Mechanistic Models Are Decision-making Models

It is easier to understand the information provided by logic and mechanistic models if they are treated as environmental decision-making models (also known as "multiple criteria assessment" models). Decision-making models represent "the acquisition and merging of subjective, expert knowledge…Often several persons with varying backgrounds are to be taken into the analysis, e.g., engineers, ecologists, economists, managers, and politicians" (Varis et al. 1994). **Each variable in a model represents a decision criterion used to establish a level of performance, rather than an independent variable that estimates the rate of an environmental process.** These decision criteria are based on the judgements and experience of the Assessment Teams and on the research that has been done to date.

2.1.2 What Do Mechanistic Models Represent?

Mechanistic models assessing wetland functions are constructed as a set of relationships between environmental characteristics and the performance of a function. Many of the relationships are only hypothesized because specific information about the relationship may be lacking.

For example, a model for the function "Removing Sediments" might be phrased as follows: "The performance of a wetland in removing sediments from incoming surface waters is based on its ability to reduce water velocities and to filter out sediments." These environmental processes of reducing velocities and filtering sediments become variables in an equation. The equation for "Removing Sediments" would be:

Performance = reduction in water velocity + amount of filtration of sediment

It is not possible to develop a rapid assessment methods that measures how much a wetland reduces water velocities or filters water to estimate sediment removal. Such estimates would require measuring changes in current velocities over the entire wetland for at least one year, and the relative cross section provided by vegetation. Rapid assessment methods have to rely on easily observed characteristics that are correlated with the actual environmental processes.

2.1.3 Use of Indicators as Surrogates for Variables

When it is not feasible to use a variable because it cannot be rapidly assessed, it is sometimes possible to use an indicator as a surrogate for that variable. Indicators are easily observed characteristics that are correlated with quantitative or qualitative observations of an environmental variable.

Most indicators are fixed characteristics that describe the structure of the ecosystem or its physical, chemical, and geologic properties (Brinson 1995). Such indicators are time

independent conditions (on the scale of most environmental processes), and thus cannot reflect actual rates of performance. Rather, they reflect the potential or probability that functions are performed at a certain level. Model scores based on indicators, therefore, do not reflect the levels at which a function may actually be performed. Instead, they estimate the potential or probability that a function is being performed.

The potential of a wetland to reduce water velocities might be established by using the size and shape of its outlets and the depth of water stored in the wetland as indicators. An indicator of the potential for filtration of sediment might be based on the percent cover of dense erect vegetation near the ground surface. The equation for removing sediments could then be rewritten as:

> *Potential performance = type of outlets + depth of water storage + %cover of different types of vegetation*

In a logic model, the level of performance would be described using conditional phrases such as "the wetland rates high for removing sediments if it has a constricted outlet and an average depth of storage that is greater than 1 m and erect vegetation over more than 80% of its area."

With mechanistic models, the authors choose the variables and scale them based on their judgement. They assign scores to different "states" of a variable (e.g., > 80% cover of emergent vegetation might be given an index of [1]; 40 - 79% cover of emergent vegetation receives an index of [0.5], etc.). Different types of outlets, and different depths of water storage, would also be assigned scaled scores in this manner.

In developing models, the sum of the scores for the variables in an equation are adjusted (normalized) to [1] or [10] for each function. Normalizing is important because each function may have a different number of variables with correspondingly different total sums. The indices of different functions are more easily interpreted if the highest levels are all recorded as a [10].

2.1.4 Scoring Wetlands

Application of a method results in a set of indices, one for each function in each wetland unit being assessed. The indices are presented as a number, for example between 0 and 10, with a 10 representing the highest level of performance.

The index represents an index per hectare or acre of wetland. For example, a small, 1 hectare wetland, and a large 100 hectare wetland may both have an index of [10] for a specific function.An index itself is without any numeric "dimensions".

6.9.5 Calculation of Habitat Suitability
Depressional Outflow – Habitat Suitability for Amphibians

Variable	Description of Scaling		Score for Variable	Result
Vbuffcond	*Highest:*	Buffer category of 5	If D42 = 5, enter "1"	
	High:	Buffer category of 4	If D42 = 4, enter "0.8"	
	Moderate:	Buffer category of 3	If D42 = 3, enter "0.6"	
	Medium Low:	Buffer category of 2	If D42 = 2, enter "0.4"	
	Low:	Buffer category of 1	If D42 = 1, enter "0.2"	
	Lowest:	Buffer category of 0	If D42 = 0, enter "0"	
Vsubstrate	*Highest:*	3 categories of organic litter + 2 inorganic surface layers	If D46.1 + D46.2 + D46.3 =3 **and** sum (D46.4 to D46.8) > = 2, enter "1"	
	Lowest:	AU has no ground surface exposed	If sum (D46.1-D46.8) = 0, enter "0"	
	Calculation:	Scaling is based on the number of categories of surface layers present; with organic surface layers weighted by a factor of two.	Enter result of calculation	
	If Sum(D46.4 – D46.8) >= 2 calculate [(D46.1+D46.2+D46.3)x2 + 1]/8 If Sum(D46.4-D46.8) <= 1 calculate [(D46.1+D46.2+D46.3)x2 + sum (D46.4 - D46.8)]/8			
Vwintersp	*Highest:*	High interspersion between land and water	If D38 = 3, enter "1"	
	Moderate:	Moderate interspersion	If D38 = 2, enter "0.67"	
	Low:	Low interspersion	If D38 = 1, enter "0.33"	
	Lowest:	no interspersion	If D38 = 0, enter "0"	
Vlwd	*Highest:*	AU has at least 10 size categories and decomposition states of LWD	If calculation > = 1, enter "1"	
	Lowest:	No categories of LWD	If calculation = 0, enter "0"	
	Calculation:	Scaling based on the number of categories divided by 10	Enter result of calculation	
	Calculate (D44 + D45)/10 to get result			
Vwater	*Highest:*	AU has at least 50% permanently exposed inundation	If D8.3 + D14.6 > = 50, enter "1"	
	High:	Au has 10 – 49% permanently exposed inundation	If D8.3 + D14.6 > = 10 and < 50, enter "0.8"	
	Moderate:	AU has no exposed inundation but has permanent inundation	If D8.3 + D14.6 = 0 **and** D9.1 = 1, enter "0.5"	
	Low:	AU has 1 – 9% permanently exposed inundation	If D8.3 + D14.6 > = 1 and < 10, enter "0.2"	
	Lowest:	Lowest – AU has no permanent inundation	If D8.3 + D14.6 = 0 **and** D9.1 = 0, enter "0"	

