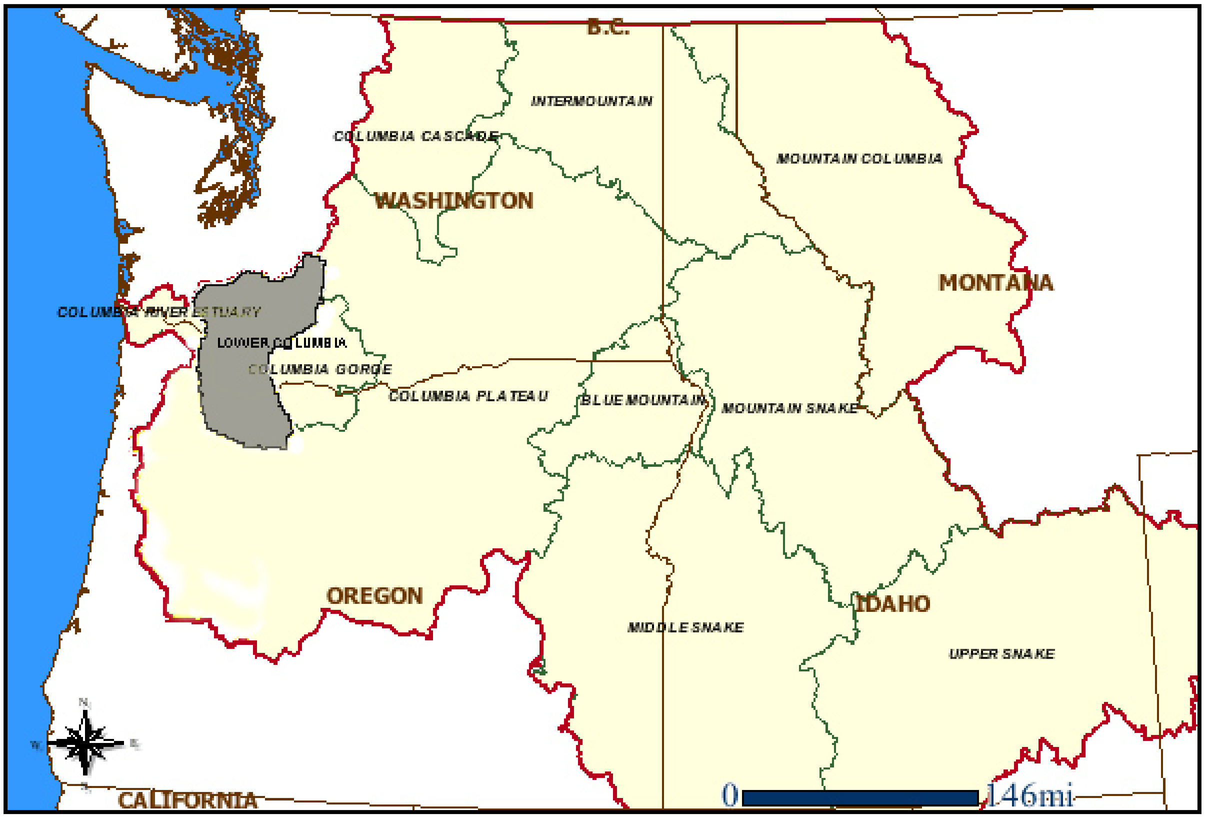
U.S. Fish and Wildlife Service - Pacific Region
Columbia River Basin Hatchery Review Team

Columbia River Basin, Lower Columbia Province

Clackamas River Watershed



Eagle Creek National Fish Hatchery
Assessments and Recommendations

Final Report, Appendix A:
All-H Analyzer (AHA) Output for Salmon and Steelhead Stocks

July 2007

Appendix A: All-H Analyzer (AHA) Output for Salmon and Steelhead Stocks in the Clackamas River

What is AHA?

AHA is an *Excel*-based spreadsheet simulation model that quantifies the mean number of adults returning to a watershed after many generations (years) of reproduction and migration based on equilibrium, or near equilibrium, conditions. Recent versions of AHA (Versions 6.x and 7.x) for the Columbia River allocate returning adults to six physical geographic locations: (1) a hatchery and other recapture facilities within the watershed under consideration; (2) the natural habitat within the watershed where adults spawn; (3) marine harvest areas; (4) the lower Columbia River mainstem downstream from Bonneville Dam; (5) the upper Columbia River mainstem upstream from Bonneville Dam, and (5) a terminal harvest area in the watershed where adults return to spawn. The model was developed primarily by Lars Mobrand (Mobrand Biometrics), in collaboration with the Washington Department of Fish and Wildlife (WDFW) and the Northwest Indian Fisheries Commission (NWIFC), as part of the HSRG review[1] of salmon and steelhead hatcheries in Puget Sound and coastal Washington state.

AHA is based on the Beverton-Holt spawner-recruit model where habitat *capacity* represents the maximum number of adult recruits (asymptote of the Beverton-Holt curve) that the habitat can produce, and *productivity* represents the slope of the spawner-recruit curve at the origin (i.e., the number of adult recruits per adult spawner [*R/S*] when the number of adult spawners is very low and density-dependent factors or competition can be ignored). The actual model (spreadsheet) consists of several sheets (e.g. natural component sheet, hatchery component sheet, genetic fitness sheet, etc.) where estimated mean values of biological and population dynamic parameters are provided by the user (e.g. mean fecundity of females, estimated egg-to-smolt survival, etc.). The genetic fitness function is based on the model of Ford (2002)[2] and allows the mean fitness of a population (productivity) to decrease incrementally over time depending on (a) the mean proportion of natural spawners composed of hatchery-origin adults (*pHOS*) relative to the mean proportion of the hatchery broodstock composed of natural-origin adults (*pNOB*), and (b) the number of generations that hatchery-origin fish spawn naturally in the watershed. The model is currently being used by fishery comanagers in the Pacific Northwest as a “planning tool” to (a) document assumptions and goals (e.g. current and future habitat conditions, respectively) and (b) assess the likelihood that harvest and conservation goals can be achieved given the aforementioned assumptions and desired future conditions. Only those scenarios achieving realistic or desired outcomes are considered valid. For example, any scenario that results in extirpation of a stock is considered invalid, where any or all of the four H’s[3] can contribute to stock extirpation.

For more detail on AHA, see AHA Technical Discussion Paper on the Publications page of www.hatcheryreform.org. An AHA user’s guide and all AHA analyses are available from the AHA section of the prototype Managing for Success web site at www.mobrand.com/mfs (log in with user

[1] www.hatcheryreform.org
[2] *Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16: 815-825.*
[3] *Habitat, Harvest, Hydropower effects, Hatchery program effects*

name and password "public"). The AHA User's Guide is also available at www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/.

