Pacific Northwest Region, Forest Service
Basin-scale Restoration Prioritization Process

Pacific Northwest Region
U.S.D.A. Forest Service

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I. General Background

A prioritization process to identify geographic emphasis areas for restoration work has been developed by the Pacific Northwest Region, Forest Service. It provides an ecological basis for priority setting. The Regional process consists of three "modules" displaying priorities for aquatic, terrestrial and community/social environments. The modules are designed to operate independently or be combined to produce an integrated priority ranking for basins. These modules have been initially applied at the basin scale (3rd level hydrologic unit or HUC), to provide information for broad-scale strategic planning. It is anticipated that the general approach and criteria used in the modules will be used at other spatial scales (4th, 5th and even 6th field HUC's) as a basis for developing a consistent, nested strategy for restoration work at all levels in the Pacific NW Region. Increasingly more detailed local data would be used as watershed size decreases. Basic concepts guiding development of the three modules has emphasized analysis of whole basins (not just Federal lands), as well as rating areas in the best relative condition as the highest priority for restoration.

II. Aquatic Module Approach

The aquatic module considers resource condition, watershed sensitivity, and management-related risk factors in establishing priorities. It addresses ecological needs of at-risk fish stocks, watershed condition and water quality. The underlying approach in developing the model is to utilize quantitative information, using the best data consistently available across the two-state area (Oregon and Washington).

The model utilizes the same general methodology developed in the interagency (IIT) Interim Watershed Restoration Strategy, for Biological Opinions in the PACFISH/INFISH areas (May 2000). Please refer to this document for details on derivation of the model. It is included as Appendix A. This Regional model incorporates additional variables for reflecting water quality improvement needs. It also uses some different information than was used in the IIT Restoration Strategy analysis, in an effort to utilize uniform data sets available for the entire two-state area.

III. Model Development and Framework

The model construction incorporates three primary categories for analysis: 1) Aquatic Resource Condition; 2) Watershed Sensitivity; and 3) Management Intensity. The paradigm of risk reduction in the "best" basins first drives the weighting of the model components from 4 for aquatic resource condition to 1 for watershed integrity. These weights were assigned based on the modelers' belief of their relative importance. The model is intended to select for basins with a

higher proportion of watersheds in a “fully functioning” or “functioning at risk” condition. Among basins with similar condition ratings, the most “sensitive” are rated highest for treatment, and then among similar groupings, the basins with the greatest amount of risk factors are rated highest.

Each of the categories is represented by a series of criteria/indicators. These are both physical and biological for each of the categories. Basins are scored for each indicator and the indicator ratings are ranked to normalize. In an Excel spreadsheet, each indicator ranking is then weighted by multiplying it’s relative importance within the category by the reliability of the data – high-3, medium 2, and low-1. This results in a possible range of weights for each indicator, ranging from 1-9. The weighted indicator scores within each category for each basin are summed and averaged to produce a weighted average score for the category. The weighted average score for each category is then multiplied by the category weight. The scores for each of the categories are then totaled for each basin. The general logic track followed for model development follows (refer also to Table I):

1. Aquatic Resource Condition: With a weighting of 4, this category is weighted as the most important category in the model. It represents basin condition under existing management regimes. It also infers the potential for detectable response in resources of concern (fish populations, water quality, etc.) to restoration work. It is intended to select for basins with the highest proportion of sub basins/watersheds in “functioning” or “functioning at risk” condition. The category uses both physical and biological criteria/indicators.

- Physical Indicators
    - Current condition/potential for response: Water quality impaired stream segments
    - Future status: Land-use (amount of protected/reserved lands)
- Biological Indicators
    - General condition: Native biodiversity
    - Condition/potential for response: Healthy fish stocks

2. Basin Sensitivity: This category has a weighting of 2. It characterizes the inherent relative sensitivity of the watershed to disturbance using selected risk factors (see #3 below).

- Physical Indicators
    - Surface erosion risk
    - Mass failure risk
- Biological Indicator
    - Federally Listed T& E species

3. Management Intensity: This category measures the degree of human impact on the landscape, and is a measure of potential to affect significant change in resource conditions through restoration work. Human-caused disturbance such as road building and consumptive water use are considered risk factors. This is the lowest weighted category and is intended to help sort basins after each basins' condition and sensitivity are factored together.