Table continued on next page

Variable	Description of Scaling		Score for Variable	Result
Vsubstruc	*Highest:*	Score of 4 on underwater structures for egg laying	If D35 = 4, enter "1"	
	High:	Score of 3 on underwater structures for egg laying	If D35 = 3, enter "0.75"	
	Moderate:	Score of 2 on underwater structures for egg laying	If D35 = 2, enter "0.5"	
	Low:	Score of 1 on underwater structures for egg laying	If D35 = 1, enter "0.25"	
	Lowest:	Score of 0 on underwater structures for egg laying	If D35 = 0, enter "0"	
			Total of Variable Scores:	
Reducer				
Vphow	pH of standing water < 4.5		If D26.2 < = 4.5, enter "0"	
	pH of standing water >4.5 and < 5.5		If D26.2 > 4.5 and < 5.5, enter "0.5"	
	pH of standing water > =5.5		If D26.2 > = 5.5, enter "1.0"	
Vupcover	AU has > + 60% urban or high density residential land use; OR > = 50% clear cut within 1 km		If D3.4 + D3.5 > = 60 **OR** D3.3 > = 50, enter "0.5"	
	AU has as least 30% of area within 1 km in active land uses		If sum (D3.2-D3.6) > = 30, enter "0.8"	
	AU has less than 30% of area within 1 km in active land uses		If sum (D3.2-D3.6) < 30, enter "1"	
			Score for Reducer (Choose Lowest Value)	
Index for Amphibians = Total for variables x reducer x 1.85 rounded to nearest 1				
			FINAL RESULT:	

6.15.5 Calculation of Potential Performance
Depressional Outflow – Primary Production and Organic Export

Variable	Description of Scaling		Score for Variable	Result
Vvegcover	*Highest:*	AU is100% vegetated	If calculation =1, enter "1"	
	Lowest:	AU has minimal vegetation cover	If calculation = <0.05, enter "0"	
	Calculation:	Scaling is set as % vegetated/100	Enter result of calculation	
	Calculate [sum (D14.1 to D14.6)[/100 to get result			
Vnonevergreen	*Highest:*	100% of AU has cover of non-evergreen vegetation	If calculation = 1, enter "1"	
	Lowest:	AU has only evergreen vegetation	If calculation = 0, enter "0"	
	Calculation:	Scaled as a fraction based on % area	Enter result of calculation	
	Calculate (D14.2 + D14.4 + D14.5 + D14.6) / 100 to get result			
Vunderstory	*Highest:*	AU has 100% herbaceous understory	If calculation = 1.0 enter "1"	
	Lowest:	AU has no understory	If D16 = 0, enter "0"	
	Calculation:	Scaling based on understory as % of the total area of AU	Enter result of calculation	
	Calculate (0.01 x D16) x (D14.1 + D14.2 + D14.3 +D14.4)/100 to get result			
			Total of Variables for Primary Production:	
Vorg	*Highest:*	AU has no organic soils	If D47.1 + D47.2 = 0, enter "1"	
	Moderate:	AU has organic soils but < 50%	If D47.1 + D47.2< = 1, enter "0.8"	
	Low:	AU has > 50% and < 95% organic soils	If D47.1 **or** D47.2 = 2, enter "0.3"	
	Lowest:	AU has > 95% organic soils	If D47.1 **or** D47.2 = 3, enter "0"	
Veffectarea1	*Highest:*	100% of AU annually inundated	If D8.1 = 100, enter "1"	
	Lowest:	0% of AU annually inundated	If D8.1 = 0, enter "0"	
	Calculation:	Scaling = (% of AU inundated/100)	Enter result of calculation	
	Calculate D8.1/100 to get result			
			Total of Variables for Export:	
Reducer				
Vbogs	Bog component > 75% of AU		If D23.1 = 1, enter "0.5"	
	Bog component 50-75% of AU		If D23.2 = 1, enter "0.7"	
	Bog component 25-49% of AU		If D23.3 = 1, enter "0.9"	
	Bog component < 25% of AU		If D23.4 + D23.5 = 1, enter "1"	
			Score for Reducer	
Index for Primary Production and Export = (Total for production x total for export) x Reducer x 2.06 rounded to nearest 1				
			FINAL RESULT:	

Rationale: Emergent species have, in general, been found to sequester metals and remove oils and other organics better than other plant species (Hammer 1989; Horner 1992). AUs dominated by emergents were judged to sequester toxic metals and remove organic compounds better than those dominated by forest or scrub/shrub. Furthermore, the emergent vegetation and herbaceous understory support a higher microbial population that can decompose organic toxicants. This is due to a larger surface area exposed to incoming water.

Indicators: No indicators are needed. The areal extent (as % of AU) of emergent species and herbaceous understory is estimated directly.

Scaling: The scaling of the variable is based on the percent of the AU covered by emergent species (using the Cowardin definition) and by an herbaceous understory. AUs with a 100% cover of emergents + understory are scaled as [1]. AUs with a cover of less than 100% are scaled proportionally as %area/100.

$V_{effectarea1}$ – The area of the AU over which the removal of metals and toxic organic compounds is expected to take place. Some parts of an AU may never be inundated by surface waters and thus will not remove toxics from surface waters.

Rationale: In this assessment method, an index for an AU is calculated on a "per acre" basis. An index for an AU is then calculated by multiplying its "per acre" score by its area. Thus, a correction factor representing the area of the AU that actually performs the function, relative to its overall size, is needed.

Indicators: In western Washington, there is some difficulty in establishing the area of an AU that is regularly flooded because the water regime can be so variable for many AUs. The indicator chosen by the Assessment Teams to represent this variable is the area of the AU that is inundated or flooded on a annual basis. The area of surface water inundation during the summer must be determined by indicators such as water marks, deposition lines, or other discoloration on vegetation or rocks.

Scaling: This variable is scaled based on the percentage of the AU that is annually inundated. AUs that are inundated over their entire surface (100%) score a [1]. Areas or inundation less than 100% are scaled proportionally as %area/100.

