Summary Report:

Assessment of Summer Chum Performance in Hood Canal and the Eastern Strait of Juan de Fuca

in Relation to Habitat Conditions and Strategic Priorities for Recovery and Conservation Actions

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Hood Canal Coordinating Council

By

Lawrence C. Lestelle
Gregory R. Blair
Lars E. Mobrand

Mobrand Biometrics, Inc.

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Section 1. Introduction

This document summarizes an assessment of baseline performance and strategic priorities for recovery and conservation of summer chum salmon in Hood Canal and the eastern Strait of Juan de Fuca. The assessment is based on application of the Ecosystem Diagnosis and Treatment (EDT) Method to eight populations of summer chum salmon produced in these areas:

- Union River
- Lilliwaup Creek
- Hamma Hamma River
- Dosewallips River
- Duckabush River
- Big/Little Quilicene rivers
- Salmon/Snow creeks
- Jimmycomelately Creek

The EDT Method is a widely used tool to help prioritize habitat restoration and protection measures for salmon populations. It provides a systematic way of diagnosing habitat conditions that have contributed to the current state of populations, and it enables an assessment of priorities for developing restoration and protection plans. It also provides an analytical procedure for assessing the potential benefits to salmon populations of actions that might be taken to address habitat related issues impeding recovery.

This project represents a ground-breaking effort for the EDT Method. An integral part of the project was the development of a set of chum salmon habitat rules for analyzing the role of habitat conditions in the estuarine and marine environments to chum performance (Lestelle and others 2005a). The EDT method applies species-specific habitat rules that relate environmental conditions to life stage survival responses of salmonid fishes. EDT species-habitat rules have been developed for most anadromous species of *Oncorhynchus* (Lestelle and others 2004 and 2005b), but until now were only developed for freshwater environments. These new rules provide a more direct and effective way of modeling actions in estuarine and marine waters than has been done with EDT in the past.

The results are presented in two sections. The first provides a summary of baseline population performance measures for the eight populations—both for current and historic conditions. The second provides a summary of strategic priorities. These sections include conclusions about what the results indicate regarding population health and recovery planning.

It is assumed that the reader has a basic understanding of EDT and the way in which EDT analyses are performed. Background information is available at http://www.mobrand.com/MBI/library.html. The streams and salmon populations referred to in this document may now be analyzed by interested parties with the EDT web application at http://www.mobrand.com/edt/.

Section 2. Methods

Standard EDT procedures were followed in delineating and characterizing reaches within the stream systems utilized by the eight summer chum populations. The upper limits of summer chum utilization in each stream were identified by Thom Johnson (WDFW). Stream reaches in the Dosewallips, Duckabush, and Hamma Hamma rivers were characterized by the mid Hood Canal Chinook Technical Committee in 2001-2002 as part of the Chinook EDT assessment on those rivers. We applied those characterizations as part of this assessment for summer chum salmon.[1] For the other streams, we characterized the reaches, relying heavily on the limiting factors reports (Haring 1999; Correa 2002; Correa 2003; Kuttel 2003). We also drew on our past work on the Union and Quilicene systems and Snow Creek in which an earlier form of EDT had been applied (Lestelle and others 1996[2]; PNPTC *unpublished*[3]).

The procedures for characterizing the estuarine and marine waters of Hood Canal, Admiralty Inlet, and the Strait of Juan de Fuca are described in Lestelle and others (2005a). We briefly summarize some aspects here to aid the reader.

We separate estuarine and marine waters into two broad categories in the analysis: natal subestuaries and the estuarine-marine waters that extend beyond them. The term *subestuary* refers to the estuarine portion of a stream, beginning on the upper end at the upstream extent of tidal influence and extending downstream to the outer edge of the delta. A *natal subestuary* refers to the subestuary on the natal spawning river of a salmon population. Hence there are eight natal subestuaries that were analyzed as part of this project. Beyond the natal subestuaries is the Puget Sound estuarine-complex, which we refer to here as estuarine-marine waters.[4]

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[1] / In reviewing the characterizations for the Dosewallips, Duckabush and Hamma Hamma rivers, we concluded that several attributes should be revisited by the technical team. The team initiated its review on February 28, 2005. Any updates to the database that result from that review will need to be incorporated into the chum analysis at a future date.

[2] / Information on Snow Creek was used to illustrate aspects of EDT analysis in the document cited.

[3] / Most streams in the Hood Canal basin were characterized using an earlier form of the EDT Method in the mid 1990s. Contact Chris Weller at Point No Point Treaty Council for additional information.

[4] / Technically, all of Puget Sound, including Hood Canal and the Strait of Juan de Fuca, are considered estuarine because freshwater is measurably diluted by seawater. However, there is clearly a continuum of estuarine characteristics—from strong to faint—moving from the southern ends of Hood Canal and Puget Sound to the western extremity of the Strait.

We characterized the natal subestuaries drawing on information contained in the limiting factors reports cited above, topographic maps, and a review of the Washington Department of Ecology's oblique shoreline photos. We also drew on two other sources of information. Steve Todd (PNPTC), Allan Carter-Mortimer (PNPTC), and Richard Brocksmith (HCCC) made an independent assessment of habitat function loss within each subestuary by estimating loss in area of emergent marsh, combined with a visual assessment using maps and photographs of loss in connectivity with the marine environment or other obvious constraints imposed by development. They recorded their conclusion of loss as a rating. Their assessment did not characterize condition through a set of attributes and one cannot determine what aspects of loss thereby contribute the most to the degraded state. Still, their assessment provided an independent measure about the extent of degradation in each subestuary that helped in our assessment. The second source of additional information was the characterization of the lower freshwater reaches of each stream. Some attributes used in freshwater are also applied to the subestuary. For these attributes, we generally applied the same ratings in the lowest freshwater reach to the subestuarine reach.

To characterize the estuarine-marine waters beyond the natal subestuaries, we relied heavily on data contained in the Washington Department of Natural Resource's ShoreZone database. The shoreline units within the database are alongshore stretches of beach with similar geomorphological characteristics. The average length of a shore unit in the database is 0.5 miles, although their lengths vary substantially. Hood Canal and the Strait of Juan de Fuca (including Admiralty Inlet) have 574 and 362 shore units delineated respectively.

We aggregated the shore units from ShoreZone into segments. We performed the analysis at the segment scale on waters beyond the natal subestuaries. We sized the segments such that the mouth of no more than one major river entered into a single segment. Based on our synthesis of the issues affecting salmon performance within the Puget Sound complex, we concluded that this scale was appropriate to incorporate the concept of landscape on survival (as described in Lestelle and others 2005a).

Figure 1 shows segment boundaries for Hood Canal and the Strait. Hood Canal was segmented so that there are eastside and westside segments, joined approximately in mid channel. Large bays were delineated as single segments, often with a major river entering approximately halfway along the length of the shoreline. In Hood Canal, we delineated 20 segments. North of Hood Canal along the west side of Admiralty Inlet and then along the entirety of the Strait of Juan de Fuca, we delineated another 22 segments. The total number incorporated into the analysis was 42 (Table 1).

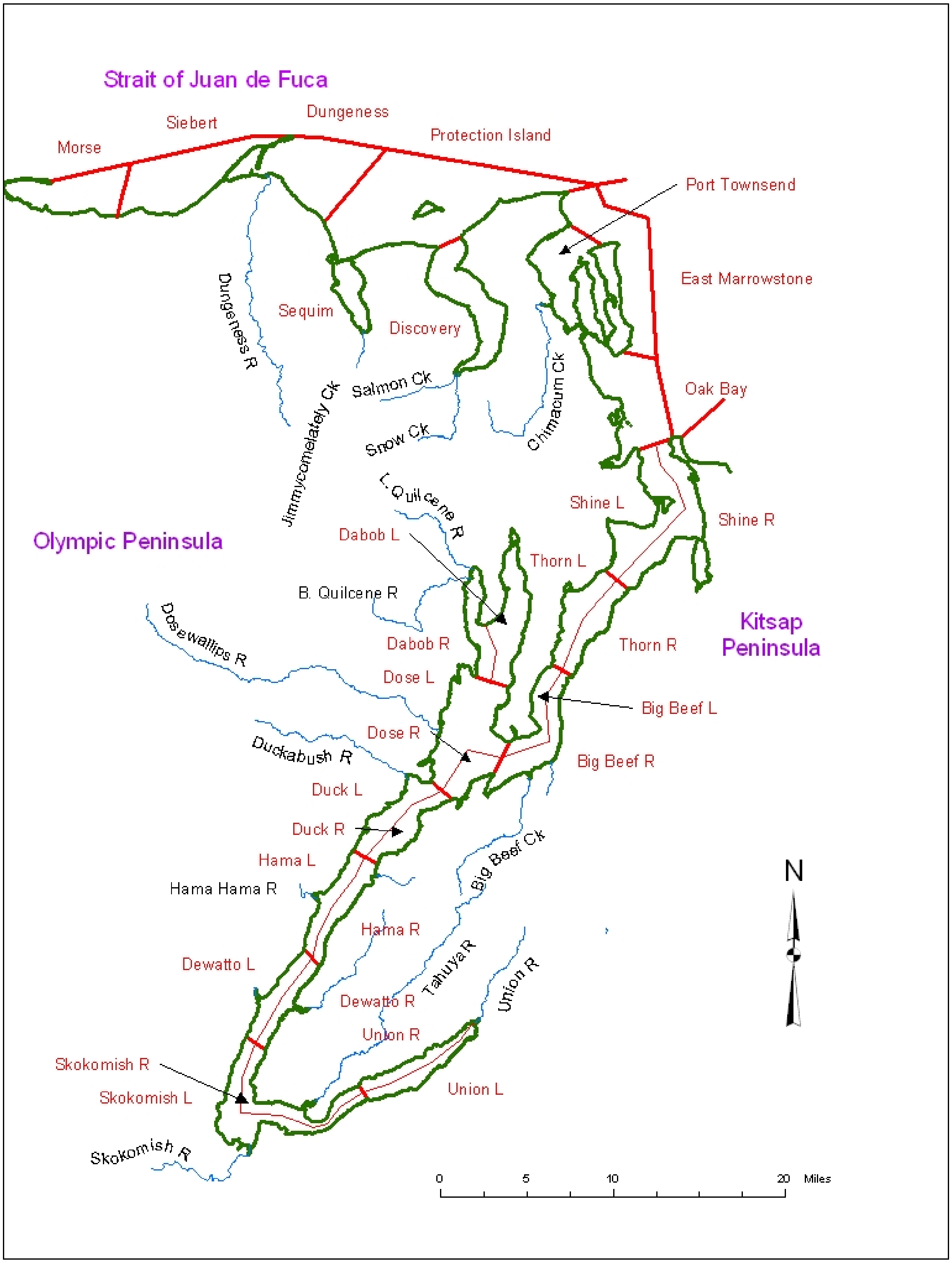

Figure 1. Segmentation of Hood Canal and the Strait of Juan de Fuca.

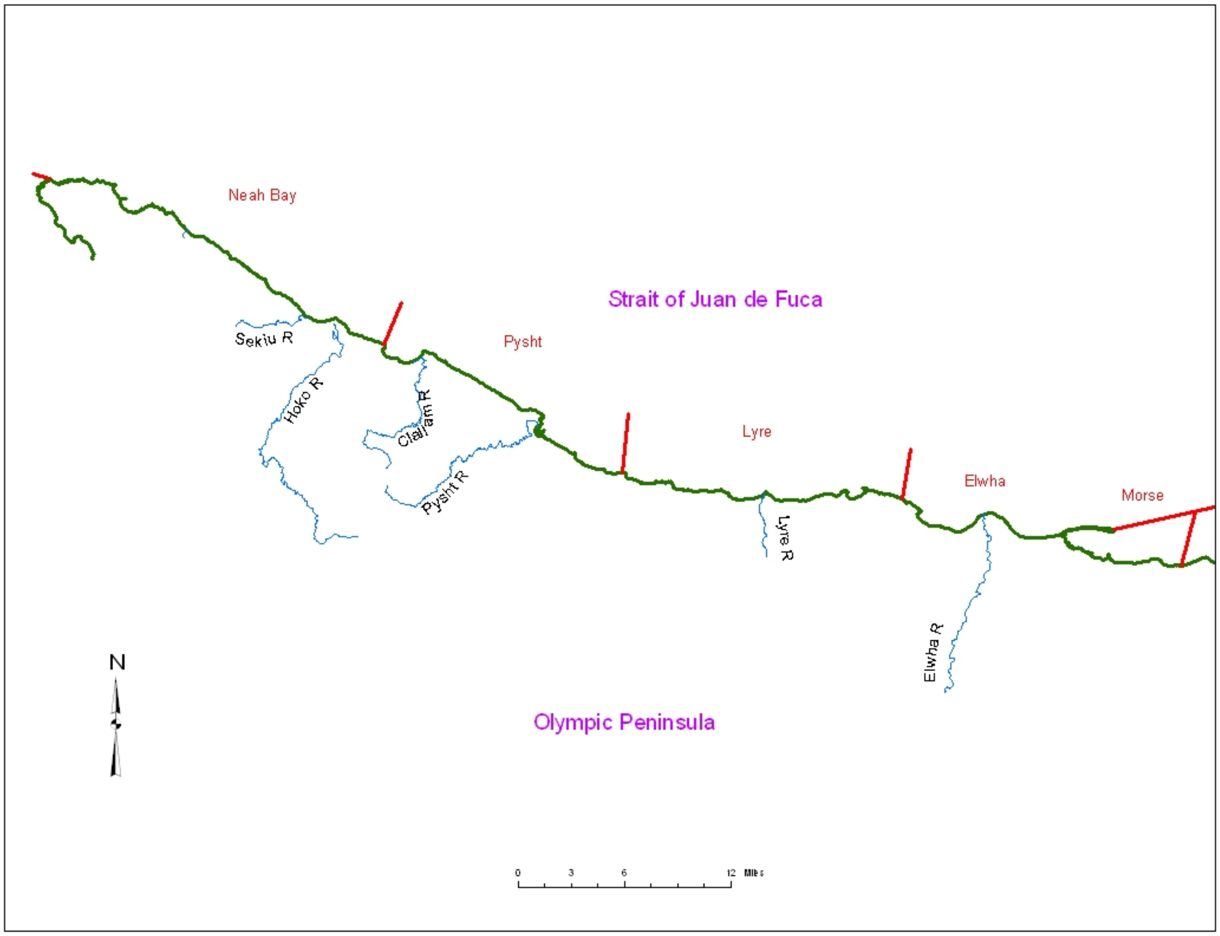

Figure 1 continued. Segmentation of Hood Canal and the Strait of Juan de Fuca.

We further divided each segment into two zones, a shallow littoral zone, here approximately coinciding with the intertidal zone, and a deeper water zone. Attributes differ in their effects on the modeled populations within these two zones.

Table 1. Number of segments and associated ShoreZone Units within Hood Canal and the Strait of Juan de Fuca.

Area	No. of Segments	No. of ShoreZone Units
Hood Canal	20	574
Strait of Juan de Fuca	22	362
Combined	42	936

Appendix A lists all reaches and segments used in the analysis—freshwater, natal subestuarine, and estuarine-marine—and provides other pertinent information on their grouping, naming, and description.

In presenting the baseline performance results for the eight populations, we compare the estimates of average spawning escapements derived with the EDT model to estimates of average spawning escapements reported by the Co-Managers. Such a comparison provides a simple way of judging how reasonable the results of the modeling are based solely on average abundance as derived by modeling versus actual observation. Table 2 and Figure 2 provide estimates of annual spawning escapements for the populations. It is important to recognize certain aspects of the patterns seen in the observed spawning escapements, highlighted below. How we compare modeling results to the empirical data is based on our interpretation of the observed escapement patterns.

Hood Canal populations excluding Union River: Five Hood Canal populations besides Union River were analyzed: Lilliwaup, Hamma Hamma, Duckabush, Dosewallips, and Quilcene (Big and Little combined). These populations had large escapements prior to about 1980, followed by severe drops in abundance until the mid to late 1990s or turn of the century when escapements jumped higher. We attribute this consistent pattern to the following:

- Favorable ocean conditions for marine survival until the mid 1970s, followed by a regime shift in the ocean that was unfavorable for survival until near the turn of the century when conditions switched again to favor marine survival;
- Low harvest rates prior to the mid 1970s, followed by steadily increasing rates on Hood Canal populations, sometimes exceeding 80% and averaging close to 60% in the 1980s; harvest rates fell sharply in the mid 1990s and were at very low levels again when ocean survival conditions turned favorable;
- Hatchery supplementation fish beginning to return to the Quilcene system in 1995 and several years later to the Hamma Hamma and Lilliwaup systems, roughly near or corresponding to the period of improving ocean conditions and low harvest rates; although no directed supplementation has occurred in the Dosewallips or Duckabush systems, some stray hatchery fish are suspected to have entered those streams in the late 1990s.

Union River population: This population, produced in the southern terminus of Hood Canal, exhibits a pattern of spawner abundance distinctly different than the other seven populations, except for its sudden dramatic increase in the past several years; the pattern can be further characterized as follows:

Table 2. Estimated total spawning escapements of eight populations of summer chum salmon. From Ames and others (2000), WDFW and PNPTT (2001, 2003), Adicks and others (2005), Thom Johnson (WDFW, *personal communications*).

Year	JCL	Salm-Sno	Quilicene	Dose	Duck	Hamma	Lilliwaup	Union
1968			6,694		4,693	13,548		
1969					3,871	3,104		
1970			667		2,301	1,390		
1971			1,869		3,904	4,282	318	
1972		970	2,367	1,733	13,546	5,346	716	
1973			3,345	623	5,761			
1974	438	1,330	839	3,593	3,581	2,448	616	68
1975	348	1,082	2,273	2,250	2,245	7,341	706	84
1976	365	1,129	3,533	3,271	6,095	7,648	1,612	100
1977	405	1,239	1,594	3,215	2,453	1,675	420	75
1978	778	2,293	4,794	1,901	1,898	8,215	1,331	35
1979	170	591	455	1,190	1,190	3,096	163	90
1980	1,326	3,783	529	1,216	827	329	247	208
1981	203	681	222	63	557	926	293	41
1982	599	2,152	281	507	690	801	84	153
1983	254	885	240	64	80	190	18	170
1984	367	1,212	143	212	299	170	187	194
1985	61	171	45	236	30	231	92	334
1986	292	795	27	57	177	173	97	1,892
1987	464	1,527	79	9	12	26	32	497
1988	1,052	2,638	297	661	497	440	275	629
1989	173	215	2	16	60	16	43	450
1990	63	278	6	8	42	90	2	275
1991	125	184	50	250	102	68	30	208
1992	616	475	743	655	617	123	90	140
1993	110	474	159	105	105	69	72	251
1994	15	165	742	225	263	370	105	738
1995	223	636	4,581	2,787	825	476	79	721
1996	30	1,214	9,626	6,976	2,650	774	40	494
1997	61	968	8,025	47	475	104	10	410
1998	98	1,190	3,053	336	226	95	4	223
1999	7	528	3,237	351	92	255	13	159
2000	55	901	5,898	1,260	464	229	22	744
2001	260	2,792	6,373	990	942	1,227	92	1,491
2002	42	6,049	4,487	1,627	530	2,328	858	872
2003	446	5,955	12,733	7,066	1,869	854	353	11,916
2004	1,662	6,417	38,153	11,549	8,631	2,691	1,017	5,976
1968-75	393	1,127	2,579	2,050	4,988	5,351	589	76
1980-91	415	1,210	160	275	281	288	117	421
1992-98	165	612	3,356	1,590	737	287	57	425
1999-05	412	3,774	11,814	3,807	2,088	1,264	393	3,526

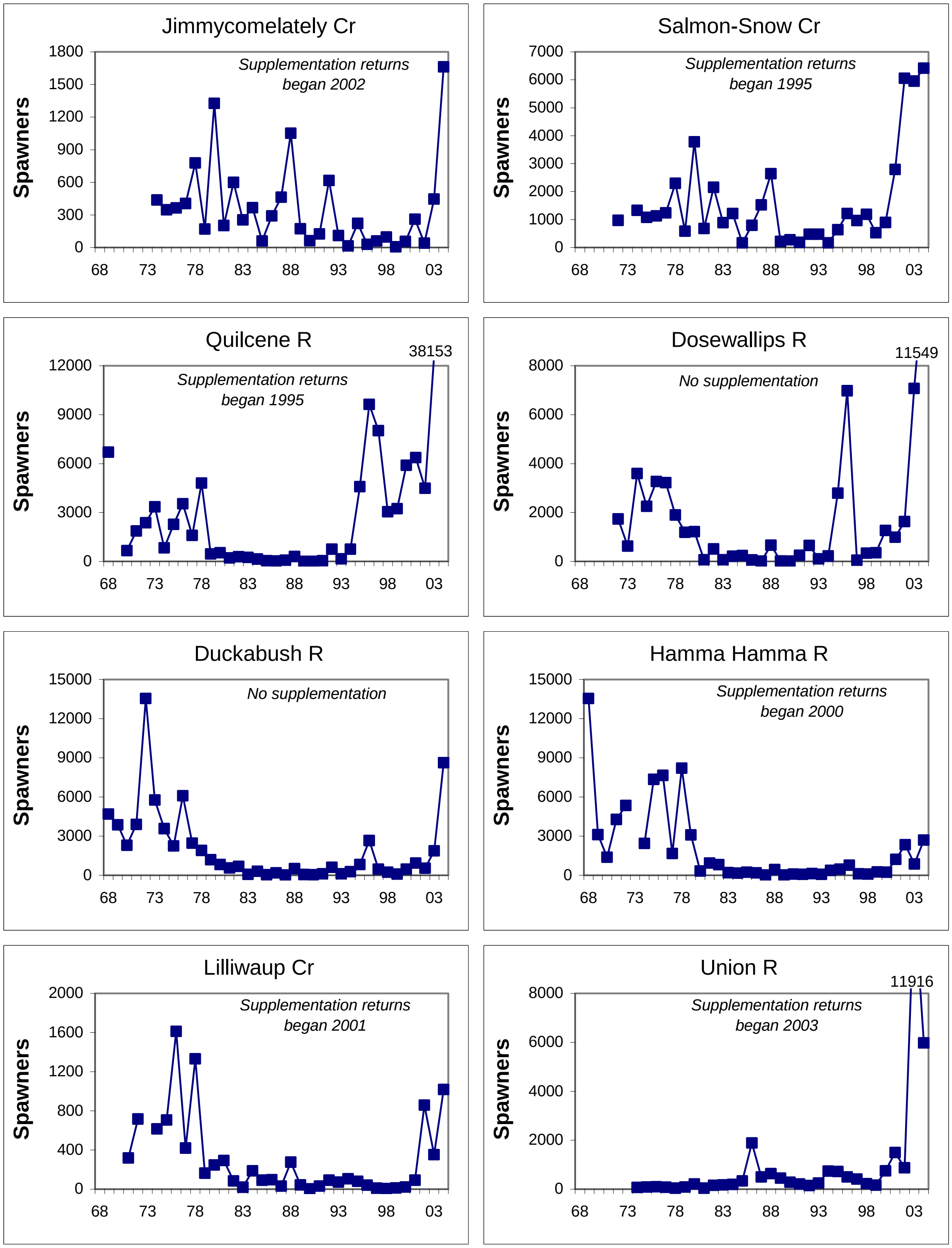

Figure 2. Estimated total spawning escapements of eight populations of summer chum salmon from Table 2. Years when returning supplementation fish began are noted.