- Terrestrial/Watershed Indicator- Road density
- Aquatic Indicator (channel condition)- Consumptive water use

TABLE I: Aquatic Model Construction

1. Aquatic Resource Condition

Indicator	Score->	Rank (1-9) X	Indicator Weight*=	Weighted Rank
303d segments	___	___	3	___
Key watershed %	___	___	9	___
Wild/Parks %	___	___	9	___
Healthy Stocks	___	___	6	___
Biodiversity	___	___	6	___

Condition Category = $\frac{\text{Sum Indicator Weighted Ranks}}{\text{Sum of Indicator Weights (33)}} \times 4$ (Category Score Weight*)

2. Basin Sensitivity

Indicator	Score->	Rank (1-9) X	Indicator Weight*=	Weighted Rank
Surf. Erosion risk	___	___	4	___
Mass failure risk	___	___	4	___
T&E species	___	___	3	___

Sensitivity Category= $\frac{\text{Sum Indicator Weighted Ranks}}{\text{Sum of Indicator Weights (11)}} \times 2$ (Category Score Weight*)

3. **Management Intensity (Risk)**

Indicator	Score->Rank (1-9)	X	Indicator Weight*	=Weighted Rank
Road Density	___	___	3	___
Water Use	___	___	3	___

Risk Category = Sum Indicator Weighted Ranks / Sum of Indicator Weights (6) X 1 (Category Score / Category Weight*)

Total Basin Score = Condition+Sensitivity+Risk Scores

*Weighting assignment:

Category Weighting- relative importance based on restoration philosophy

Indicator Weighting- importance in category times the reliability of the data

IV. Criteria description/derivation

An attempt was made to use the most robust, ecologically representative, and direct measure for each indicator. In many cases, it was difficult to find complete data sets derived in a consistent fashion that covered both states for preferred indicators. Therefore a different, less directly related indicator was sometimes used. Indicators utilized include:

Water Quality/Physical Criteria

1. Number of currently listed 303(d) segments in the basin.

   303(d) listed segments identify those water-bodies that are currently not meeting water quality standards and, therefore, are not providing for beneficial uses. Data was taken from an EPA source. No attempt to validate the listings was made. The data is for total number of segments and does not represent miles of "impaired" segments.

2. Irrigation water use

   Measures water withdrawal without return flow to streams in million gallons/day. 1998 water use values were taken from published USGS data.

3. Surface erosion risk

   Potential for surface erosion was estimated for each basin. A professional panel was convened to qualitatively assign a Very High, High, Moderate, or Low rating to each of Omernick's eco-regions (level IV). A GIS query was made to intersect the basin and eco-region maps with a resultant data table showing acres of

each eco-region in each basin. A final rating for each basin was determined based on the relative real extent of each erosion class within a basin.

4. Mass failure risk
   Derived in the same fashion as Surface Erosion, above.

5. Road density
   Percent of basin with transportation network greater than or equal to 2 miles per sq. mile. A "moving windows" approach was applied to a GIS layer that contains transportation maps for all ownerships in both Oregon and Washington. The result of the analysis is a tabulation of acres of density classes by ownership by basin. The table, in concert with the spatial arrangement of the densities, provides a good representation of the variability of roads within each basin. Ownership was ignored in the model input. The total area for road networks with density greater than or equal to 2 miles per square mile was totaled for use in the model.

Land-use "Condition" Indicators

Two general classes of land-uses were identified as likely to maintain or improve watershed conditions over time:

1. Wilderness and National parks
   Highly protected lands with relatively limited current and future amounts of human caused disturbance. The percent of each basin's acreage in these lands was calculated.

2. Key Watersheds
   These are high quality and readily restorable watersheds with high biological fish recovery and/or water quality values. They are the focus areas for protection and restoration efforts on FS and BLM lands. The percent of each basin's acreage allocated to Key watersheds (Northwest Forest Plan, Tier I/Tier II) and/or A1/A2 watersheds (ICBEMP) was calculated.