7.3.5 Calculations of Potential Performance
Depressional Closed – Removing Metals and Toxic Organics

Variable	Description of Scaling		Score for Variable	Result
Vsorp	*Highest:*	Non-clay mineral soils are <50% of area	If D47.3 < =1, enter "1"	
	Moderate:	Non-clay mineral soils are 50-95% of area	If D47.3 = 2, enter "0.5"	
	Lowest:	Non-clay mineral soils are >95% of area	If D47.3 = 3, enter "0"	
Vph	*Highest:*	pH less than of equal to 4.5	If D26.1 < = 4.5, enter "1"	
	Moderate:	pH between 4.5 and 5.5	If D26.1 > 4.5 and < = 5.5, enter 0.5	
	Lowest::	pH greater than 5.5	If D26.1 > 5.5, enter "0"	
Vtotemergent	*Highest:*	100% of AU has herbaceous understory and/or emergents	If calculation = 1, enter "1"	
	Lowest:	AU has 0% of emergents	If D14.5 + D16 = 0, enter "0"	
	Calculation:	Scaling = (% of AU with emergents + understory/100)	Enter result of calculation	
	Calculate D14.5 + (D16/100x sum (D14.1 to D14.4)) /100 to get result			
Veffectarea1	*Highest:*	100% of the AU annually inundated	If D8.1 =100, enter "1"	
	Lowest:	0% of the AU annually inundated	If D8.1 = 0, enter "0"	
	Calculation:	Scaling = (% of AU annually inundated/100)	Enter result of calculation	
	Calculate D8.1/100 to get result			
			Total of Variable Scores:	
Index for Removing Metals and Toxic Organics = Total x 3.23 rounded to nearest 1				
			FINAL RESULT:	

Variable	Description of Scaling		Score for Variable	Result
Vsubstruc	*Highest:*	Score of 4 on underwater structures for egg laying	If D35 = 4, enter "1"	
	High:	Score of 3 on underwater structures for egg laying	If D35 = 3, enter "0.75"	
	Moderate:	Score of 2 on underwater structures for egg laying	If D35 = 2, enter "0.5"	
	Low:	Score of 1 on underwater structures for egg laying	If D35 = 1, enter "0.25"	
	Lowest:	Score of 0 on underwater structures for egg laying	If D35 = 0, enter "0"	
			Total of Variable Scores:	
Reducer				
Vphow	pH of standing water < 4.5		If D26.2 < = 4.5, enter "0"	
	pH of standing water >4.5 and < 5.5		If D26.2 > 4.5 and < 5.5, enter "0.5"	
	pH of standing water > =5.5		If D26.2 > = 5.5, enter "1"	
Vupcover	AU has > + 60% urban or high density residential land use; OR > = 50% clear cut within 1 km		If D3.4 + D3.5 > = 60 **OR** D3.3 > = 50, enter "0.5"	
	AU has as least 30% of area within 1 km in active land uses		If sum (D3.2-D3.6) > = 30, enter "0.8"	
	AU has less than 30% of area within 1 km in active land uses		If sum (D3.2-D3.6) < 30, enter "1"	
			Score for Reducer (Choose Lowest Value)	
Index for Amphibians = Total for variables x reducer x 1.72 rounded to nearest 1				
			FINAL RESULT:	

7.10 Habitat Suitability for Wetland Associated Birds — Depressional Closed Wetlands

Note: Please read the introduction to the assessment models (Chapter 2) before using these models. It describes several basic assumptions used in modeling that will help you better understand how to use and apply the methods.

7.10.1 Definition and Description of Function

Habitat Suitability for Wetland-associated birds is defined as the environmental characteristics in a wetland that provide habitats or life resources for species of wetland-associated birds. Wetland-associated bird species are those that depend on aspects of the wetland ecosystem for some part of their life needs: food, shelter, breeding, and resting. The guilds of wetland associated birds used as the basis for building the assessment model includes waterfowl, shorebirds, and herons.

In general, the suitability of an AU as bird habitat increases as the number of appropriate habitat characteristics increase. Another assumption used in developing the model is that AUs that provide habitat for the greater number of wetland dependent bird species are scored higher than those that have fewer. **The assessment models are focused on species richness, not on the importance of a wetland to a specific threatened or endangered species or to a specific regionally important guild.**

If the AU is a habitat type that appears to be critical to a specific species, another method is needed in order to determine the habitat suitability of that AU (e.g. USFWS Habitat Evaluation Procedures (HEP), USFWS 1981).

7.10.2 Assessing this Function for Depressional Closed Wetlands

The suitability of wetlands in the depressional closed subclass as habitat for wetland-associated birds is modeled based on the plant structure, physical components, and the condition of the buffers around the AU. In addition, the models include the indices for other habitat functions that represent food for birds: namely the habitat suitability index for amphibians, invertebrates, and fish.

AUs that have a closed canopy are judged to have a reduced level of performance because access for waterfowl is limited. The Assessment Teams also judged that the presence of invasive or non-native birds may reduce the suitability of an AU. A variable for this factor was not included in the model because reproducible data on invasive or non-native birds could not be collected during one site visit.

Size is not used as a variable in the equation although it is often cited as an important characteristic of wetlands that provide bird habitat (Richter and Azous in preparation). The question of size is a vexing one, and no satisfactory size thresholds have been identified in

7.11 Habitat Suitability for Wetland Associated Mammals — Depressional Closed Wetlands

Note: Please read the introduction to the assessment models (Chapter 2) before using these models. It describes several basic assumptions used in modeling that will help you better understand how to use and apply the methods.

7.11.1 Definition and Description of Function

Habitat Suitability for Wetland-associated Mammals is defined as wetland features and characteristics that support life requirements of four aquatic or semi-aquatic mammals. Mammalian species whose habitat requirements were modeled are the beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), river otter (*Lutra canadensis*), and mink (*Mustela vison*).

The model for this function is based on general habitat requirements for each of the four wetland-associated mammals. The model reflects the suitability of an AU to support mammal richness rather than individual species abundance. Habitat considerations in the model are restricted to the condition of the wetland buffer, and characteristics that can be found within the AU itself. It is assumed that wetlands that provide habitat for all four of the aquatic mammal species function more effectively than ones that meets the habitat needs of fewer species.

Wetlands that are found within urban or residential areas are modeled as having a reduced level of performance. Adjacent areas that are developed provide an avenue for humans, cats, dogs, and other domestic animals to harass mammal populations.

The SWTC and Assessment Teams decided to focus the model specifically on the aquatic fur-bearing mammals because these are wetland dependent species that are important to society, and they represent different types of mammals that use wetlands. Many terrestrial mammals will use wetlands, if they are available, to meet some of their life maintenance requirements. These species, however, do not need wetlands. It would have been too difficult to develop a mammal model that incorporates habitat features for all mammals using wetlands. Such models would have had to incorporate too much information about the surroundings uplands and expanded the scope of the assessment methods to the extent that they would no longer be considered "rapid."

If the AU is a habitat type that appears to be critical to a specific species, another method is needed in order to determine the habitat suitability of that AU (e.g. USFWS Habitat Evaluation Procedures (HEP), USFWS 1981).

7.11.2 Assessing this Function for Depressional Closed Wetlands

The suitability of wetlands in the depressional closed subclass as mammal habitat is modeled by buffer conditions, water depths, presence of open water, connectivity of the site to other suitable habitat, interspersion of vegetation and open water, and the presence of characteristics important to each species modeled. Reduction in suitability is modeled based on the percentage of the surrounding landscape, within 1 km, that is developed ($V_{upcover}$).