Explanation of Tables A1-A6[4]

Information in the following tables (Tables A1-A6) is intended to provide a summary "snapshot" of the predicted future outcomes associated with the highest ranked alternatives considered by the Review Team. The AHA outputs summarized here were initially parameterized at a co-manager workshop (led by Lars Mobrand, formerly Mobrand Biometrics) on August 18, 2006. Six sets of simulations are presented: (1) coho salmon in the lower Clackamas River including Eagle Creek NFH coho; (2) coho salmon in the upper Clackamas River (natural population only); (3) steelhead in the lower Clackamas River, including Eagle Creek NFH steelhead; (4) steelhead in the upper Clackamas River including Clackamas State Hatchery steelhead; (5) Clackamas River fall Chinook (natural population only); and (6) Clackamas River spring Chinook, including Clackamas State Hatchery spring Chinook. The Review Team only examined program alternatives for Eagle Creek NFH coho and Eagle Creek NFH steelhead. Simulations representing different scenarios for the other four stocks/species only examined outcomes resulting from improved habitat conditions relative to "current" conditions and the maximum, recoverable habitat potentially available ("100% Recovery"). Habitat conditions were set at 25% and 50% of full recovery levels, largely reflecting short-term (25%) and mid to long-term goals (50-100%). The habitat parameters of "productivity" and "capacity" for each species were obtained from the values reported in the Willamette River Sub-Basin Plan[5] as estimated by the *Ecosystem Diagnosis and Treatment* model[6]. As a foundation for comparison, the Review Team included a "no hatchery" option under current conditions as one of the scenarios (alternatives) simulated to show the predicted equilibrium abundance of natural populations if the existing hatchery program was terminated. Only natural populations are simulated for fall Chinook and coho salmon in the upper Clackamas River. All other stocks/species are associated with a hatchery program, two of which are managed by ODFW and were not reviewed (upper Clackamas River "late-run" steelhead and Clackamas River spring Chinook).

Output of AHA is displayed in a series of colored bar graphs representing adult fish (recruits). Solid green represents natural-origin fish; solid pink represents hatchery-origin fish. Pink diagonal hash bars represent hatchery-origin fish in excess of comanager goals, and gray vertical bars represent hatchery-origin fish that have been selected at least one generation in the natural environment (e.g. as occurs in a genetically-integrated hatchery program).

The graph in the lower-left portion of each table shows the realized mean values of *pNOB* and *pHOS* (mean proportions of the hatchery broodstock and natural spawners composed of natural-origin adults and hatchery-origin adults, respectively). The diagonal lines represent combination values of *pNOB* and *pHOS* that yield the same value of the parameter, *PNI*, which stands for *proportional natural influence*, where *PNI = pNOB/(pNOB + pHOS)*. *PNI* varies from 0.0 to 1.0 and represents the relative degree to which the genetic constitution of hatchery-origin fish and/or natural-origin fish are influenced by the natural environment versus the hatchery environment. When *pHOS* = 0.0 and *pNOB*

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[4] *Parameter estimates used to generate the following tables have not all been verified and should be considered preliminary. However, their values are based on the best information available, and the general results presented in the following tables are not expected to change significantly as the parameter estimates are verified and updated.*
[5] *Draft Willamette Subbasin Plan. 2004. Prepared for the Northwest Power and Conservation Council by Willamette Restoration Initiative, May 28, 2004. Available at: www.nwcouncil.org/fw/subbasinplanning.*
[6] *Mobrand Biometrics: www.mobrand.com/MBI/edt.html*

> 0.0, then *PNI* = 1.0 and the genetic constitution of hatchery-origin fish will be determined primarily by the natural environment. (Note: In practice, *pNOB* must be greater than 0.1 to overcome random genetic effects and single-generation selection effects of the hatchery; otherwise, hatchery fish will essentially represent a "hatchery stock" genetically regardless of the value of *pHOS* .) When *pHOS* = *pNOB*, then the hatchery and natural environments will have equal influence on the genetic constitutions of both hatchery and wild fish, and *PNI* = 0.5. For integrated hatchery populations and natural stocks, the goal is for *PNI* to be greater than 0.5 and as close to 1.0 as possible (e.g., > 0.67) as a long-term goal. Symbols on the *PNI* graph correspond with each of the five current and future scenarios shown as bar graphs (see also the *Components of this Report* section for definitions of biological significance, population viability, habitat and harvest ratings).

The outputs presented in Tables A1-A6 are intended to be viewed as part of an electronic report via a desktop computer where portions of the tables can be zoomed in and out for clarity. The Review Team acknowledges that they are difficult to read as printed paper copies.

The data files and specific version of AHA (V.6.4) used to generate the outputs in Tables A1-A6 are available upon request to the Chair of the Hatchery Review Team. Some familiarity with AHA is required, and expected, before implementing the software.

Table A1. AHA output for coho salmon in lower Clackamas River, including Eagle Creek NFH coho. Harvest rates and mean recruit per spawner (R/S) for release years 1995-2002 were estimated by iteration based on empirical data. Those estimates were then used to generate AHA outputs for the other scenarios. Broodstock export goals provide eggs and fish for tribal reintroduction programs and net-pen releases in the Columbia River estuary.

AHA - Version 6.4
July 19, 2006

	Biological Significance:		MED		LOW		LOW		LOW		LOW		LOW	
Subregion/Subbasin	*Species/Race*	*Population Management Intent:*			Recovery in upper basin only		Recovery in upper basin only		Recovery in upper basin only		Recovery in lower-upper basins		Recovery in lower-upper basins	
Willamette	Coho	*Harvest&Hatchery Strategy:*			Hatchery-Harvest in lower basin		Hatchery-Harvest in lower basin		33% reduction in releases		Artificial propagation to assist		Habitat improvements only	
Lower Clackamas River: Eagle Creek NFH			Historic (=100% Recovery)		1995-2002 Release Years		Current		Alt.1: Current + Recommend.		Alt. 2: Integrated Hatchery		Alt. 3-7: No on-site releases	
Hab	Productivity (Adult)	Ad. Capacity	13.40	8,262	1.80	704	1.80	704	1.80	704	1.80	704	1.80	704
	Min NOR Escape	% Kelt	1		1		1		1		1		1	
	Smolt Productivity	Sm. Capacity	248.15	153,000	33.33	13,037	33.33	13,037	33.33	13,037	33.33	13,037	33.33	13,037
Hydro	Ocean Surv / Baseline SAR	Vary? (Y/N)	0.054 / 0.054	n	0.054 / 0.054	y	0.054 / 0.054	y	0.054 / 0.054	y	0.054 / 0.054	y	0.054 / 0.054	y
	Juv Passage Surv.	Adult Passage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Adjusted Productivity	Adj. Capacity	13.40	8,262	1.80	704	1.80	704	1.80	704	1.80	704	1.80	704
Harv	Harv -Marine		NORs	HORs	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	
	Harv-L Mainstem		NORs	HORs	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	0.092	
	Harv-U Mainstem		NORs	HORs										
	Harv -Terminal		NORs	HORs	0.015	0.130	0.015	0.130	0.015	0.130	0.015	0.015	0.015	
	Total Exploitation Rate		NORs	HORs	0.213	0.305	0.213	0.305	0.213	0.305	0.213	0.213	0.213	
Hatch					pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
	Broodstock Composition		pNOB-Goal	pHOS-Goal							50%			
			pNOB-Realized	pHOS-Realized		86%		81%		78%	50%	76%		
	Purpose	Type	Cons/Harv/Both	Int /Seg /None	Harvest	Segregated	Harvest	Segregated	Harvest	Segregated	Conservation	Integrated		None
	Broodstock by Source		Local / Imported	Smolt Release	885	892,908	496	500,432	347	350,101	100	100,894		-
	Brood Exported (from HOR Surplus)		Export Goal/Realized	Strays			1250 / 1250		1400 / 1400					
	Destination for HOR Returns		% to Hatchery	% to Nat. Spawn.	90%	10%	90%	10%	90%	10%	20%	80%		100%
	Productivity of Hatchery Fish		Recruits/Spawner	Fitness? [Y / N]	22.3	y	22.3	y	22.3	y	22.3	y		

