

Salmon Methodology Review

Coded-Wire Tag Representation for Columbia River Summer Chinook in FRAM

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BACKGROUND

The current run of Columbia River summer Chinook produced in areas upstream of Priest Rapids Dam is descended from the Chinook populations that were blocked by construction of Grand Coulee Dam in 1939-41. The Grand Coulee Fish Maintenance Project was a federally funded program that was intended to relocate salmon runs blocked by the dam into tributaries located downstream via hatchery programs and adult fish transfers to spawning areas. Historically, upper Columbia summer Chinook were considered to be “ocean-type” fish that migrated to the ocean as fingerlings as opposed to “stream-type” which migrate as yearlings; a life history commonly associated with spring run Chinook. Production from the federal hatcheries funded under this program located on the Methow and Entiat rivers, and Icicle Creek (Wenatchee Basin) initially released several salmon species/runs but had limited success with most stocks and became entirely used for spring Chinook production in the mid-1970’s. Wells Hatchery located at the base of Wells Dam began operation in 1967 and has released summer Chinook and steelhead since then. Coded-wire tagging of summer Chinook from Wells Hatchery began in the late 1970’s and has continued as an annual program to produce tag groups to represent summer Chinook in fisheries exploitation analysis for all of the production in tributaries and mainstem areas upstream of Priest Rapids Dam. Hatchery supplementation in the upper Columbia was expanded in the late 1980’s to produce a wide range of salmon species/stocks including a significant number of yearling summer Chinook from acclimation ponds in the Wenatchee and Methow basins.

The Chinook Technical Committee (CTC) under the direction of the Pacific Salmon Commission (PSC) conducts an annual exploitation rate analysis of ongoing CWT indicator tag groups and these studies have shown a greater contribution of upper Columbia summer Chinook to marine area fisheries south of the U.S. and Canada border. Since the mid 1990’s, scale age readings have shown a substantial portion of the juvenile summer Chinook are overwintering in the mainstem Columbia reservoirs and out-migrating in the late winter/spring similar to a stream-type life history. As part of their annual exploitation rate analysis, the CTC uses a combination of yearling and fingerling coded-wire tag groups from Wells Hatchery when both release types have been tagged. A review of the CWT data representing upper Columbia summer Chinook was warranted given this information on life history patterns, increases in hatchery supplementation of fingerling and yearling production and results from the PSC CWT indicator tagging program.

METHOD

CODED-WIRE TAG GROUPS

The current FRAM base period dataset contains 1976-77 brood fingerling tag groups from Wells Hatchery (Table 1). Survival of these tag groups was relatively poor and may not have been high enough to provide recoveries in fisheries that were not in the main migration/rearing path of this stock. The number of recoveries of the proposed additional CWT groups is higher, especially for the yearling tag groups. The proposed CWT groups were selected because of their higher survival and availability across a wide range of fisheries in 2000-2005 including the Vancouver Island troll fishery that has a different season structure than during the base period. The blending of the recovery data from the base period tag groups with the recoveries from the new tag groups was done after the “Out-of-Base” (OOB) simulation process was performed on the new groups.

Table 1. Coded-wire tag release groups from Wells Hatchery used to represent Columbia River summer Chinook in FRAM Base Period data set.

Tag Code	Brood Year	Recoveries		
		Observed	Estimated	
Current Base Period Groups				
631607	1976 Fingerling	46	117	
631642	1976 Fingerling	173	322	
631762	1977 Fingerling	82	177	
Proposed Additional Groups				
631018	1998 Fingerling	147	350	
631061	1998 Yearling	3809	9171	
630267	1999 Fingerling	207	511	
630468	1999 Yearling	540	1581	
630775	2000 Fingerling	81	189	
630995	2000 Yearling	3018	8105	

OUT-OF-BASE SIMULATION AND FRAM BASE PERIOD DATASET

An estimate of the number of tags from the proposed groups that would have been recovered during the base period was calculated using OOB process. Available CWT data for the OOB tag groups are translated to equivalent base period recovery and escapement data using known fishing effort and harvest relationships between recovery years. For this OOB exercise, FRAM based fishing effort scalars from post season runs for the 2000-2005 fisheries were used to simulate the number of base period recoveries by fishery, age, and time period from the recoveries that did occur for the 1998-2000 brood

year tag groups. See MEW (2007b) for a more detailed description of the development of the Chinook base period data.

Because of the large differences in the number of tag recoveries between the base period fingerling groups and the OOB tag groups of fingerlings and yearlings, the estimated number of recoveries was adjusted to weight the base period and OOB tag data. Combining both base period and OOB tag data provides representation for Columbia summer Chinook across a wide range of fisheries and season structure. For the OOB broods, the number of fingerling recoveries by fishery, age, and time period were increased so that the sum was equal to the total recoveries for the yearling counterpart. This 1:1 relationship between fingerlings and yearlings is approximately the proportion observed in the scale readings from naturally produced summer Chinook in the upper Columbia River. The adjusted tag recoveries were then combined to produce a single dataset for each brood representing fingerling and yearling production. The simulated recoveries from each of the OOB brood groups were merged with the Wells Hatchery base period tag recovery data to create one recovery dataset representing Columbia River summer Chinook in FRAM.