7.11.3 Model at a Glance

Depressional Closed — Habitat Suitability for Wetland-associated Mammals

Characteristics	Variables	Measures or Indicators
Breeding, feeding, and refuge for beaver, mink, otter, and muskrat (applies to all variables)	**Vbuffcond**	Descriptive table of buffer conditions
	Vwaterdepth	Number of water depth categories present
	Vcorridor	Categorical rating of corridor
	Vbrowse	Area of woody vegetation for beaver
	Vemergent2	At least .25 ha of emergent vegetation
	Vwintersp2	Diagrams of interspersion if AU
	Vow	% of AU in open water and aquatic bed
	Vbank	Banks present of fine material
Reducers		
Development	**Vupcover**	Land uses within 1 km of AU
Index:		(Vbuffcond + Vwaterdepth + Vcorridor + Vbrowse + Vemergent2 + Vwintersp2 + Vow + Vbank) x Vupcover / Score for reference standard site

7.11.4 Description and Scaling of Variables

$V_{buffcond}$ – Land-use patterns within 100 m of the edge of the AU.

Rationale: A relatively undisturbed buffer serves to minimize disturbance (Burgess 1978, Allen and Hoffman 1984), provide habitat for prey species and food sources for mammals (Brenner 1962, Dunstone 1978, Allen 1983), cover from predators

7.11.5 Calculation of Habitat Suitability
Depressional Closed – Habitat Suitability for Wetland-associated Mammals

Variable	Description of Scaling		Score for Variable	Result
Vbuffcond	*Highest:*	Buffer category of 5	If D42 = 5, enter "1"	
	High:	Buffer category of 4	If D42 = 4, enter "0.8"	
	Moderate:	Buffer category of 3	If D42 = 3, enter "0.6"	
	Medium Low:	Buffer category of 2	If D42 = 2, enter "0.4"	
	Low:	Buffer category of 1	If D42 = 1, enter "0.2"	
	Lowest:	Buffer category of 0	If D42 = 0, enter "0"	
Vwaterdepth	*Highest:*	Water depths >1 m present	If D12.3 = 1, enter "1"	
	Moderate:	Water depths between 1-100 cm present	If D12.1 = 1 **and** D12.2 = 1, enter "0.5"	
	Low:	Depths between 1-20 cm present	If D12.1 = 1, enter "0.3"	
	Lowest:	No surface water present	If all D10 are 0, enter "0"	
Vcorridor	*Highest:*	Corridor rating is 3	If D43 = 3, enter "1"	
	Moderate:	Corridor rating is 2	If D43 = 2, enter "0.67"	
	Low:	Corridor rating is 1	If D43 = 1, enter "0.33"	
	Lowest:	Corridor rating is 0	If D43= 0, enter "0"	
Vbrowse	*Highest:*	AU has more than 1 ha (2.5 acres) of preferred woody vegetation for beaver in and within 100 m of AU	If D30 =1, enter "1"	
	Lowest:	Above not present	If D30 = 0, enter "0"	
Vemergent2	*Highest:*	AU has cover of emergent vegetation that is > = 0.4 ha (1 acre)	If (D1 x D14.5)/100 > = 0.4, enter "1"	
	Lowest:	AU has no cover of emergents or emergents < 0.4 ha	If (D1 x D14.5)/100 < 0.4, enter "0"	
Vwintersp2	*Highest:*	If AU is > 0.4 ha (1 acre) and interspersion between vegetation and exposed water is high	If D1 > = 0.4 and D38 = 3, enter "1"	
	Moderate:	If AU > 0.4 ha and interspersion is moderate	If D1 > = 0.4 and D38 = 2, enter "0.67"	
	Low:	If AU > 0.4 ha and interspersion is low	If D1 > = 0.4 and D38 = 1, enter "0.33"	
	Lowest:	AU has < 0.4 ha or AU has no interspersion	If D38 = 0 OR D1 < 0.4, enter "0"	
Vow	*Highest:*	If OW > 0.1 ha (0.25 acres) and OW at least 30% of AU	If (D1 x D8.3) / 100 > 0.1 and D8.3 > = 30, enter "1"	
	High:	If OW > 0.1 ha and OW = 10 - 29% of AU	If (D1 x D8.3) / 100 > 0.1 and 10< = D8.3 < 30, enter "0.8"	
	Lowest:	If OW < = 0.1 ha	If (D1 x D8.3)/100 < 0.1, enter "0"	
	Calculation:	If OW > 0.1 ha scaled as % OW x 0.08	Enter result of calculation	
	If (D1xD8.3)/100 > 0.1 and D8.3 < 10 calculate as D8.3x0.08 to get result			

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Variable	Description of Scaling		Score for Variable	Result
Vbank	*Highest:*	Steep banks suitable for denning (>45 degree slope, fine material, >10 m long)	If D37 = 1, enter "1"	
	Lowest:	No steep banks present	If D37 = 0, enter "0"	
			Total of Variable Scores:	
Reducer				
Vupcover	Land use within 1 km - > = 15% urban commercial, or > = 20% high density residential; or > = 40% low density residential		If D3.4 > = 15 OR D3.5 > = 20 OR D3.6 > = 40, enter "0.7"	
	Land use criteria described above not met		If above conditions not met, enter "1"	
			Score for Reducer	
Index for Habitat Suitability for Wetland-associated Mammals = Total for variables x reducer x 1.33 rounded to nearest 1				
			FINAL RESULT:	