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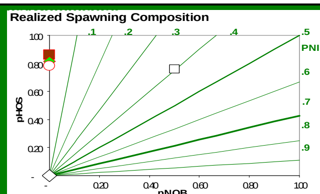

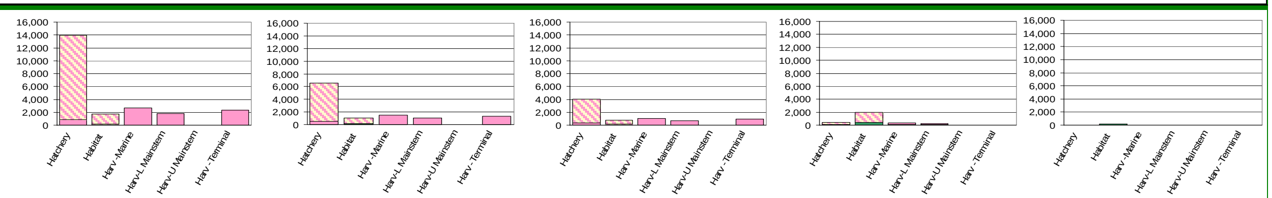

	1995-2002 Release Years	Current	Alt.1: Current + Recommend.	Alt. 2: Integrated Hatchery	Alt. 3-7: No on-site releases
Relative Hatchery Optimum ->	80	80	80	90	90
Relative Reproductive Success (HOS) ->	80%	80%	80%	80%	80%
Initial Fitness Factor (A)	0.81	0.81	0.81	0.81	0.81
Fitness Factor after 100 generations (B)	0.23	0.23	0.23	0.87	1.00
Average Fitness Factor (100 Generations)	0.25	0.25	0.25	0.85	0.99
Generations until average fitness is reached	43	43	43	29	30
Minimum Hatchery Program (as % of BS Goal):					
"Fitness Floor" ->					
Calculated Hatchery SAR ->	2.21%	2.21%	2.21%	2.21%	
Calculated Natural SAR ->	5.4%	5.4%	5.4%	5.4%	5.4%

	1995-2002 Max	Min	Ave	Current Max	Min	Ave	Alt.1 Max	Min	Ave	Alt. 2 Max	Min	Ave	Alt. 3-7 Max	Min	Ave
NOR Escapement	771	67	196	671	49	159	601	39	136	1,475	148	400	551	54	167
HoS Total Escapement	5,088	788	1,550	2,852	441	868	1,995	309	607	5,208	807	1,586	-	-	-
HoS Effective Escapement	4,070	630	1,240	2,282	353	695	1,596	247	486	4,166	646	1,269	-	-	-
Total Natural Escapement (NoS & All HoS)	5,783	855	1,746	3,419	490	1,027	2,479	348	744	6,675	955	1,986	551	54	167
Total Harvest	22,471	3,476	6,851	12,643	1,951	3,853	8,869	1,366	2,702	2,172	326	658	149	15	45
Hatchery Broodstock	885	885	885	496	496	496	347	347	347	100	100	100	-	-	-
Surplus at Hatchery	44,914	6,212	13,067	23,923	2,232	6,074	16,211	1,036	3,724	1,253	152	347	-	-	-
Total Runsize	73,984	11,428	22,549	41,693	6,419	12,700	29,280	4,497	8,917	10,197	1,533	3,092	700	69	212

Natural Runsize over 50 generations
Initial Natural Runsize: 1,000
Initial Hatchery Runsize: 1,000

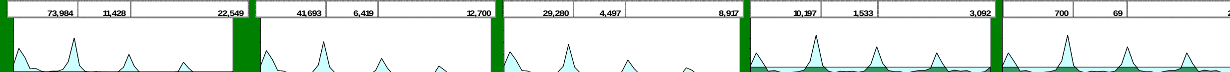

Table A1. Continued. These scenarios examine the effects of habitat improvements and the transition of an integrated hatchery broodstock from a conservation role (see preceding table) to a harvest role. The goal here was to provide a terminal harvest of 1,000 fish. At 100% habitat recovery, no hatchery program is needed to meet that harvest goal.

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July 19, 2006

Subregion/Subbasin: Willamette — Species/Race: Coho

			Historic (=100% Recovery)		Current		25% Habitat Recovery		25% Habitat Recovery		50% Habitat Recovery		100% Habitat Recovery	
	Biological Significance:		MED		LOW		LOW		LOW		LOW		MED	
	Population Management Intent:				Recovery in upper basin only		Recovery in lower-upper basins		Recovery in lower-upper basins		Recovery in lower-upper basins		Natural Reproduction Only	
	Harvest&Hatchery Strategy:				Hatchery-Harvest in lower basin		No Hatchery		Integrated Hatchery-Harvest		Integrated Hatchery-Harvest		No Hatchery: Terminal Fishery	
Lower Clackamas River: Eagle Creek NFH														
Hab	Productivity (Adult)	Ad. Capacity	13.40	8,262	1.80	704	4.70	2,594	4.70	2,594	7.60	4,483	13.40	7,000
	Min NOR Escape	% Kelt	1		1		1		1		1		1	
	Smolt Productivity	Sm. Capacity	248.15	153,000	33.33	13,037	87.04	48,037	87.04	48,037	140.74	83,019	248.15	129,630
Hydro	Ocean Surv / Baseline SAR	Vary? (Y/N)	0.054 / 0.054	n	0.054 / 0.054	y	0.054 / 0.054	y	0.054 / 0.054	y	0.054 / 0.054	y	0.054 / 0.054	y
	Juv Passage Surv.	Adult Passage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Adjusted Productivity	Adj. Capacity	13.40	8,262	1.80	704	4.70	2,594	4.70	2,594	7.60	4,483	13.40	7,000
Harv	Harv -Marine		NORs	HORs	0.120	0.120	0.120		0.120	0.120	0.120	0.120	0.120	
	Harv-L Mainstem		NORs	HORs	0.092	0.092	0.092		0.092	0.092	0.092	0.092	0.092	
	Harv-U Mainstem		NORs	HORs										
	Harv -Terminal		NORs	HORs	0.015	0.130	0.015		0.033	0.333	0.033	0.333	0.250	
	Total Exploitation Rate		NORs	HORs	0.213	0.305	0.213		0.227	0.467	0.227	0.467	0.401	
Hatch					pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
	Broodstock Composition		pNOB-Goal	pHOS-Goal					50%	25%	33%	15%		
			pNOB-Realized	pHOS-Realized		81%			50%	10%	33%	5%		
	Purpose	Type	Cons/Harv/Both	Int /Seg /None	Harvest	Segregated		None	Both	Integrated	Harvest	Integrated		None
	Broodstock by Source		Local / Imported	Smolt Release	496	500,432		-	150	151,340	150	151,340		-
	Brood Exported (from HOR Surplus)		Export Goal/Realized	Strays	1250 / 1250				500 / 500		500 / 500			
	Destination for HOR Returns		% to Hatchery	% to Nat. Spawn.	90%	10%		100%	90%	10%	90%	10%		100%
	Productivity of Hatchery Fish		Recruits/Spawner	Fitness? [Y / N]	22.3	y		y	22.3	y	22.3	y		y