Biological/Fish criteria

The three biological criteria utilized include:

1. Healthy stocks – number/status of healthy anadromous fish stocks.
   Some agencies and interest groups have proposed these stocks as a logical focal point for protection/restoration efforts. The rationale for this index recognizes healthy stocks as indicators of functional habitats. They also infer a relative lack of other significant impacts

acting on the populations, which suggests good potential for response from further habitat restoration.

The number of species represented by a healthy stock in each basin was taken from Huntington, et al. (1994), Healthy Native Stocks of Anadromous Salmonids in the Pacific Northwest and California. Basins shown with a "Healthy Level 1" stock (greater than 2/3 potential productivity for the river system) were given two points; basins with only a "Healthy Level 2" stock (10-66% of potential productivity) were given one point. Points for each species were summed to give a total basin score. No attempt was made to verify the information from the source document. (There is no comprehensive information on relative status of resident fish populations available for the two-state area.)

2. Threatened and Endangered Species- number of federal threatened and endangered fish species in each basin.

   Each listed species is given one point. These are totaled for each basin. Distribution of fish species listed as Endangered or Threatened (or proposed for listing) were taken from Listing Status Maps (see www.nwr.noaa). The rationale for the criterion is to reflect the relative risk for loss of fish species, as well as to recognize potential benefits from restoration work to help recover listed species.

3. Biodiversity- number/basin of native salmonid plus rare endemic non-salmonid fish species.

   Each native salmonid species and each Regionally listed sensitive non-salmonid species was given one point and totaled for each basin. Due to the current lack of consistent, complete information on aquatic biodiversity in the watersheds across Oregon and Washington, the modeling effort utilized two of the more complete data sets available: The number of native salmonid species in each basin and the Pacific NW Region FS Sensitive Species list (which incorporates species listed by both States and Natural Heritage databases). It was assumed that the diversity of these native species still present in these basins could function as an indicator of aquatic community status, and also reflect the additive benefits for watershed restoration to multiple species. Sources for data were StreamNet GIS maps, USFWS Distinct Population Segment maps, and NOAA Coastal Listing Status Map (see www.nwr.noaa.gov/1salmon/salmesa/cuttesum .htm.) Efforts are underway in both Oregon and Washington to compile general aquatic biodiversity information. When this is available, the model can be updated with more representative criteria.

V. Sensitivity Testing

In initial tests of early versions of the model, weighting of the indicators differed from that shown above. Weighting was adjusted for several indicators to provide better balance within the model. Computing weighted average scores for each category also helped to balance the indicators. Subsequent sensitivity testing has shown that results from the present version of the model do not change significantly with small changes to weighting in any of the indicators or categories.

VII. Results

Values for the indicators in each basin, and the resulting total model scores are displayed in Table II. The basin total scores are shown in Table III. Basins ranking 30 or more were rated as having “high” ecological priority for restoration. These basins include: Puget Sound, Lower Columbia, Washington Coastal, Southern Oregon Coastal, Northern Oregon Coast, Lower Snake and John Day. Basins ranking 23-29 were rated moderate, and include Willamette, Klamath, Upper Columbia, Northern California Coastal, Deschutes, Middle Columbia, Clearwater, and Yakima. Basins ranking 22 and below rated low, including Pend Oreille, Middle Snake-Powder, Spokane, Oregon Closed Basins, Middle Snake-Boise, Upper Sacramento and Black Rock Basin.