8.7.5 Calculation of Habitat Suitability
Riverine Flow-through – General Habitat Suitability

Variable	Description of Scaling		Score for Variable	Result
Vbuffcond	*Highest:*	Buffer category of 5	If D42 = 5, enter "1"	
	High:	Buffer category of 4	If D42 = 4, enter "0.8"	
	Moderate:	Buffer category of 3	If D42 = 3, enter "0.6"	
	Medium Low:	Buffer category of 2	If D42 = 2, enter "0.4"	
	Low:	Buffer category of 1	If D42 = 1, enter "0.2"	
	Lowest:	Buffer category of 0	If D42 = 0, enter "0"	
V%closure	*Highest:*	Canopy closure between 30-70%	If D17 > = 30 and D17 < = 60, enter "1"	
	Moderate:	Canopy closure between 10-29% or 71-100%	If D17 = 10-29 or D17 > 60, enter "0.5"	
	Lowest:	Canopy closure <10 %	If D17 <10, enter "0"	
Vstrata	*Highest:*	5 or 6 strata present	If D21 > = 5, enter "1"	
	High:	4 strata present	If D21 = 4, enter "0.75"	
	Moderate:	3 strata present	If D21 = 3, enter "0.5"	
	Medium low:	2 strata present	If D21 = 2, enter "0.25"	
	Low:	1 stratum present	If D21 = 1, enter "0"	
Vsnags	*Highest:*	AU has at least 6 categories of snags and some have > 30 cm dbh	If D31 > = 6 and D31.1 =1, enter "1.3"	
	Lowest:	No snags present	If D31 = 0, enter "0"	
	Calculation:	Scaled as number of categories divided by 6 + 0.3 if dbh is > 30 cm	Enter result of calculation	
	If D31 < 6 calculate D31/6 + (D31.1 x 0.3) to get result			
Vvegintersp	*Highest:*	High interspersion	If D39 = 3, enter "1"	
	Moderate:	Moderate interspersion	If D39 = 2, enter "0.67"	
	Low:	Low interspersion	If D39 = 1, enter "0.33"	
	Lowest:	AU has no interspersion (1 class only)	If D39 = 0, enter "0"	
Vlwd	*Highest:*	AU has at least 8size and decomposition categories of LWD	If calculation > = 1, enter "1"	
	Lowest:	No categories of LWD	If calculation = 0, enter "0"	
	Calculation:	Scaling based on the number of categories divided by 8	Enter result of calculation	
	Calculate (D44 + D45)/8 to get result			
Vhydrop	*Highest:*	AU has 3 or 4 water regimes present	If D9.3 + D9.4 + D9.5 + D9.6 > = 3, enter "1"	
	High:	AU has 2 water regimes present	If D9.3 + D9.4 + D9.5 + D9.6 = 2, enter "0.50"	
	Low:	AU has 1 water regime present	If D9.3 + D9.4 + D9.5 + D9.6 = 1, enter "0"	
Vwintersp	*Highest:*	High interspersion	If D38 = 3, enter "1"	
	Moderate:	Moderate interspersion	If D38 = 2, enter "0.67"	
	Low:	Low interspersion	If D38 = 1, enter "0.33"	
	Lowest:	No interspersion	If D38 = 0, enter "0"	

Table continued on next page

Variable	Description of Scaling		Score for Variable	Result
Vprichness	*Highest:*	Number of plant species > = 40	If calculation > = 1.0, enter "1"	
	Lowest:	AU has 2 or less plant species	If calculation < = 0.05, enter "0"	
	Calculation:	Scaled as # of species/40	Enter result of calculation	
	Calculate (D19.1 + D19.2)/40 to get result			
Vmature	*Highest:*	AU has mature trees present	If D22 = 1, enter "1"	
	Lowest:	AU has no mature trees present	If D22 = 0, enter "0"	
Vedgestruc	*Highest:*	High or moderate structure at edge of AU	If D41 >=2, enter "1"	
	Moderate:	Low structure	If D41 = 2, enter "0.5"	
	Lowest:	No structure	If D41 = 0, enter "0"	
			Total of Variable Scores:	
Reducer				
Vupcover	If clear cutting, high and low density residential, and urban land uses within 1 km are > = 60%		If D3.3 + D3.4 + D3.5 + D3.6 > = 60, enter "0.9"	
	If critical land uses < 60%		Enter 1	
			Score for Reducer:	
Index for General Habitat Suitability = Total for variables x reducer x 1.09 rounded to nearest 1				
			FINAL RESULT:	

8.10 Habitat Suitability for Anadromous Fish — Riverine Flow-through Wetlands

Note: Please read the introduction to the assessment models (Chapter 2) before using these models. It describes several basic assumptions used in modeling that will help you better understand how to use and apply the methods.

8.10.1 Definition and Description of Function

Habitat Suitability for Anadromous Fish in riverine flow-through wetlands is defined as the environmental characteristics that contribute to the refuge and egg-laying needs of anadromous fish species.

The suitability of riverine flow-through wetlands to provide habitat for anadromous fish is modeled by combining variables that represent refuge conditions for the fish during a flood event with one indicative of gravels that can be used for egg laying. Riverine flow-through wetlands are frequently flooded but do not retain the flood-water by definition. This means that anadromous fish have little time to feed in the wetland and do not overwinter there.

The models assess general habitat suitability, not the importance of a wetland to a specific threatened or endangered species, or to a specific regionally important species assemblage. The function is modeled based on the structural elements, physical components, and the characteristics of the AU that are considered to be important elements of habitat for anadromous fish. In general, the suitability of an AU as habitat for anadromous fish is assumed to improve as the number of beneficial habitat characteristics increase.

If the AU is a habitat type that appears to be critical to a specific species, another method is needed to better determine the habitat suitability of that AU [e.g. USFWS Habitat Evaluation Procedures (HEP) USFWS 1980].

8.10.2 Assessing this Function for Riverine flow-through Wetlands

The structural elements of a wetland that are considered to provide refuge are the presence of bars with or without herbaceous vegetation, woody debris, a forest canopy over the stream, and adequate water depth. One variable is used to indicate gravels that can be used for egg-laying.

Habitat Suitability for Anadromous Fish is one of the two habitat functions for which it may be possible to also judge opportunity as part of a rapid assessment method. The Assessment Teams decided that an AU does have the opportunity to provide habitat for anadromous fish if has a direct connection to a stream with anadromous fish in it. Information on locations used by anadromous fish is more readily available than for other wildlife. WDFW maintains an extensive database of streams used by anadromous fish, and this can be used as a guide in

rating the opportunity. Local sources may also be contacted for information on the presence of anadromous fish.

8.10.3 Model at a Glance

Riverine Flow-through — Habitat Suitability for Anadromous Fish

Process	Variables	Measures or Indicators
Egg laying and refuge for anadromous fish (applies to all variables)	**Vflowmods**	Structures in AU that create low velocity eddies
	Vcover	Number and type of refuge present in water
	V%closurest	% of stream with canopy closure
	Vstreamsubs	Gravel or cobbles present in stream
	Index:	2 x Vflowmods + 2 x Vcover + V%closurest + Vstreamsubs / Score from reference standard site

8.10.4 Description and Scaling of Variables

$V_{flowmods}$ – The AU has structures on its surface such as large rocks and log jams that modify flows and create eddies on the downstream side. **This variable was judged to be a critical habitat feature in riverine flow-through wetlands and is weighted by a factor of 2.**

> **Rationale**: Water velocities are often higher during floods and small juvenile salmonids can be swept away from their usual overwintering habitats. The presence of large structures in the flow path of floodwaters will create eddies of calmer water on the downstream side. These eddies can provide refuge for the juvenile salmonids.
>
> **Indicators:** No indicators are needed. The presence of large structures on the surface of the AU can be established during the site visit.
>
> **Scaling:** This is an "on/off" variable. AU's with structures present score a [2]; those without score a [0].

