Spring Run

Spring-run chinook salmon in the Hood River are believed to have been extirpated (Kostow 1995, Kostow et al. 2000). Fish from a number of different hatcheries have been released into the Hood River Basin to reestablish a spring run. From 1985 to 1992, over one million fish were released into the Basin from the Carson NFH and the ODFW Looking glass Hatchery (ODFW Stock #81, a Carson NFH derivative). Currently, fish from the Round Butte Hatchery (Deschutes River, Middle Columbia River Spring-Run ESU) are being released into the Hood River Basin as part of a reintroduction program. Fish from the Round Butte introductions and their descendants are not considered part of the Lower Columbia River ESU, and although there appears to be some natural production it is still uncertain if the existing population is sustainable. The existing spring-run population is thought to be wholly derived from Deschutes River spring-run chinook salmon. The existing spring-run is not considered part of the ESU and was not evaluated.

Overall Score = 0.0.

DV – Criterion Summary

With the exception of populations in the Sandy and Clatskanie Rivers, it is possible that most populations in Oregon's portion of this chinook ESU have been either lost or depressed to levels that are currently undetectable. This loss of genetic resources and high incidence of hatchery strays in many of these basins are the primary reasons that 10 of the 12 populations scored so low and fall into a most probable risk category of 'moderate' or 'high' (Figure 41). Only the late fall and spring chinook populations in the Sandy meet the viable threshold, and just barely so. Because of the uncertainty associated with the population ratings for the DV criterion, the possibility exists that all except one of the populations fall into the 'high risk' category, as illustrated by the placement of the lower portion of the diamonds in Figure 41. In light of these results, we conclude that the most probable DV risk classification for Oregon's LCR chinook populations is 'high'.