- Low spawning escapements in the early years of the data record, at a time when escapements to the other rivers were large and when marine survival rates are believed to have been high and harvest rates on the other populations quite low;
- Spawning escapements tending to increase in the 1980s, then remaining relatively stable through the 1990s, with the notable exception of 1986 when it jumped markedly;
- Escapements beginning to increase again around the turn of the century and prior to the onset of returning hatchery fish, then jumping to record highs corresponding with the return of hatchery supplementation fish in 2003-04.

Eastern Strait of Juan de Fuca populations: The Salmon-Snow and Jimmycomelately populations exhibit generally declining trends from the start of the data record in the early 1970s until the late 1980s to the early 1990s when few fish returned, followed by dramatic increases near the turn of the century, which correspond in part with returning hatchery supplementation fish. We attribute this consistent pattern between the two populations to the following:

- The gradual declines in escapements of the two populations correspond with the period of regime shift in ocean conditions during the mid to late 1970s (favorable to unfavorable) associated with generally increasing harvest rates, reaching their highest levels in the late 1980s—the rate of decline in these populations was much more gradual compared to the abrupt collapses that occurred around 1980 for five of the six populations in Hood Canal;
- Harvest rates on these two populations were much less than the rates estimated for Hood Canal populations (average of approximately 20% compared to 60%) during the 1980s;
- The dramatic increases in escapements seen in the past several years correspond with returning hatchery supplementation fish, the regime shift in the ocean favoring marine survival, and low overall harvest rates.

Based on the foregoing, it is apparent that all of the populations except the Union have experienced dramatic responses to the ocean regime (favorable vs. unfavorable conditions), harvest levels, and supplementation. This does not mean that habitat conditions in the freshwater, subestuarine, and nearshore have no or little effect—it means that we need to consider the effect of habitat within the prevailing ocean and harvest regimes. We also need to consider natural population potential in the absence of supplementation.

The Union population presents a more difficult pattern to interpret, particularly in regards to understanding why the population was at such low levels in the early 1970s. Ames and others (2000) also could not find an adequate explanation for the low abundance during that time. We suspect that the low escapements seen in the early to mid 1970s are not representative of habitat conditions experienced by Union summer chum in the freshwater and estuarine environments during the relevant years. The population was generally increasing or stable during the years when the other Hood Canal populations crashed in the 1980s, corresponding to the period of unfavorable ocean conditions and high harvest rates. We suspect that the low escapements of the 1970s were due to some other constraint—perhaps harvest, though this is speculative.

We modeled baseline population performance (for both historic and current habitat conditions) for the two ocean survival regimes seen over the past 30 years. These are the two regimes of the Pacific Decadal Oscillation (PDO). The PDO regime favorable for marine survival of chum salmon occurred prior to approximately 1977 (affecting adult returns until about 1979 or 1980 in the data record) and again beginning in about 1997 or 1998 (affecting adult returns beginning about 2000 or 2001). The unfavorable PDO occurred during the years between those periods.[5] We also model both ocean regimes with and without the harvest regimes experienced in the 1980s—allowing us to consider the cumulative effects of habitat condition, ocean survival regime, and harvest.[6] For the sake of comparing modeling results to empirical data, we apply the observed escapements for years listed below:

Scenario	Years of observed escapement	Comment
Favorable PDO – no harvest	1968-75; 2003	Generally low harvest rates in years shown; estimates for natural production only were available in 2003.
Favorable PDO – high harvest	No applicable years	Years when both favorable PDO and high harvest occurred did not occur in data record.
Unfavorable PDO – no harvest	No applicable years	Mid 1990s could be used for comparison but supplementation began on 2 streams
Unfavorable PDO – high harvest	1980-91	Years of highest harvest rates; prior to supplementation effects.

[5] / See Lestelle and others (2005a) for a discussion on the PDO regime shift and its effect on chum marine survival. The PDO appears to undergo so called regime shifts about every 25-35 years, switching between states that are either generally favorable or unfavorable to salmon survival.

[6] / Harvest rates obtained from Ames and others (2000).

Section 3. Results and Conclusions

Results are presented in two sections. Section 3.1 provides a summary of baseline population performance obtained by modeling. Section 3.2 gives strategic priorities for each population.

All results presented here are contained in a set of report viewers (Excel applications) that accompany this report. The diagnostic report viewers contain more detailed information than presented here and should be used to obtain the complete results. The material given here is a summary of those results. A complete list of the report viewer files and their contents is given below for easy reference:

Viewer file name	Contents
Five Rivers-Good PDO-Report 1 Viewer.xls	Baseline performance for five rivers with favorable PDO
Five Rivers-Poor PDO-Report 1 Viewer.xls	Baseline performance for five rivers with unfavorable PDO
Three Creeks-Good PDO-Report 1 Viewer.xls	Baseline performance for three creeks with favorable PDO
Three Creeks-Poor PDO-Report 1 Viewer.xls	Baseline performance for three creeks with unfavorable PDO
Union Sum Chum Report 2 Viewer - broad scale.xls	Union population diagnostics – broad scale only
Union Sum Chum Report 2 Viewer - detailed scale.xls	Union population diagnostics – detailed scale
Lilliwaup Sum Chum Report 2 Viewer - broad scale.xls	Lilliwaup population diagnostics – broad scale only
Lilliwaup Sum Chum Report 2 Viewer - detailed scale.xls	Lilliwaup population diagnostics – detailed scale
Hamma Sum Chum Report 2 Viewer - broad scale.xls	Hamma Hamma population diagnostics – broad scale only
Hamma Sum Chum Report 2 Viewer - detailed scale.xls	Hamma Hamma population diagnostics – detailed scale
Duck Sum Chum Report 2 Viewer - broad scale.xls	Duckabush population diagnostics – broad scale only
Duck Sum Chum Report 2 Viewer - detailed scale.xls	Duckabush population diagnostics – detailed scale
Dose Sum Chum Report 2 Viewer - broad scale.xls	Dosewallips population diagnostics – broad scale only
Dose Sum Chum Report 2 Viewer - detailed scale.xls	Dosewallips population diagnostics – detailed scale
Quilcene Sum Chum Report 2 Viewer - broad scale.xls	Quilcene population diagnostics – broad scale only
Quilcene Sum Chum Report 2 Viewer - detailed scale.xls	Quilcene population diagnostics – detailed scale
Salmon-Snow Sum Chum Report 2 Viewer - broad scale.xls	Salmon-Snow population diagnostics – broad scale only
Salmon-Snow Sum Chum Report 2 Viewer - detailed scale.xls	Salmon-Snow population diagnostics – detailed scale
Jimmy Sum Chum Report 2 Viewer - broad scale.xls	JImmycomelately population diagnostics – broad scale only
Jimmy Sum Chum Report 2 Viewer - detailed scale.xls	JImmycomelately population diagnostics – detailed scale
Marine-Estuarine Attribute Diagnostic Report Viewer v1.xls	Detailed diagnosis of estuarine attributes

3.1 Baseline Performance

We present the summary of baseline population performance results in two sections below. Section 3.1.1 compares modeling results to independent estimates of spawning escapement for each population based on spawner surveys. This is a type of check for the reader to see how well modeling results match average escapements seen under different ocean survival and harvest regimes. Section 3.1.2 provides population performance measures estimated using the EDT model for different scenarios. The performance measures are productivity, capacity, average abundance, and life history diversity.

All results are shown as generated by the EDT model. Regarding precision of the results, a good rule of thumb is to consider the parameter values given as being within one significant digit. For example, an average abundance value of 5,822 might reasonably be interpreted as being "five to six thousand."

3.1.1 Comparisons to Empirical Data

Figure 3 compares average spawning escapements estimated using the model to estimates based on empirical data for all eight populations under favorable and unfavorable ocean conditions—with and without harvest (based on 1980s levels). For ocean conditions favorable to marine survival, we compare the modeling estimates to the period 1968-75, when fishing rates were generally very low, and to 2003, a year when estimates of escapement for just naturally produced fish was available. The year 2003 was also a year of low harvest rates. For ocean conditions unfavorable to marine survival, we compare the modeling estimates to years when harvest rates were high, i.e., the period 1980-91.

Conclusions:

- Overall, we conclude that modeling estimates of average spawner abundances under steady state conditions for the two scenarios shown in Figure 3 are reasonable approximations of what has been observed for the eight populations. We conclude on this basis that the characterizations of the affected environments and the rules and modeling procedures being employed are reasonable for purposes of diagnostic analysis. Population specific conclusions are listed below.
- Union River: Modeling estimates overestimate abundance compared to the periods 1968-75 and 1980-91 but, as noted earlier in this document, we think it is likely that the Union River population was being constrained by some as yet unidentified factor(s) during those periods. We regard the recent strong returns, even discounting for supplementation, as evidence that habitat conditions are capable of producing larger abundances than seen in the early part of the data record.

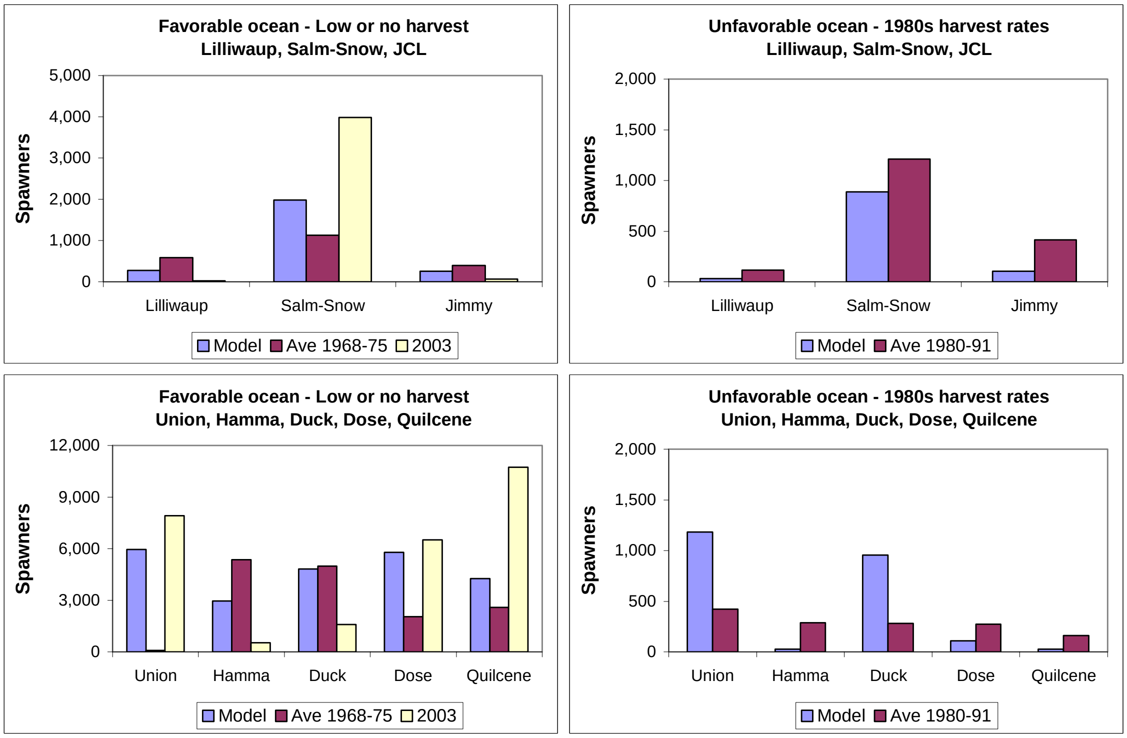

Figure 3. Comparison of modeled estimates of average spawning escapements to estimates reported by Co-Managers for eight summer chum populations. Results representative of ocean conditions favorable to marine survival are compared to unfavorable ocean conditions. Numbers represent escapements of natural fish only - see text.

- Lilliwaup Creek: Modeling estimates correspond well with empirical escapements except as seen in some recent years, e.g., 2003. We believe it is likely that this recent disparity reflects a population that is recovering from extremely low escapements in the recent past.
- Hamma Hamma River: The pattern of comparisons for this river is similar to that seen for Lilliwaup summer chum (adjacent stream)—overall we find the results to correspond well with empirical observations.
- Duckabush River: Modeling estimates correspond well with empirical escapements for favorable ocean conditions as seen for the period 1968-75. The low escapement of 2003 suggests that recovery is still underway under improved ocean conditions from the very low escapements of the 1990s. The modeling results overestimated abundance under unfavorable ocean conditions combined with high harvest rates and may reflect conservative estimates of harvest rates applied in modeling. The modeling results indicate that habitat has generally been characterized to be in better condition in the Duckabush than in the adjacent Dosewallips and Hamma Hamma. However, the similar

pattern of observed escapements in recent years for the three streams may suggest that they are essentially the same in habitat characteristics.[7]

- Dosewallips River: Modeling estimates correspond reasonably well with empirical escapements particularly in light of the recent improvement in natural origin fish returning to the river, e.g., year 2003.
- Quilcene rivers (Big and Little): Modeling estimates correspond well with empirical escapements, although recent returns (e.g., 2003) are far greater than predicted by the model. We think that the recent extremely strong returns is evidence of production being added by on-going supplementation.
- Salmon-Snow creeks: Modeling estimates correspond well with empirical escapements, although recent returns (e.g., 2003) are far greater than predicted by the model. We think that the recent extremely strong returns is evidence of production being added by on-going supplementation
- Jimmycomelately Creek: Modeling estimates correspond well with empirical observations for favorable ocean conditions as seen for the period 1968-75. The low escapement of 2003 suggests that recovery is lagging under improved ocean conditions from the very low escapements of the 1990s. The modeling results underestimated abundance under unfavorable ocean conditions combined with high harvest rates.

3.1.2 Baseline Summaries

Population performance measures are given for each population under unfavorable and favorable ocean survival conditions for the five rivers and three creeks in Figures 4-7. The measures represent life cycle population performance expected under steady state conditions and measured at the point of spawning. Productivities approaching a value of 1 (i. e., 1 spawning adult per parent spawner) would indicate a population that is either functionally extinct or on the verge of extinction. Productivities in the neighborhood of a value of 2 indicate a population that is in serious danger of extinct of extinction.

[7] / The mid Hood Canal technical team recently revisited the characterization of the freshwater parts of the Hamma Hamma, Duckabush, and Dosewallips rivers. A similar review should be carried out of the three corresponding subestuaries.

Unfavorable PDO - Union, Hamma, Duck, Dose, Quilcene

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Union Su Chum	T	100%	14.9	6,240	5,822
	P with Harvest	87%	2.8	1,824	1,182
	P without Harvest	100%	9.2	4,666	4,161
Hamma Hamma Su Chum	T	83%	13.5	5,288	4,895
	P with Harvest	28%	1.0	1,514	30
	P without Harvest	41%	2.4	2,950	1,716
Duckabush Su Chum	T	69%	13.3	7,097	6,563
	P with Harvest	33%	2.0	1,960	955
	P without Harvest	49%	4.4	3,991	3,078
Dosewallips Su Chum	T	100%	14.0	10,340	9,602
	P with Harvest	40%	1.0	2,840	109
	P without Harvest	59%	2.4	5,565	3,284
Quilcene Su Chum	T	90%	11.7	8,760	8,011
	P with Harvest	32%	1.0	2,687	27
	P without Harvest	73%	2.3	4,684	2,612

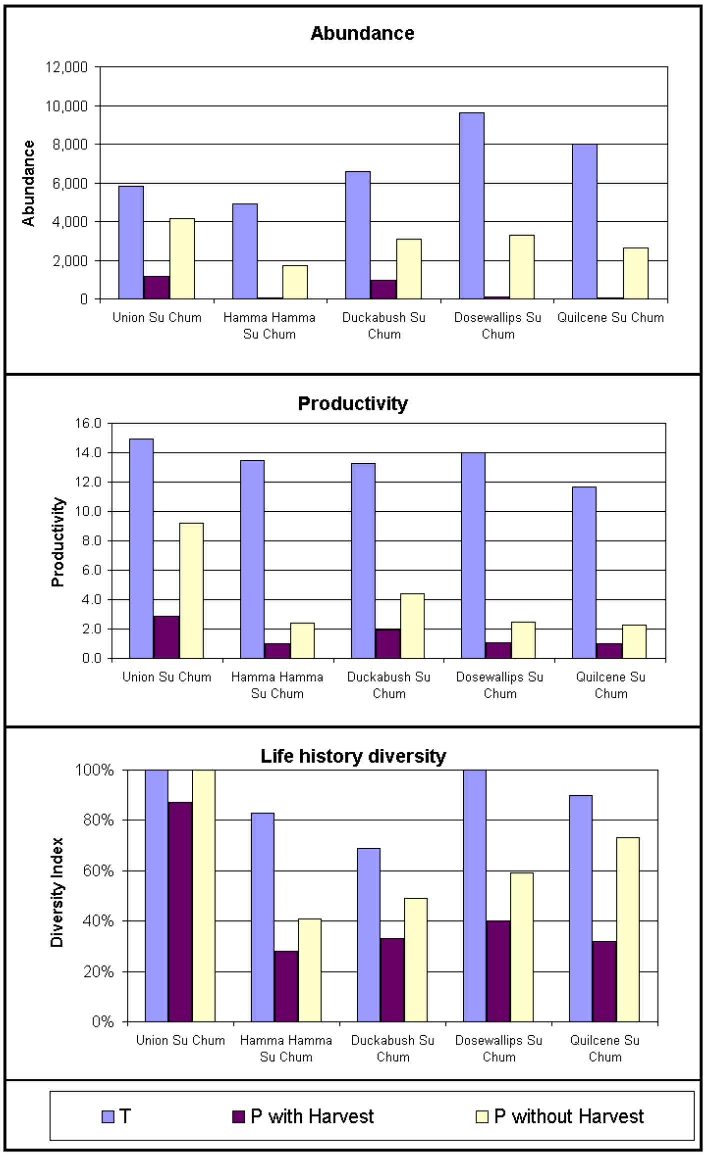

Figure 4. Summary of EDT population performance measures for five river populations of summer chum under ocean conditions <u>unfavorable</u> to marine survival.