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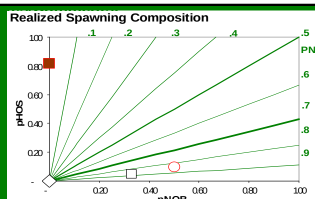

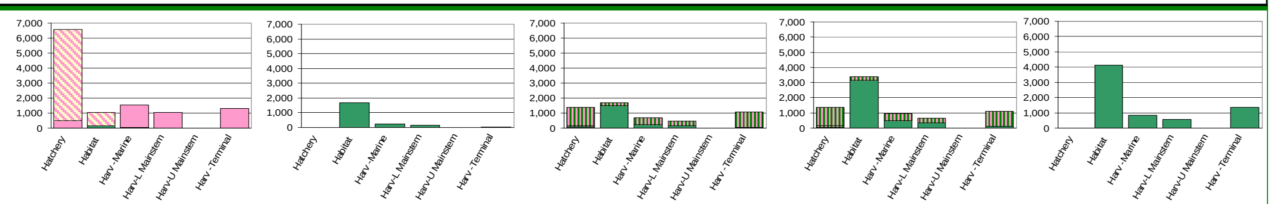

	Current	25% Habitat Recovery	25% Habitat Recovery	50% Habitat Recovery	100% Habitat Recovery
Relative Hatchery Optimum ->	80	80	80	90	90
Relative Reproductive Success (HOS) ->	80%	80%	80%	80%	80%
Initial Fitness Factor (A)	0.81	0.81	0.81	0.81	0.81
Fitness Factor after 100 generations (B)	0.23	1.00	0.96	0.99	1.00
Average Fitness Factor (100 Generations)	0.25	0.99	0.94	0.98	0.99
Generations until average fitness is reached	43	30	35	33	30
Minimum Hatchery Program (as % of BS Goal):					
"Fitness Floor" ->					
Calculated Hatchery SAR ->	2.21%		2.21%	2.21%	
Calculated Natural SAR ->	5.4%	5.4%	5.4%	5.4%	5.4%

	Current Max	Current Min	Current Ave	25% HR Max	25% HR Min	25% HR Ave	25% HR Max	25% HR Min	25% HR Ave	50% HR Max	50% HR Min	50% HR Ave	100% HR Max	100% HR Min	100% HR Ave
NOR Escapement	571	63	159	6,844	828	1,667	6,434	695	1,502	13,300	1,651	3,174	17,028	2,198	4,128
HoS Total Escapement	3,525	472	867	-	-	-	817	109	201	817	109	201	-	-	-
HoS Effective Escapement	2,820	378	694	-	-	-	654	87	161	654	87	161	-	-	-
Total Natural Escapement (NoS & All HoS)	4,096	536	1,026	6,844	828	1,667	7,251	812	1,703	14,117	1,760	3,375	17,028	2,198	4,128
Total Harvest	15,616	2,089	3,849	1,852	224	451	9,079	1,196	2,228	11,092	1,460	2,712	11,386	1,469	2,760
Hatchery Broodstock	496	496	496	-	-	-	150	150	150	150	150	150	-	-	-
Surplus at Hatchery	29,988	2,506	6,067	-	-	-	6,783	411	1,237	6,758	386	1,211	-	-	-
Total Runsize	51,446	6,877	12,688	8,696	1,052	2,118	23,763	3,094	5,817	32,617	4,257	7,948	28,413	3,667	6,888

Natural Runsize over 50 generations

Initial Natural Runsize: 1,000

Initial Hatchery Runsize: 1,000

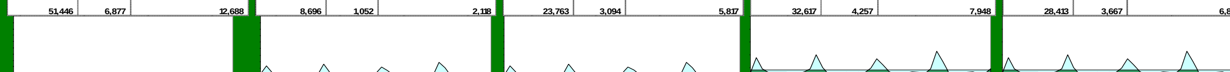

Table A2. AHA output for coho salmon in the upper Clackamas River basin. Hatchery-origin coho are excluded from upper basin at North Fork Dam.

AHA - Version 6.4
July 19, 2006

Biological Significance:		MED		HIGH		HIGH		HIGH		HIGH	
Subregion/Subbasin	*Species/Race*	*Population Management Intent:*		Conservation and Recovery		Conservation and Recovery		Conservation and Recovery		Conservation and Recovery	
Willamette	Coho	*Harvest&Hatchery Strategy:*		No hatchery, Habitat Improvements		No hatchery, Habitat Improvements		No hatchery, Habitat Improvements		No hatchery, Terminal Harvest	
Upper Clackamas River: Natural population only		Historic (=100% Recovery)		Current		25% Habitat Recovery		50% Habitat Recovery		100% Habitat Recovery	
Hab	Productivity (Adult) / Ad. Capacity	13.10	6,785	4.70	2,202	6.80	3,348	8.90	4,494	13.10	6,785
	Min NOR Escape / % Kelt	1		1		1		1		1	
	Smolt Productivity / Sm. Capacity	242.59	125,648	86.97	40,748	125.83	61,954	164.69	83,161	242.41	125,555
Hydro	Ocean Surv / Baseline SAR / Vary? (Y/N)	0.054 0.054	n	0.054 0.054	y	0.054 0.054	y	0.054 0.054	y	0.054 0.054	y
	Juv Passage Surv. / Adult Passage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Adjusted Productivity / Adj. Capacity	13.10	6,785	4.70	2,200	6.80	3,348	8.90	4,494	13.10	6,785
Harv	Harv -Marine	NORs	HORs	0.130		0.130		0.130		0.130	
	Harv-L Mainstem	NORs	HORs	0.060		0.060		0.060		0.060	
	Harv-U Mainstem	NORs	HORs								
	Harv -Terminal	NORs	HORs	0.050		0.050		0.050		0.300	
	Total Exploitation Rate	NORs	HORs	0.223		0.223		0.223		0.428	
Hatch				pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
	Broodstock Composition	pNOB-Goal	pHOS-Goal								
		pNOB-Realized	pHOS-Realized								
	Purpose / Type	Cons/Harv/Both	Int /Seg /None		None		None		None		None
	Broodstock by Source	Local / Imported	Smolt Release		-		-		-		-
	Brood Exported (from HOR Surplus)	Export Goal/Realized	Strays								
	Destination for HOR Returns	% to Hatchery	% to Nat. Spawn.		100%		100%		100%		100%
	Productivity of Hatchery Fish	Recruits/Spawner	Fitness? [Y / N]								