Using this new dataset representing Columbia River summer Chinook, a new FRAM base period dataset was developed from a cohort reconstruction for each of the FRAM stocks using the calibration programs CHDAT and CHCAL (MEW 2007b).

BASE PERIOD COMPARISON

Exploitation and river return rates were compared for the two FRAM base period runs (Table 1). Exploitation rates were similar in northern fisheries (southeast Alaska and Other BC), but dramatically different for Vancouver Island. Some or all of this difference may be attributed to the different impact rates for the new tag groups as a result of the different season structure in the Vancouver Island troll fishery that began in the late 1990's. For the new base period, the exploitation rate in Council fisheries of 3.9% is more than double the current base period but is still below 5% total.

Adult equivalent total fishing mortality in Council fisheries does not show the same patchwork pattern using the new base period dataset as the current dataset that uses only 1976-77 brood tag recovery data (Table 2). Fishery mortalities are distributed more appropriately across time and fishery under the new base period. The presence or absence of impacts in adjacent fisheries is the strongest evidence that the current base period dataset is inadequate to properly represent impacts in Council fisheries.

Table 1. Chinook FRAM Base Period (BP) adult equivalent (AEQ) exploitation and river return rates for Columbia River summer Chinook.

Fishery/Region	Base Period Rates	
	Current BP	New BP
S.E. Alaska	0.165	0.157
Other BC	0.233	0.194
West Coast Vancouver Is.	0.135	0.329
Council-No. of Falcon	0.011	0.028
Council-So. of Falcon	0.006	0.011
Other U.S. marine	0.000	0.003
River Return (fisheries +esc.)	0.448	0.278

Table 2. AEQ total mortality for Columbia River summer Chinook during the FRAM Base Period.

PFMC Fishery	Current Base Period					New Base Period				
	Time 1 Oct-Apr	Time 2 May-Jun	Time 3 Jul-Sep	Time 4 Oct-Apr	Annual Total	Time 1 Oct-Apr	Time 2 May-Jun	Time 3 Jul-Sep	Time 4 Oct-Apr	Annual Total
NT Area 3,4 Trl	0	0	0	0	0	0	97	123	0	220
T Area 3,4 Trl	183	1	8	183	192	160	23	34	160	217
NT Area 3,4 Spt	0	0	0	0	0	0	4	16	0	20
NT Area 2 Trl	0	0	0	0	0	0	250	161	0	411
T Area 2 Trl	0	0	0	0	0	0	3	3	0	6
NT Area 2 Spt	0	406	12	0	418	0	543	238	0	781
Area 1 Trl	0	0	0	0	0	0	420	48	0	468
Area 1 Spt	0	0	0	0	0	0	61	239	0	300
Central OR Trl	0	136	16	0	152	4	469	101	4	574
Central OR Spt	0	1	198	0	199	0	29	139	0	168
KMZ Troll	0	0	0	0	0	1	6	1	1	8
KMZ Spt	0	0	0	0	0	0	64	3	0	67
Ca Troll	0	0	0	0	0	0	14	1	0	15
Ca Spt	0	0	0	0	0	78	6	3	78	87

Comparisons in exploitation rates were made to the rates estimated by the CTC during their annual exploitation rate analysis process. Exploitation rates estimated by CTC for yearling CWT groups (Table 3) and fingerling (Table 4) show the annual variability that occurs by analyzing ongoing CWT indicator tag groups. Rates in Council fisheries are generally low (<10%) with rates for yearlings slightly higher (but not significant) than fingerlings. Generally, exploitation rates during 2001-05 were higher in Council fisheries than those during the adjacent years. The new base period data combines new and old tag groups so the effect of these higher impact years is dampened in the dataset that is intended to cover an “average” condition.

Exploitation rates using the current and new base period FRAM datasets were also compared to the CTC’s annual CWT estimates of exploitation for 2003-08 (Table 5). Because of the annual variability in exploitation rates using ongoing CWT tag groups, it is unlikely the FRAM estimates will exactly match the CTC rates for any given year. On average though, the exploitation rate range for a fishery/region should be similar. Percentage of the marine area impacts in the 2003-07 fisheries occurring in the northern fisheries (Alaska and Canadian combined) was similar between the new base period and CTC estimates (86% vs 82% of marine fishery impacts, respectively) although the rates in each of the component fisheries differed considerably. Impacts in Council fisheries measured as exploitation rates or as percentage of marine area impacts were similar between the new base period model runs and the CTC estimates and both were much higher than the values using the current base period data for 2003-07.

