

FINAL  
 Three Year Review of the Lower Columbia River Natural Coho  
 Abundance-based Harvest Matrix  
 March 7, 2019

At its November 2014 meeting, the Pacific Fishery Management Council (Council) proposed to update the harvest control rule for Lower Columbia River (LCR) natural coho salmon for salmon fisheries in 2015 and beyond (McIsaac 2015). The control rule identifies exploitation rate limits based on two levels of parental escapement and five levels of marine survival (a 2 x 5 harvest matrix), see Table 1.

Table 1. Harvest management matrix for LCR natural coho showing allowable fishery exploitation rates based on parental escapement and marine survival index.

Parental Escapement (rate of full seeding)		Marine Survival Index (based on return of jacks per hatchery smolt)					
		Very Low ( $\leq 0.06\%$ )	Low ( $\leq 0.08\%$ )	Medium ( $\leq 0.17\%$ )	High ( $\leq 0.40\%$ )	Very High ( $> 0.40\%$ )	
Normal	$\geq 0.30$	10%	15%	18%	23%	30%	Allowable exploitation rate
Very Low	$< 0.30$	$\leq 10\%$	$\leq 15\%$	$\leq 18\%$	$\leq 23\%$	$\leq 30\%$	

Subsequently, in 2015 NOAA’s National Marine Fishery Service (NMFS) issued a biological opinion under the authority of Section 7 of the Endangered Species Act (ESA), evaluating the proposed harvest impacts of implementing the new harvest control rule on the ESA-listed LCR Coho Salmon Evolutionarily Significant Unit (ESU). NMFS concluded in the biological opinion that the proposed update to the control rule was not likely to jeopardize the continued existence of the LCR Coho Salmon ESU (NMFS 2015). The LCR Coho Salmon ESU is synonymous with the Lower Columbia River natural coho stock (LCN coho) in the Fishery Management Plan. The opinion concurred with the recommendation from the Council to assess the performance of the harvest matrix every three years as a check on projected results and any changes in key presumptions.

This report comprises our review. We invited comment between the November 2018 Council meeting and February 1, 2019 prior to finalizing this review. We received no written comments.

This harvest control rule depends on parental escapement and marine survival of the LCN wild coho stock. In Table 1 the average seeding level of parental escapement is expressed as a percentage of the full seeding level. If a particular parental escapement was greater than 100 percent of full seeding it is set at 100 percent. For example in 2014 the parental escapement of the Clatskanie population was 3,246 (Table 2) which calculates to 270 percent of the full seeding level, but is instead set at 100 percent. The parental seeding level then used to establish the tiers in the matrix is the average seeding levels of ten LCN coho salmon populations (McIsaac 2015). The ten primary populations are: Clatskanie, Scappoose, Elochoman/Skamokawa,

Grays/Chinook, Clackamas, Sandy, Lower Cowlitz, Toutle, Coweeman, and East Fork Lewis.

Full seeding levels for Oregon populations were defined based on a combination of stock-recruitment and habitat analyses. Full seeding levels for Washington populations were defined as equilibrium abundance in stock-recruitment parameters inferred with the Ecosystem Diagnosis and Treatment Model from assessments of the available habitat quantity and quality (Beamesderfer et al. 2014). In the event that LCN coho salmon average spawning escapements fall below 30 percent of full seeding when considered as an average of the ten reference populations, the Council would then work to the extent possible to minimize LCN coho salmon exploitation rates on adult returns from the corresponding brood year. In no case would the exploitation rate exceed the exploitation rate for a given marine survival index category.

Table 2 indicates that contributing parental brood year escapement levels have been in the normal category and generally well above the 30 percent criterion since implementation of the new control rule in 2015.

Table 2. Annual LCN coho salmon parental escapements in 10 populations used to determine harvest matrix seeding level (full seeding determinations are described in Kern and Zimmerman 2013).