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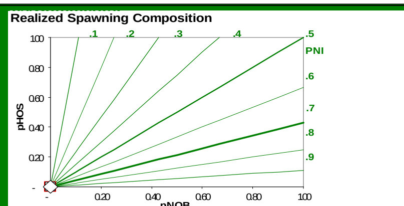
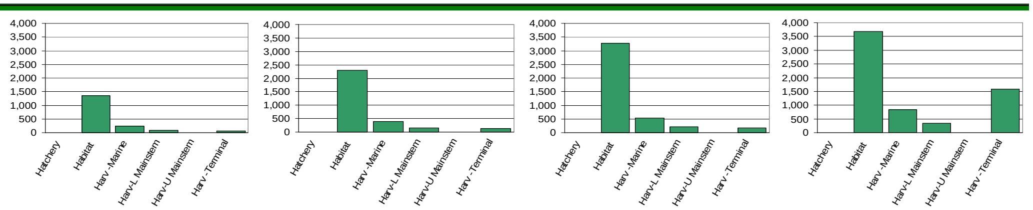
Realized Spawning Composition





	Current	25% Habitat Recovery	50% Habitat Recovery	100% Habitat Recovery
Relative Hatchery Optimum ->				
Relative Reproductive Success (HOS) ->	80%	80%	80%	80%
Initial Fitness Factor (A)	0.81	0.81	0.81	0.81
Fitness Factor after 100 generations (B)	1.00	1.00	1.00	1.00
Average Fitness Factor (100 Generations)	0.99	0.99	0.99	0.99
Generations until average fitness is reached	30	30	30	30
Minimum Hatchery Program (as % of BS Goal):				
"Fitness Floor" ->				
Calculated Hatchery SAR ->				
Calculated Natural SAR ->	5.4%	5.4%	5.4%	5.4%

	Current Max	Current Min	Current Ave	25% Max	25% Min	25% Ave	50% Max	50% Min	50% Ave	100% Max	100% Min	100% Ave
NOR Escapement	4,757	597	1,350	7,961	1,096	2,301	11,164	1,613	3,262	12,550	1,835	3,678
HoS Total Escapement	-	-	-	-	-	-	-	-	-	-	-	-
HoS Effective Escapement	-	-	-	-	-	-	-	-	-	-	-	-
Total Natural Escapement (NoS & All HoS)	4,757	597	1,350	7,961	1,096	2,301	11,164	1,613	3,262	12,550	1,835	3,678
Total Harvest	1,366	171	388	2,286	315	661	3,206	463	937	9,373	1,371	2,747
Hatchery Broodstock	-	-	-	-	-	-	-	-	-	-	-	-
Surplus at Hatchery	-	-	-	-	-	-	-	-	-	-	-	-
Total Runsize	6,123	768	1,737	10,248	1,411	2,962	14,370	2,076	4,199	21,923	3,206	6,425

Natural Runsize over 50 generations
Initial Natural Runsize: 1,000
Initial Hatchery Runsize: 1,000

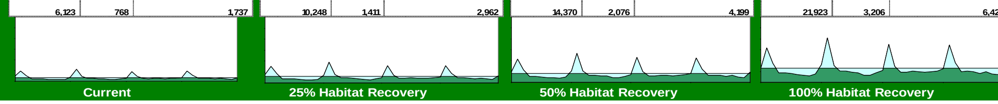


Table A3. AHA output for winter-run steelhead in lower Clackamas River basin, including Eagle Creek NFH "early-returning" WR steelhead.

AHA - Version 6.4

July 19, 2006 — Biological Significance: MED | LOW | LOW | LOW | LOW | LOW

	Subregion/Subbasin	*Species/Race*	*Population Management Intent:*			Recovery in upper basin only		Recovery in upper basin only		Recovery in lower-upper basins		Recovery in lower-upper basins		Recovery in lower-upper basins	
	Willamette	Winter Steelhead	*Harvest&Hatchery Strategy:*			Hatchery-Harvest in lower basin		33% reduction in releases		Habitat Improvements Only		Habitat Improvements Only		Habitat Improvements+Hatchery	
	Lower Clackamas River: Eagle Creek NFH			Historic (=100% Recovery)		Current		Alt. 1: Current+Recommend.		Alt. 3-6: No Hatchery		25% Recovery: No Hatchery		25% Recovery: Current Recs.	
Hab	Productivity (Adult)	Ad. Capacity		20.90	5,129	2.40	833	2.40	833	2.40	833	7.03	1,907	7.03	1,907
	Min NOR Escape	% Kelt		1		1		1		1		1		1	
	Smolt Productivity	Sm. Capacity		522.50	128,225	60.00	20,825	60.00	20,825	60.00	20,825	175.75	47,675	175.75	47,675
Hydro	Ocean Surv	Baseline SAR	Vary? (Y/N)	0.040 0.040	n	0.040 0.040	y	0.040 0.040	y	0.040 0.040	y	0.040 0.040	y	0.040 0.040	y
	Juv Passage Surv.		Adult Passage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Adjusted Productivity		Adj. Capacity	20.90	5,129	2.40	833	2.40	833	2.40	833	7.03	1,907	7.03	1,907
Harv			Harv -Marine	NORs	HORs	0.005	0.005	0.005	0.005	0.005		0.005		0.005	0.005
			Harv-L Mainstem	NORs	HORs	0.005	0.010	0.005	0.010	0.005		0.005		0.005	0.005
			Harv-U Mainstem	NORs	HORs										
			Harv -Terminal	NORs	HORs	0.030	0.540	0.030	0.540	0.030		0.250		0.030	0.540
			Total Exploitation Rate	NORs	HORs	0.040	0.547	0.040	0.547	0.040		0.257		0.040	0.545
Hatch						pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
			Broodstock Composition	pNOB-Goal	pHOS-Goal		5%		5%		5%				
				pNOB-Realized	pHOS-Realized		24%		14%						1%
	Purpose	Type		Cons/Harv/Both	Int /Seg /None	Harvest	Segregated	Harvest	Segregated		None		None	Harvest	Segregated
			Broodstock by Source	Local / Imported	Smolt Release	103	150,071	69	100,533		-		-	69	100,533
			Brood Exported (from HOR Surplus)	Export Goal/Realized	Strays										
			Destination for HOR Returns	% to Hatchery	% to Nat. Spawn.	90%	10%	90%	10%		100%		100%	90%	10%
			Productivity of Hatchery Fish	Recruits/Spawner	Fitness? [Y / N]	16.2	y	16.2	y		y		y	16.2	

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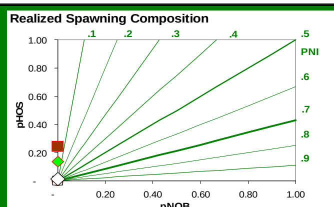
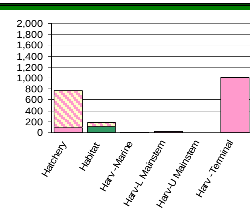
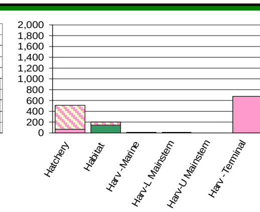
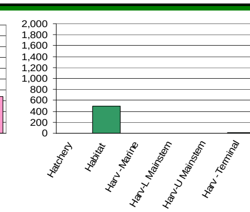
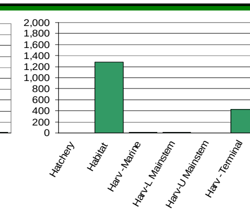
Realized Spawning Composition

