



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 review¹ 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's³ 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

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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-A6⁴

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 Plan⁵ as estimated by the *Ecosystem Diagnosis and Treatment* model⁶. 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*

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

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> 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).

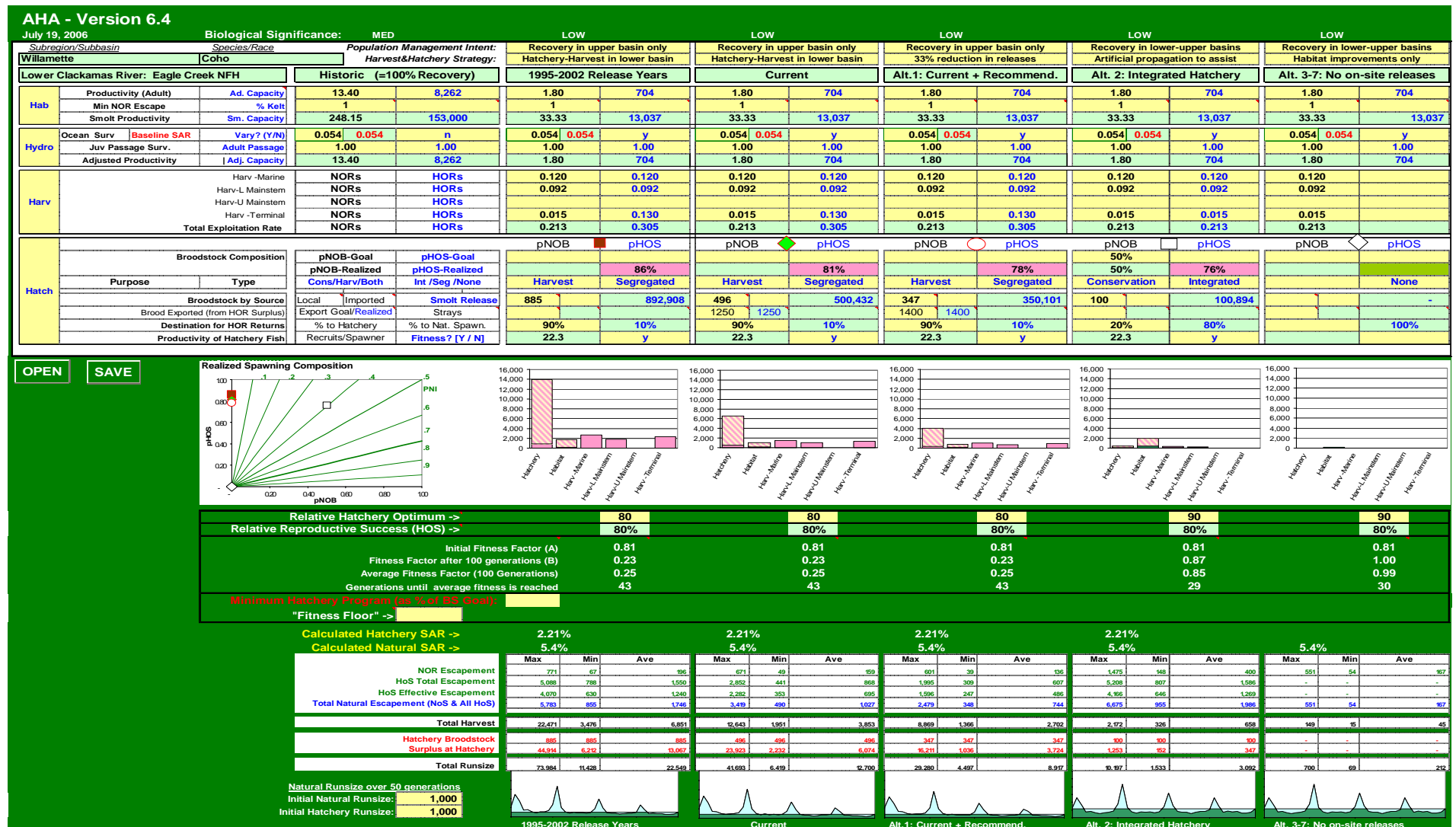
The outputs presented in Tables A1-A6 are intended to be viewed as part of an electronic report via a desktop computer where portions of the tables can be zoomed in and out for clarity. The Review Team acknowledges that they are difficult to read as printed paper copies.