Populations	Year →	2012		2013		2014	
	Full seeding level	natural origin spawning escapement	% of full	natural origin spawning escapement	% of full	natural origin spawning escapement	% of full
Clatskanie	1,200	619	52%	611	51%	3,246	100%
Scappoose	1,200	210	18%	979	82%	1,587	100%
Elochoman/Skamokawa	2,429	505	21%	721	30%	4,158	100%
Grays/Chinook	1,113	795	71%	1,212	100%	3,700	100%
Clackamas	3,800	1,580	42%	3,202	84%	10,670	100%
Sandy	1,200	1,165	97%	667	56%	5,942	100%
Lower Cowlitz <sup>1</sup>	3,890	6,274	100%	3,394	87%	1,565	40%
Toutle <sup>2</sup>	3,164	3488	100%	6846	100%	17557	100%
Coweeman	931	2,964	100%	4,047	100%	5,021	100%
East Fork Lewis	568	3,681	100%	3,251	100%	2,531	100%
Average			70%		79%		94%

1. Lower Cowlitz full-seeding and spawner estimates are for tributary habitat only and do not include the main stem river.
2. Composite Toutle coho population includes both the North Fork/Green population and South Fork Toutle population.

Table 3 lists the annual pre- and postseason return of LCN coho salmon since 2015 along with the associated marine survival index and exploitation rate. Returns of Lower Columbia hatchery adult coho are highly correlated with the marine survival index based on jack returns per smolts – indicating that this marine survival index predicts marine conditions which likely affect both hatchery and wild coho. For context, the recent 10-year average abundance estimate for LCN coho salmon was 29,200 (PFMC 2018b, Table III-1).

Table 3. Annual LCN coho salmon stock pre- and post-season returns and resulting exploitation rates (from PFMC 2018a and PFMC 2018b).

Year	Average Parental Escapement (rate of full seeding)	Marine Survival Index	Preseason LCN coho forecast	Postseason LCN coho run	Exploitation Rate limit preseason	Exploitation Rate achieved <sup>1</sup>
2015	Normal	High	35,900	20,900	23.0%	24.4%
2016	Normal	Medium	40,000	16,000	18.0%	8.9%
2017	Normal	Medium	30,100	31,200	18.0%	10.8%

<sup>1</sup> Calculated total exploitation on LCN coho salmon in all fisheries in the ocean and in the Columbia River below Bonneville Dam. These are estimated using the Fisheries Regulation Assessment Model (FRAM) which is currently used by the Council to annually estimate impacts of proposed ocean and terminal fisheries on Chinook and coho salmon stocks.

The exploitation rate estimates in Table 3 include harvest from all fisheries in marine waters and the Columbia River, below Bonneville Dam. Ongoing monitoring efforts continue to be directed at gathering consistent natural population status and trends (e.g., abundance numbers, age composition, hatchery fractions, and productivity). Escapement information gathered over the last four or five year shows no substantive changes in abundance or hatchery fractions that are inconsistent with previous trends (Table 4, Table 5). As evidenced by blank columns, escapement data for 14 populations in Table 5 were not previously monitored, but are now tracked including six populations which are included in the tier selection. Tracking escapement of these populations is expected to continue since they are now part of the tier selection calculations. Updated spawning abundances come from either the Washington Department of Fish and Wildlife’s Salmon Conservation and Reporting Engine or Oregon Department of Fish and Wildlife’s Salmon and Steelhead Recovery Tracker online databases.

Since implementing the new harvest control rule, abundance forecasts for LCN coho salmon have been tracking above the 10 year average at 35,300 between 2015 and 2017. Because abundance forecasts have been high, fisheries have been managed subject to a 23 percent or an 18 percent exploitation rate limit (Table 3) depending on the marine survival index for that year. Post season estimates of abundance indicate that the abundance was over forecast in two of the three years. Preliminary post season estimates based on FRAM model analysis indicate that exploitation rates exceeded the preseason limit in 2015 but were subsequently well below the limit in 2016 and 2017, indicating the approach is risk averse to forecast error. When more data points allow for a more comprehensive review, the review should include comparisons of the estimates of exploitation rates from FRAM to population specific independent exploitation rate estimates derived from coded-wire tag groups that are now being used to track the new status information on the additional populations being monitored. Trends in pHOS should also be

evaluated once more data points associated with the new control rule are available. Council fisheries harvesting LCN coho are broadly mark selective and the long-term expectation is that levels of pHOS will decline from historically high averages.