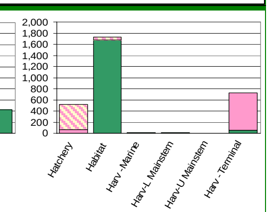












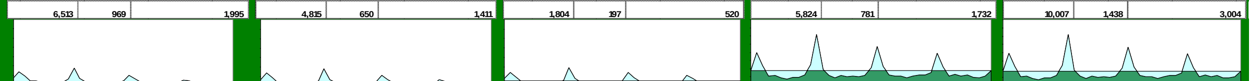
	Current	Alt. 1: Current+Recommend.	Alt. 3-6: No Hatchery	25% Recovery: No Hatchery	25% Recovery: Current Recs.
Relative Hatchery Optimum ->	80	80	80	80	80
Relative Reproductive Success (HOS) ->	40%	40%	40%	40%	40%
Initial Fitness Factor (A)	0.81	0.81	0.81	0.81	0.81
Fitness Factor after 100 generations (B)	0.25	0.25	1.00	1.00	0.92
Average Fitness Factor (100 Generations)	0.35	0.43	0.99	0.99	0.93
Generations until average fitness is reached	43	52	30	30	15

Minimum Hatchery Program (as % of BS Goal): a

"Fitness Floor" ->

	Current			Alt. 1: Current+Recommend.			Alt. 3-6: No Hatchery			25% Recovery: No Hatchery			25% Recovery: Current Recs.		
Calculated Hatchery SAR ->	1.11%			1.11%									1.11%		
Calculated Natural SAR ->	4.0%			4.0%			4.0%			4.0%			4.0%		
	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave
NOR Escapement	941	10	105	1,075	7	142	1,732	190	499	4,324	580	1,286	5,634	764	1,672
HoS Total Escapement	280	43	85	187	29	57	-	-	-	-	-	-	188	29	57
HoS Effective Escapement	112	17	34	75	12	23	-	-	-	-	-	-	75	12	23
Total Natural Escapement (NoS & All HoS)	1,162	53	190	1,223	36	199	1,732	190	499	4,324	580	1,286	5,822	793	1,729
Total Harvest	3,393	525	1,035	2,291	352	697	72	8	21	1,500	201	446	2,487	381	757
Hatchery Broodstock	103	103	103	69	69	69	-	-	-	-	-	-	69	69	69
Surplus at Hatchery	2,422	289	666	1,623	193	447	-	-	-	-	-	-	1,631	195	449
Total Runsize	6,513	969	1,995	4,815	650	1,411	1,804	197	520	5,824	781	1,732	10,007	1,438	3,004

Natural Runsize over 50 generations
Initial Natural Runsize: 1,000
Initial Hatchery Runsize: 1,000



Current | Alt. 1: Current+Recommend. | Alt. 3-6: No Hatchery | 25% Recovery: No Hatchery | 25% Recovery: Current Recs.

Table A4. AHA output for winter-run steelhead in upper Clackamas River basin, including Clackamas Hatchery steelhead. All hatchery-origin steelhead are excluded from the upper basin at North Fork Dam. This upper basin population in integrated with the Clackamas Hatchery stock.

AHA - Version 6.4
July 19, 2006

Biological Significance:			MED		MED		MED		MED		MED	
Subregion/Subbasin		*Species/Race*	*Population Management Intent:*		Recovery in upper basin only		Recovery in lower and upper basins		Recovery in lower and upper basins		Recovery in lower and upper basins	
Willamette		Winter Steelhead	*Harvest&Hatchery Strategy:*		Hatchery-Harvest in lower basin		Catch-and-Release on Wild Fish		Harvest on Clackamas Hatchery fish		Emphasis on Habitat and Nat.	
Upper Clackamas River: Clackamas Hatchery			Historic (=100% Recovery)		Current		Current: No Hatchery		50% Recovery + Hatchery		100% Recovery: No Hatchery	
Hab	Productivity (Adult)	Ad. Capacity	20.06	5,208	8.70	2,693	8.70	2,693	14.38	3,950	20.06	5,208
	Min NOR Escape	% Kelt	1		1		1		1		1	
	Smolt Productivity	Sm. Capacity	334.11	86,742	144.90	44,853	144.90	44,853	239.51	65,789	334.11	86,742
Hydro	Ocean Surv Baseline SAR	Vary? (Y/N)	0.060 0.060	n	0.060 0.060	y	0.060 0.060	y	0.060 0.060	y	0.060 0.060	y
	Juv Passage Surv.	Adult Passage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Adjusted Productivity	Adj. Capacity	20.06	5,208	8.70	2,693	8.70	2,693	14.38	3,950	20.06	5,208
Harv	Harv -Marine		NORs	HORs	0.005	0.005	0.005		0.005	0.005	0.005	
	Harv-L Mainstem		NORs	HORs	0.005	0.010	0.005		0.005	0.010	0.005	
	Harv-U Mainstem		NORs	HORs								
	Harv -Terminal		NORs	HORs	0.030	0.250	0.030		0.030	0.250	0.250	
	Total Exploitation Rate		NORs	HORs	0.040	0.261	0.040		0.040	0.261	0.257	
Hatch					pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
	Broodstock Composition		pNOB-Goal	pHOS-Goal	30%	15%			30%	15%		
			pNOB-Realized	pHOS-Realized	30%	5%			30%	3%		
	Purpose	Type	Cons/Harv/Both	Int /Seg /None	Harvest	Integrated		None	Harvest	Integrated		None
	Broodstock by Source		Local / Imported	Smolt Release	130	160,811		-	130	160,811		-
	Brood Exported (from HOR Surplus)		Export Goal/Realized	Strays								
	Destination for HOR Returns		% to Hatchery	% to Nat. Spawn.	95%	5%		100%	95%	5%		100%
	Productivity of Hatchery Fish		Recruits/Spawner	Fitness? [Y / N]	27.4	y		y	27.4	y		y

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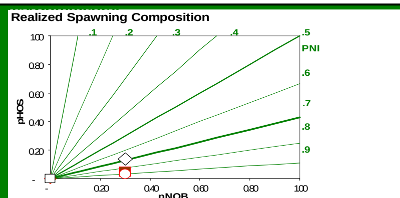

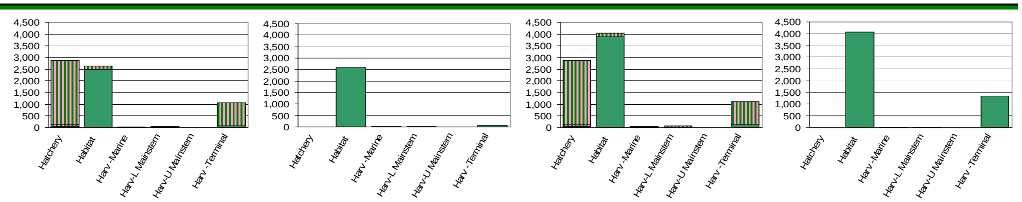

	Current	Current: No Hatchery	50% Recovery + Hatchery	100% Recovery: No Hatchery
Relative Hatchery Optimum ->	80	80	80	80
Relative Reproductive Success (HOS) ->	80%	80%	80%	80%
Initial Fitness Factor (A)	0.81	0.81	0.81	0.81
Fitness Factor after 100 generations (B)	0.98	1.00	0.99	1.00
Average Fitness Factor (100 Generations)	0.96	0.99	0.98	0.99
Generations until average fitness is reached	35	30	34	30