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.

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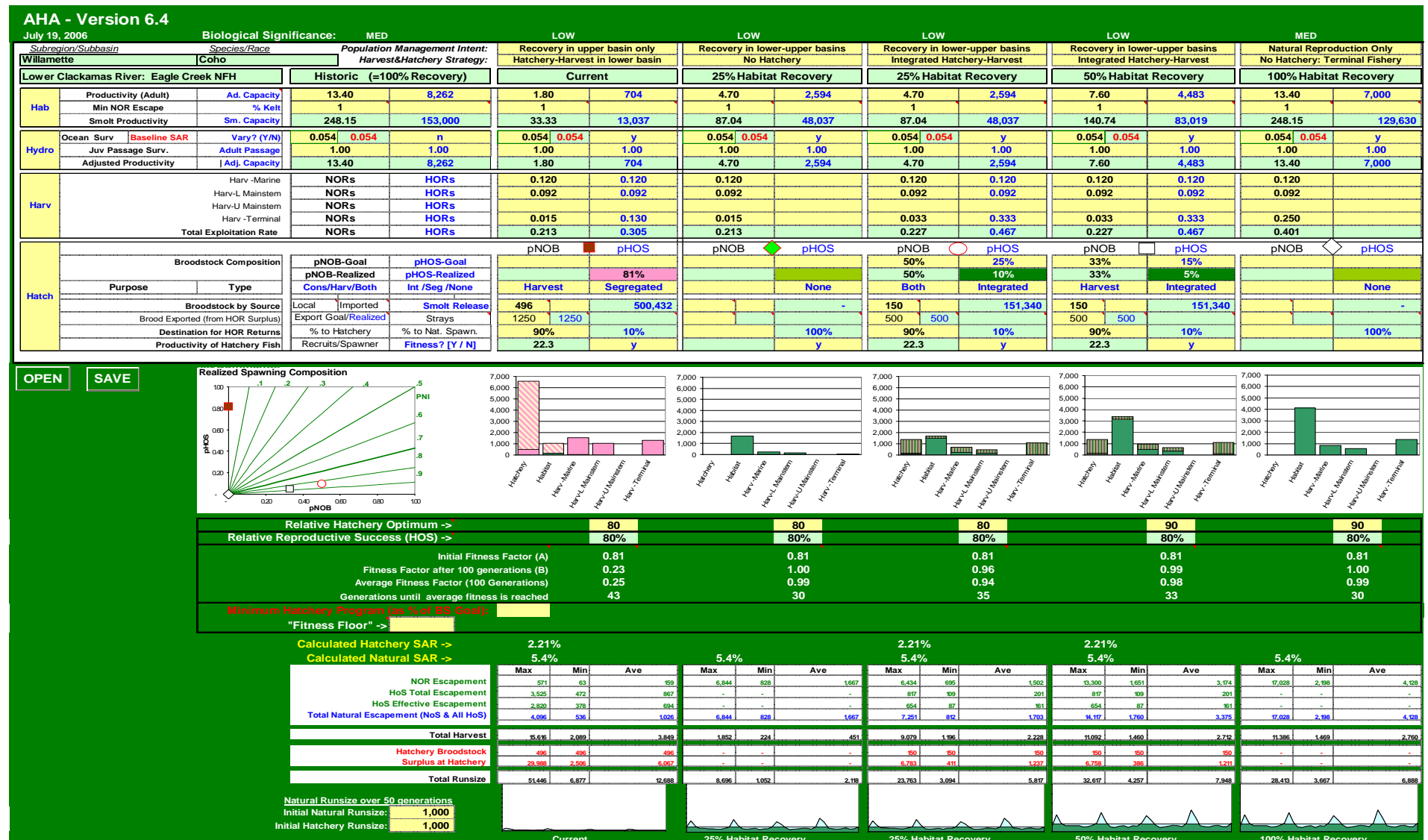
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Table A1. AHA output for coho salmon in lower Clackamas River, including Eagle Creek NFH coho. Harvest rates and mean recruit per spawner (R/S) for release years 1995-2002 were estimated by iteration based on empirical data. Those estimates were then 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.