V_{cover} – Structures in the AU that provide cover in and over water. This variable is assessed based on three structural elements: 1) vegetation that overhangs permanent streams or channels; 2) undercut banks; and 3) large woody debris in the stream or channel. **This variable is considered to be a critical habitat component and is weighted by a factor of 2 relative to the other variables.**

> **Rationale:** Overhanging vegetation and undercut banks provide both temperature control and protection from predation. McMahon (1983) reported the need for streamside vegetation for shading. Small coho juveniles tend to be harassed, chased and nipped by larger juveniles unless they stay near the bottom, obscured by rocks or logs (Groot and Margolis 1994). Cover for salmonids can be provided by overhanging vegetation, undercut banks, submerged vegetation, submerged objects

provide refuge for the larger adults. Varying water depths also provide different potential food sources since they are host to different populations of plants and invertebrates.

Indicators: The variable is characterized using a condensed form of the depth classes first developed for WET habitat assessments (Adamus et al. 1987). These are 0-20 cm, 20-100 cm, and > 100 cm.

Scaling: AUs with all three depth classes present are scored a [1]. Those with the two shallower ones are scored a [0.5]; those with 0-20 cm of water are scored a [0.1]. AUs with no permanent or seasonal inundation are scored a [0]. In some cases an AU may have steep sides. If the water depth is greater than 100 cm but the AU does not have enough shallow water to meet the size requirements (0.1 ha or 10%, whichever is the smaller) it is scored a [0.7].

8.11.5 Calculation of Habitat Suitability

Riverine Flow-through – Habitat Suitability for Resident Fish

Variable	Description of Scaling		Score for Variable	Result
Vpermflow	*Highest:*	Permanent channel or stream	If D4.1 = 1, enter "2"	
	Lowest:	No permanent channel	If D4.1 = 0, enter "0"	
Vcover	*Highest:*	Both categories of cover present: overhanging vegetation and undercut banks; and has 10 or more categories of woody debris on surface and in permanent water	If D32 = 1 and D34 = 1 and (D44 + D45) > = 10, enter "1"	
	Lowest:	No categories of cover present	If D32 + D34 + D44 + D45 = 0, enter "0"	
	Calculation:	Scaled as # of categories with the following weights: 1 for overhang, 2 for banks and 3 for LWD normalized to 6	Enter result of calculation	
	If D44 + D45 > = 10 calculate (D32 + 2 x D34 + 3)/6; if D44 + D45 < 10 calculate [D32 + 2 x D34 + 3 x (D44 + D45)/10]/6			
V%closurest	*Highest*	100% canopy closure over stream	If D18 = 100, enter "1"	
	Lowest:	No canopy closure over stream	If D18 = 0, enter "0"	
	Calculation:	Scaled as % of stream length with canopy closure	Enter result of calculation	
	Calculate D18/100 to get result			
Vstreamsubs	*Highest:*	AU has gravel or cobbles in stream bed	If D49.1 + D49.2 > = 1, enter "1"	
	Lowest:	AU has no gravel or cobbles in stream bed	If D49.1 + D49.2 = 0, enter "0"	
Vwaterdepth	*Highest:*	All water depth categories present	If D12.1 + D12.2 + D12.3 = 3, enter "1"	
	High:	Water depths between 0-100 cm present	If D12.1 = 1 **and** D12.2 = 1, enter "0.8"	
	Medium High:	Water depths > 100 cm present	If D12.3 = 1 **and** D12.1 + D12.2 = 0, enter "0.7"	
	Low:	Depths between 0-20 cm present	If D12.1 = 1, enter "0.1"	
	Lowest:	No surface water present	If all D10 = 0, enter "0"	
			Total of Variable Scores:	
Index for Habitat Suitability for Resident Fish = Total for variables x 1.75 rounded to nearest 1				
			FINAL RESULT:	

count of native species determined during the site visit is only an indicator of the actual number present.

Indicators: The indicator of overall native plant richness is the number of native species found during the site visit.

The Assessment Teams recognize that observations made during the summer may result in a higher count of plant species than in the winter. The impact of seasonal variability in the number of species observed was tested at several reference sites by collecting data on plants both in the summer and in the winter. The average difference in the index score between summer and winter was 1 unit (out of 10). This was within the variability found among users and was considered acceptable. (The results of the methods are only accurate to +- (1).

Scaling: If the AU has 30 or more native species it is scored a [1]. AUs with a fewer number of native species are scaled proportionally (# of native species/30).

$V_{nonative}$ – The percent of the AU where non-native species are dominant or co-dominant (non-native species are listed in Part 2, Appendix L) **This is a variable of reduced performance.**

Rationale: The Assessment Teams judged that wetlands where one or more of the dominant species is non-native have lost some of their potential for maintaining native regional plant biodiversity. Non-native plants that become dominant tend to exclude many of the less common native plants.

Indicators: No indicator is needed for this variable. The areal extent of non-native species can be determined in the field.

Scaling: AUs where non-native species extend over more than 75% of the AU have their score reduced by a factor of 0.5. Those with an extent of 50 – 75% are reduced by a factor of 0.7, and those with an extent of non-native between 25-49% are reduced by a factor of 0.9. AUs where non-native species are dominant or co-dominant on less than 25% of the AU do not have their score reduced.

8.14.5 Calculation of Habitat Index
Riverine Flow-through – Native Plant Richness

Variable	Description of Scaling		Score for Variable	Result
Vstrata	*Highest:*	5 strata present (no blackberries)	If D21-D21.1 = 5, enter "1"	
	High:	4 strata present "	If D21-D21.1 = 4, enter "0.8"	
	Moderate:	3 strata present "	If D21-D21.1 = 3, enter "0.6"	
	Medium Low:	2 strata present "	If D21-D21.1 = 2, enter "0.4"	
	Low:	1 stratum present "	If D21-D21.1 = 1, enter "0.2"	
	Lowest:	Blackberries only stratum	If D21-D21.1 = 0, enter "0"	
Vassemb	*Highest:*	At least 9 plant assemblages	If calculation > = 1, enter "1"	
	Lowest:	One plant assemblage present	If calculation < = 0.11, enter "0.1"	
	Calculation:	Scaling based on the number of assemblages divided by 9	Enter result of calculation	
	Calculate D20/9 to get result			
Vmature	*Highest:*	Mature trees present	If D22 = 1, enter "1"	
	Lowest:	No mature trees present	If D22 = 0, enter "0"	
Vnplants	*Highest:*	# of native plant species > = 30	If calculation > = 1, enter "1"	
	Lowest	One or less native plant species	If calculation < = 0.04, enter "0"	
	Calculation:	Scaled as # of native species/30	Enter result of calculation	
	Calculate (D19.1)/30 to get result			
			Total of Variable Scores:	
Reducer				
Vnonnat	>75% cover of non-native plants		If D24.1 = 1, enter "0.5"	
	50-75% cover of non-native plants		If D24.2 = 1, enter "0.7"	
	25 - 49% cover of non-native plants		If D24.3 = 1, enter "0.9"	
			Score for Reducer	
Index for Native Plant Richness = Total for variables x reducer x 2.94 rounded to nearest 1				
			FINAL RESULT:	

$V_{understory}$ **–** The areal extent of herbaceous vegetation under forested and scrub/shrub areas of the AU.