Minimum Hatchery Program (as % of BS Goal):
"Fitness Floor" ->

	Current			Current: No Hatchery			50% Recovery + Hatchery			100% Recovery: No Hatchery		
Calculated Hatchery SAR ->	2.22%						2.22%					
Calculated Natural SAR ->	6.0%			6.0%			6.0%			6.0%		
	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave
NOR Escapement	10,044	1,385	2,489	10,250	1,453	2,571	15,345	2,182	3,902	15,870	2,292	4,075
HoS Total Escapement	562	82	149	-	-	-	562	82	149	-	-	-
HoS Effective Escapement	450	66	119	-	-	-	450	66	119	-	-	-
Total Natural Escapement (NoS & All HoS)	10,606	1,472	2,638	10,250	1,453	2,571	15,907	2,264	4,050	15,870	2,292	4,075
Total Harvest	4,391	644	1,159	423	60	106	4,610	676	1,217	5,503	795	1,413
Hatchery Broodstock	130	130	130	-	-	-	130	130	130	-	-	-
Surplus at Hatchery	10,587	1,477	2,743	-	-	-	10,587	1,477	2,743	-	-	-
Total Runsize	25,714	3,743	6,670	10,673	1,513	2,677	31,234	4,556	8,141	21,374	3,087	5,488

Natural Runsize over 50 generations
Initial Natural Runsize: 1,000
Initial Hatchery Runsize: 1,000

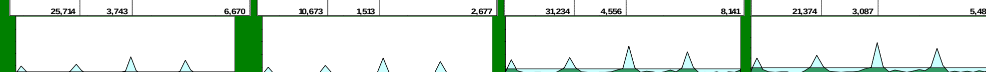

Table A5. AHA output for fall Chinook in lower Clackamas River basin. No hatchery program for fall Chinook currently exists in the Clackamas or lower Willamette River basins. These graphs do not reflect potential strays from out-of-basin programs.

AHA - Version 6.4

July 19, 2006

				Current		25% Habitat Recovery		50% Habitat Recovery		100% Habitat Recovery	
Biological Significance:				LOW		LOW		LOW		LOW	
Subregion/Subbasin: Willamette	*Species/Race*: Fall Chinook	*Population Management Intent:*		Marine harvest determines viability		Recovery of natural population		Recovery of natural population		Maintain viable, self-sustaining	
		Harvest&Hatchery Strategy:		Focus on other species		Habitat improvements		Habitat improvements		Protect habitat, terminal harvest	
Clackamas and Lower Willamette rivers		Historic		Current		25% Habitat Recovery		50% Habitat Recovery		100% Habitat Recovery	
Hab	Productivity (Adult) / Ad. Capacity	9.50	7,816	2.20	1,904	4.03	3,382	5.85	4,860	9.50	7,816
Hab	Min NOR Escape / % Kelt	1		1		1		1		1	
Hab	Smolt Productivity / Sm. Capacity	727.41	598,469	168.45	145,789	308.58	258,959	447.93	372,129	727.41	598,469
Hydro	Ocean Surv / Baseline SAR / Vary? (Y/N)	0.013 0.013	n	0.013 0.013	y	0.013 0.013	y	0.013 0.013	y	0.013 0.013	y
Hydro	Juv Passage Surv. / Adult Passage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hydro	Adjusted Productivity / Adj. Capacity	9.50	7,816	2.20	1,904	4.03	3,382	5.85	4,860	9.50	7,816
Harv	Harv -Marine	NORs	HORs	0.390		0.390		0.390		0.390	
Harv	Harv-L Mainstem	NORs	HORs	0.020		0.020		0.020		0.020	
Harv	Harv-U Mainstem	NORs	HORs								
Harv	Harv -Terminal	NORs	HORs	0.020		0.020		0.020		0.300	
Harv	Total Exploitation Rate	NORs	HORs	0.414		0.414		0.414		0.582	
Hatch				pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
Hatch	Broodstock Composition	pNOB-Goal	pHOS-Goal								
Hatch		pNOB-Realized	pHOS-Realized								
Hatch	Purpose / Type	Cons/Harv/Both	Int /Seg /None		None		None		None		None
Hatch	Broodstock by Source	Local / Imported	Smolt Release		-		-		-		-
Hatch	Brood Exported (from HOR Surplus)	Export Goal/Realized	Strays								
Hatch	Destination for HOR Returns	% to Hatchery	% to Nat. Spawn.		100%		100%		100%		100%
Hatch	Productivity of Hatchery Fish	Recruits/Spawner	Fitness? [Y / N]		y		y		y		y

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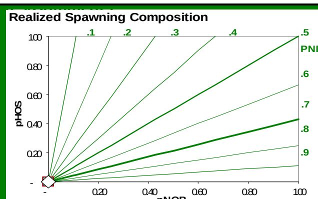
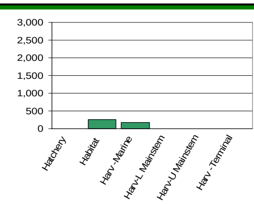
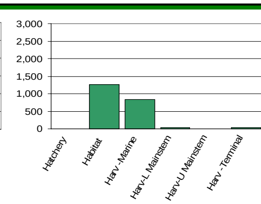
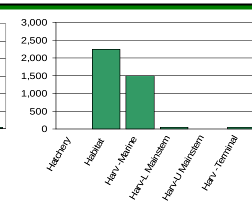
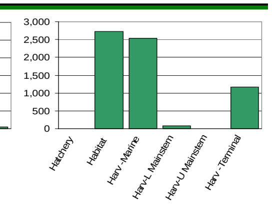
Realized Spawning Composition











	Current	25% Habitat Recovery	50% Habitat Recovery	100% Habitat Recovery
Relative Hatchery Optimum ->				
Relative Reproductive Success (HOS) ->	80%	80%	80%	80%
Initial Fitness Factor (A)	0.81	0.81	0.81	0.81
Fitness Factor after 100 generations (B)	1.00	1.00	1.00	1.00
Average Fitness Factor (100 Generations)	0.99	0.99	0.99	0.99
Generations until average fitness is reached	30	30	30	30

Minimum Hatchery Program (as % of BS Goal):

"Fitness Floor" ->

Calculated Hatchery SAR ->

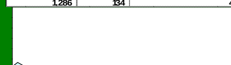
Calculated Natural SAR -> 1.3% | 1.3% | 1.3% | 1.3%

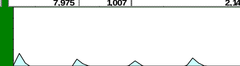
	Current Max	Current Min	Current Ave	25% Max	25% Min	25% Ave	50% Max	50% Min	50% Ave	100% Max	100% Min	100% Ave
NOR Escapement	754	78	256	4,672	590	1,258	8,305	1,180	2,242	10,034	1,459	2,725
HoS Total Escapement	-	-	-	-	-	-	-	-	-	-	-	-
HoS Effective Escapement	-	-	-	-	-	-	-	-	-	-	-	-
Total Natural Escapement (NoS & All HoS)	754	78	256	4,672	590	1,258	8,305	1,180	2,242	10,034	1,459	2,725
Total Harvest	533	55	181	3,303	417	890	5,871	834	1,585	13,945	2,027	3,788
Hatchery Broodstock	-	-	-	-	-	-	-	-	-	-	-	-
Surplus at Hatchery	-	-	-	-	-	-	-	-	-	-	-	-
Total Runsize	1,286	134	437	7,975	1,007	2,148	14,176	2,015	3,826	23,979	3,486	6,513