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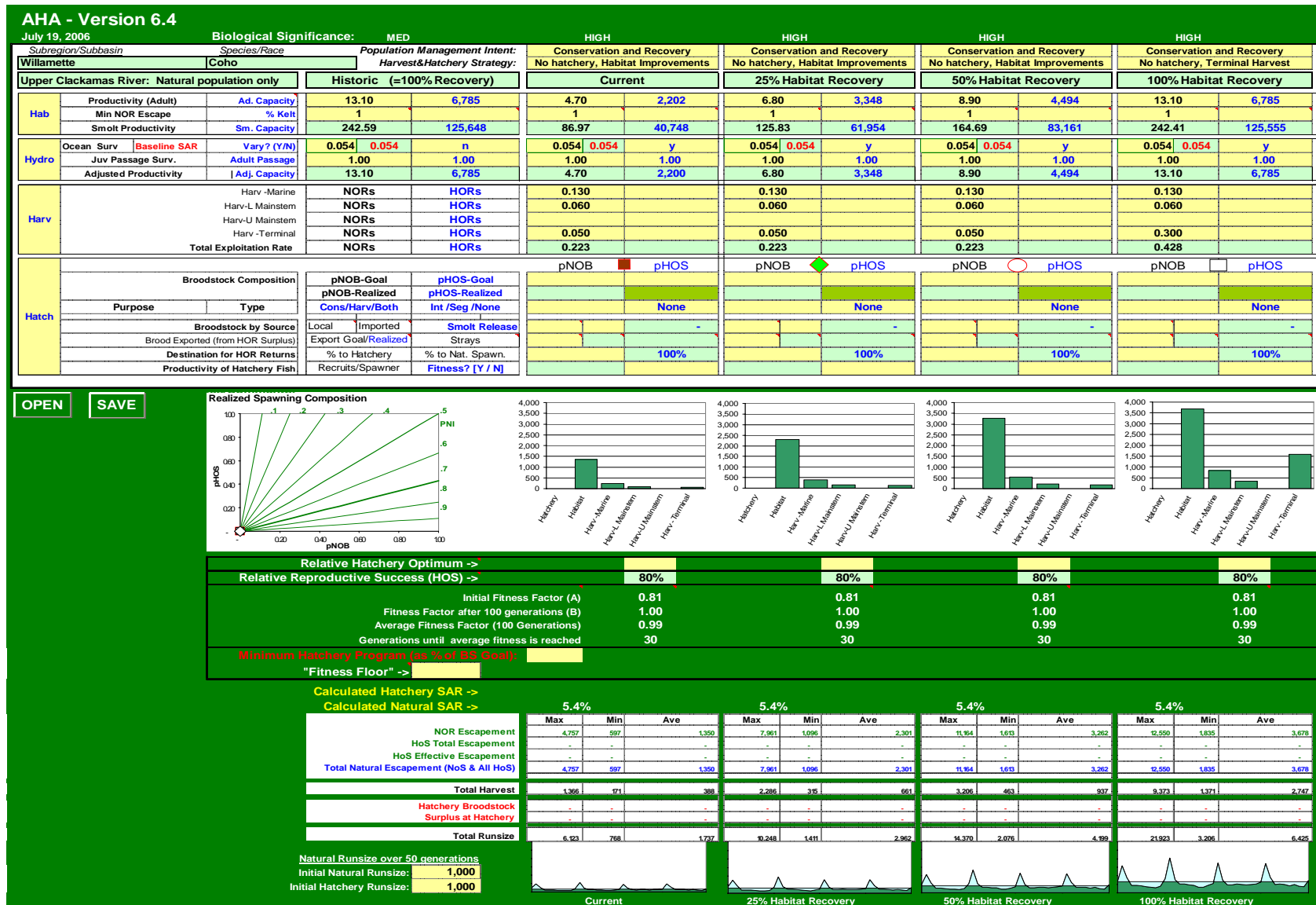
Table A1. Continued. These scenarios examine the effects of habitat improvements and the transition of an integrated hatchery broodstock from a conservation role (see preceding table) to a harvest role. The goal here was to provide a terminal harvest of 1,000 fish. At 100% habitat recovery, no hatchery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