Favorable PDO - Union, Hamma, Duck, Dose, Quilcene

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Union Su Chum	T	100%	23.6	8,458	8,098
	P with Harvest	98%	4.5	2,718	2,117
	P without Harvest	100%	14.6	6,401	5,962
Hamma Hamma Su Chum	T	86%	21.3	7,225	6,885
	P with Harvest	37%	1.6	2,183	819
	P without Harvest	46%	3.8	4,028	2,956
Duckabush Su Chum	T	75%	20.5	9,790	9,312
	P with Harvest	39%	3.1	2,921	1,969
	P without Harvest	57%	6.8	5,659	4,828
Dosewallips Su Chum	T	100%	22.3	14,171	13,535
	P with Harvest	52%	1.7	4,200	1,715
	P without Harvest	63%	4.0	7,747	5,795
Quilcene Su Chum	T	92%	18.1	11,012	10,402
	P with Harvest	59%	1.6	3,681	1,322
	P without Harvest	85%	3.5	5,988	4,267

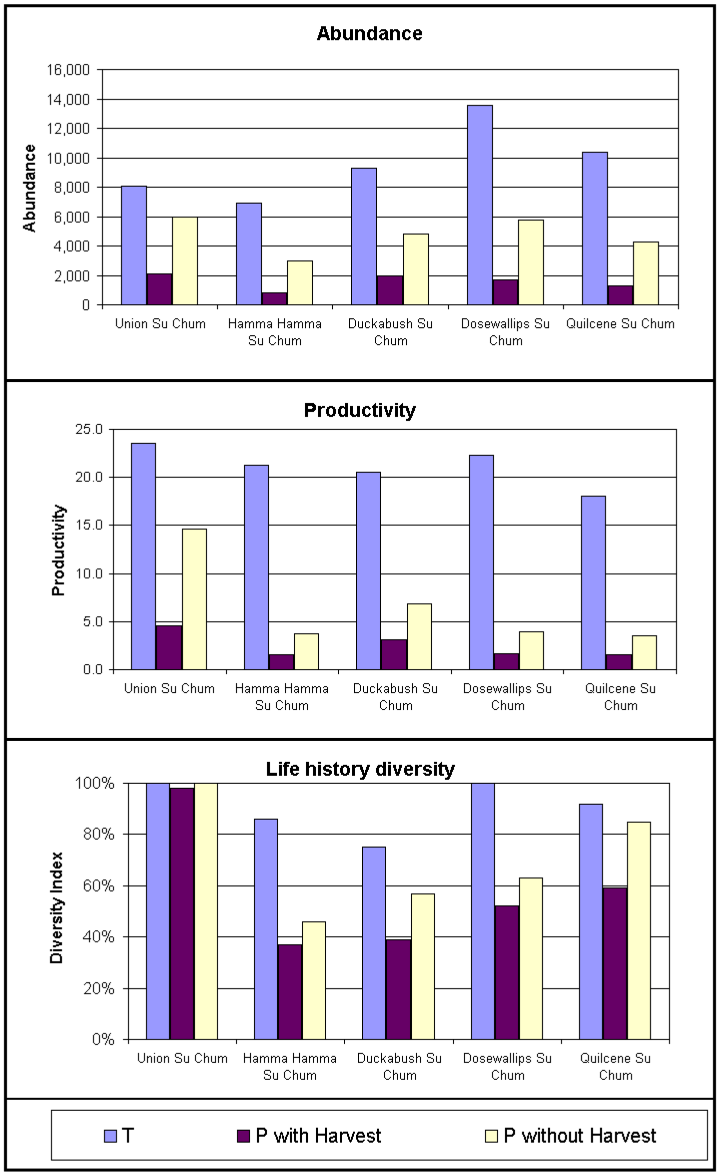

Figure 5. Summary of EDT population performance measures for five river populations of summer chum under ocean conditions favorable to marine survival.

Unfavorable PDO - Lilliwaup, Snow-Salmon, Jimmycomelately

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Lilliwaup Su Chum	T	100%	14.3	402	374
	P with Harvest	40%	1.3	166	33
	P without Harvest	89%	2.8	286	184
Snow-Salmon Su Chum	T	100%	14.2	3,703	3,442
	P with Harvest	39%	2.0	1,782	887
	P without Harvest	46%	2.4	2,026	1,182
Jimmy Su Chum	T	100%	14.3	702	653
	P with Harvest	63%	1.6	272	105
	P without Harvest	74%	2.0	299	149

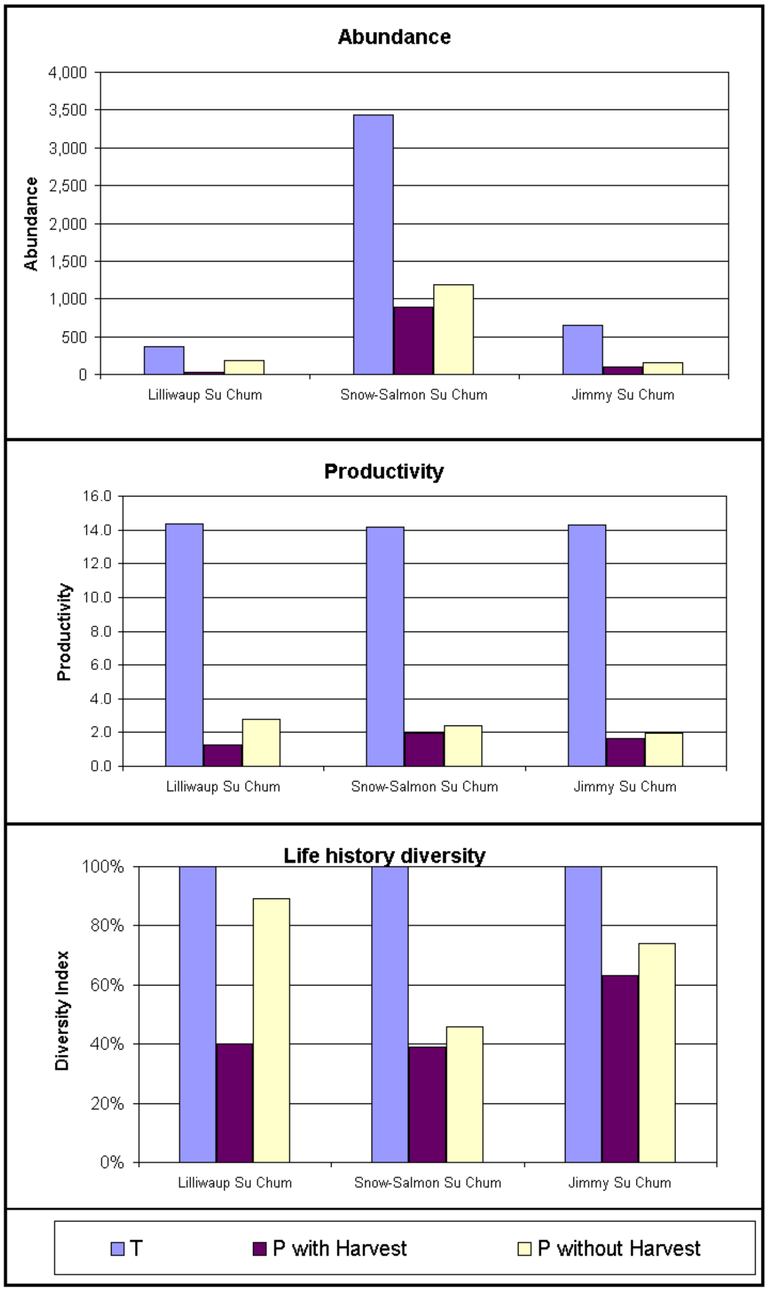

Figure 6. Summary of EDT population performance measures for three creek populations of summer chum under ocean conditions unfavorable to marine survival.

Favorable PDO - Lilliwaup, Snow-Salmon, Jimmycomelately

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Lilliwaup Su Chum	T	100%	21.5	497	474
	P with Harvest	78%	1.9	222	104
	P without Harvest	96%	4.2	357	273
Snow-Salmon Su Chum	T	100%	23.3	4,700	4,499
	P with Harvest	56%	3.2	2,414	1,652
	P without Harvest	67%	3.8	2,688	1,986
Jimmy Su Chum	T	100%	24.3	854	819
	P with Harvest	85%	2.8	346	220
	P without Harvest	89%	3.4	373	262

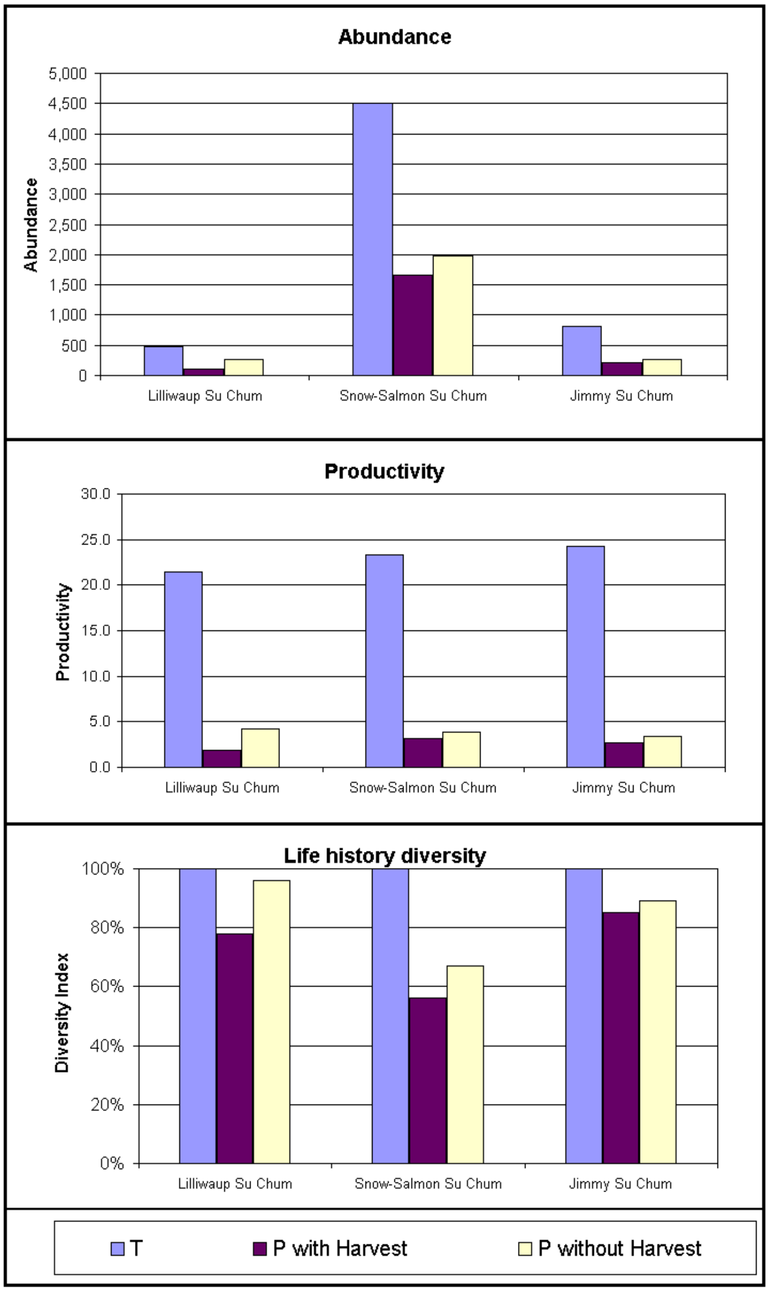

Figure 7. Summary of EDT population performance measures for three creek populations of summer chum under ocean conditions favorable to marine survival.

Conclusions:

- Under both unfavorable and favorable ocean conditions and in the absence of fisheries, all populations show a high loss in performance from historic levels, most dramatically in productivity. These losses are the result of the combined habitat alterations that have occurred in freshwater and estuarine-marine waters.
- Under unfavorable ocean survival conditions with harvest rates as they existed in the 1980s, all of the populations with the exception of Union River would appear to have gone extinct or would be in serious trouble if these conditions persisted for an extended period of years. This conclusion is not surprising given that most of these modeled populations were on the verge of extinction in the 1980s and early 1990s.
- Under unfavorable ocean survival conditions with no harvest, most populations would appear to be relatively safe from extinction, though several would be problematic, particularly Quilcene and Jimmycomelately. However, those populations with productivities in between 2 and 3 would be especially susceptible to extreme environmental variation, when it occurs. In general, losses in performance for all populations exceed 60% (most notably for productivity) and are due to habitat alterations.
- Under favorable ocean survival conditions with harvest rates as they existed in the 1980s, several populations would appear to be at high risk of extinction, namely, Hamma Hamma, Dosewallips, Quilcene, and Lilliwaup.
- Under favorable ocean survival conditions with no harvest, all populations appear to be safe from extinction. In general, average spawner abundance numbers under existing habitat conditions are approximately half of those estimated to have been present historically under favorable ocean conditions. This means that habitat alterations associated with shoreline and watershed development are responsible for roughly a 50% reduction in spawner abundances, more or less depending on the population. However, the loss in productivity is much greater than 50% associated with habitat alterations.

3.2 Strategic Priorities

We summarize here the results of analysis to assess strategic priorities of restoration and protection of different geographic areas for each of the eight populations. The priorities shown are based entirely on expected benefits to the various populations accruing due either to restoration or protection. For each population, we present a series of graphics. The first graphic provides the stock-recruitment curve for the population as derived by modeling—both for unfavorable and favorable PDO conditions. The graphics are particularly helpful to illustrate the magnitude of change in population performance associated with habitat alterations.

This is followed by two charts (both on one page), called “tornado charts”, that show priorities for geographic areas for both restoration and protection (i.e., protection from further degradation) for a population. The two charts show results at two different scales. At the top of the page is a chart showing broad scale priorities, where we compare four major categories of the environment: (1) the freshwater natal stream; (2) the natal subestuary; (3) Puget Sound estuarine-marine beyond the natal subestuary; and (4) the ocean. This chart allows the reader to quickly compare the relative magnitude of the effects of these different environments to the population. At the bottom of the page is a chart showing fine scale priorities, where we compare the various segments of the estuarine-marine environment, including both shoreline areas and deepwater areas, to the natal subestuary and to reach aggregates in freshwater. This chart allows the reader to assess where within the various landscapes are the greatest effects on the populations occurring.

The tornado charts show priorities within broad categories of benefit, listed as A through E, where A segments are those with the greatest amount of benefit and D and E provide essentially no benefit of restoration. It is essential to note that the analysis does not provide an assessment of protection benefits within estuarine-marine waters, i.e., those waters beyond the natal subestuary.[8] The charts also provide an expectation of the amount of benefit in the population performance measures shown as the percentage of increase or decrease in a particular measure. This allows the reader to compare the potential benefits associated with each segment.

The tornado charts are followed by a one-page chart that gives a summary of diagnostics for the various survival factors (associated with attributes) within each segment for a population. The chart is a summary of the diagnosis with respect to where and what factors are most responsible for the loss in population performance. The chart is meant only to be a snapshot of the issues that have contributed most to the loss. More detailed diagnostics are given in the various Report 2 Viewers described earlier. For each population, we provide a brief set of written conclusions. All conclusions are based on our interpretation of modeling results.

3.2.1 Union River Summer Chum

Figures 8-10 provide results for Union River summer chum. The Union population shows the least loss in performance of the eight populations. In general, it appears that the Union River mainstem is reasonably intact for spawning chum salmon. The population also has the benefit of extensive wetlands and mudflat at the mouth of the river. Although these areas have undergone changes from historic condition, they appear to still provide relatively good nursery conditions for chum fry.

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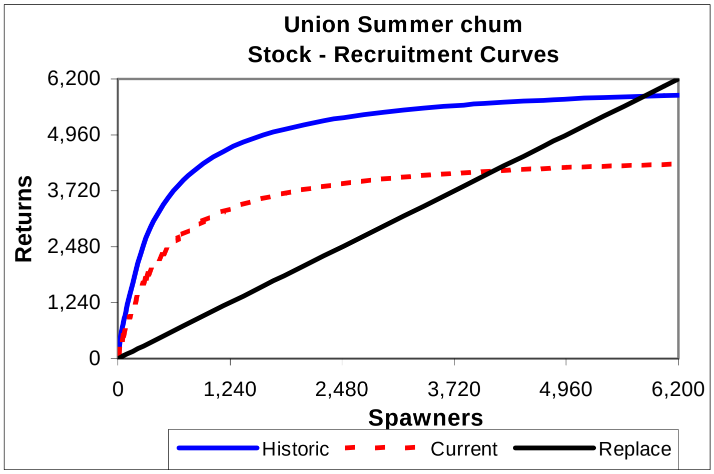
[8] / To assess protection benefits the analysis looks at loss in population performance if a segment is degraded to what we apply as a degradation reference condition. This condition has not yet been profiled for estuarine-marine waters beyond the natal subestuary.

Union Su Chum
Unfavorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	6,240	4,666
Productivity	14.9	9.2



Union Su Chum
Favorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	8,458	6,401
Productivity	23.6	14.6

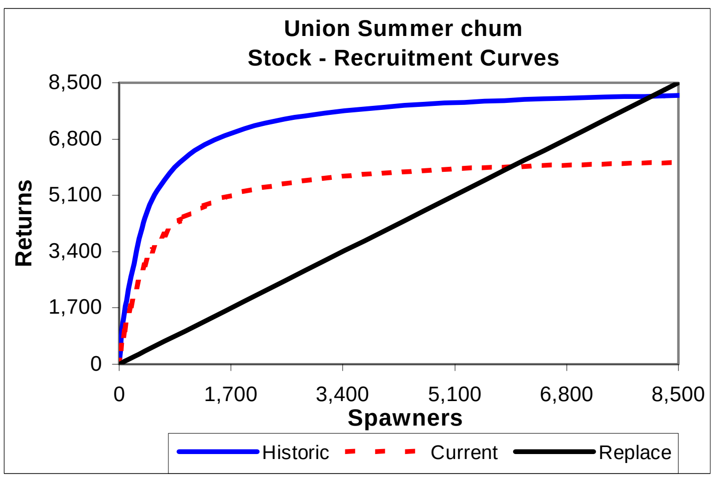
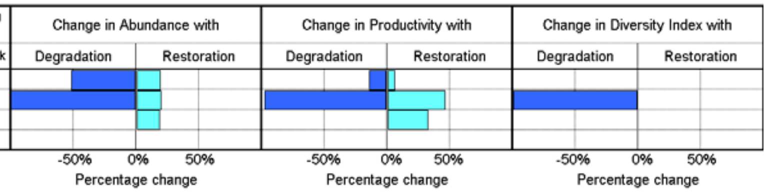


Figure 8. Union River summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Union Summer chum
Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Union subestuary	B	2	B	2
Union FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Union Summer chum
Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Union subestuary	B	3	A	2
Union lower FW	A	2	A	3
Union mid FW	A	1	A	1
Courtney FW	C	4	B	7
Union south shore	E	5	C	15
Belfair shallow	E	5	E	34
Union north shore	E	5	D	25
Skok west shore	E	5	B	4
South HC deep	E	5	E	36
Skok east shore	E	5	C	14
Dewatto west shore	E	5	D	27
Dewatto east shore	E	5	D	32
Hamma west shore	E	5	D	19
Hamma east shore	E	5	D	24
Duck west shore	E	5	D	18
Duck east shore	E	5	D	21
Dose west shore	E	5	C	10
Dabob deep	E	5	E	36
Dose east shore	E	5	D	30
Dabob Bay shore	E	5	D	17
North HC deep	E	5	D	22
Big Beef west shore	E	5	D	25
Big Beef east shore	E	5	D	19
Thorn west shore	E	5	D	29
Thorn east shore	E	5	C	15
Shine west shore	E	5	C	11
Shine east shore	E	5	C	8
Oak Bay shore	E	5	B	4
Admiralty Inlet deep	E	5	C	13
Pt Towns shore	E	5	C	8
Marrow west shore	E	5	E	35
Protection shore	E	5	E	36
East SJDF deep	E	5	B	6
Discovery Bay shore	E	5	D	32
Sequim Bay shore	E	5	D	31
Dungeness shore	E	5	D	23
East SJDF shore	E	5	D	28
West SJDF deep	E	5	C	12
Ocean	E	5	E	36

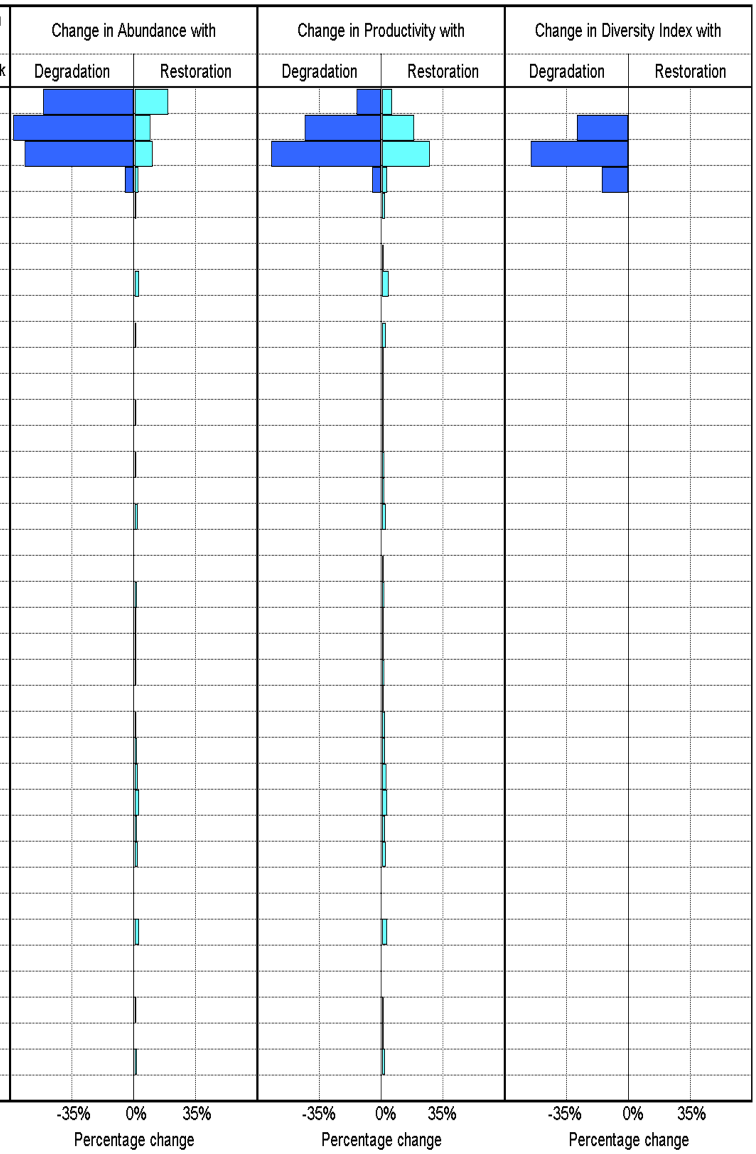


Figure 9. Union River summer chum strategic priorities - broad and detailed scale.