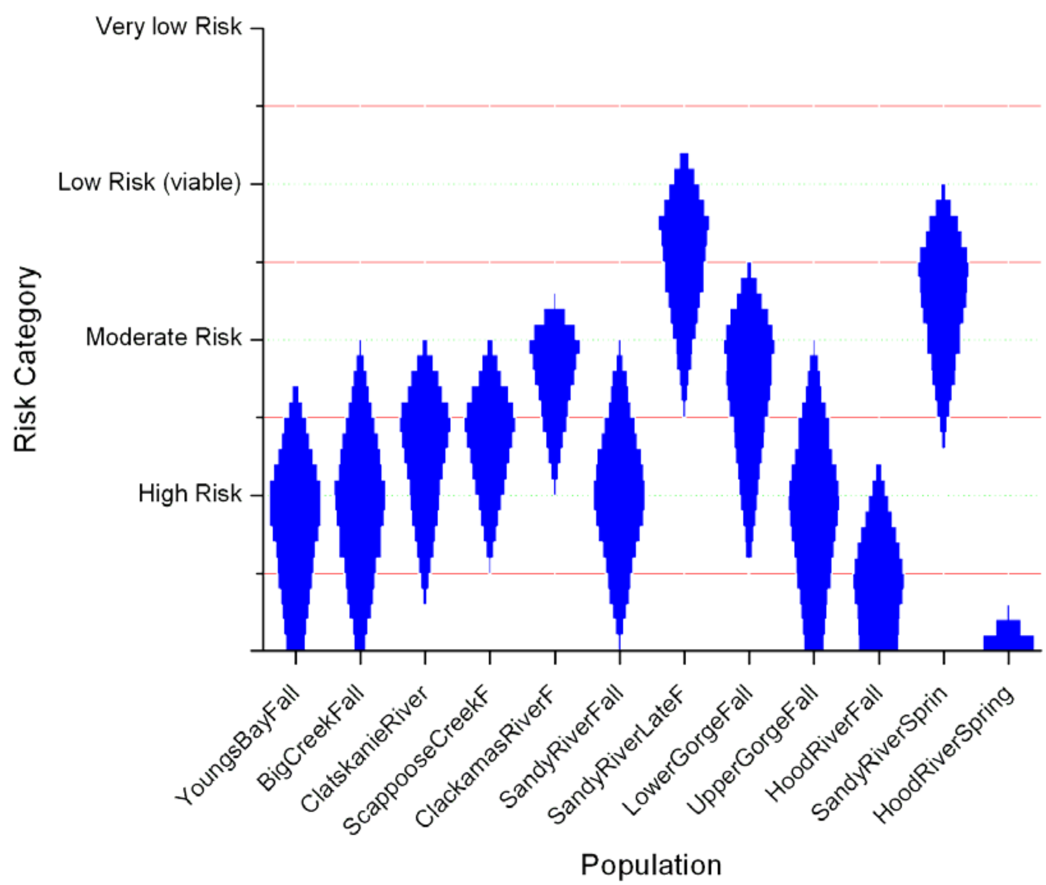

Figure 41: Lower Columbia River chinook salmon risk summary based on the evaluation of diversity only.

V. Summary of Population Results

When the three criteria scores were combined for all the populations, the results indicated that the risk of extinction for LCR chinook in Oregon's portion of the ESU is high (Figure 42 and Figure 43). On a population by population basis, a most probable classification of moderate was obtained for only two populations. Ten of the populations were clearly in the high risk category. In addition, their 'high risk' classification was made with considerable certainty as evidenced by the relatively shortened aspect of the diamonds representing population status. Overall, these chinook populations can be characterized as having a high risk of extinction.

Although a final ESU score is not possible without an assessment of Washington chinook populations using the same methodology, we expect that the overall finding would be similar our results for the Oregon populations. In all likelihood the extinction risk for the combined LCR chinook ESU is high.

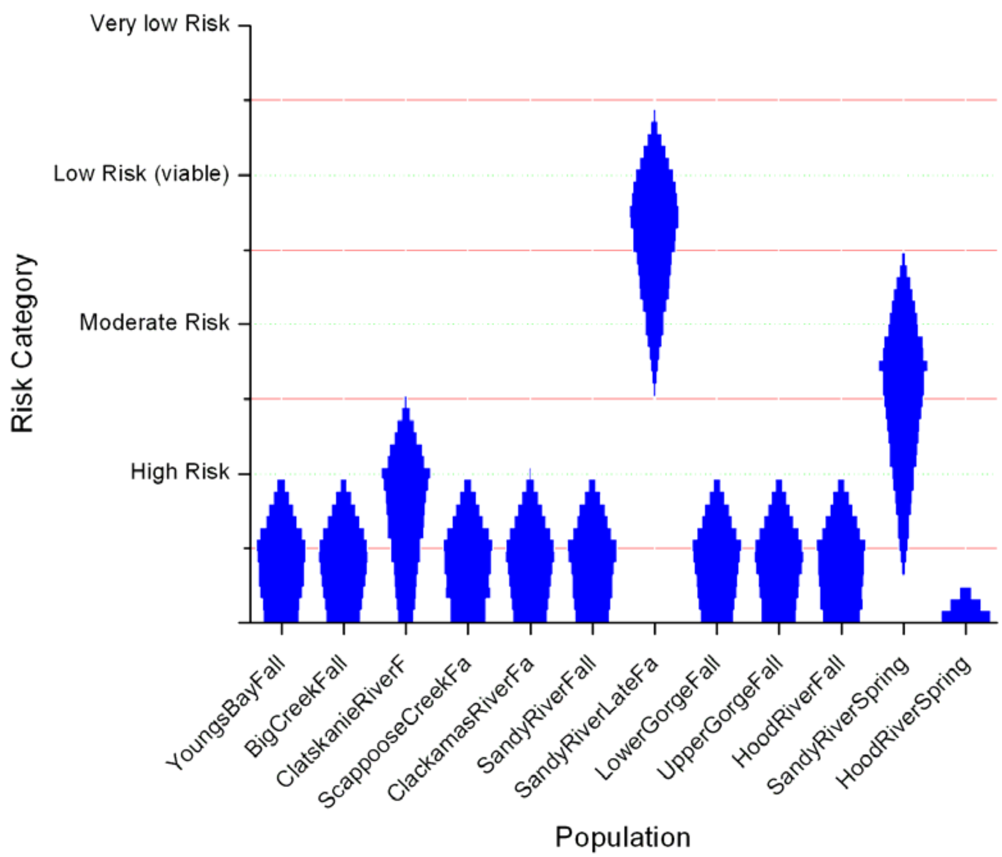

Figure 42: Oregon Lower Columbia River populations status summaries.