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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.



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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

Species/Race

Subregion/Subbasin

Willamette

Winter Steelhead

Population Management Intent:

Harvest&Hatchery Strategy:

LOW

Recovery in upper basin only

Hatchery-Harvest in lower basin

LOW

Recovery in upper basin only

33% reduction in releases

LOW

Recovery in lower-upper basins

Habitat Improvements Only

LOW

Recovery in lower-upper basins

Habitat Improvements Only

LOW

Recovery in lower-upper basins

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

% Kelt

1

5,129

2.40

833

2.40

833

2.40

833

7.03

1,907

7.03

1,907

Min NOR Escape

Sm. Capacity

522.50

128,225

60.00

20,825

60.00

20,825

175.75

47,675

175.75

47,675

Smolt Productivity

Hydro

Ocean Surv

Baseline SAR

Vary? (Y/N)

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

Adjusted Productivity

Adj. Capacity

20.90

5,129

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

0.005

0.005

0.005

Harv-L Mainstem

NORs

HORs

0.005

0.010

0.005

0.010

0.005

0.010

0.005

0.010

0.005

0.010

0.005

0.010

Harv-U Mainstem

NORs

HORs

0.030

0.540

0.030

0.540

0.030

0.540

0.250

0.540

0.030

0.540

0.030

0.540

Harv-Terminal

NORs

HORs

0.040

0.547

0.040

0.547

0.040

0.547

0.257

0.545

0.040

0.545

Total Exploitation Rate

Hatch

Broodstock Composition

pNOB-Goal

pPHOS-Goal

5%

5%

5%

5%

5%

5%

1%

1%

Purpose

Type

pNOB-Realized

pPHOS-Realized

24%

14%

24%

14%

24%

14%

24%

14%

Cons/Harv/Both

Int /Seg /None

Harvest

Segregated

Harvest

Segregated

None

None

Harvest

Segregated

103

150,071

69

100,533

-

-

69

100,533

Broodstock by Source

Local

Imported

103

150,071

69

100,533

Brood Exported (from HOR Surplus)

Export Goal/Realized

Strays

90%

10%

90%

10%

100%

100%

90%

10%

Destination for HOR Returns

% to Hatchery

% to Nat. Spawn.

16.2

y

16.2

y

y

y

16.2

y

Productivity of Hatchery Fish

Recruits/Spawner

Fitness? [Y / N]

16.2

y

16.2

y

y

y

16.2

y

Realized Spawning Composition

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):

"Fitness Floor" ->

Calculated Hatchery SAR ->

1.11%

1.11%

4.0%

4.0%

1.11%

Calculated Natural SAR ->

4.0%

4.0%

4.0%

4.0%

4.0%

NOR Escapement

HoS Total Escapement

HoS Effective Escapement

Total Natural Escapement (NoS & All HoS)