Union Summer chum
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	**Protection benefit**	**Restoration benefit**	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Union subestuary	○	◯					•	•	•						•			⬤
Union lower FW	◯	◯	•				•	•	●	•					●			•
Union mid FW	◯	◯	•				•	•	•	•					●			•
Courtney FW	∘	○	•				•	•	●	•					●			●
Union south shore		∘						●	•									
Belfair shallow								•										
Union north shore								●	•									
Skok west shore		○						⬤	•									
South HC deep																		
Skok east shore		∘						●	•									
Dewatto west shore								●	•									
Dewatto east shore								•	•									
Hamma west shore								●	•									
Hamma east shore								●	•									
Duck west shore								●	•									
Duck east shore								●	•									
Dose west shore		∘						●	•									
Dabob deep																		
Dose east shore								•	•									
Dabob Bay shore								●	•									
North HC deep																		
Big Beef west shore								•	•									
Big Beef east shore								●	•									
Thorn west shore								•	•									
Thorn east shore		∘						⬤	•									
Shine west shore		∘						●	•									
Shine east shore		∘						●	•									
Oak Bay shore		○						●	•									
Admiralty Inlet deep		∘			•			•										
Pt Towns shore		∘						●	•									
Marrow west shore								•										
Protection shore								•	•									
East SJDF deep		○			•			•										
Discovery Bay shore								●	•									
Sequim Bay shore								●	•									
Dungeness shore								●	•									
East SJDF shore								●	•									
West SJDF deep		∘			•													
Ocean																		

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯ / ⬤	High	○ / ●	Medium	∘ / •	Low	(blank)	Indirect or General

Figure 10. Union River summer chum strategic priorities by segment and survival factor.

Conclusions:

- The Union population appears have relatively high productivity under both unfavorable and favorable ocean survival conditions (Figure 8) and shows the least loss in performance of the eight populations.
- The amount of potential increase in population abundance is approximately equal between the Union River (freshwater), the natal subestuary, and the estuarine-marine waters beyond if each area was able to be fully restored (Figure 9 top). Potential gain in productivity is highest for freshwater, followed by estuarine-marine waters.
- Protection of freshwater reaches shows the highest priority, followed closely by the natal subestuary (Figure 9).
- Potential benefits of restoring estuarine-marine areas are diffused over many segments but the Skokomish west shore is ranked highest among these areas, tied with the Oak Bay segment (Figure 9 bottom). The reason for the high value of the Skokomish west shore is due to its amount of change that has occurred in conjunction with its proximity to the Union River. The reason for the high value of the Oak Bay segment is less clear. We believe this to be partly the result of how we expect migration to proceed as fish from both shores of Hood Canal to be concentrated on the west side of Admiralty inlet as they move to the Strait. The importance of the Oak Bay area is also partly due to the increasing amount of competition with hatchery fish as summer chum move through Admiralty Inlet (picking up fish from other areas in Puget Sound)(Figure 10).
- Within freshwater, sediment load and habitat diversity are seen as the most important factors to restore (Figure 10).
- Within the natal subestuary, several factors appear to be equally important for restoration, along with the amount of area available to be used for rearing (Figure 10).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 10), associated with loss of eelgrass, revetments, and loss of riparian corridors.

3.2.2 Lilliwaup Creek Summer Chum

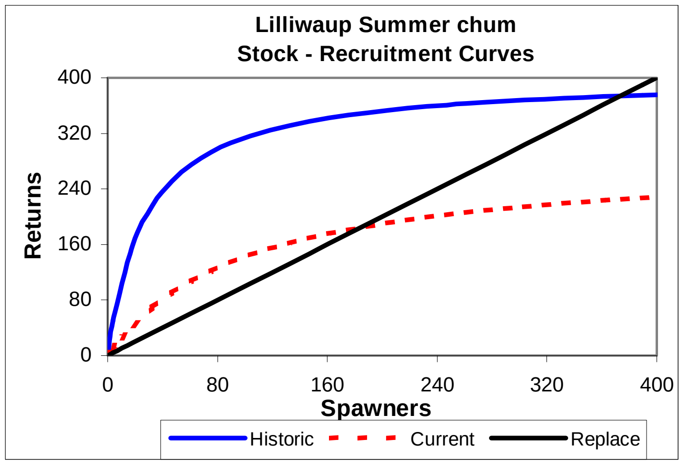
Figures 11-13 provide results for Lilliwaup Creek summer chum. The Lilliwaup population shows a dramatic loss in performance, particularly in productivity. Under sustained, unfavorable ocean conditions, the population would be severely depressed.

Conclusions:

- The Lilliwaup population shows a high loss in performance compared to historic levels both in abundance and productivity, particularly under unfavorable ocean survival conditions (Figure 11).

Lilliwaup Su Chum
Unfavorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	402	286
Productivity	14.3	2.8



Lilliwaup Su Chum
Favorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	497	357
Productivity	21.5	4.2

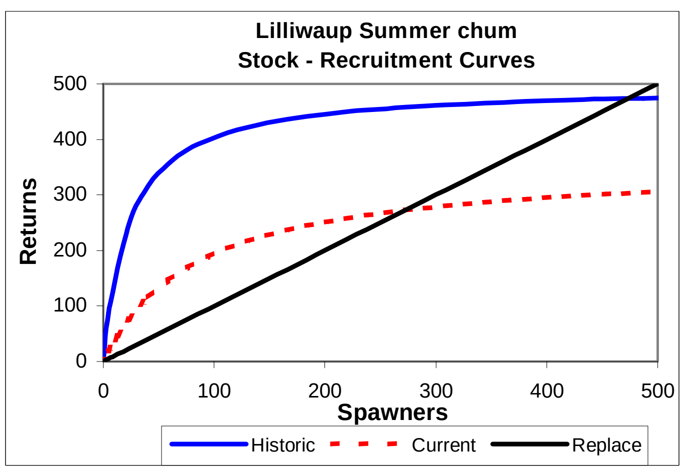
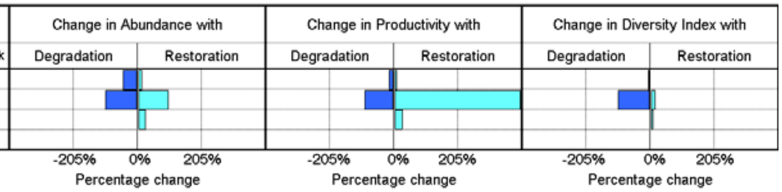


Figure 11. Lilliwaup Creek summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Lilliwaup Summer chum
Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Lilliwaup subestuary	B	2	C	3
Lilliwaup FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Lilliwaup Summer chum
Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Lilliwaup subestuary	B	2	B	2
Lilliwaup FW	A	1	A	1
Union south shore	E	3	D	26
Belfair shallow	E	3	E	29
Skok west shore	E	3	D	26
South HC deep	E	3	E	29
Skok east shore	E	3	D	26
Dewatto west shore	E	3	C	13
Dewatto east shore	E	3	E	29
Hamma west shore	E	3	C	16
Hamma east shore	E	3	C	19
Duck west shore	E	3	C	14
Duck east shore	E	3	C	19
Dose west shore	E	3	C	8
Dabob deep	E	3	E	29
Dose east shore	E	3	D	25
Dabob Bay shore	E	3	C	4
North HC deep	E	3	C	10
Big Beef west shore	E	3	D	23
Big Beef east shore	E	3	C	18
Thorn west shore	E	3	D	21
Thorn east shore	E	3	C	12
Shine west shore	E	3	C	10
Shine east shore	E	3	C	3
Oak Bay shore	E	3	C	6
Admiralty Inlet deep	E	3	C	7
Pt Towns shore	E	3	C	8
Marrow west shore	E	3	E	29
Marrow east shore	E	3	E	29
Protection shore	E	3	D	23
East SJDF deep	E	3	C	4
Discovery Bay shore	E	3	E	29
Sequim Bay shore	E	3	E	29
Dungeness shore	E	3	C	16
East SJDF shore	E	3	D	22
West SJDF deep	E	3	C	14
Ocean	E	3	E	29

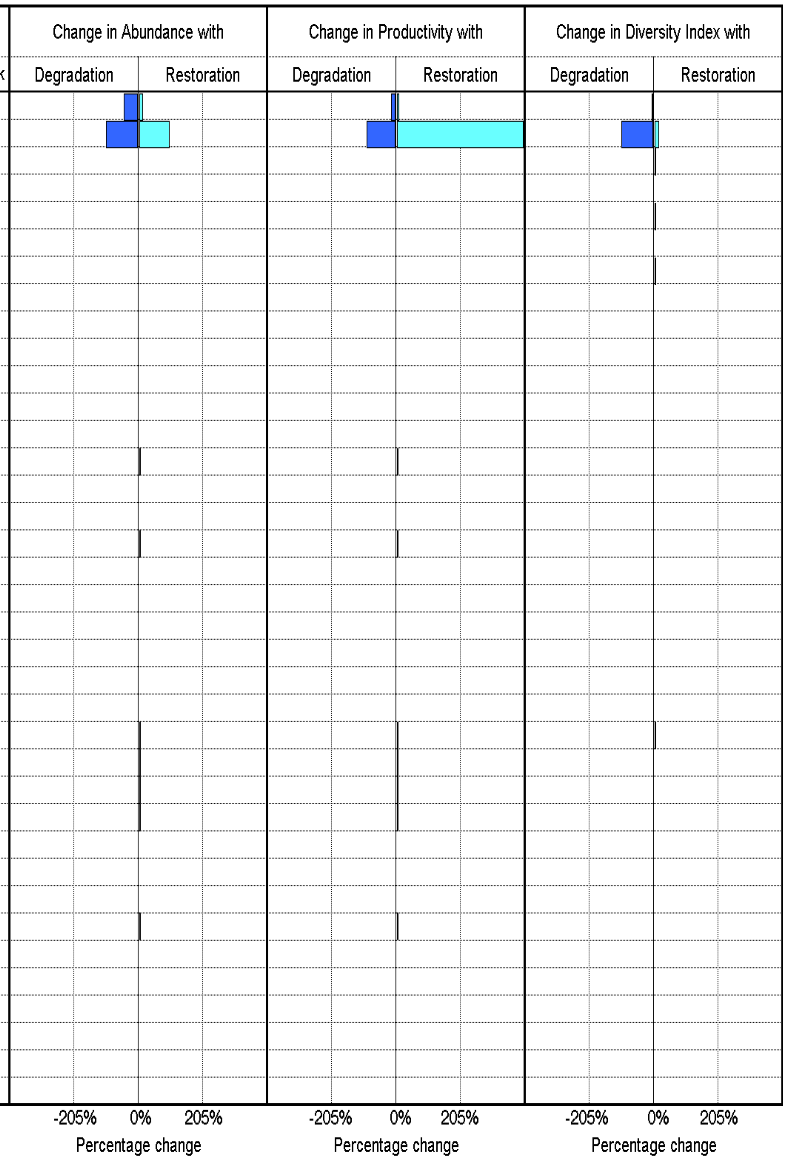


Figure 12. Lilliwaup Creek summer chum strategic priorities - broad and detailed scale.

Lilliwaup Summer chum
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Lilliwaup subestuary	○	○					•	•	•									●
Lilliwaup FW	◯	◯	•				●	•	⬤	•					●			•
Union south shore								●	•									
Belfair shallow								•										
Skok west shore								●	•									
South HC deep																		
Skok east shore								●	•									
Dewatto west shore		∘						●	•									
Dewatto east shore								•	•									
Hamma west shore		∘						●	•									
Hamma east shore		∘						●	•									
Duck west shore		∘						●	•									
Duck east shore		∘						●	•									
Dose west shore		∘						●	•									
Dabob deep																		
Dose east shore								•	•									
Dabob Bay shore		∘						●	•									
North HC deep		∘			•			•										
Big Beef west shore								•	•									
Big Beef east shore		∘						●	•									
Thorn west shore					•			•	•									
Thorn east shore		∘						●	•									
Shine west shore		∘			•			●	•									
Shine east shore		∘			•			●	•									
Oak Bay shore		∘			•			●	•									
Admiralty Inlet deep		∘			•			•										
Pt Towns shore		∘			•			●	•									
Marrow west shore					•			•										
Marrow east shore					•			•										
Protection shore					•			•	•									
East SJDF deep		∘			•			•										
Discovery Bay shore					•			•	•									
Sequim Bay shore					•			●	•									
Dungeness shore		∘			•			●	•									
East SJDF shore					•			●	•									
West SJDF deep		∘																
Ocean																		

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯ / ⬤	High	○ / ●	Medium	∘ / •	Low	(blank)	Indirect or General

Figure 13. Lilliwaup Creek summer chum strategic priorities by segment and survival factor.

- The amount of potential increase in population abundance is greatest through restoration of freshwater reaches (Figure 12); full restoration of estuarine-marine waters beyond the natal subestuary offers the next highest level of benefit, though much less than would be provided in freshwater (Figure 12 top).
- Protection of freshwater reaches shows the highest priority (Figure 12).
- Potential benefits of restoring estuarine-marine areas are diffused over many segments (Figure 12 bottom).
- Within freshwater, habitat diversity and sediment load are seen as the most important factors to restore (Figure 13).
- Within the natal subestuary, several factors appear to be equally important for restoration, along with the amount of area available to be used for rearing (Figure 13).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 13), associated with loss of eelgrass, revetments, and loss of riparian corridors.

3.2.3 Hamma Hamma River Summer Chum

Figures 14-16 provide results for Hamma Hamma River summer chum. The Hamma Hamma population shows a dramatic loss in performance, particularly in productivity. Under sustained, unfavorable ocean conditions, the population would be severely depressed and approaching a high-risk condition.

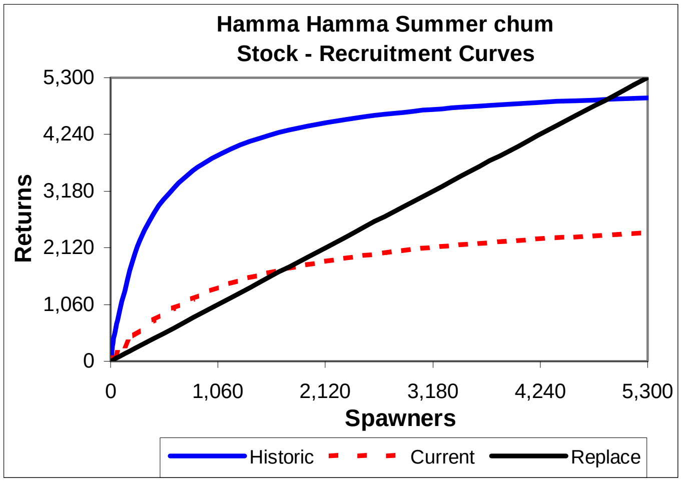
<u>Conclusions:</u>

- The Hamma Hamma population shows a high loss in performance compared to historic levels both in abundance and productivity, particularly under unfavorable ocean survival conditions (Figure 14).
- The amount of potential increase in population abundance is greatest through restoration of freshwater reaches (Figure 15); full restoration of estuarine-marine waters and the natal subestuary appear to offer similar levels of benefit (Figure 15 top).
- Protection of freshwater reaches shows the highest priority (Figure 15).
- Potential benefits of restoring estuarine-marine areas are diffused over many segments (Figure 15 bottom).
- Within freshwater, habitat diversity, channel stability, and sediment load are seen as the most important factors to restore (Figure 16) (see detailed diagnostics in the Report 2 Viewer).
- Within the natal subestuary, several factors appear to be equally important for restoration, along with the amount of area available to be used for rearing (Figure 16).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 16), associated with loss of eelgrass, revetments, and loss of riparian corridors.