TABLE II: Basin Criteria and Category Scores

Resource Condition

	Basin Name	303(d)		key WS		NP/wild		healthy stk		biodivers.		Wtd. Rank
160402	Black Rock Basin	9	27	0	0	0	0	0	0	0	0	**1**
170102	Pend Oreille	9	27	4	38	0	1	0	0	3	20	**3**
170103	Spokane	9	27	1	12	0	0	0	0	2	15	**2**
170200	Upper Columbia	7	21	3	29	3	26	5	27	7	44	**4**
170300	Yakima	7	21	4	38	3	24	0	0	5	29	**3**
170501	Middle Snake-Boise	8	25	2	20	0	1	0	0	2	10	**2**
170502	Middle Snake-Powder	8	25	4	35	0	0	0	0	1	5	**2**
170601	Lower Snake	7	21	5	43	4	35	0	0	5	29	**4**
170603	Clearwater	9	27	7	67	0	0	0	0	4	25	**4**
170701	Middle Columbia	7	21	2	17	0	4	2	14	6	34	**3**
170702	John Day	6	19	9	81	1	13	2	14	4	25	**5**
170703	Deschutes	8	23	3	31	2	14	0	0	4	25	**3**
170800	Lower Columbia	7	21	5	42	5	44	3	20	7	39	**5**
170900	Willamette	7	22	5	41	3	23	0	0	6	34	**4**
171001	Washington Coastal	7	22	2	15	4	39	9	54	8	49	**5**
171002	Northern Oregon Coastal	7	22	4	37	0	3	5	27	5	29	**4**
171003	Southern Oregon Coastal	2	7	6	55	2	19	6	34	5	29	**4**
171100	Puget Sound	0	0	5	43	9	81	7	41	9	54	**7**
171200	Oregon Closed Basins	8	23	1	12	0	0	0	0	6	34	**2**
180101	Northern California Coastal	9	27	5	48	0	0	1	7	2	15	**3**
180102	Klamath	8	25	7	61	1	12	0	0	7	44	**4**
180200	Upper Sacramento	9	27	1	10	0	0	0	0	0	0	**1**
	importance	1		3		3		2		2		
	data reliability	3		3		3		3		3		
	criteria wt.	3		9		9		6		6	33	

Risk

	Basin Name	roads		water use		
160402	Black Rock Basin	0	0	9	27	**5**
170102	Pend Oreille	0	1	9	27	**5**
170103	Spokane	3	9	9	26	**6**
170200	Upper Columbia	4	13	0	0	**2**
170300	Yakima	5	16	4	11	**4**
170501	Middle Snake-Boise	1	2	7	20	**4**
170502	Middle Snake-Powder	3	9	7	22	**5**
170601	Lower Snake	3	9	7	20	**5**
170603	Clearwater	0	0	9	27	**5**
170701	Middle Columbia	4	12	5	14	**4**
170702	John Day	4	12	8	25	**6**

170703	Deschutes	5	15	7	21			**6**
170800	Lower Columbia	6	18	9	26			**7**
170900	Willamette	8	23	6	18			**7**
171001	Washington Coastal	5	16	9	27			**7**
171002	Northern Oregon Coastal	9	27	9	27			**9**
171003	Southern Oregon Coastal	6	19	8	23			**7**
171100	Puget Sound	5	14	9	26			**7**
171200	Oregon Closed Basins	3	9	6	17			**4**
180101	Northern California Coastal	0	0	9	27			**5**
180102	Klamath	2	6	7	21			**5**
180200	Upper Sacramento	0	1	8	25			**4**
	importance	1		1				
	data reliability	3		3				
	criteria wt.	3		3	6			

Sensitivity

	Basin Name	sfc eros.		mass fail		T&E		
160402	Black Rock Basin	2	8	2	8	0	0	**1**
170102	Pend Oreille	5	20	2	8	1	3	**3**
170103	Spokane	5	20	2	8	1	3	**3**
170200	Upper Columbia	5	20	2	8	3	9	**3**
170300	Yakima	5	20	2	8	3	9	**3**
170501	Middle Snake-Boise	5	20	2	8	1	3	**3**
170502	Middle Snake-Powder	5	20	2	8	1	3	**3**
170601	Lower Snake	8	32	2	8	4	12	**5**
170603	Clearwater	5	20	2	8	3	9	**3**
170701	Middle Columbia	5	20	2	8	4	12	**4**
170702	John Day	8	32	2	8	2	6	**4**
170703	Deschutes	5	20	2	8	1	3	**3**
170800	Lower Columbia	2	8	5	20	5	15	**4**
170900	Willamette	2	8	2	8	6	18	**3**
171001	Washington Coastal	2	8	2	8	2	6	**2**
171002	Northern Oregon Coastal	2	8	6	24	1	3	**3**
171003	Southern Oregon Coastal	5	20	6	24	2	6	**5**
171100	Puget Sound	2	8	2	8	3	9	**2**
171200	Oregon Closed Basins	2	8	2	8	1	3	**2**
180101	Northern California Coastal	9	36	5	20	1	3	**5**
180102	Klamath	2	8	2	8	5	15	**3**
180200	Upper Sacramento	5	20	2	8	0	0	**3**
	importance	2		2		1		
	data reliability	2		2		3		
	criteria wt	4		4		3	11	