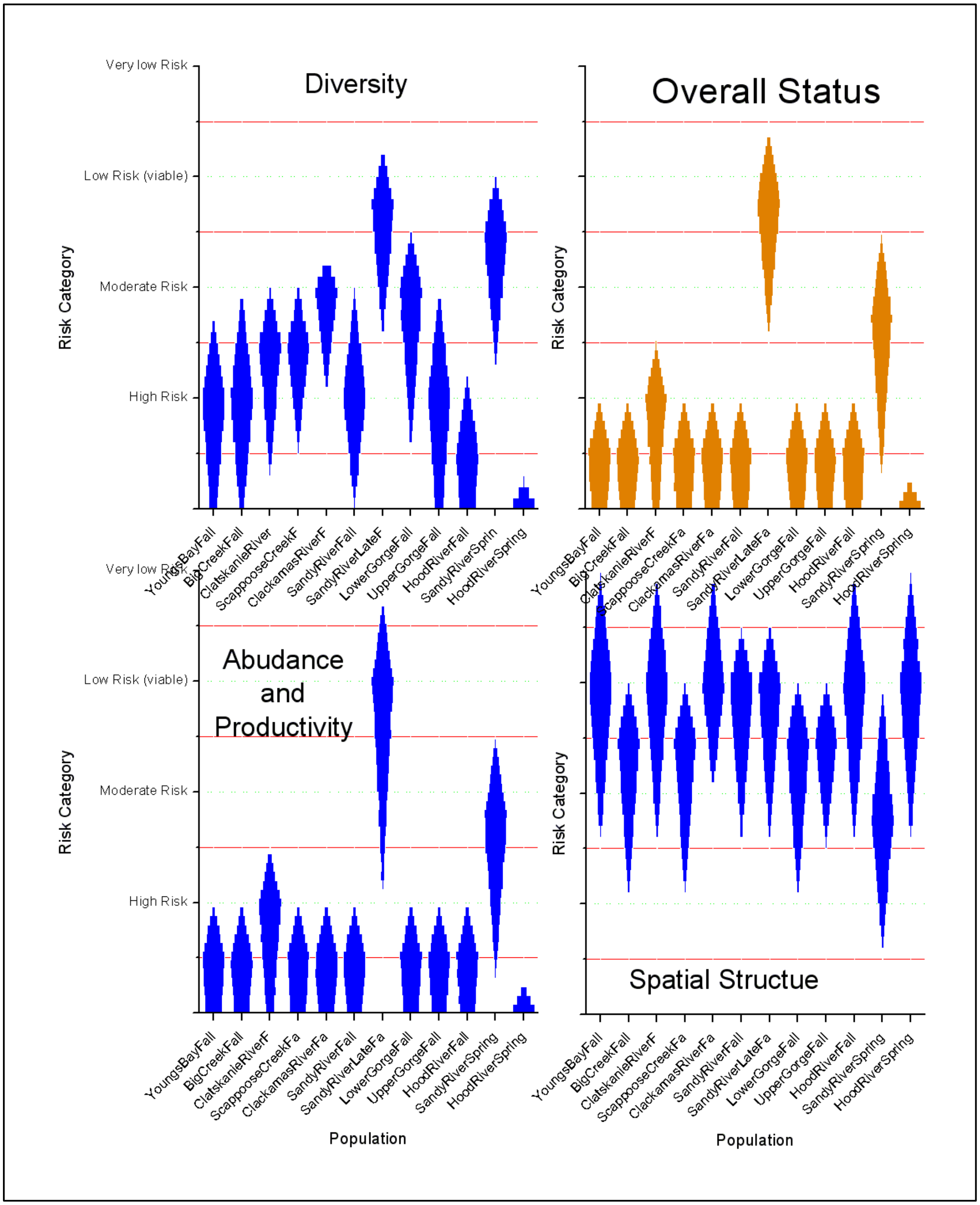

Figure 43: Oregon Lower Columbia River chinook salmon status graphs and overall summary.

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