Hamma Hamma Su Chum
Unfavorable PDO conditions

(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	5,288	2,950
Productivity	13.5	2.4



Hamma Hamma Su Chum
Favorable PDO conditions

(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	7,225	4,028
Productivity	21.3	3.8

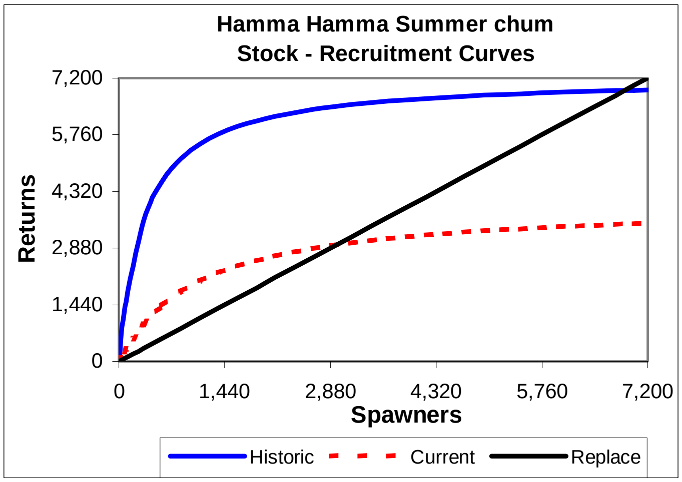
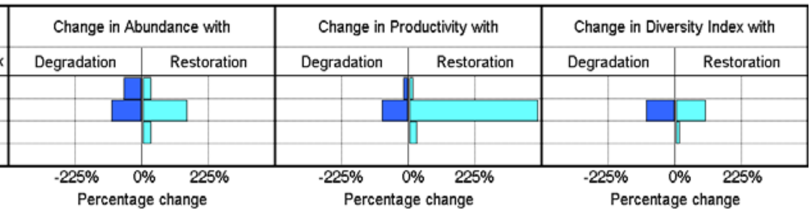


Figure 14. Hamma Hamma River summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Hamma Hamma Summer chum
Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Hamma subestuary	B	2	C	3
Hamma FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Hamma Hamma Summer chum
Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Hamma subestuary	B	2	B	8
Hamma main FW	A	1	A	1
John Cr FW	C	3	A	2
Union south shore	E	4	D	29
Belfair shallow	E	4	E	33
Skok west shore	E	4	D	22
South HC deep	E	4	E	36
Skok east shore	E	4	D	27
Dewatto west shore	E	4	D	31
Dewatto east shore	E	4	E	33
Hamma west shore	E	4	B	8
Hamma east shore	E	4	E	32
Duck west shore	E	4	C	14
Duck east shore	E	4	C	17
Dose west shore	E	4	C	10
Dabob deep	E	4	E	36
Dose east shore	E	4	D	28
Dabob Bay shore	E	4	B	5
North HC deep	E	4	C	18
Big Beef west shore	E	4	D	23
Big Beef east shore	E	4	C	15
Thorn west shore	E	4	D	20
Thorn east shore	E	4	C	11
Shine west shore	E	4	C	12
Shine east shore	E	4	B	5
Oak Bay shore	E	4	B	4
Admiralty Inlet deep	E	4	C	13
Pt Towns shore	E	4	B	5
Marrow west shore	E	4	E	33
Marrow east shore	E	4	D	29
Protection shore	E	4	D	26
East SJDF deep	E	4	B	3
Discovery Bay shore	E	4	D	25
Sequim Bay shore	E	4	D	24
Dungeness shore	E	4	D	19
East SJDF shore	E	4	D	21
West SJDF deep	E	4	C	15
Ocean	E	4	E	36

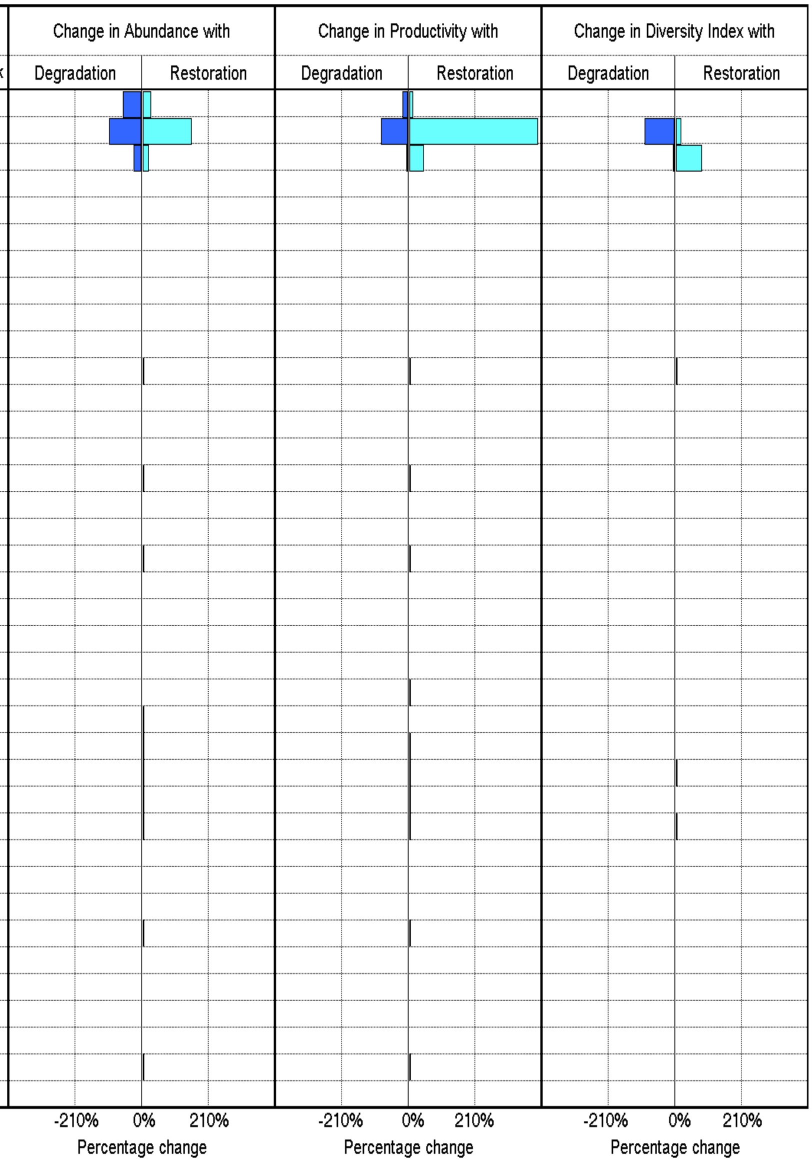


Figure 15. Hamma Hamma River summer chum strategic priorities - broad and detailed scale.

Hamma Hamma Summer chum
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Hamma subestuary	○	○					●	•	●									⬤
Hamma main FW	◯	◯	●				●		⬤						●			●
John Cr FW	∘	◯	●				●	•	⬤						●			•
Union south shore								●	•									
Belfair shallow								•										
Skok west shore								●	•									
South HC deep																		
Skok east shore								●	•									
Dewatto west shore								●	•									
Dewatto east shore					•			•	•									
Hamma west shore		○						●	•									
Hamma east shore					•			●	•									
Duck west shore		∘						●	•									
Duck east shore		∘						●	•									
Dose west shore		∘						●	•									
Dabob deep																		
Dose east shore								•	•									
Dabob Bay shore		○						●	•									
North HC deep		∘			•			•										
Big Beef west shore					•			•	•									
Big Beef east shore		∘						●	•									
Thorn west shore					•			•	•									
Thorn east shore		∘						●	•									
Shine west shore		∘			•			●	•									
Shine east shore		○			•			●	•									
Oak Bay shore		○			•			●	•									
Admiralty Inlet deep		∘			•			•										
Pt Towns shore		○			•			●	•									
Marrow west shore					•			•										
Marrow east shore					•			•										
Protection shore					•			•	•									
East SJDF deep		○			•			•										
Discovery Bay shore					•			•	•									
Sequim Bay shore					•			●	•									
Dungeness shore					•			●	•									
East SJDF shore					•			●	•									
West SJDF deep		∘																
Ocean																		

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯ / ⬤	High	○ / ●	Medium	∘ / •	Low	(blank)	Indirect or General

Figure 16. Hamma Hamma River summer chum strategic priorities by segment and survival factor.

3.2.4 Duckabush River Summer Chum

Figures 17-19 provide results for Duckabush River summer chum. The Duckabush population shows a high loss in performance, particularly in productivity, though losses are not as great as most other Hood Canal populations. Under sustained, unfavorable ocean conditions, the population would appear to relatively safe from extinction provided that fishing did not occur.

Conclusions:

- The Duckabush population shows a marked loss in performance compared to historic levels both in abundance and productivity, particularly under unfavorable ocean survival conditions (Figure 17).
- The amount of potential increase in population abundance is greatest through restoration of freshwater reaches (Figure 18); full restoration of estuarine-marine waters and the natal subestuary appear to offer similar levels of benefit (Figure 18 top).
- Protection of freshwater reaches shows the highest priority (Figure 18).
- Potential benefits of restoring estuarine-marine areas are diffused over many segments (Figure 18 bottom).
- Within freshwater, habitat diversity, channel stability, and sediment load are seen as the most important factors to restore (Figure 19) (see detailed diagnostics in the Report 2 Viewer).
- Within the natal subestuary, several factors appear to be equally important for restoration, along with the amount of area available to be used for rearing (Figure 19).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 19), associated with loss of eelgrass, revetments, and loss of riparian corridors.

3.2.5 Dosewallips River Summer Chum

Figures 20-22 provide results for Dosewallips River summer chum. The Dosewallips population shows a severe loss in performance, particularly in productivity. Under sustained, unfavorable ocean conditions, the population would be severely depressed and approaching a high-risk condition.

Conclusions:

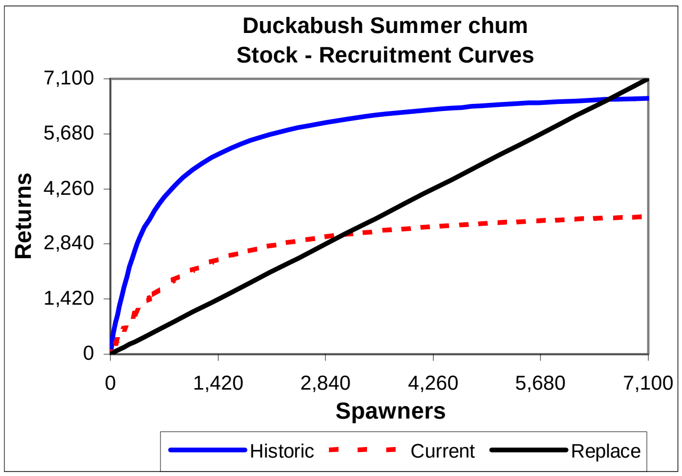
- The Dosewallips population shows a high loss in performance compared to historic levels both in abundance and productivity, particularly under unfavorable ocean survival conditions (Figure 20).
- The amount of potential increase in population abundance is greatest through restoration of freshwater reaches (Figure 21); full restoration of estuarine-marine waters and the natal subestuary appear to offer similar levels of benefit (Figure 21 top). The lower section of the Dosewallips mainstem (upstream of subestuary) provides the greatest potential for restoration benefits.

Figure 17. Duckabush River summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Duckabush Su Chum
Unfavorable PDO conditions

(recruitment measured at return in absence of all harvest)

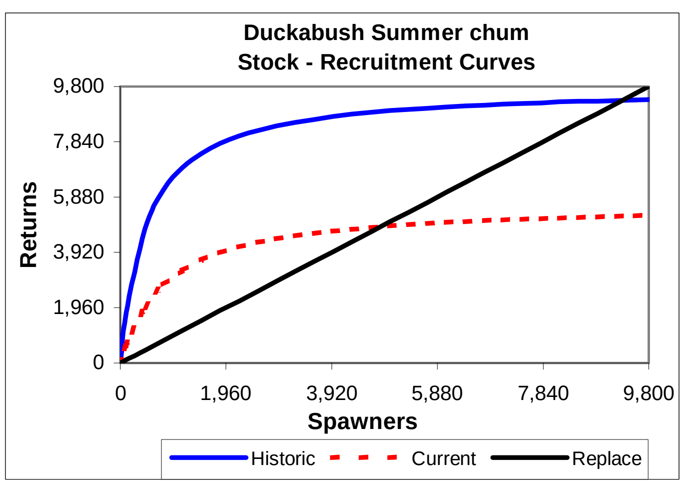
Parameter	Historic	Current
Capacity	7,097	3,991
Productivity	13.3	4.4



Duckabush Su Chum
Favorable PDO conditions

(recruitment measured at return in absence of all harvest)

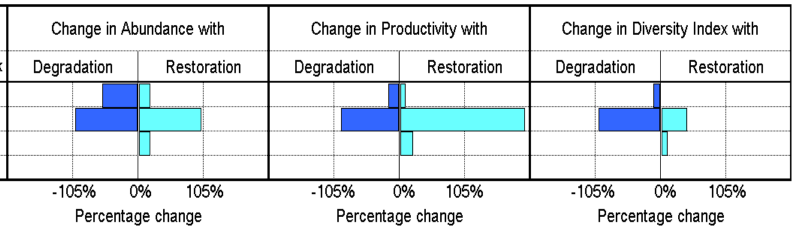
Parameter	Historic	Current
Capacity	9,790	5,659
Productivity	20.5	6.8



Duckabush Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Duck subestuary	B	2	C	3
Duckabush FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Duckabush Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Duck subestuary	B	2	B	2
Duck lower FW	A	1	A	1
Duck mid FW	C	3	C	10
Union south shore	E	4	E	28
Belfair shallow	E	4	E	34
Skok west shore	E	4	D	18
South HC deep	E	4	E	34
Skok east shore	E	4	E	26
Dewatto west shore	E	4	E	32
Dewatto east shore	E	4	E	34
Hamma west shore	E	4	E	29
Hamma east shore	E	4	E	29
Duck west shore	E	4	C	9
Duck east shore	E	4	E	29
Dose west shore	E	4	C	11
Dabob deep	E	4	E	34
Dose east shore	E	4	E	26
Dabob Bay shore	E	4	C	7
North HC deep	E	4	C	15
Big Beef west shore	E	4	D	20
Big Beef east shore	E	4	C	15
Thorn west shore	E	4	D	18
Thorn east shore	E	4	C	12
Shine west shore	E	4	C	12
Shine east shore	E	4	C	4
Oak Bay shore	E	4	C	3
Admiralty Inlet deep	E	4	C	8
Pt Towns shore	E	4	C	6
Marrow west shore	E	4	E	32
Marrow east shore	E	4	E	25
Protection shore	E	4	E	22
East SJDF deep	E	4	C	4
Discovery Bay shore	E	4	E	24
Sequim Bay shore	E	4	E	23
Dungeness shore	E	4	D	17
East SJDF shore	E	4	E	21
West SJDF deep	E	4	C	14
Ocean	E	4	E	34

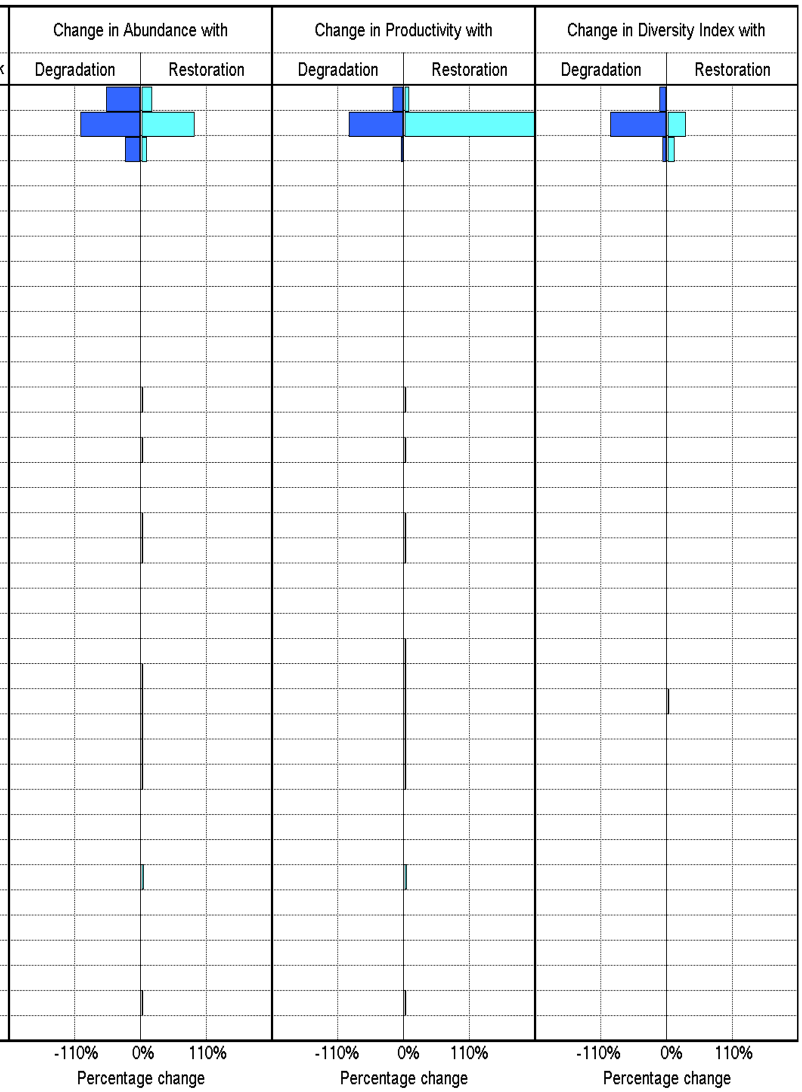


Figure 18. Duckabush River summer chum strategic priorities - broad and detailed scale.

Duckabush Summer chum
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Duck subestuary	○	○					•	•	•									⬤
Duck lower FW	◯	◯	●				●		⬤						●			●
Duck mid FW	∘	∘	●				●	•	⬤									
Union south shore								●	•									
Belfair shallow								•										
Skok west shore								●	•									
South HC deep																		
Skok east shore								●	•									
Dewatto west shore								●	•									
Dewatto east shore								•	•									
Hamma west shore								●	•									
Hamma east shore					•			●	•									
Duck west shore		∘						●	•									
Duck east shore					•			●	•									
Dose west shore		∘						●	•									
Dabob deep																		
Dose east shore								•	•									
Dabob Bay shore		∘						●	•									
North HC deep		∘			•			•										
Big Beef west shore								•	•									
Big Beef east shore		∘						●	•									
Thorn west shore					•			•	•									
Thorn east shore		∘			•			●	•									
Shine west shore		∘			•			●	•									
Shine east shore		∘			•			●	•									
Oak Bay shore		∘			•			●	•									
Admiralty Inlet deep		∘			•			•										
Pt Towns shore		∘			•			●	•									
Marrow west shore					•			•										
Marrow east shore					•			•										
Protection shore					•			•	•									
East SJDF deep		∘			•			•										
Discovery Bay shore					•			•	•									
Sequim Bay shore					•			●	•									
Dungeness shore					•			●	•									
East SJDF shore					•			●	•									
West SJDF deep		∘			•													
Ocean																		

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

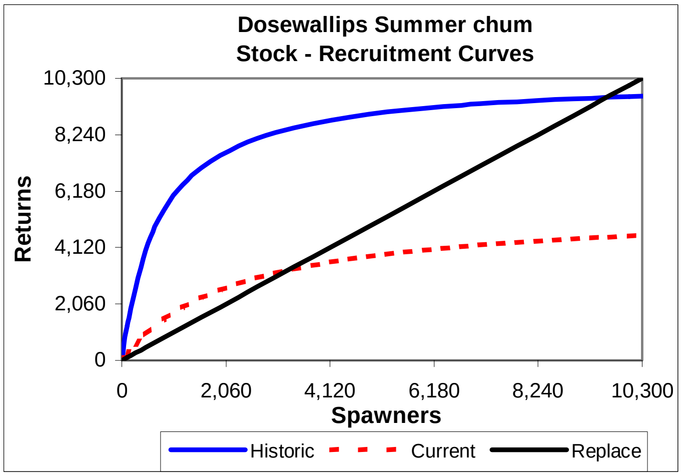
A	B	C	D & E
◯ / ⬤ High	○ / ● Medium	∘ / • Low	(blank) Indirect or General

Figure 19. Duckabush River summer chum strategic priorities by segment and survival factor.