Table 4. Natural-origin spawning escapement numbers and the proportion of natural spawners composed of hatchery-origin fish (pHOS<sup>1</sup>) on the spawning grounds for LCN coho salmon populations in Oregon from 2005 through 2016. (<http://www.odfwrecoverytracker.org/>)\*.

Major Population Group	Oregon Populations	Origin	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Coast	Youngs Bay	Natural	79	74	21	82	26	68	161	129	-	-	-	-
		pHOS	75%	84%	40%	22%	92%	61%	66%	46%	-	-	-	-
	Big Creek	Natural	219	225	212	360	792	279	160	409	-	-	-	-
		pHOS	36%	50%	15%	54%	30%	52%	21%	18%	-	-	-	-
	Clatskanie	Natural	494	421	927	995	1,195	1,686	1,546	619	611	3,246	240	464
		pHOS	1%	10%	4%	0%	1%	3%	1%	11%	11%	4%	4%	6%
	Scappoose	Natural	348	719	375	292	778	1,960	298	210	979	1,587	487	1,200
		pHOS	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
Cascade	Clackamas	Natural	1,301	3,464	3,608	1,694	7,982	1,757	2,254	1,580	3,202	10,670	1,784	1,628
		pHOS	28%	76%	14%	45%	27%	57%	10%	10%	2%	14%	11%	9%
	Sandy	Natural	856	923	687	1,277	1,493	901	3,494	1,165	667	5,942	443	939
		pHOS	0%	n/a	9%	0%	10%	12%	8%	3%	12%	3%	5%	3%
Gorge	Lower Gorge	Natural	263	226	126	223	468	920	216	96	151	362	30	395
		pHOS	85%	70%	67%	46%	29%	7%	54%	56%	6%	51%	38%	7%
	Upper Gorge/ Hood	Natural	1,262	373	170	69	65	223	232	169	561	42	4	57
		pHOS	45%	48%	45%	29%	0%	85%	69%	78%	65%	76%	64%	65%

<sup>1</sup> For example, Clatskanie in 2007 had 927 natural-origin spawners and 4% hatchery spawners. To calculate hatchery-origin numbers multiply  $(927/(1-.04))-583 = 39$  hatchery-origin spawners.

\*[http://www.odfwrecoverytracker.org/summary/#/species=1&run=2&esu=159/esu=159&metric=1&level=3/filter=160&start\\_year=1992&end\\_year=2017](http://www.odfwrecoverytracker.org/summary/#/species=1&run=2&esu=159/esu=159&metric=1&level=3/filter=160&start_year=1992&end_year=2017) Date accessed: October 4, 2017.

Table 5. Natural-origin spawning escapement numbers and the proportion of all natural spawners composed of hatchery-origin fish (pHOS<sup>1</sup>) on the spawning grounds for LCN coho salmon populations in Washington from 2005 through 2016. (<https://fortress.wa.gov/dfw/score/score/species/coho.jsp?species=Coho>)\*.