Rationale: This variable was included to correct a potential error in the previous variable ($V_{vegclass}$). The Cowardin classification characterizes only the highest layer of vegetation and does not characterize the understory. AU's that are forested may still provide good sediment retention if they have an herbaceous understory. Only relatively dense areas of understory with a minimum cover of 20% are included in this variable.

Indicators: No indicators are needed. The areal extent of the herbaceous understory can be estimated directly.

Scaling: The scaling of the variable is based on the percent of the AU covered by a herbaceous understory. AU's with a 100% cover of understory over the entire unit are scaled as [1]. AU's with a cover of less than 100% are scaled proportionally as %area/100.

9.1.5 Calculations of Potential Performance
Riverine Impounding – Removing Sediment

Variable	Description of Scaling		Score for Variable	Result
Vstorage	*Highest:*	Average depth of live + deadstorage > = 2.1 m	If calculation > =1 Enter "1"	
	Lowest:	No live or deadstorage	If calculation = 0 Enter "0"	
	Calculation:	Scaling is set as average depth/2.1	Enter result of calculation	
	1. Calculate livestorage as: D10 x (0.67 x D11.1 + 0.5 x D11.2 + 1 x D11.3) 2. Calculate deadstorage as: D8.3 x 0.01 x 2 3. Storage = live + deadstorage 4. Result = storage/2.1			
Vout	*Highest:*	No outlet, or severely constricted	If D13.3 = 1 or D13.4 = 1, enter "1"	
	Moderate:	Moderately constricted	If D13.2 = 1, enter "0.5"	
	Lowest:	Slightly, or un-constricted	If D13.1 = 1, enter "0"	
Veffectareal	*Highest:*	100% of the AU is annually inundated	If D8.1 = 100, enter "1"	
	Lowest:	0% of the AU is annually inundated	If D8.1 = 0, enter "0"	
	Calculation:	Scaling = (% of AU inundated /100 rounded off to 1 decimal)	Enter result of calculation	
	Calculate D8.1/100 to get result			
Vunderstory	*Highest:*	100% of AU has herbaceous understory and FO + SS =100%	If calculation = 1, enter "1"	
	Lowest:	No herbaceous understory in AU	If D16 = 0, enter "0"	
	Calculation:	Scaling based on understory as % of the total area of AU	Enter result of calculation	
	Calculate (0.01xD16) x (D14.1 +D14.2+D14.3 +D14.4)/100 to get result			
Vvegclass	*Highest:*	100% of AU has emergent class	If D14.5 = 100, enter "1"	
	Lowest:	No emergent, scrub/shrub, or forest vegetation present in AU	If sum of (D14.1 to D14.5) = 0, enter "0"	
	Calculation:	Emergent vegetation scaled as 1, scrub/shrub as 0.8 and forested as 0.3 x the relative % area of each in AU	Enter result of calculation	
	Calculate [(D14.5 x 1) + ((D14.3 + D14.4) x 0.8) + ((D14.1 + D14.2) x 0.3))] x 0.01 to get result			
			Total of Variable Scores:	
Index for Removing Sediment = Total x 2.70 rounded to nearest 1				
			FINAL RESULT:	

9.4.5 Calculations of Potential Performance
Riverine Impounding – Reducing Peak Flows

Variable	Description of Scaling		Score for Variable	Result
Vlivestorage	*Highest:*	Average depth of livestorage > = 2 m	If livestorage > = 2, enter "1"	
	Lowest:	No livestorage	If livestorage = 0, enter "0"	
	Calculation:	Scaling is set as average depth	Enter result of calculation	
	Calculate livestorage as: D10 x (0.67 x D11.1 + 0.5 x D11.2 + 1 x D11.3). Scaled score = livestorage/2.0			
Vout	*Highest:*	No outlet	If D13.4 = 1 enter "1"	
	High:	Severely constricted	If D13.3 = 1, enter "0.8"	
	Moderate:	Moderately constricted	If D13.2 = 1, enter "0.5"	
	Lowest::	Slightly or unconstricted	If D13.1 = 1, enter "0"	
Vinund/shed	*Highest:*	Ratio of area annually inundated to area of contributing basin is > = 0.01	If (D8.1 x 0.01 x D1)/D2 > = 0.01, enter "1"	
	Lowest:	0% of the AU is annually inundated	If D8.1 = 0, enter "0"	
	Calculation:	Scaling is based on the absolute value of the log of the ratio	Enter result of calculation	
	Calculate 2/ABS [log {(D8.1 x 0.01 x D1)/D2}]			
			Total of Variable Scores:	
			Index for Reducing Peak Flows = Total x 4.7 rounded to nearest 1	
			FINAL RESULT:	

9.4.6 Qualitative Rating of Opportunity

The opportunity for an AU to reduce peak flows will increase as the water regime in the upgradient watershed is destabilized. Research at in western Washington has shown that peak flows increase as the percentage of impermeable surface increase (Reinelt and Horner 1995). The opportunity should therefore be judged by the amount of upgradient watershed that is developed.

Users must make a qualitative judgement on the opportunity of the AU to actually reduce peak flows by considering the land uses in the contributing watershed. The opportunity for an AU in the riverine impounding subclass is **"Low"** if most of its contributing watershed is undeveloped, not farmed, or not recently logged.

The opportunity is also **"Low"** if the AU receives most of its water from groundwater, rather than from an incoming stream, ditches, or storm drains.).

The opportunity for the AU is **"High"** is the contributing watershed is mostly urban or high density residential. The opportunity is **"Moderate"** if the development is a small part of the contributing watershed, if the upgradient watershed is mostly agricultural, or if these areas are relative far away from the AU. Clear cut logging can also increase peak flows if a significant part of the watershed has recently been cut. These areas, however, will re-vegetate and within 5-7 years the peak flows may again be close to those found before logging. Too many variables are involved in trying to assess the increase in peak flows from logging (e.g. road density, time of cutting, % of watershed cut, etc.) and the rating for opportunity is too difficult to describe in a rapid method. Users will have to use their judgement in deciding whether the opportunity is low, moderate or high, and document their decision on the summary sheet (Appendix E, Part 2).