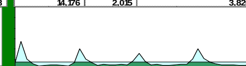
Natural Runsize over 50 generations

Initial Natural Runsize: 1,000

Initial Hatchery Runsize: 1,000


Current


25% Habitat Recovery


50% Habitat Recovery

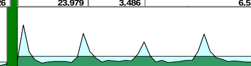
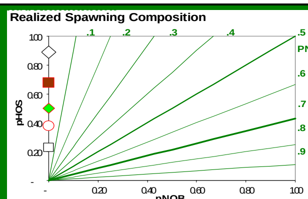

100% Habitat Recovery

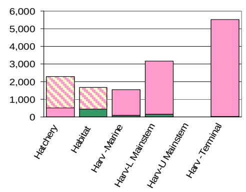
Table A6. AHA output for spring Chinook in Clackamas River basin, including Clackamas Hatchery spring Chinook.

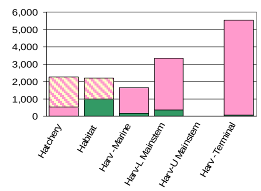
AHA - Version 6.4
July 19, 2006 — Biological Significance: HIGH

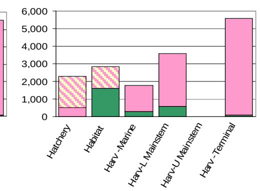
			Historic		Current		25% Habitat Recovery		50% Habitat Recovery		100% Habitat Recovery	
Subregion/Subbasin: Willamette	Species/Race: Spring Chinook	Biological Significance	HIGH		HIGH		HIGH		HIGH		HIGH	
		Population Management Intent:			Conserve Natural Population		Conserve Natural Population		Conserve Natural Population		Conserve Natural Population	
		Harvest&Hatchery Strategy:			Hatchery Program for Terminal		Hatchery Program for Terminal		Hatchery Program for Terminal		Hatchery Program for Terminal	
Clackamas River			Historic		Current		25% Habitat Recovery		50% Habitat Recovery		100% Habitat Recovery	
Hab	Productivity (Adult)	Ad. Capacity	17.90	10,716	4.70	2,434	8.00	4,505	11.30	6,575	17.90	10,716
Hab	Min NOR Escape	% Kelt	1		1		1		1		1	
Hab	Smolt Productivity	Sm. Capacity	291.91	174,755	76.65	39,693	130.46	73,467	184.28	107,224	291.91	174,755
Hydro	Ocean Surv / Baseline SAR	Vary? (Y/N)	0.061 / 0.061	n	0.061 / 0.061	y	0.061 / 0.061	y	0.061 / 0.061	y	0.061 / 0.061	y
Hydro	Juv Passage Surv.	Adult Passage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hydro	Adjusted Productivity	Adj. Capacity	17.90	10,716	4.70	2,434	8.00	4,505	11.30	6,575	17.90	10,716
Harv	Harv -Marine		NORs	HORs	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
Harv	Harv-L Mainstem		NORs	HORs	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
Harv	Harv-U Mainstem		NORs	HORs								
Harv	Harv -Terminal		NORs	HORs	0.061	0.610	0.061	0.610	0.061	0.610	0.061	0.610
Harv	Total Exploitation Rate		NORs	HORs	0.373	0.740	0.373	0.740	0.373	0.740	0.373	0.740
Hatch					pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
Hatch	Broodstock Composition		pNOB-Goal	pHOS-Goal								
Hatch			pNOB-Realized	pHOS-Realized		68%		50%		38%		23%
Hatch	Purpose	Type	Cons/Harv/Both	Int /Seg /None	Harvest	Segregated	Harvest	Segregated	Harvest	Segregated	Harvest	Segregated
Hatch	Broodstock by Source		Local / Imported	Smolt Release	520	1,210,696	520	1,210,696	520	1,210,696	520	1,210,696
Hatch	Brood Exported (from HOR Surplus)		Export Goal/Realized	Strays								
Hatch	Destination for HOR Returns		% to Hatchery	% to Nat. Spawn.	65%	35%	65%	35%	65%	35%	65%	35%
Hatch	Productivity of Hatchery Fish		Recruits/Spawner	Fitness? [Y / N]	23.0	y	23.0	y	23.0	y	23.0	y

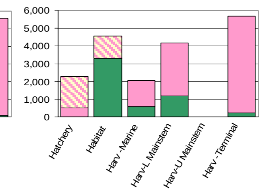
OPEN SAVE







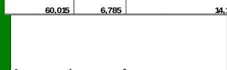


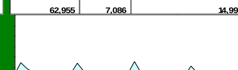


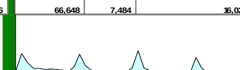
	Current	25% Habitat Recovery	50% Habitat Recovery	100% Habitat Recovery
Relative Hatchery Optimum ->	80	80	80	80
Relative Reproductive Success (HOS) ->	80%	80%	80%	80%
Initial Fitness Factor (A)	0.81	0.81	0.81	0.81
Fitness Factor after 100 generations (B)	0.24	0.25	0.26	0.30
Average Fitness Factor (100 Generations)	0.26	0.27	0.30	0.35
Generations until average fitness is reached	45	45	45	46
Minimum Hatchery Program (as % of BS Goal):				
"Fitness Floor" ->				
Calculated Hatchery SAR ->	0.99%	0.99%	0.99%	0.99%
Calculated Natural SAR ->	6.1%	6.1%	6.1%	6.1%

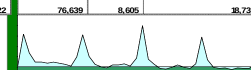
	Current Max	Current Min	Current Ave	25% Max	25% Min	25% Ave	50% Max	50% Min	50% Ave	100% Max	100% Min	100% Ave
NOR Escapement	2,326	172	467	4,880	360	973	8,025	610	1,616	15,579	1,313	3,316
HoS Total Escapement	5,204	593	1,224	5,204	593	1,224	5,204	593	1,224	5,204	593	1,224
HoS Effective Escapement	4,163	474	980	4,163	474	980	4,163	474	980	4,163	474	980
Total Natural Escapement (NoS & All HoS)	7,015	765	1,692	8,857	953	2,197	11,859	1,203	2,841	19,413	1,906	4,541
Total Harvest	43,333	4,918	10,222	44,430	5,030	10,523	45,809	5,179	10,906	49,537	5,597	11,919
Hatchery Broodstock	520	520	520	520	520	520	520	520	520	520	520	520
Surplus at Hatchery	9,147	582	1,755	9,147	582	1,755	9,147	582	1,755	9,147	582	1,755
Total Runsize	60,015	6,785	14,189	62,955	7,086	14,996	66,648	7,484	16,022	76,639	8,605	18,735

Natural Runsize over 50 generations
Initial Natural Runsize: 1,000
Initial Hatchery Runsize: 1,000


Current


25% Habitat Recovery


50% Habitat Recovery


100% Habitat Recovery

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U.S. Fish and Wildlife Service
www.fws.gov

For Columbia River Basin Hatchery Review Information
www.fws.gov/pacific/Fisheries/Hatcheryreview/

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July 2007