CONCLUSIONS:

- 1. The current FRAM base period dataset that uses only 1976-77 brood fingerling CWT groups from Wells Hatchery does not adequately represent all life history types of Columbia River summer Chinook.**
- 2. The low survival and low number of recoveries for 1976-77 brood fingerling CWTs probably contributed to the patchwork pattern of recoveries in Council fisheries during the base period years.**
- 3. Combining the tag recovery data from the original base period CWT groups with recovery data simulated back to the base period for 1998-2000 brood fingerling and yearling groups would provide better estimates of impacts to Columbia River summer Chinook covering a broad range of season structure in Council area and northern area fisheries.**

Supplementary Reference

MEW. 2007b. Chinook FRAM Base Data Development (Document prepared for the Council and its advisory entities). Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384.

Table 3. Distribution of total fishing mortality and escapement for PSC CWT indicator tag groups representing Columbia River yearling summer Chinook.

Catch Year	AK-BC	PFMC		Other		Escapement	Estimated CWT's		
		North of Falcon	South of Falcon	So.US Marine	Terminal		Catch	Esc	Total
1986	30%	10%	0%	0%	13%	47%	14	14	28
1987	29%	8%	18%	4%	7%	34%	47	34	81
1988	44%	3%	0%	2%	18%	33%	156	97	253
1989	35%	11%	5%	4%	8%	37%	371	251	622
1990	42%	4%	4%	1%	10%	39%	491	352	843
1991	17%	3%	1%	1%	4%	74%	175	533	708
1992	41%	3%	3%	3%	1%	50%	124	141	265
1993	26%	6%	2%	0%	3%	64%	62	120	182
1994	35%	0%	0%	0%	0%	65%	5	15	20
1995	13%	0%	0%	5%	0%	82%	16	143	159
1996	31%	0%	2%	2%	6%	59%	104	247	351
1997	15%	0%	3%	0%	2%	80%	228	1028	1256
1998	15%	1%	1%	0%	5%	78%	276	1130	1406
1999	34%	6%	5%	0%	5%	51%	242	352	594
2000 a/	45%	3%	3%	1%	3%	45%	868	931	1799
2001 a/	39%	10%	11%	1%	2%	37%	3834	2668	6502
2002 a/	56%	7%	6%	0%	3%	28%	6983	3034	10017
2003 a/	55%	3%	5%	0%	9%	29%	4717	2101	6818
2004 a/	37%	4%	7%	3%	22%	27%	2920	1229	4149
2005 a/	30%	2%	4%	0%	15%	48%	4414	4459	8873
2006	26%	2%	1%	0%	19%	52%	1813	2108	3921
2007	18%	2%	1%	0%	16%	63%	1959	3622	5581
2008	11%	1%	0%	0%	35%	53%	438	518	956
1985-2008	30%	4%	3%	1%	13%	49%			
1979-1984	0%	0%	0%	0%	0%	0%			
1985-1995	28%	4%	3%	2%	15%	48%			
1996-1998	20%	0%	2%	1%	4%	72%			
1999-2008	35%	4%	4%	0%	13%	43%			

a/ Catch years associated with 1998-2000 brood year CWT groups

Table 4. Distribution of total fishing mortality and escapement for PSC CWT indicator tag groups representing Columbia River fingerling summer Chinook.

Catch Year	AK-BC	PFMC		Other		Escapement	Estimated CWT's		
		North of Falcon	South of Falcon	So.US Marine	Terminal		Catch	Esc	Total
1979	63%	3%	4%	0%	4%	27%	110	54	164
1980	67%	2%	0%	0%	1%	30%	222	109	331
1981	38%	1%	0%	0%	1%	60%	123	189	312
1982	46%	0%	0%	0%	0%	54%	11	13	24
1983	--	--	--	--	--	--	0	0	0
1984	--	--	--	--	--	--	0	0	0
1985	30%	0%	0%	0%	0%	70%	3	7	10
1986	59%	0%	0%	0%	20%	21%	37	12	49
1987	49%	0%	13%	0%	26%	13%	36	6	42
1988	--	--	--	--	--	--	8	0	8
1989	--	--	--	--	--	--	0	7	7
1990	--	--	--	--	--	--	4	1	5
1991	14%	14%	0%	0%	0%	73%	6	16	22
1992	29%	6%	0%	0%	12%	53%	8	9	17
1993	53%	0%	0%	0%	7%	40%	16	12	28
1994	29%	0%	0%	0%	24%	47%	9	8	17
1995	--	--	--	--	--	--	0	0	0
1996	--	--	--	--	--	--	0	1	1
1997	56%	0%	0%	0%	2%	42%	17	18	35
1998	6%	0%	0%	0%	27%	67%	20	47	67
1999	26%	7%	4%	0%	0%	63%	60	157	217
2000 a/	46%	0%	1%	0%	2%	51%	261	318	579
2001 a/	40%	3%	9%	0%	9%	40%	161	132	293
2002 a/	52%	5%	8%	0%	6%	29%	252	125	377
2003 a/	62%	2%	6%	0%	8%	22%	299	100	399
2004 a/	25%	3%	9%	0%	19%	44%	242	211	453
2005 a/	28%	3%	6%	0%	8%	55%	320	427	747
2006	17%	0%	2%	0%	23%	58%	184	286	470
2007	20%	1%	0%	0%	15%	63%	191	381	572
2008	12%	2%	1%	0%	24%	61%	189	319	508
1979-2008	32%	2%	2%	0%	10%	43%			
1979-1984	36%	1%	1%	0%	1%	29%			
1985-1995	33%	2%	1%	0%	15%	40%			
1996-1998	21%	0%	0%	0%	10%	70%			
1999-2008	33%	3%	5%	0%	11%	49%			