Total Harvest

Hatchery Broodstock

Surplus at Hatchery

Total Runsize

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

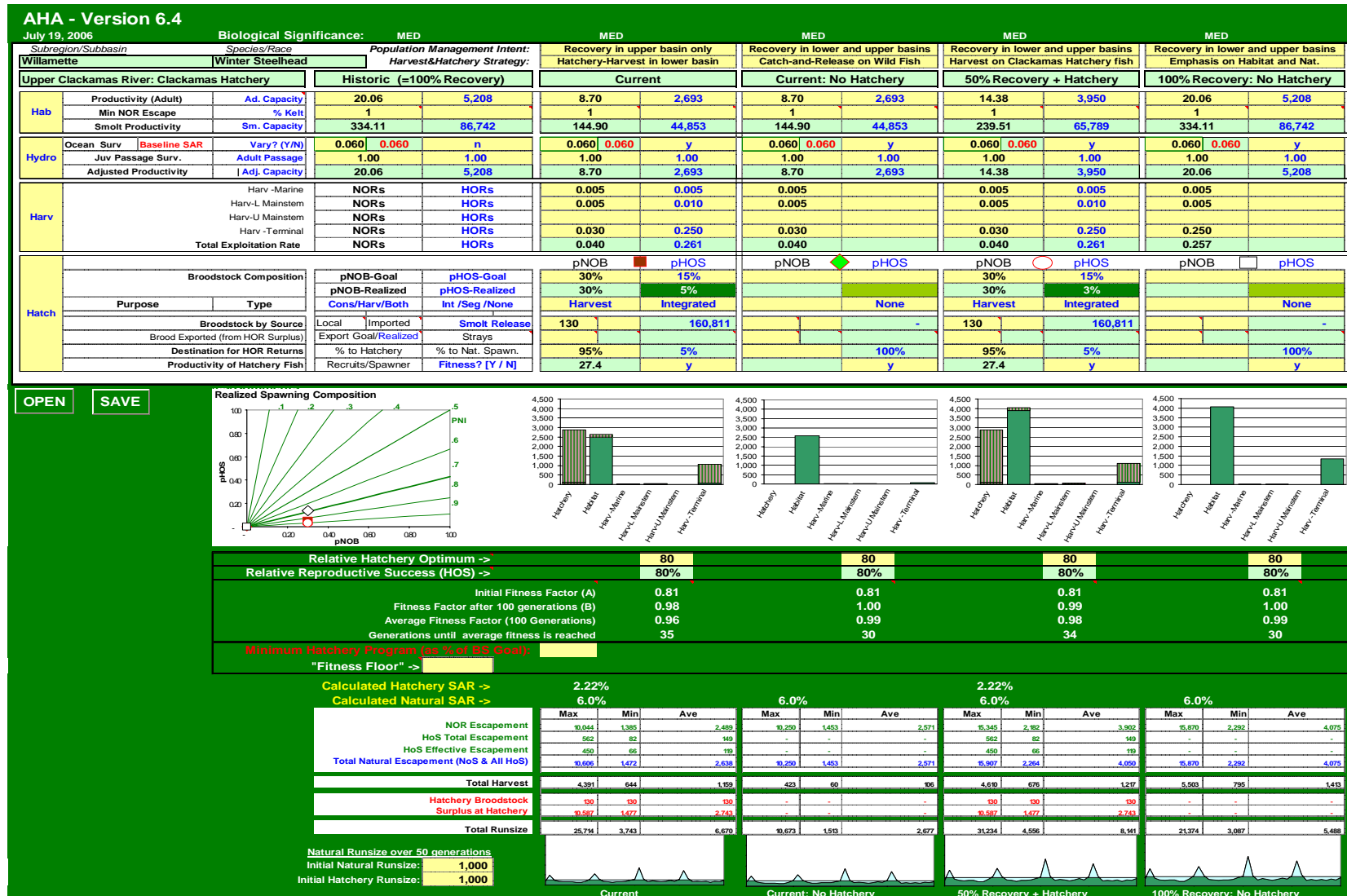
25% Recovery: No Hatchery

25% Recovery: Current Recs.