Dosewallips Su Chum
Unfavorable PDO conditions

(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	10,340	5,565
Productivity	14.0	2.4



Dosewallips Su Chum
Favorable PDO conditions

(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	14,171	7,747
Productivity	22.3	4.0

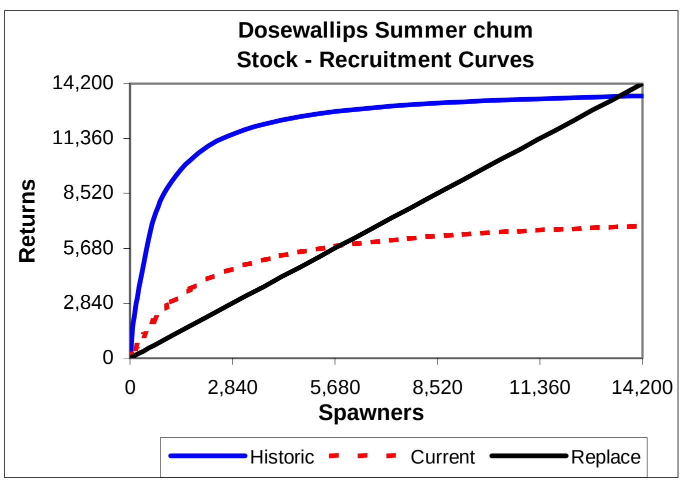
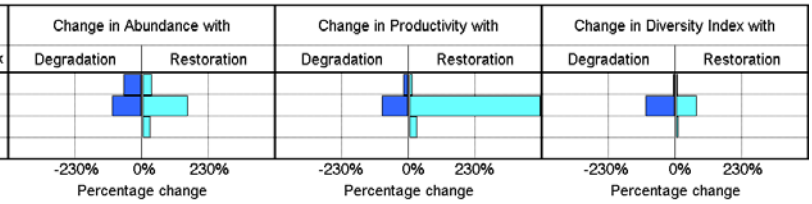


Figure 20. Dosewallips River summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Dosewallips Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Dose subestuary	B	2	C	3
Dosewallips FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Dosewallips Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category	Protection benefit rank	Restoration benefit Category	Restoration benefit rank
Dose subestuary	B	2	B	3
Dose lower FW	A	1	A	1
Dose mid FW	C	3	A	2
Union south shore	E	4	D	22
Belfair shallow	E	4	E	34
Skok west shore	E	4	D	18
Skok east shore	E	4	D	21
Dewatto west shore	E	4	E	31
Dewatto east shore	E	4	E	34
Hamma west shore	E	4	E	29
Hamma east shore	E	4	E	29
Duck west shore	E	4	E	27
Duck east shore	E	4	E	27
Dose west shore	E	4	C	4
Dabob deep	E	4	E	36
Dose east shore	E	4	E	32
Dabob Bay shore	E	4	C	5
North HC deep	E	4	D	15
Big Beef west shore	E	4	D	19
Big Beef east shore	E	4	D	14
Thorn west shore	E	4	D	17
Thorn east shore	E	4	C	12
Shine west shore	E	4	C	8
Shine east shore	E	4	C	8
Oak Bay shore	E	4	C	7
Admiralty Inlet deep	E	4	C	11
Pt Towns shore	E	4	C	10
Marrow west shore	E	4	E	32
Marrow east shore	E	4	E	26
Protection shore	E	4	E	23
East SJDF deep	E	4	C	6
Discovery Bay shore	E	4	E	25
Sequim Bay shore	E	4	E	24
Dungeness shore	E	4	D	16
East SJDF shore	E	4	D	20
West SJDF deep	E	4	C	13
Ocean	E	4	E	36

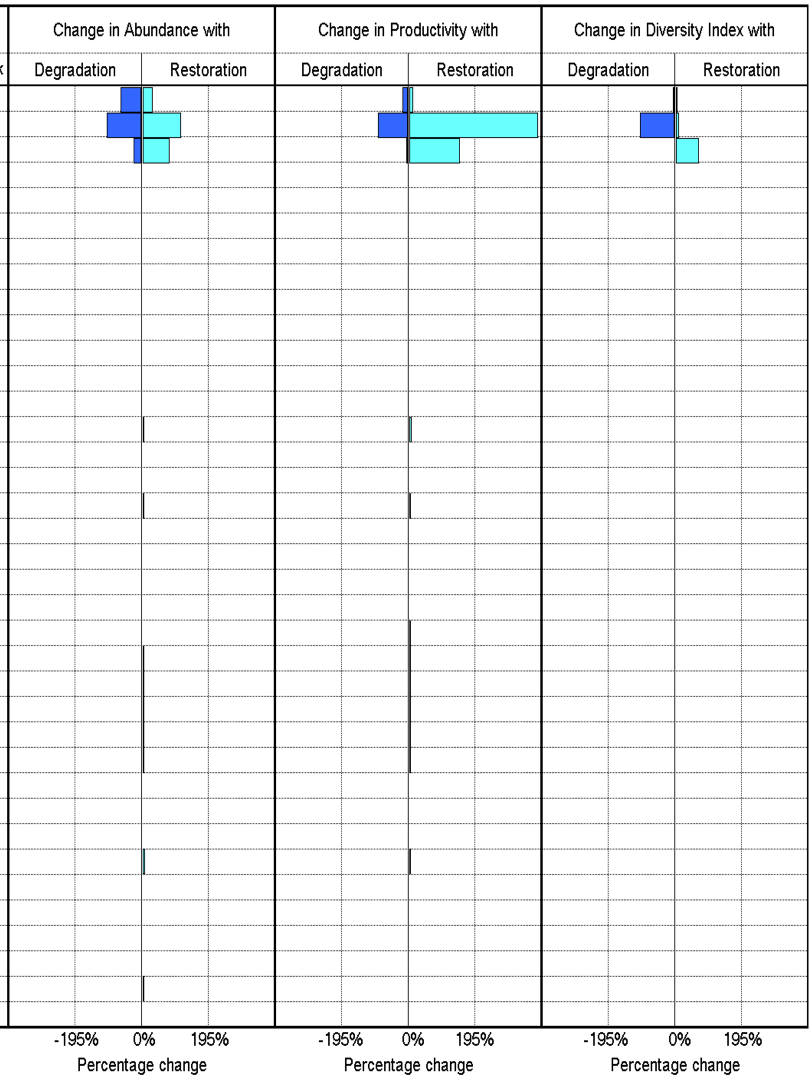


Figure 21. Dosewallips River summer chum strategic priorities - broad and detailed scale.

Dosewallips Summer chum
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	**Protection benefit**	**Restoration benefit**	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Dose subestuary	○	○					•	●	●									⬤
Dose lower FW	◯	◯	●				●		⬤						●			●
Dose mid FW	∘	◯	●				●		⬤						●			●
Union south shore								●	•									
Belfair shallow								•										
Skok west shore								●	•									
Skok east shore								●	•									
Dewatto west shore								●	•									
Dewatto east shore								•	•									
Hamma west shore								●	•									
Hamma east shore								●	•									
Duck west shore								●	•									
Duck east shore								●	•									
Dose west shore		∘						●	•									
Dabob deep																		
Dose east shore								•	•									
Dabob Bay shore		∘						●	•									
North HC deep					•			•										
Big Beef west shore								•	•									
Big Beef east shore								●	•									
Thorn west shore								•	•									
Thorn east shore		∘						●	•									
Shine west shore		∘			•			●	•									
Shine east shore		∘			•			●	•									
Oak Bay shore		∘			•			●	•									
Admiralty Inlet deep		∘			•			•										
Pt Towns shore		∘			•			●	•									
Marrow west shore					•			•										
Marrow east shore					•			•										
Protection shore					•			•	•									
East SJDF deep		∘			•			•										
Discovery Bay shore					•			•	•									
Sequim Bay shore					•			●	•									
Dungeness shore					•			●	•									
East SJDF shore					•			●	•									
West SJDF deep		∘			•													
Ocean																		

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯ / ⬤	High	○ / ●	Medium	∘ / •	Low	(blank)	Indirect or General

Figure 22. Dosewallips River summer chum strategic priorities by segment and survival factor.

- Protection of freshwater reaches shows the highest priority (Figure 21).
- Potential benefits of restoring estuarine-marine areas are diffused over many segments (Figure 21 bottom).
- Within freshwater, habitat diversity, channel stability, and sediment load are seen as the most important factors to restore (Figure 22) (see detailed diagnostics in the Report 2 Viewer).
- Within the natal subestuary, several factors appear to be equally important for restoration, along with the amount of area available to be used for rearing (Figure 22).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 22), associated with loss of eelgrass, revetments, and loss of riparian corridors.

3.2.6 Quilcene Summer Chum

Figures 23-25 provide results for Quilcene summer chum, including fish produced in the Big and Little Quilcene rivers. The Quilcene population shows a severe loss in performance, particularly in productivity. Under sustained, unfavorable ocean conditions, the population would be severely depressed and approaching a high-risk condition.

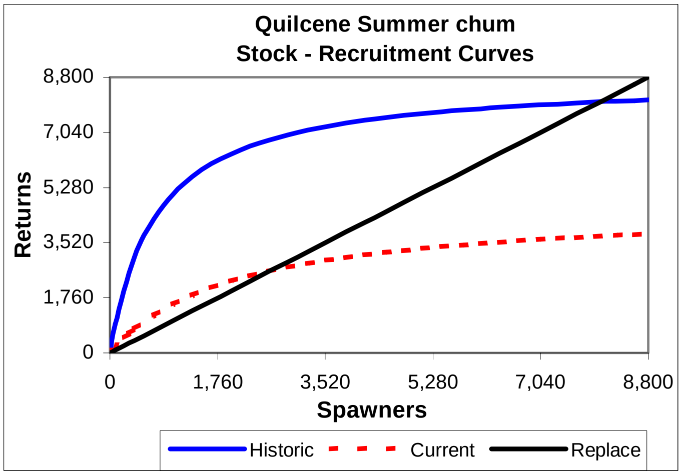
Conclusions:

- The Quilcene population shows a high loss in performance compared to historic levels both in abundance and productivity, particularly under unfavorable ocean survival conditions (Figure 23).
- The amount of potential increase in population abundance is greatest through restoration of freshwater reaches (Figure 24); full restoration of estuarine-marine waters offers a somewhat higher potential benefit than would occur for the natal subestuary (Figure 24 top). Restoration of the Big and Little Quilcene rivers offers similar levels of benefit.
- Protection of freshwater reaches shows the highest priority (Figure 24).
- Potential benefits of restoring estuarine-marine areas are diffused over many segments but the Dabob Bay shore is ranked highest among these areas, followed by the Oak Bay segment (Figure 24 bottom). The reason for the high value of the Dabob Bay shore is due to its amount of change that has occurred in conjunction with its proximity to the Union River. The reason for the high value of the Oak Bay segment is less clear. We believe this to be partly the result of how we expect migration to proceed as fish from both shores of Hood Canal to be concentrated on the west side of Admiralty inlet as they move to the Strait. The importance of the Oak Bay area is also partly due to the increasing amount of competition with hatchery fish as summer chum move through Admiralty Inlet (picking up fish from other areas in Puget Sound) (Figure 24).

Quilcene Su Chum
Unfavorable PDO conditions

(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	8,760	4,684
Productivity	11.7	2.3



Quilcene Su Chum
Favorable PDO conditions

(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	11,012	5,988
Productivity	18.1	3.5

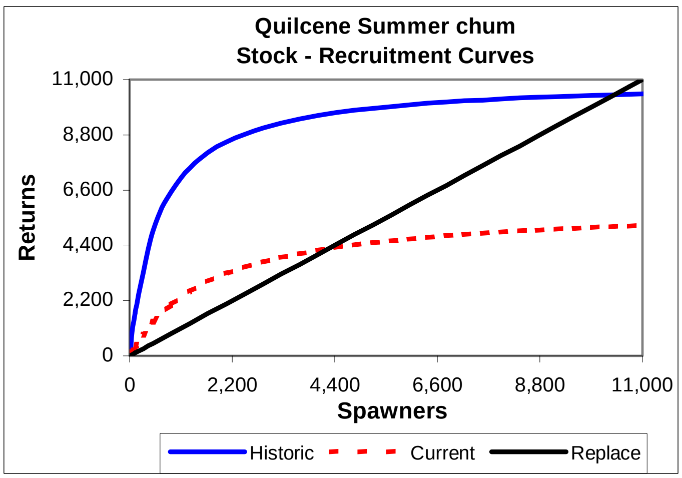
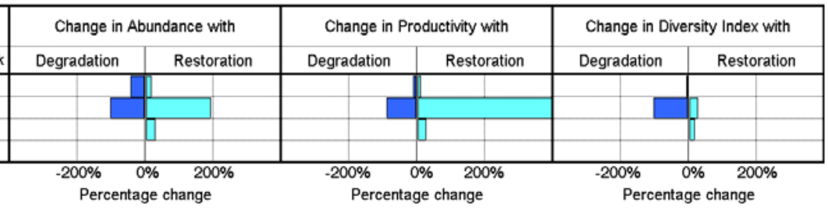


Figure 23. Quilcene (Big and Little) River summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Quilcene Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Quilcene subestuary	B	2	C	3
Quilcene FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Quilcene Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit Category/rank		Restoration benefit Category/rank	
Quilcene subestuary	C	3	B	4
Big Quil FW	A	1	A	1
Little Quil FW	B	2	A	2
Union south shore	E	4	E	24
Belfair shallow	E	4	E	34
Skok west shore	E	4	D	17
Skok east shore	E	4	E	22
Dewatto west shore	E	4	E	32
Dewatto east shore	E	4	E	34
Hamma west shore	E	4	E	28
Hamma east shore	E	4	E	31
Duck west shore	E	4	E	28
Duck east shore	E	4	E	28
Dose west shore	E	4	E	23
Dabob deep	E	4	E	37
Dose east shore	E	4	E	32
Dabob Bay shore	E	4	B	3
North HC deep	E	4	D	14
Big Beef west shore	E	4	D	19
Big Beef east shore	E	4	D	12
Thorn west shore	E	4	D	18
Thorn east shore	E	4	C	10
Shine west shore	E	4	C	9
Shine east shore	E	4	C	7
Oak Bay shore	E	4	B	4
Admiralty Inlet deep	E	4	D	11
Pt Towns shore	E	4	C	8
Marrow west shore	E	4	E	34
Marrow east shore	E	4	D	19
Protection shore	E	4	D	19
East SJDF deep	E	4	C	6
Discovery Bay shore	E	4	E	26
Sequim Bay shore	E	4	E	25
Dungeness shore	E	4	D	15
East SJDF shore	E	4	D	16
West SJDF shore	E	4	E	27
West SJDF deep	E	4	D	13
Ocean	E	4	E	37

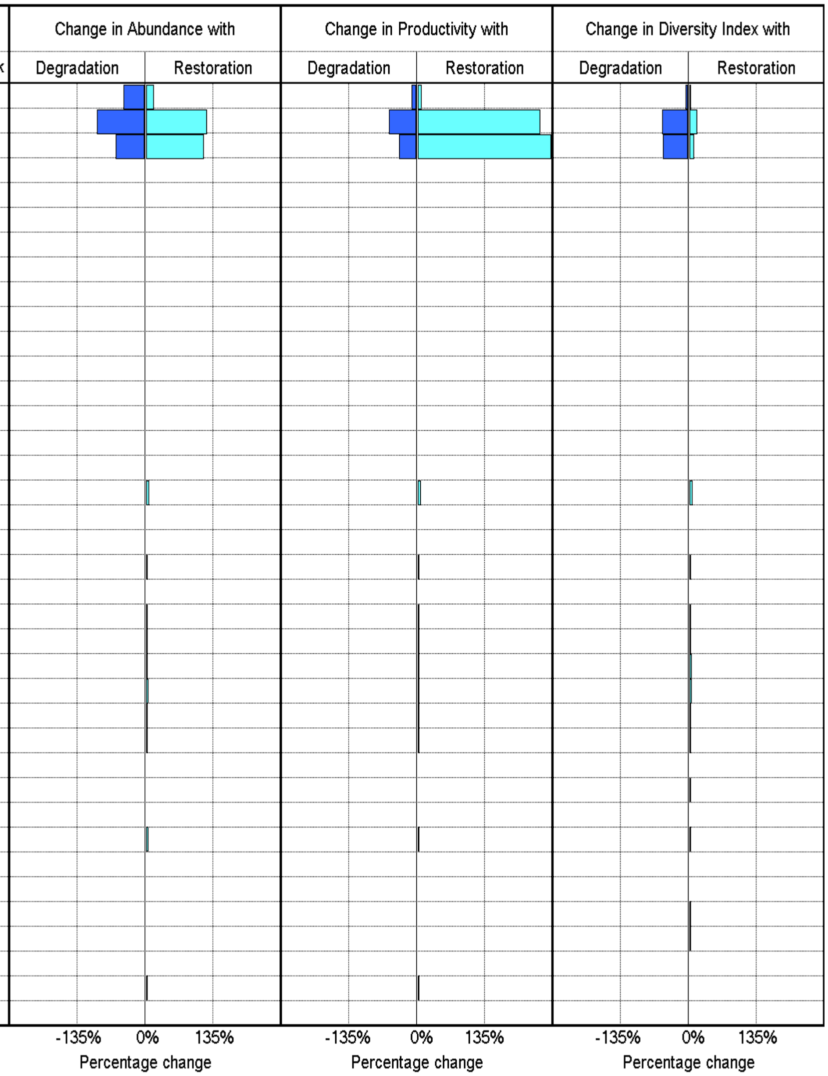


Figure 24. Quilcene summer chum strategic priorities - broad and detailed scale.

Quilcene Summer chum
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	*Channel stability*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Quilcene subestuary	○C	○B			●C		●C	●B	●B									●A
Big Quil FW	○A	○A	●B				●B		●A	●B	●B				●B			●B
Little Quil FW	○B	○A	●B				●B	●C	●A	●C					●B			●B
Union south shore					●C			●B	●C									
Belfair shallow					●C			●C										
Skok west shore					●C			●B	●C									
Skok east shore					●C			●B	●C									
Dewatto west shore								●B	●C									
Dewatto east shore					●C			●C	●C									
Hamma west shore								●B	●C									
Hamma east shore					●C			●B	●C									
Duck west shore								●B	●C									
Duck east shore					●C			●B	●C									
Dose west shore								●B	●C									
Dabob deep																		
Dose east shore					●C			●C	●C									
Dabob Bay shore		○B						●B	●C									
North HC deep					●C			●C										
Big Beef west shore								●C	●C									
Big Beef east shore								●B	●C									
Thorn west shore								●C	●C									
Thorn east shore		○C			●C			●B	●C									
Shine west shore		○C			●C			●B	●C									
Shine east shore		○C			●C			●B	●C									
Oak Bay shore		○B			●C			●B	●C									
Admiralty Inlet deep					●C			●C										
Pt Towns shore		○C			●C			●B	●C									
Marrow west shore					●C			●C										
Marrow east shore					●C			●C										
Protection shore					●C			●C	●C									
East SJDF deep		○C			●C			●C										
Discovery Bay shore					●C			●C	●C									
Sequim Bay shore					●C			●B	●C									
Dungeness shore					●C			●B	●C									
East SJDF shore					●C			●B	●C									
West SJDF shore					●C			●B	●C									
West SJDF deep					●C													
Ocean																		

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
○A / ●A High	○B / ●B Medium	○C / ●C Low	(blank) Indirect or General

Figure 25. Quilcene summer chum strategic priorities by segment and survival factor.

- Within freshwater, habitat diversity, channel stability, flow, and sediment load are seen as the most important factors to restore (Figure 25) (see detailed diagnostics in the Report 2 Viewer).
- Within the natal subestuary, food and habitat diversity appear to be equally important for restoration, along with the amount of area available to be used for rearing (Figure 25).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 25), associated with loss of eelgrass, shoreline development, and loss of riparian corridors.

3.2.7 Salmon-Snow Creek Summer Chum

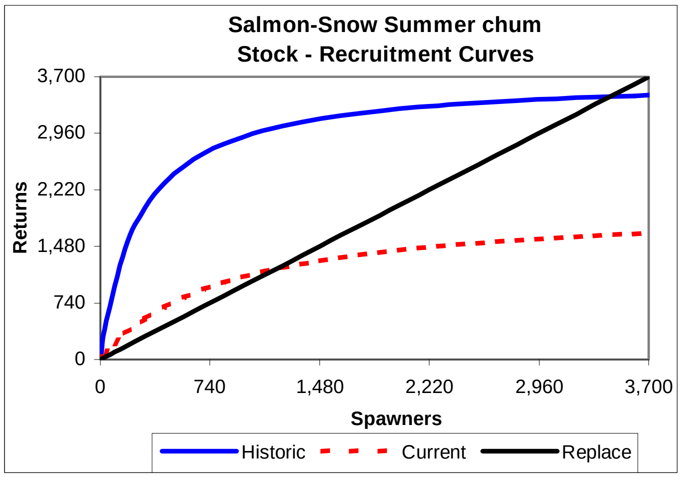
Figures 26-28 provide results for Salmon-Snow creek summer chum, including fish produced in Salmon and Snow creeks. The Salmon-Snow population shows a severe loss in performance, particularly in productivity. Under sustained, unfavorable ocean conditions, the population would be severely depressed and approaching a high-risk condition.

Conclusions:

- The Salmon-Snow population shows a high loss in performance compared to historic levels both in abundance and productivity, particularly under unfavorable ocean survival conditions (Figure 26).
- The amount of potential increase in population abundance is greatest through restoration of freshwater reaches (Figure 27); full restoration of estuarine-marine waters and the natal subestuary appear to offer similar levels of benefit (Figure 27 top). Snow Creek mainstem (upstream of subestuary) provides the greatest potential for restoration benefits within the freshwater environment.
- Protection of freshwater reaches shows the highest priority with Salmon Creek having the greatest strategic priority (Figure 27).
- Potential benefits of restoring estuarine-marine areas are diffused over many segments but the Discovery Bay shore is ranked highest among these areas (Figure 27 bottom).
- Within freshwater, habitat diversity and sediment load are seen as the most important factors to restore (Figure 28) (see detailed diagnostics in the Report 2 Viewer).
- Within the natal subestuary, food and habitat diversity appear to be equally important for restoration, along with the amount of area available to be used for rearing (Figure 28).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 28), associated with loss of eelgrass, shoreline development, and loss of riparian corridors.