TABLE III: Total Basin Scores, Aquatic Restoration Priority Model

		Cond.	Risk	Sens.	**total**
160402	Black Rock Basin	3	5	3	**11**
170102	Pend Oreille	10	5	6	**21**
170103	Spokane	7	6	6	**18**
170200	Upper Columbia	18	2	7	**27**
170300	Yakima	14	4	7	**25**
170501	Middle Snake-Boise	7	4	6	**16**
170502	Middle Snake-Powder	8	5	6	**19**
170601	Lower Snake	16	5	9	**30**
170603	Clearwater	14	5	7	**26**
170701	Middle Columbia	11	4	7	**23**
170702	John Day	18	6	8	**33**
170703	Deschutes	11	6	6	**23**
170800	Lower Columbia	20	7	8	**35**
170900	Willamette	15	7	6	**28**
171001	Washington Coastal	22	7	4	**33**
171002	Northern Oregon Coastal	14	9	6	**30**
171003	Southern Oregon Coastal	17	7	9	**34**
171100	Puget Sound	26	7	5	**38**
171200	Oregon Closed Basins	8	4	3	**16**
180101	Northern California Coastal	12	5	11	**27**
180102	Klamath	17	5	6	**27**
180200	Upper Sacramento	4	4	5	**14**

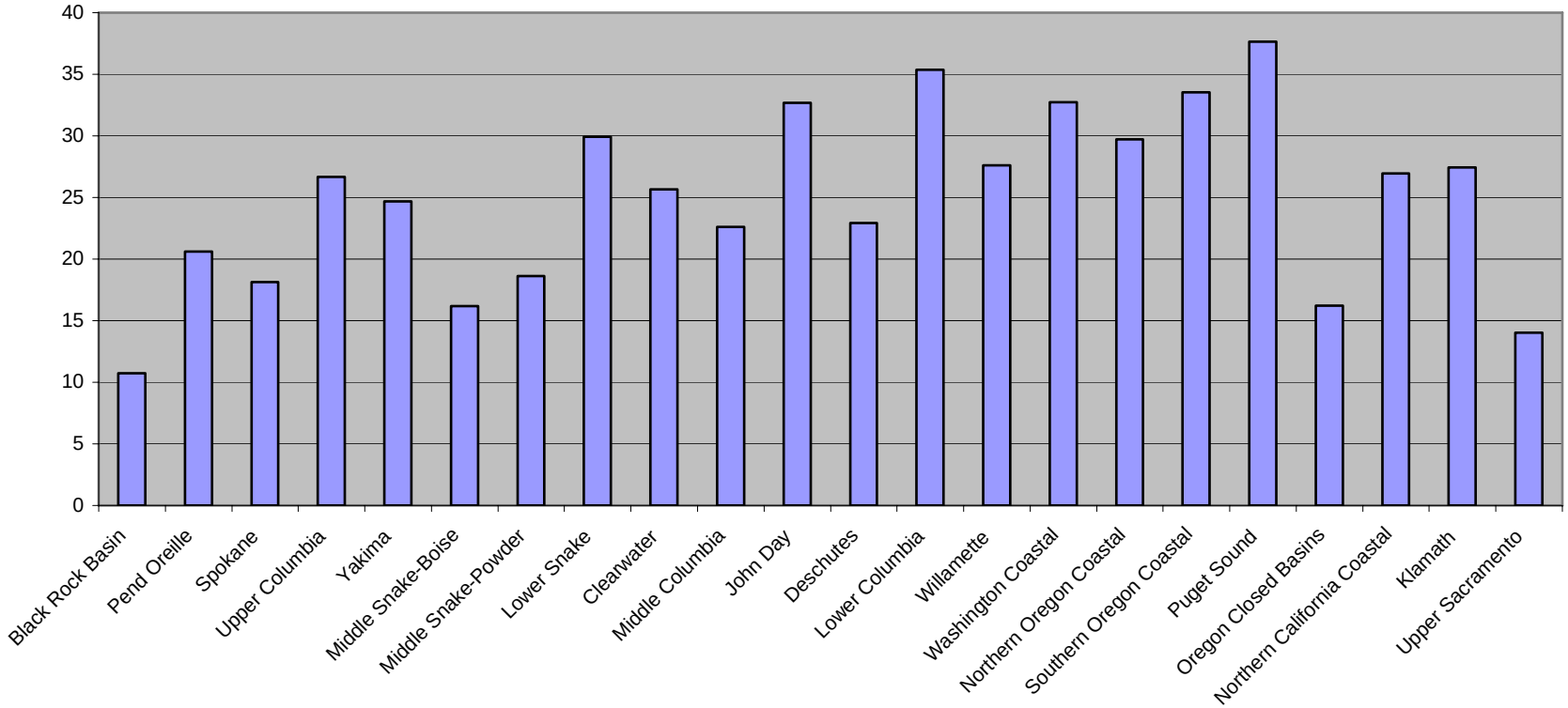
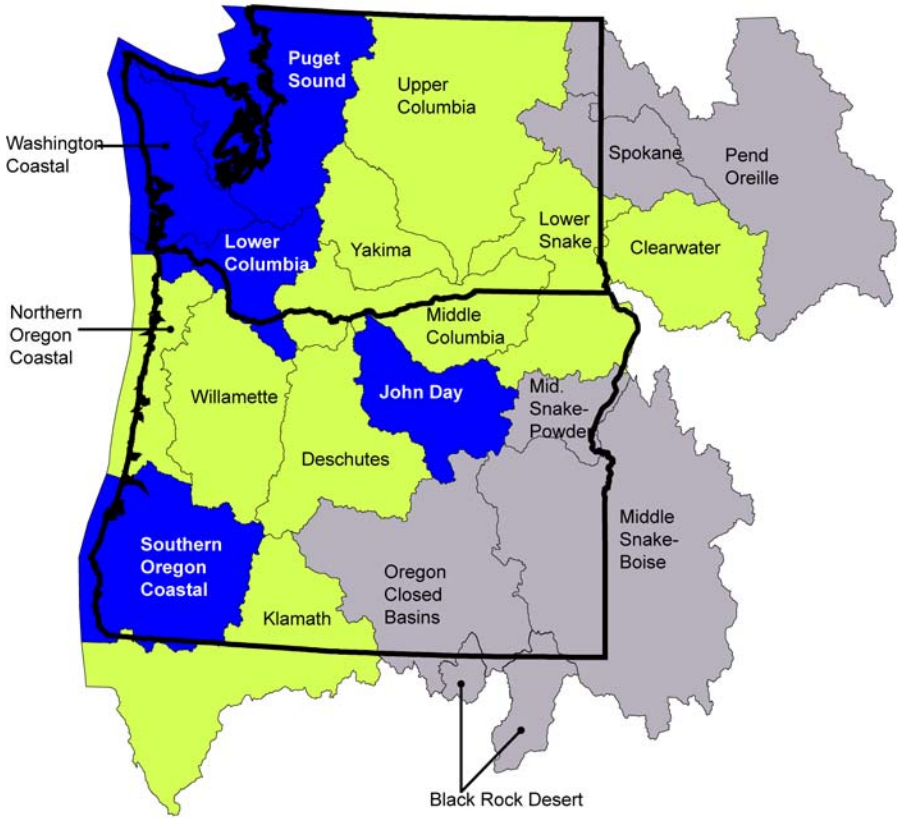


Table IV. TOTAL BASIN SCORES, Aquatic Restoration Priority Model

Aquatic



Resource Condition
- 303(d) waterbodies
- Key-A1/A2 watersheds
- National Parks, wilderness
- Healthy fish stocks
- Biodiversity

Risk
- Road density
- Consumptive water use

Sensitivity
- Surface erosion
- Mass failure
- T&E species

Legend: Blue= Highest priority for restoration, Green= Moderate, Gray= Low.