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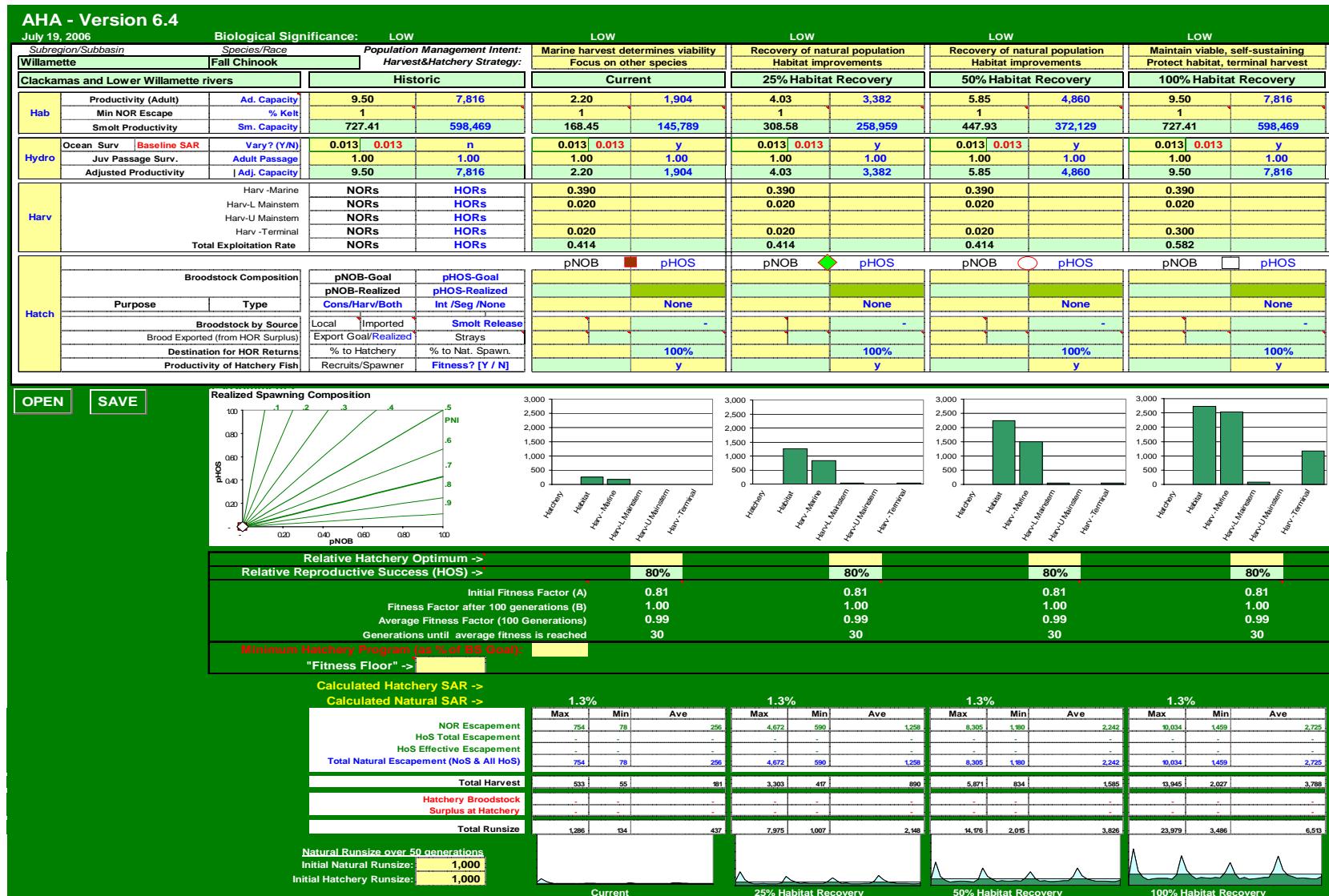
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Table A4. AHA output for winter-run steelhead in upper Clackamas River basin, including Clackamas Hatchery steelhead. All hatchery-origin steelhead are excluded from the upper basin at North Fork Dam. This upper basin population is integrated with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