Snow-Salmon Su Chum
Unfavorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	3,703	2,026
Productivity	14.2	2.4



Snow-Salmon Su Chum
Favorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	4,700	2,688
Productivity	23.3	3.8

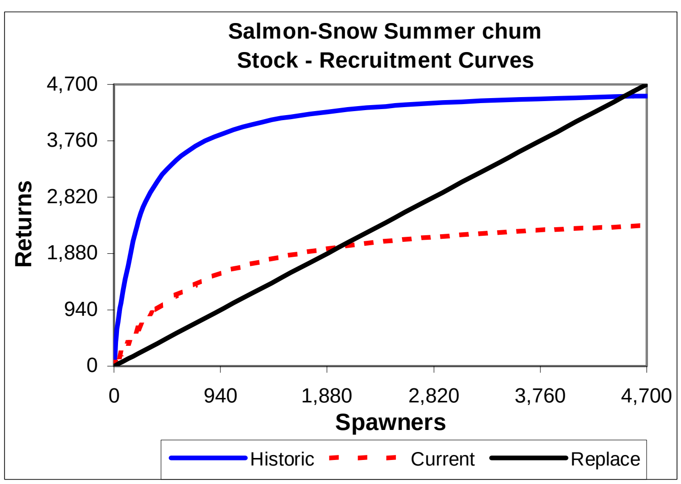
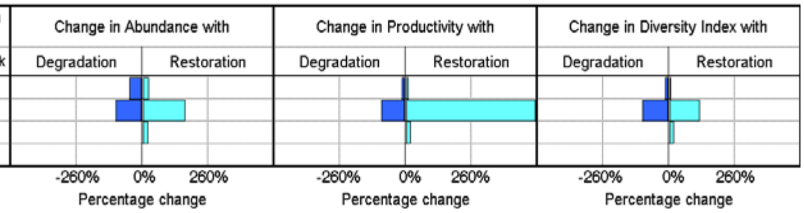


Figure 26. Salmon-Snow creek summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Salmon-Snow Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Snow-Salmon subestuary	B	2	C	3
Snow-Salmon FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Salmon-Snow Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Snow-Salmon subestuary	C	3	B	4
Salmon FW	A	1	A	2
Snow FW	B	2	A	1
Pt Towns shore	E	4	D	11
Marrow west shore	E	4	E	14
Protection shore	E	4	C	10
East SJDF deep	E	4	C	5
Discovery Bay shore	E	4	B	3
Discovery Bay deep	E	4	C	8
Sequim Bay shore	E	4	D	13
Dungeness shore	E	4	C	5
East SJDF shore	E	4	C	8
West SJDF shore	E	4	D	12
West SJDF deep	E	4	C	7
Ocean	E	4	E	14

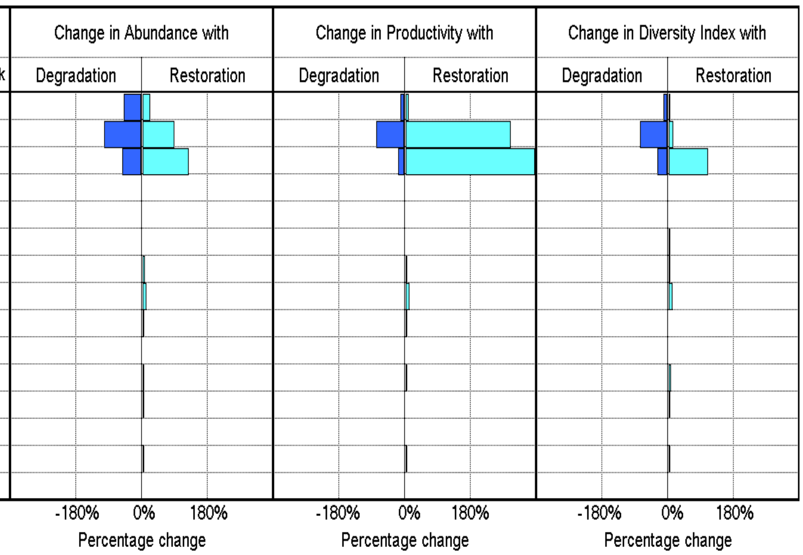


Figure 27. Salmon-Snow creek summer chum strategic priorities - broad and detailed scale.

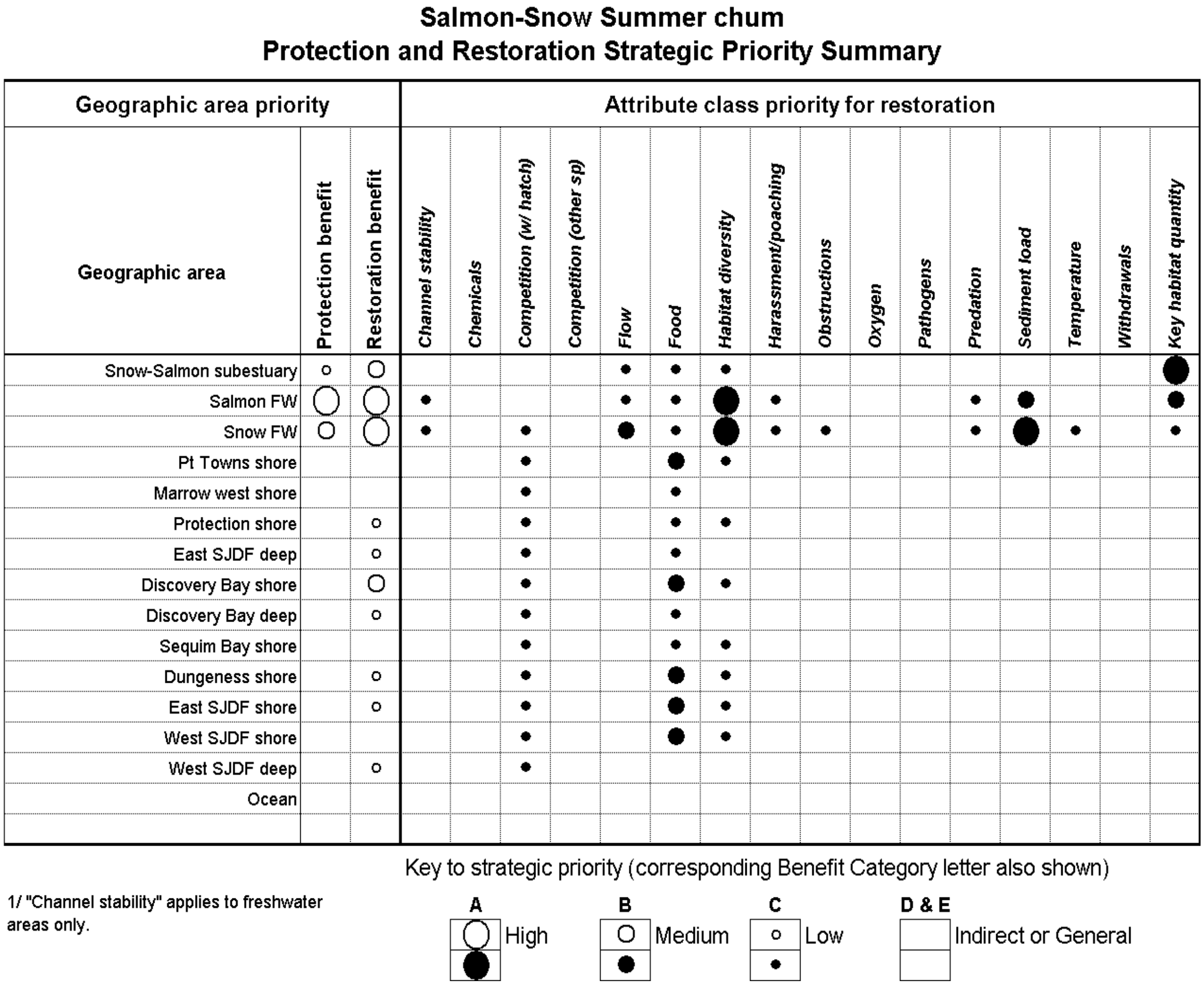


Figure 28. Salmon-Snow summer chum strategic priorities by segment and survival factor.

3.2.8 Jimmycomelately Creek Summer Chum

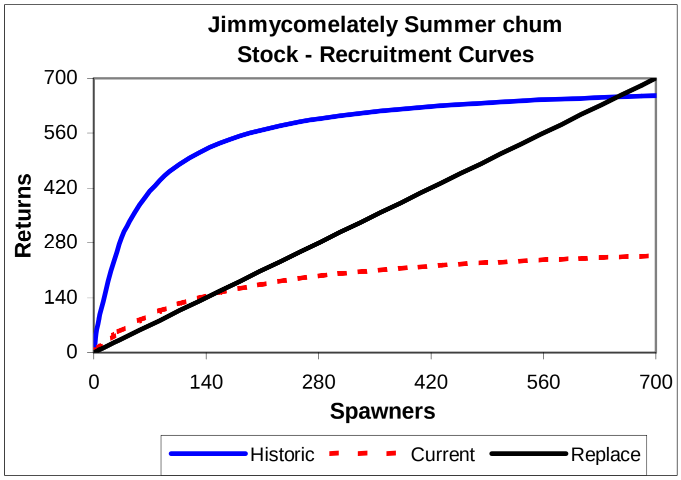
Figures 29-31 provide results for Jimmycomelately Creek summer chum. The Jimmycomelately population shows a severe loss in performance, particularly in productivity. Under sustained, unfavorable ocean conditions, the population would be at a high risk of extinction.

Conclusions:

- The Jimmycomelately population shows a high loss in performance compared to historic levels both in abundance and productivity, particularly under unfavorable ocean survival conditions (Figure 29).
- The amount of potential increase in population abundance is greatest through restoration of freshwater reaches (Figure 30); full restoration of estuarine-marine waters offers somewhat higher benefits than those associated with the natal subestuary (Figure 30 top).

Jimmy Su Chum
Unfavorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	702	299
Productivity	14.3	2.0



Jimmy Su Chum
Favorable PDO conditions
(recruitment measured at return in absence of all harvest)

Parameter	Historic	Current
Capacity	854	373
Productivity	24.3	3.4

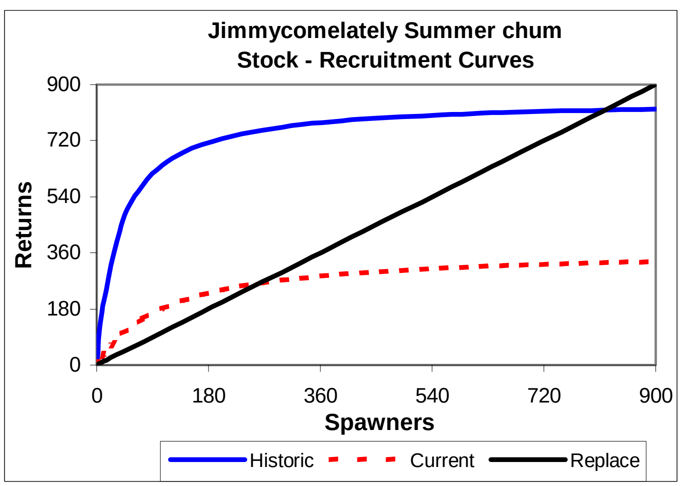
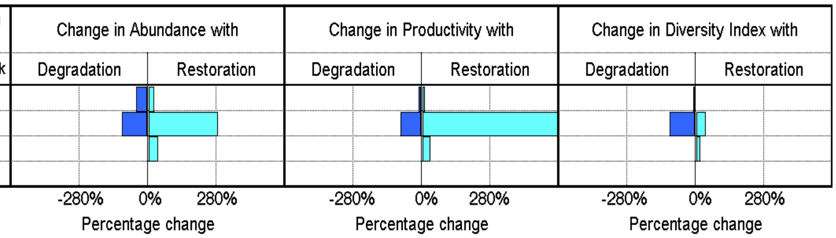


Figure 29. Jimmycomelately Creek summer chum stock-recruitment curves under unfavorable and favorable marine survival conditions.

Jimmycomelately Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Jimmycomelately subestuary	B	2	C	3
Jimmycomelately FW	A	1	A	1
PS marine	D	3	B	2
Ocean	D	3	D	4



Jimmycomelately Summer chum

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit	
	Category/rank		Category/rank	
Jimmycomelately subestuary	B	2	C	3
Jimmycomelately FW	A	1	A	1
Pt Towns shore	E	3	E	9
Marrow west shore	E	3	E	10
Protection shore	E	3	E	10
East SJDF deep	E	3	D	8
Discovery Bay shore	E	3	D	7
Sequim Bay shore	E	3	B	2
Sequim Bay deep	E	3	E	10
Dungeness shore	E	3	D	6
East SJDF shore	E	3	D	4
West SJDF shore	E	3	E	10
West SJDF deep	E	3	D	5
Ocean	E	3	E	10

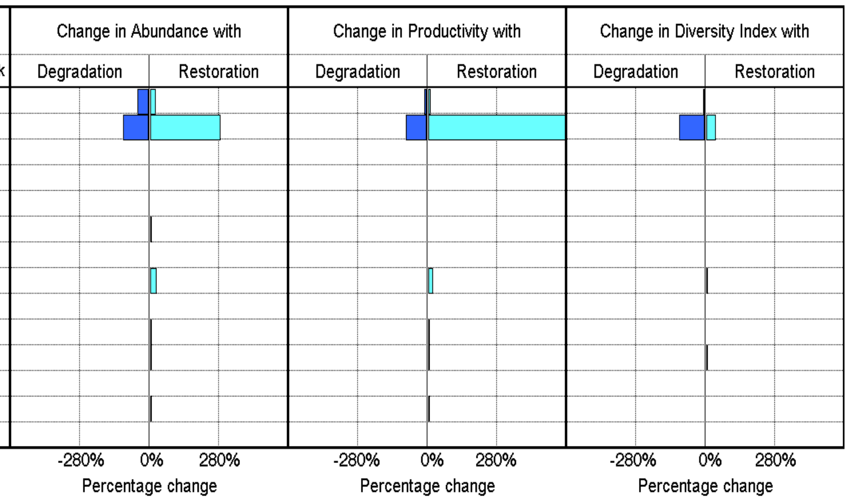


Figure 30. Jimmycomelately summer chum strategic priorities - broad and detailed scale.

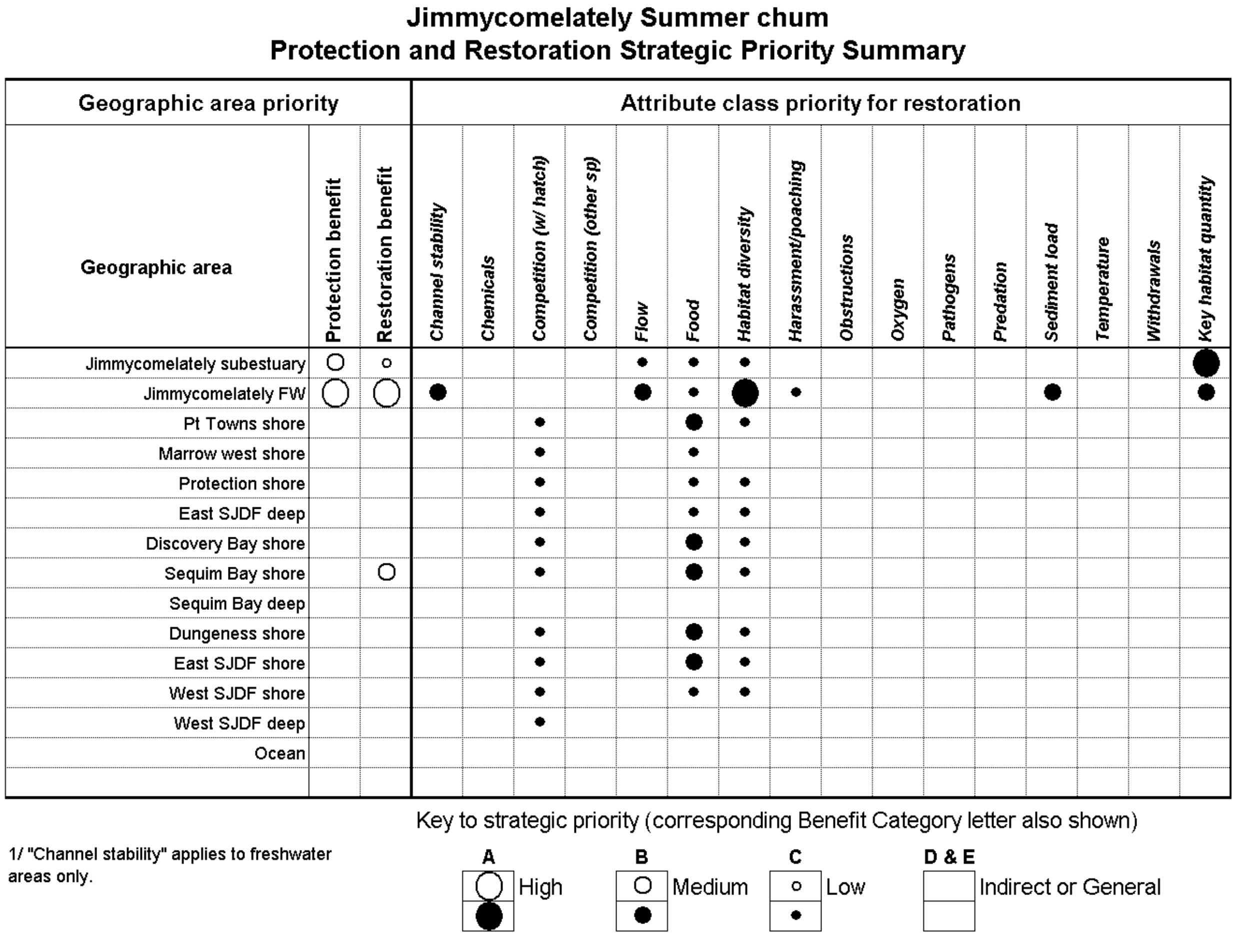


Figure 31. Jimmycomelately Creek summer chum strategic priorities by segment and survival factor.

- Protection of freshwater reaches shows the highest (Figure 30).
- Potential benefits of restoring estuarine-marine areas are is greatest by restoring the Sequim Bay shore (Figure 30 bottom).
- Within freshwater, habitat diversity, channel stability, and sediment load are seen as the most important factors to restore (Figure 31) (see detailed diagnostics in the Report 2 Viewer).
- Within the natal subestuary, several factors are approximately equal in importance for restoration, along with the amount of area available to be used for rearing (Figure 31).
- Within the estuarine-marine environment, the most important factor for restoration is food (Figure 31), associated with loss of eelgrass, shoreline development, and loss of riparian corridors.

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Appendix A

Appendix Table A. Reach and segment descriptions used in EDT analysis of summer chum populations in Hood Canal and the eastern Strait of Juan de Fuca.

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Estuarine/marine reach	Neah Bay-L	West SJDF deep	Deep water associated with the southern shore of SJDF extending from Sekiu Pt to Cape Flattery.	53,514
Estuarine/marine reach	Neah Bay-L_ITZ	West SJDF shore	Intertidal/shallow subtidal zone of the southern shore of SJDF extending from Sekiu Pt to Cape Flattery.	53,514
Estuarine/marine reach	Pysht-L	West SJDF deep	Deep water associated with the southern shore of SJDF extending from approx 1/2 mile east of Deep Cr to Sekiu Pt. Pysht R enters this segment.	36,794
Estuarine/marine reach	Pysht-L_ITZ	West SJDF shore	Intertidal/shallow subtidal zone of the southern shore of SJDF extending from approx 1/2 mile east of Deep Cr to Sekiu Pt. Pysht R enters this segment.	36,794
Estuarine/marine reach	Lyre-L	West SJDF deep	Deep water associated with the southern shore of SJDF extending from approx 1/2 mile west of Observatory Pt (western edge of Freshwater Bay) to approx 1/2 east of Deep Cr. Lyre R enters this segment.	33,756
Estuarine/marine reach	Lyre-L_ITZ	West SJDF shore	Intertidal/shallow subtidal zone of the southern shore of SJDF extending from approx 1/2 mile west of Observatory Pt (western edge of Freshwater Bay) to approx 1/2 east of Deep Cr. Lyre R enters this segment.	33,756
Estuarine/marine reach	Elwha-L	West SJDF deep	Deep water associated with the southern shore of SJDF extending from the eastern tip of Ediz Hook to approx 1/2 mile west of Observatory Pt (western edge of Freshwater Bay). Elwha R enters this segment.	24,880
Estuarine/marine reach	Elwha-L_ITZ	West SJDF shore	Intertidal/shallow subtidal zone of the southern shore of SJDF extending from the eastern tip of Ediz Hook to approx 1/2 mile west of Observatory Pt (western edge of Freshwater Bay). Elwha R enters this segment.	24,880
Estuarine/marine reach	Morse-L	East SJDF deep	Deep water associated with the southern shore of SJDF extending from approx 1/2 east of Bagley Cr to the eastern tip of Ediz Hook.	21,199