a/ Catch years associated with 1998-2000 brood year CWT groups

Table 5. AEQ exploitation rates for Columbia River summer Chinook from FRAM post season runs and PSC Chinook Technical Committee (CTC) CWT analysis.

Fishery	2003 Fishing Year				2004 Fishing Year				2005 Fishing Year			
	Current BP	New BP	CTC CWT Fing	CTC CWT Yrlng	Current BP	New BP	CTC CWT Fing	CTC CWT Yrlng	Current BP	New BP	CTC CWT Fing	CTC CWT Yrlng
S.E. Alaska	0.083	0.096	0.288	0.289	0.090	0.124	0.106	0.160	0.093	0.122	0.123	0.097
Other BC	0.313	0.231	0.119	0.143	0.302	0.200	0.044	0.073	0.302	0.147	0.063	0.089
WCVI	0.038	0.177	0.208	0.117	0.048	0.133	0.100	0.136	0.059	0.228	0.090	0.114
PFMC NoF	0.002	0.031	0.020	0.031	0.003	0.030	0.027	0.043	0.002	0.046	0.032	0.024
PFMC SoF	0.028	0.093	0.064	0.046	0.028	0.037	0.094	0.071	0.030	0.053	0.061	0.042
Other U.S. marine	0.000	0.005	0.000	0.001	0.000	0.002	0.000	0.026	0.000	0.003	0.000	0.002
River Rtn	0.536	0.368	0.301	0.373	0.529	0.474	0.628	0.489	0.513	0.403	0.631	0.632
Fishery	2006 Fishing Year				2007 Fishing Year				2008 Fishing Year			
	Current BP	New BP	CTC CWT Fing	CTC CWT Yrlng	Current BP	New BP	CTC CWT Fing	CTC CWT Yrlng	Current BP	New BP	CTC CWT Fing	CTC CWT Yrlng
S.E. Alaska	0.104	0.125	0.057	0.109	0.126	0.171	0.102	0.098	0.089	0.121	0.094	0.073
Other BC	0.280	0.238	0.029	0.042	0.367	0.298	0.035	0.024	0.318	0.174	0.013	0.012
WCVI	0.032	0.085	0.086	0.104	0.032	0.091	0.066	0.052	0.026	0.108	0.015	0.020
PFMC NoF	0.001	0.027	0.002	0.019	0.001	0.024	0.013	0.017	0.002	0.023	0.021	0.010
PFMC SoF	0.009	0.011	0.018	0.010	0.013	0.020	0.005	0.015	0.000	0.000	0.008	0.001
Other U.S. marine	0.000	0.003	0.000	0.002	0.000	0.003	0.000	0.001	0.001	0.002	0.000	0.000
River Rtn	0.573	0.512	0.809	0.713	0.461	0.394	0.780	0.792	0.565	0.571	0.848	0.883
Fishery	2003-07 Average			Fishery	2003-07 Average % of Marine Area Fisheries							
	Current BP	New BP	CTC Fing+Yrlng		Current BP	New BP	CTC Fing+Yrlng					
S.E. Alaska	0.099	0.128	0.143	S.E. Alaska	0.208	0.224	0.371					
Other BC	0.313	0.223	0.066	Other BC	0.655	0.390	0.171					
WCVI	0.042	0.143	0.107	WCVI	0.088	0.250	0.279					
PFMC NoF	0.002	0.032	0.023	PFMC NoF	0.004	0.055	0.059					
PFMC SoF	0.022	0.043	0.043	PFMC SoF	0.045	0.075	0.111					
Other U.S. marine	0.000	0.003	0.003	Other U.S. ma	0.000	0.006	0.008					
River Rtn	0.522	0.430	0.615	Marine Fish	1.000	1.000	1.000					