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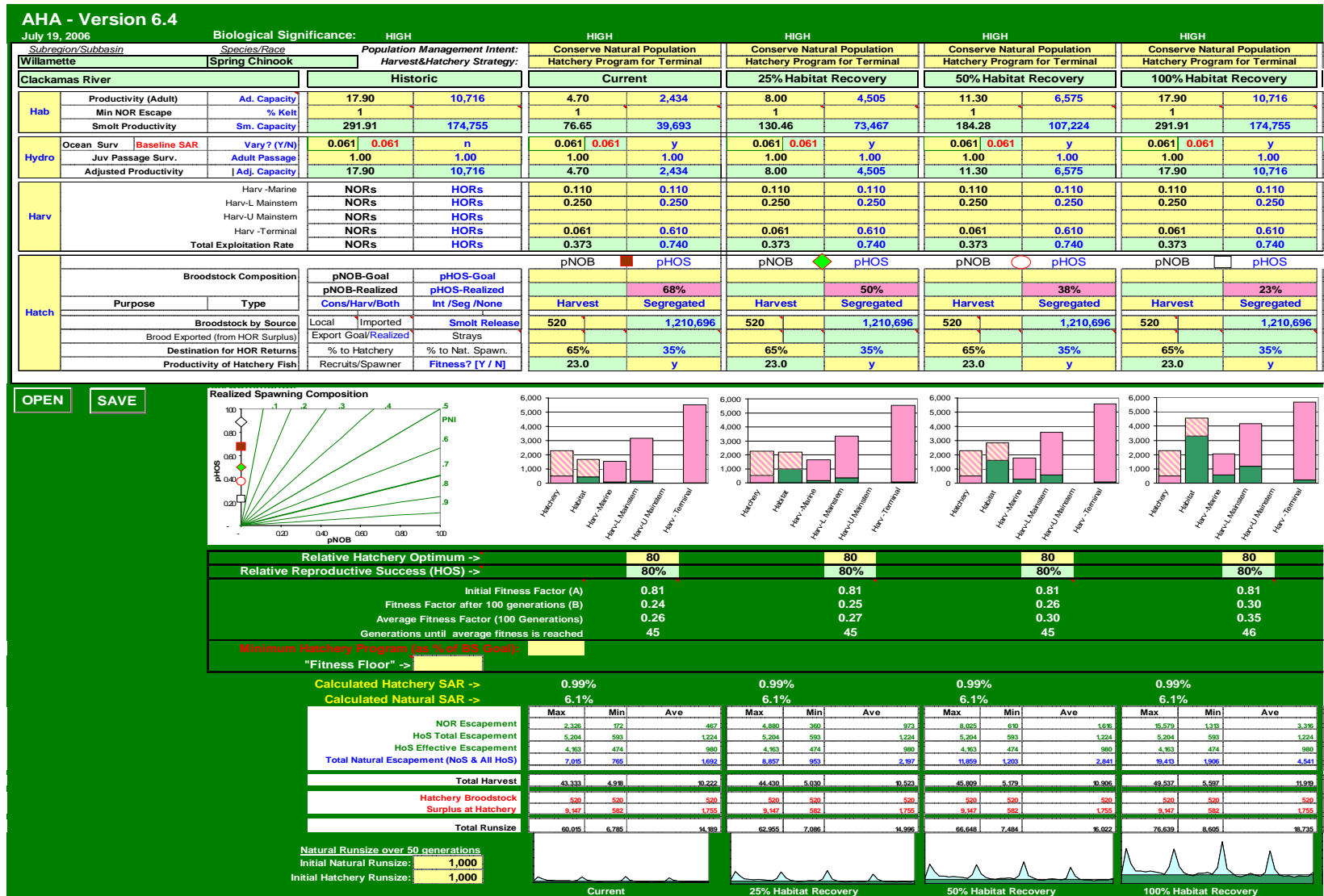
Table A5. AHA output for fall Chinook in lower Clackamas River basin. No hatchery program for fall Chinook currently exists in the Clackamas or lower Willamette River basins. These graphs do not reflect potential strays from out-of-basin programs.



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



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For Columbia River Basin Hatchery Review Information
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July 2007