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Estuarine/marine reach	Morse-L_ITZ	East SJDF shore	Intertidal/shallow subtidal zone of the southern shore of SJDF extending from approx 1/2 east of Bagley Cr to the eastern tip of Ediz Hook.	21,199
Estuarine/marine reach	Siebert-L	East SJDF deep	Deep water associated with the southern shore of SJDF extending from eastern tip of Dungeness Spit to approx 1/2 east of Bagley Cr.	19,447
Estuarine/marine reach	Siebert-L_ITZ	East SJDF shore	Intertidal/shallow subtidal zone of the southern shore of SJDF extending from eastern tip of Dungeness Spit to approx 1/2 east of Bagley Cr.	19,447
Estuarine/marine reach	Dungeness-L	East SJDF deep	Deep water associated with the southern shore of SJDF extending from approx 1/4 mile south of Gierin Cr (near Kulakala Pt) to the eastern tip of Dungeness Spit (Dungeness R enters this segment).	30,644
Estuarine/marine reach	Dungeness-L_ITZ	Dungeness shore	Intertidal/shallow subtidal zone of the southern shore of SJDF extending from approx 1/4 mile south of Gierin Cr (near Kulakala Pt) to the eastern tip of Dungeness Spit (Dungeness R enters this segment).	30,644
Estuarine/marine reach	Sequim-L	Sequim Bay deep	Deepwater within Sequim Bay. Jimmycomelately Cr enters this segment.	25,549
Estuarine/marine reach	Sequim-L_ITZ	Sequim Bay shore	Intertidal/shallow subtidal zone within Sequim Bay. Jimmycomelately Cr enters this segment.	25,549
Estuarine/marine reach	Discovery-L	Discovery Bay deep	Deepwater within Discovery Bay. Snow and Salmon Crs enter this segment.	40,849
Estuarine/marine reach	Discovery-L_ITZ	Discovery Bay shore	Intertidal/shallow subtidal zone within Discovery Bay. Snow and Salmon Crs enter this segment.	40,849
Estuarine/marine reach	Protection-L	East SJDF deep	Deep water associated with the south shore of the eastern end of SJDF extending from Pt Wilson on the east to approx 1/4 mile south of Gierin Cr (near Kulakala Pt).	25,169
Estuarine/marine reach	Protection-L_ITZ	Protection shore	Intertidal/shallow subtidal zone of the south shore of the eastern end of SJDF extending from Pt Wilson on the east to approx 1/4 mile south of Gierin Cr (near Kulakala Pt).	25,169
Estuarine/marine reach	E Marrow-RI	Admiralty Inlet deep	Deep water associated with the eastern shoreline of Marrowstone Island from near Kinney Pt on the south end to the middle of the northern shore of Marrowstone Island.	12,807

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Estuarine/marine reach	E Marrow-RI_ITZ	Marrow east shore	Intertidal/shallow subtidal zone of the eastern shoreline of Marrowstone Island from near Kinney Pt on the south end to the middle of the northern shore of Marrowstone Island.	12,807
Estuarine/marine reach	E Marrow-L	Admiralty Inlet deep	Deep water associated with the westshore of Admiralty Inlet extending from Pt Hudson to Pt Wilson.	3,672
Estuarine/marine reach	E Marrow-L_ITZ	Marrow west shore	Intertidal/shallow subtidal zone of the westshore of Admiralty Inlet extending from Pt Hudson to Pt Wilson.	3,672
Estuarine/marine reach	Pt Towns-L	Admiralty Inlet deep	Deep water associated with the westshore of Port Townsend (bay) extending from the cut at Indian IslandTala Pt to Pt Hudson just north of Port Townsend city.	26,057
Estuarine/marine reach	Pt Towns-L_ITZ	Pt Towns shore	Intertidal/shallow subtidal zone of the westshore of Port Townsend (bay) extending from the cut at Indian IslandTala Pt to Pt Hudson just north of Port Townsend city.	26,057
Estuarine/marine reach	Oak Bay-L	Admiralty Inlet deep	Deep water associated with the westshore of Admiralty Inlet extending from Tala Pt to near Kinney Pt on the south end of Marrowstone Island. Segment encompasses Oak Bay. Does not include cut into Port Townsend (bay).	30,038
Estuarine/marine reach	Oak Bay-L_ITZ	Oak Bay shore	Intertidal/shallow subtidal zone of the westshore of Admiralty Inlet extending from Tala Pt to near Kinney Pt on the south end of Marrowstone Island. Segment encompasses Oak Bay. Does not include cut into Port Townsend (bay).	30,038
Estuarine/marine reach	Shine-R	North HC deep	Deep water associated with the eastshore of Hood Canal extending from immediately south of Lofall community to Foulweather Bluff at entrance to Hood Canal.	39,288
Estuarine/marine reach	Shine-R_ITZ	Shine east shore	Intertidal/shallow subtidal zone of the eastshore of Hood Canal extending from immediately south of Lofall community to Foulweather Bluff at entrance to Hood Canal.	39,288
Estuarine/marine reach	Shine-L	North HC deep	Deep water associated with the westshore of Hood Canal extending from unnamed stream (WRIA 17.0180)(south of South Pt) to Tala Pt at entrance to Hood Canal.	29,834

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Estuarine/marine reach	Shine-L_ITZ	Shine west shore	Intertidal/shallow subtidal zone of the westshore of Hood Canal extending from unnamed stream (WRIA 17.0180)(south of South Pt) to Tala Pt at entrance to Hood Canal.	29,834
Estuarine/marine reach	Thorn-R	North HC deep	Deep water associated with the eastshore of Hood Canal extending from outlet of Bangor Lake to immediately south of Lofall community on the north. Bangor Subbase located in segment.	10,647
Estuarine/marine reach	Thorn-R_ITZ	Thorn east shore	Intertidal/shallow subtidal zone of the eastshore of Hood Canal extending from outlet of Bangor Lake to immediately south of Lofall community on the north. Bangor Subbase located in segment.	10,647
Estuarine/marine reach	Thorn-L	North HC deep	Deep water associated with the westshore of Hood Canal extending from near Brown Pt to unnamed stream (WRIA 17.0180)(south of South Pt).	15,333
Estuarine/marine reach	Thorn-L_ITZ	Thorn west shore	Intertidal/shallow subtidal zone of the westshore of Hood Canal extending from near Brown Pt to unnamed stream (WRIA 17.0180)(south of South Pt).	15,333
Estuarine/marine reach	Big Beef-R	North HC deep	Deep water associated with the eastshore of Hood Canal extending from Misery Pt. to near the outlet of Bangor Lake on the north. Big Beef Cr enters in the southern portion of segment.	21,946
Estuarine/marine reach	Big Beef-R_ITZ	Big Beef east shore	Intertidal/shallow subtidal zone of the eastshore of Hood Canal extending from Misery Pt. to near the outlet of Bangor Lake on the north. Big Beef Cr enters in the southern portion of segment.	21,946
Estuarine/marine reach	Big Beef-L	North HC deep	Deep water associated with the westshore of Hood Canal extending from Oak Head (southern tip of Toandos Peninsula) to near Brown Pt on the north.	13,292
Estuarine/marine reach	Big Beef-L_ITZ	Big Beef west shore	Intertidal/shallow subtidal zone of the westshore of Hood Canal extending from Oak Head (southern tip of Toandos Peninsula) to near Brown Pt on the north.	13,292
Estuarine/marine reach	Dabob-L	Dabob deep	Deep water associated with Dabob Bay north of a line from Pulali Pt extending straight across to the Toandos Peninsula. Big and Little Quilcene rivers enter this segment.	54,892

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Estuarine/marine reach	Dabob-L_ITZ	Dabob Bay shore	Intertidal/shallow subtidal zone of Dabob Bay north of a line from Pulali Pt extending straight across to the Toandos Peninsula. Big and Little Quilcene rivers enter this segment.	54,892
Estuarine/marine reach	Dose-R	Dabob deep	Deep water associated with the eastshore of Hood Canal extending from approx 1/2 mile south of Stavis Bay to Misery Pt. (Note: segment also includes a portion of the southwest shore of the Toandos Peninsula).	9,435
Estuarine/marine reach	Dose-R_ITZ	Dose east shore	Intertidal/shallow subtidal zone of the eastshore of Hood Canal extending from approx 1/2 mile south of Stavis Bay to Misery Pt. (Note: segment also includes a portion of the southwest shore of the Toandos Peninsula).	9,435
Estuarine/marine reach	Dose-L	Dabob deep	Deep water associated with the westshore of Hood Canal extending from Quatsap Pt. to Pulali Pt. within Dabob Bay. Dosewallips R. enters approx 1/2 way along segment shoreline.	30,433
Estuarine/marine reach	Dose-L_ITZ	Dose west shore	Intertidal/shallow subtidal zone of the westshore of Hood Canal extending from Quatsap Pt. to Pulali Pt. within Dabob Bay. Dosewallips R. enters approx 1/2 way along segment shoreline.	30,433
Estuarine/marine reach	Duck-R	South HC deep	Deep water associated with the eastshore of Hood Canal extending from approx 0.6 miles south of Tekiu Pt. to approx 1/2 mile south of Stavis Bay.	11,399
Estuarine/marine reach	Duck-R_ITZ	Duck east shore	Intertidal/shallow subtidal zone of the eastshore of Hood Canal extending from approx 0.6 miles south of Tekiu Pt. to approx 1/2 mile south of Stavis Bay.	11,399
Estuarine/marine reach	Duck-L	South HC deep	Deep water associated with the westshore of Hood Canal extending from approx 1 1/2 mile south of Triton Head to Quatsap Pt. Duckabush R. enters in the northern part of the segment shoreline.	15,612
Estuarine/marine reach	Duck-L_ITZ	Duck west shore	Intertidal/shallow subtidal zone of the westshore of Hood Canal extending from approx 1 1/2 mile south of Triton Head to Quatsap Pt. Duckabush R. enters in the northern part of the segment shoreline.	15,612

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Estuarine/marine reach	Hamma-R	South HC deep	Deep water associated with the eastshore of Hood Canal extending from a point nearly due east of Ayock Pt (on westshore of Canal) to approx 0.6 miles south of Tekiu Pt. Anderson Cr. enters near the north end of the segment shoreline.	12,693
Estuarine/marine reach	Hamma-R_ITZ	Hamma east shore	Intertidal/shallow subtidal zone of the eastshore of Hood Canal extending from a point nearly due east of Ayock Pt (on westshore of Canal) to approx 0.6 miles south of Tekiu Pt. Anderson Cr. enters near the north end of the segment shoreline.	12,693
Estuarine/marine reach	Hamma-L	South HC deep	Deep water associated with the westshore of Hood Canal extending from approx 1/2 mile south of Ayock Pt. to approx 1 1/2 mile south of Triton Head. Hamma Hamma R. enters approx halfway along the segment shoreline.	14,103
Estuarine/marine reach	Hamma-L_ITZ	Hamma west shore	Intertidal/shallow subtidal zone of the westshore of Hood Canal extending from approx 1/2 mile south of Ayock Pt. to approx 1 1/2 mile south of Triton Head. Hamma Hamma R. enters approx halfway along the segment shoreline.	14,103
Estuarine/marine reach	Dewatto-R	South HC deep	Deep water associated with the eastshore of Hood Canal extending from appox 1/2 mile north of Red Bluff on south to a point nearly due east of Ayock Pt (on westshore of Canal). Dewatto R. enters approx halfway along the segment shoreline.	14,166
Estuarine/marine reach	Dewatto-R_ITZ	Dewatto east shore	Intertidal/shallow subtidal zone of the eastshore of Hood Canal extending from appox 1/2 mile north of Red Bluff on south to a point nearly due east of Ayock Pt (on westshore of Canal). Dewatto R. enters approx halfway along the segment shoreline.	14,166
Estuarine/marine reach	Dewatto-L	South HC deep	Deep water associated with the westshore of Hood Canal extending from near Miller Creek on the south to approx 1/2 mile south of Ayock Pt. Lilliwaup Cr. enters approx halfway along the segment shoreline.	13,156
Estuarine/marine reach	Dewatto-L_ITZ	Dewatto west shore	Intertidal/shallow subtidal zone of the westshore of Hood Canal extending from near Miller Creek on the south to approx 1/2 mile south of Ayock Pt. Lilliwaup Cr. enters approx halfway along the segment shoreline.	13,156

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Estuarine/marine reach	Skok-R	South HC deep	Deep water associated with the north and eastshore of Hood Canal encompassing the Great Bend, extending from near Shoofly Creek on the east to appox 1/2 mile north of Red Bluff on the west bank of Hood Canal.	22,991
Estuarine/marine reach	Skok-R_ITZ	Skok east shore	Intertidal/shallow subtidal zone of the north and eastshore of Hood Canal encompassing the Great Bend, extending from near Shoofly Creek on the east to appox 1/2 mile north of Red Bluff on the west bank of Hood Canal.	22,991
Estuarine/marine reach	Skok-L	South HC deep	Deep water associated with the south and westshore of Hood Canal encompassing the Great Bend, extending from near Twanoh Creek on the east to near Miller Creek on the west bank of Hood Canal.	33,356
Estuarine/marine reach	Skok-L_ITZ	Skok west shore	Intertidal/shallow subtidal zone of the south and westshore of Hood Canal encompassing the Great Bend, extending from near Twanoh Creek on the east to near Miller Creek on the west bank of Hood Canal.	33,356
Estuarine/marine reach	Union-R	South HC deep	Deep water associated with northshore of Hood Canal extending from inner Lynch Cove on the east to a small promontory immediately east of Shoofly Creek.	13,463
Estuarine/marine reach	Union-R_ITZ	Union north shore	Intertidal/shallow subtidal zone of northshore of Hood Canal extending from inner Lynch Cove on the east to a small promontory immediately east of Shoofly Creek.	13,463
Estuarine/marine reach	Union-O	South HC deep	Deep water associated with inner Lynch Cove at terminus of Hood Canal.	5,801
Estuarine/marine reach	Union-O_ITZ	Belfair shallow	Intertidal/shallow subtidal zone of inner Lynch Cove at terminus of Hood Canal.	5,801
Estuarine/marine reach	Union-L	South HC deep	Deep water associated with southshore of Hood Canal extending from inner Lynch Cove on the east to a small promontory immediately east of Twanoh Creek.	12,491
Estuarine/marine reach	Union-L_ITZ	Union south shore	Intertidal/shallow subtidal zone of southshore of Hood Canal extending from inner Lynch Cove on the east to a small promontory immediately east of Twanoh Creek.	12,491
Subestuarine reach	Jimmy Est	Jimmycomelately subestuary	Jimmycomelately Cr: Jimmycomelately Creek subestuary	141
Freshwater reach	Jimmy-1	Jimmycomelately FW	Jimmycomelately Cr: Upstream extent of tidal influence to Highway 101 crossing	322

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Freshwater reach	Jimmy-2	Jimmycomelately FW	Jimmycomelately Cr: Highway 101 crossing to USGS gauging station at approximately RM 1.05	1,287
Freshwater reach	Jimmy-3A	Jimmycomelately FW	Jimmycomelately Cr: USGS gauging station to end of presumed historic summer chum distribution at RM 1.5	644
Subestuarine reach	SnoSalm Est	Snow-Salmon subestuary	Snow-Salmon Crs: Snow and Salmon creeks subestuary	282
Freshwater reach	Salmon-2B	Salmon FW	Salmon Cr: Upstream extent of tidal influence to RM Trib 0247	322
Freshwater reach	Salmon-3	Salmon FW	Salmon Cr: RB Trib 0247 to RB Trib 0248	1,529
Freshwater reach	Salmon-4	Salmon FW	Salmon Cr: RB Trib 0248 to LB Trib 0249	402
Freshwater reach	Salmon-5	Salmon FW	Salmon Cr: RB Trib 0249 to RB Trib 0253	80
Freshwater reach	Salmon-6	Salmon FW	Salmon Cr: RB Trib 0253 to cascade/falls at RM 2.0	724
Freshwater reach	Snow-1	Snow FW	Snow Cr: Upper extent of tidal influence (approx RM 0.1) to Highway 101 crossing (approx RM 0.2)	161
Freshwater reach	Snow-2	Snow FW	Snow Cr: Highway 101 crossing to fish trap at RM 0.8	965
Freshwater reach	Snow-3 (weir)	Snow FW	Snow Cr: Fish trap and weir at RM 0.8	0
Freshwater reach	Snow-4	Snow FW	Snow Cr: Fish trap to LB Trib 0220	1,931
Freshwater reach	Snow-5	Snow FW	Snow Cr: LB Trib 0220 to confluence with RB trib 0021 (Andrews Cr.)	2,414
Subestuarine reach	Quilcene Est	Quilcene subestuary	Big and Little Quilcene Rs: Big and Little Quilcene rivers subestuary	563
Freshwater reach	Little Quil-1	Little Quil FW	Little Quilcene R: Upstream end of tidal influence (approx RM 0.2) to Center Rd (approx RM 0.8)	965
Freshwater reach	Little Quil-2	Little Quil FW	Little Quilcene R: Center Rd to Leland Cr	1,448
Freshwater reach	Little Quil-3	Little Quil FW	Little Quilcene R: Leland Cr to RB Trib 0082	402
Freshwater reach	Little Quil-4	Little Quil FW	Little Quilcene R: RB Trib 0083 to RB Trib 0085	1,207
Freshwater reach	Big Quil-1	Big Quil FW	Big Quilcene R: Upstream end of tidal influence (approx RM 0.1) to Linger-Longer Rd	885
Freshwater reach	Big Quil-2	Big Quil FW	Big Quilcene R: Linger-Longer Rd to RB Trib 0013	2,655
Freshwater reach	Big Quil-3	Big Quil FW	Big Quilcene R: RB Trib 0013 to Penny Cr	885
Freshwater reach	Big Quil-3A (weir)	Big Quil FW	Big Quilcene R: Weir at Quilicene Hatchery	0
Freshwater reach	Big Quil-4	Big Quil FW	Big Quilcene R: Penny Cr to gradient steepening at RM 5.0	1,046
Subestuarine reach	Dose Est	Dose subestuary	Dosewallips R: Doeswallips subestuary	840

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Freshwater reach	Dose 1	Dose lower FW	Dosewallips R: Upstream extent of tidal influence to upstream extent of floodplain development.	4,023
Freshwater reach	Dose 2	Dose mid FW	Dosewallips R: Upstream extent of floodplain development to Rocky Brook confluence	1,448
Freshwater reach	Dose 3a	Dose mid FW	Dosewallips R: Rocky Brook confluence to upstream extent of summer chum spawning at approximately RM 4.3 (WDF catalog)	1,126
Subestuarine reach	Duck Est	Duck subestuary	Duckabush R: Duckabush subestuary	1,447
Freshwater reach	Duck 1	Duck lower FW	Duckabush R: Upstream extent of tidal influence to to upstream extent of revetments	1,287
Freshwater reach	Duck 2	Duck lower FW	Duckabush R: Upstream extent of revetments to Johnson Creek (WRIA 16.0355; hatchery).	2,092
Freshwater reach	Duck 3a	Duck mid FW	Duckabush R: Johnson Creek to Ranger Hole at approx RM 3.8.	2,414
Subestuarine reach	Ham Est	Hamma subestuary	Hamma Hamma R: Hamma Hamma subestuary	753
Freshwater reach	Hamma 1	Hamma main FW	Hamma Hamma R: Upstream extent of tidal influence to John Creek confluence	1,770
Freshwater reach	John Creek 1	John Cr FW	John Creek : Confluence With Hamma to S. Branch John Cr	1,931
Freshwater reach	John Creek 2	John Cr FW	John Creek : Confluence S. Branch John Cr. to 800' upstream of confluence (reach incl. S. Branch John Creek)	322
Freshwater reach	Hamma 2	Hamma main FW	Hamma Hamma R: John Creek to gradient change 1800' upstream	483
Freshwater reach	Hamma 3a	Hamma main FW	Hamma Hamma R: Gradient change to upper extent of summer chum spawning at approx RM 2.0	644
Subestuarine reach	Lilliwaup Est	Lilliwaup subestuary	Lilliwaup Cr: Lilliwaup Creek subestuary	741
Freshwater reach	Lilliwaup-2B	Lilliwaup FW	Lilliwaup Cr: Upper extent of tidal influence at approx RM 0.3 to LB Trib 0231	322
Freshwater reach	Lilliwaup-3	Lilliwaup FW	Lilliwaup Cr: LB Trib 0231 to cascade/falls at RM 0.7	322
Subestuarine reach	Union Est	Union subestuary	Union R: Union River subestuary	2,293
Freshwater reach	Union-1	Union lower FW	Union R: Upper extent of tidal influence to LB Trib 0504	80
Freshwater reach	Union-2	Union lower FW	Union R: LB Trib 0504 to Courtney Cr	2,253
Freshwater reach	Courtney-1	Courtney FW	Courtney Cr: Confluence with Union R to cascade/falls at approximately RM 0.7	1,126

Reach/segment type	Reach/segment name	Geographic area name	Description	Length (m)
Freshwater reach	Union-3	Union mid FW	Union R: Courtney Cr to RB Trib 0507	1,046
Freshwater reach	Union-4	Union mid FW	Union R: RB Trib 0507 to RB Trib 0508	1,529
Freshwater reach	Union-5	Union mid FW	Union R: RB Trib 0508 to LB Trib 0509	724
Freshwater reach	Union-6	Union mid FW	Union R: RB Trib 0509 to Bear Cr	965
Freshwater reach	Union-7	Union upper FW	Union R: Bear Cr to LB Trib 0512	402
Freshwater reach	Union-8	Union upper FW	Union R: LB Trib 0512 to EF Union R	1,207
Freshwater reach	Union-9	Union upper FW	Union R: EF Union r to base of McKenna Falls at approx RM 6.7	2,977