Major Population Group	Washington Populations	Origin	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Coast	Gray's/Chinook	Natural	-	-	-	-	-	303	125	518	668	2,158	125	454
		pHOS	-	-	-	-	-	84%	95%	50%	63%	37%	63%	57%
	Elochoman / Skamokawa	Natural	-	-	-	-	-	501	498	284	435	2,115	148	325
		pHOS	-	-	-	-	-	73%	57%	37%	42%	35%	47%	47%
	Mill Creek	Natural	-	-	-	-	-	859	576	207	101	932	-	-
		pHOS	-	-	-	-	-	12%	21%	2%	-	12%	-	-
	Abernathy	Natural	-	-	-	-	-	490	183	256	384	832	-	-
		pHOS	-	-	-	-	-	12%	21%	2%	-	12%	-	-
	Germany	Natural	-	-	-	-	-	322	48	122	149	475	-	-
		pHOS	-	-	-	-	-	12%	21%	2%	-	12%	-	-
Cascade	Lower Cowlitz	Natural	-	-	-	-	-	5,015	4,148	2,990	4,522	17,201	1,576	4,340
		pHOS	-	-	-	-	-	11%	9%	14%	21%	7%	9%	7%
	Upper Cowlitz/Cispus	Natural	22,329	25,574	5,691	13,805	16,162	2,906	7,877	1,689	4	6923	381	906
		pHOS	21%	18%	40%	26%	26%	87%	61%	75%	100%	77%	71%	91%
	Tilton	Natural	1,332	738	827	1,006	1,305	978	2,088	1,444	2,744	9,074	1,392	2,666
		pHOS	85%	69%	66%	64%	70%	72%	70%	78%	58%	39%	45%	66%
	SF Toutle	Natural	-	-	-	-	-	1,115	1,019	1,369	2,130	7,343	906	2,692
		pHOS	-	-	-	-	-	21%	16%	12%	15%	20%	48%	24%
	NF Toutle <sup>2</sup>	Natural	-	-	-	-	-	1,421	1,048	1,037	2,469	4,296	604	1,592
		pHOS	-	-	-	-	-	52%	30%	21%	20%	32%	57%	62%
	Coweeman	Natural	-	-	-	-	-	2,318	2,372	2,049	2,881	3,545	606	2,154
		pHOS	-	-	-	-	-	9%	5%	5%	12%	17%	23%	17%

Kalama	Natural	-	-	-	-	-	4	8	17	31	59	12	62	
	pHOS	-	-	-	-	-	99%	97%	90%	89%	91%	90%	76%	
NF Lewis <sup>3</sup>	Natural	-	-	-	-	-	1,537	1,026	545	662	1,016	160	427	
	pHOS	-	-	-	-	-	7%	11%	7%	27%	24%	22%	25%	
EF Lewis	Natural	-	-	-	-	-	1031	1,160	1,875	1,811	2,472	212	246	
	pHOS	-	-	-	-	-	25%	7%	7%	9%	18%	28%	58%	
Salmon Creek	Natural	-	-	-	-	-	2133	1,473	868	1,096	2,790	474	1,169	
	pHOS	-	-	-	-	-	8%	5%	4%	2%	1%	2%	2%	
Washougal	Natural	-	-	-	-	-	645	707	376	424	477	70	178	
	pHOS	-	-	-	-	-	40%	12%	14%	34%	71%	71%	75%	
Gorge	Lower Gorge	Natural	-	28	-	-	-	396	392	352	636	,1157	324	950
		pHOS	-	0%	-	-	-	25%	13%	15%	21%	30%	13%	7%
	Upper Gorge/ Hood	Natural	1,262	373	170	69	65	223	232	169	561	42	4	-
		pHOS	-	-	-	-	-	-	-	-	-	-	23%	24%

<sup>1</sup> For example, Mill Creek in 2010 had 859 natural-origin spawners and 12 % hatchery spawners. To calculate hatchery-origin numbers multiply  $(859/(1-.12)) - 859 = 117$  hatchery-origin spawners.

<sup>2</sup> Natural-origin escapement numbers and proportion of hatchery-origin fish combines the Green River (NF Toutle) coho salmon, the North Fork Toutle River coho salmon, and trap count data.

<sup>3</sup> Natural-origin escapement numbers and proportion of hatchery-origin fish combines the Cedar Creek (NF Lewis) coho salmon and the North Fork Lewis River Mainstem coho salmon.

\* Date accessed: October 4, 2017.

## References

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