9.5.5 Calculation of Potential Performance
Riverine Impounding – Decreasing Downstream Erosion

Variable	Description of Scaling		Score for Variable	Result
Vlivestorage	*Highest:*	Average depth of livestorage > = 2 m	If livestorage > = 2, enter "0.5"	
	Lowest:	No livestorage	If livestorage = 0, enter "0"	
	Calculation:	Scaling is set as (average depth of livestorage /1) x 0.5	Enter result of calculation	
	Calculate average livestorage as [D10 x (0.67 x D11.1 + 0.5 x D11.2 + 1 x D11.3)]. If livestorage < 2 m, scaled score = (livestorage/2 x 0.5)			
Vout	*Highest:*	No outlet	If D13.4 = 1 enter "1"	
	High:	Severely constricted	If D13.3 = 1, enter "0.8"	
	Moderate:	Moderately constricted	If D13.2 = 1, enter "0.5"	
	Lowest::	Slightly or unconstricted	If D13.1 = 1, enter "0"	
Vwoodyveg	*Highest:*	100% cover of shrub or forest	If calculation = 1, enter "1"	
	Lowest:	No cover of forest or shrubs	If calculation = 0, enter "0"	
	Calculation:	Scaling is set as % cover of (SS+FO)/100	Enter result of calculation	
	Calculate (D14.1+D14.2+ D14.3+D14.4) / 100			
Vinund/shed	*Highest:*	Ratio of area inundated to area of contributing basin is > = 0.01	If (D8.1 x 0.01 x D1)/D2 > = 0.01, enter "2"	
	Lowest:	0% of AU, is annually inundated	If D8.1 = 0, enter "0"	
	Calculation:	Scaling is based on the absolute value of the log of the ratio	Enter result of calculation	
	Calculate 2 x 2/ ABS[log{(D8.1 x 0.01 x D1)/D2}]			
			Total of Variable Scores:	
Index for Decreasing Downstream Erosion = Total x 3.00 rounded to nearest 1				
			FINAL RESULT:	

9.5.6 Qualitative Rating of Opportunity

The opportunity for an AU to decrease erosion will increase as the water regime in the upgradient watershed is destabilized. Research in western Washington has shown that peak flows and velocities increase as the percentage of impermeable surface increase (Reinelt and Horner 1995). The opportunity should therefore be judged by the amount of upgradient watershed that is developed.

Users must make a qualitative judgement on the opportunity of the AU to actually decrease erosion by considering the land uses in the contributing watershed. The opportunity for an AU in the riverine impounding subclass is **"Low"** if most of its contributing watershed is undeveloped, not farmed, or not recently logged.

The opportunity is also **"Low"** if the AU receives most of its water from groundwater, rather than from an incoming stream, ditches, storm drains, or other surface water sources.

The opportunity for the AU is **"High"** is the contributing watershed is mostly urban or high density residential. The opportunity to is **"Moderate"** if the development is a small part of the contributing watershed, if the upgradient watershed is mostly agricultural, or if these areas are relative far away from the AU. Users must use their judgement in deciding whether the opportunity is low, moderate or high, and document their decision on the summary sheet (Part 2).

9.10.5 Calculation of Habitat Suitability
Riverine Impounding – Habitat Suitability for Anadromous Fish

Variable	Description of Scaling		Score for Variable	Result
Vwintersp	*Highest:*	Interspersion is high	If D38 = 3, enter "1"	
	Moderate:	Interspersion is moderate	If D38 = 2, enter "0.67"	
	Low:	Interspersion is low	If D38 = 1, enter "0.33"	
	Lowest:	No interspersion	If D38 = 0, enter "0"	
Vwaterdepth	*Highest:*	All water depth categories present	If D12.1 = 1 and D12.2 = 1 and D12.3 = 1, enter "1"	
	Medium High:	Only water depths > 100 cm present	If D12.3 = 1 and D12.1 + D12.2 = 0, enter "0.7"	
	Moderate:	Depths between 0-20 cm and 20-100 cm present	If D12.1 =1 and D12.2 = 1, enter "0.5"	
	Low:	Depths between 0-20 cm present	If D12.1 = 1, enter "0.1"	
	Lowest:	No surface water present	If all D10 = 0, enter "0"	
Vcover	*Highest:*	AU has overhanging vegetation, undercut banks, and has 6 or more categories of woody debris in permanent water	If D32 = 1 and D34 = 1 and D45 > = 6, enter "2"	
	Lowest:	No categories of cover present	If D32 + D34 + D45 = 0, enter "0"	
	Calculation:	Scaled as overhanging vegetation + # of categories of woody debris/6	Enter result of calculation	
	If D45 < 6 calculate [D32 + D34 + (D45/6)] **x 0.66** to get result; if D45 > 6 calculate **0.66 x** (D32 + D34 + 1) to get result			
Vpow	*Highest:*	AU has > = 30% perm. open water	If D8.3 > = 30, enter "1"	
	Lowest:	No permanent open water in AU	If D8.3 = 0, enter "0"	
	Calculation:	Scaled as % open water/30	Enter result of calculation	
	If D8.3 < 30 calculate D8.3/30 to get result			
Sinverts	*Score is scaled*	Index for Habitat Suitability for Invertebrates	Index of function/10	
			Total of Variable Scores:	
Reducer				
Vbogs	Sphagnum bog component of AU is > = 25%		If D23.1 + D23.2 + D23.3 > = 1, enter "0.5"	
	Sphagnum bog component of AU is < 25%		If D23.1 + D23.2 + D23.3 = 0, enter "1"	
			Score for Reducer	
Index for Habitat Suitability for Anadromous Fish = Total for variables x reducer x 1.67 rounded to nearest 1				
			FINAL RESULT:	

9.10.6 Qualitative Rating of Opportunity

The Assessment Teams decided that an AU does have the opportunity to provide habitat for anadromous fish if its surface water outlet has a direct connection that is passable by fish to a stream with anadromous fish in it. Information on locations used by anadromous fish is more readily available than for other wildlife. The Washington State Department of Fish and Wildlife maintains an extensive database of streams used by anadromous fish, and this can be used as a guide in rating the opportunity. Local sources may also be contacted for information on the presence of anadromous fish.

If the AU has an unobstructed passage to a stream or river with anadromous fish it should be rated as having a **"High"** opportunity to provide habitat. If there is no passage, or the passage is obstructed, the opportunity is **"Low"**.

Indicators: The variable is characterized using a condensed form of the depth classes first developed for WET habitat assessments (Adamus et al. 1987). These are 0-20 cm, 20-100 cm, and > 100 cm.

Scaling: AUs with all three depth classes present are scored a [1]. Those with the two shallower ones are scored a [0.5]; those with 0-20 cm of water are scored a [0.1]. AUs with no permanent or seasonal inundation are scored a [0]. In some cases an AU may have steep sides. If the water depth is greater than 100 cm but the AU does not have enough shallow water to meet the size requirements (0.1 ha or 10%, whichever is the smaller) it is scored a [0.7].

V_{cover} – Structures in the AU that provide cover in and over water. This variable is assessed based on three structural elements: 1) vegetation that overhangs permanent water; 2) undercut banks; and 3) large woody debris in permanent water.

Rationale: Refuge from predators is an important habitat feature for maintaining successful fish populations, and wetlands that provide such refuge have a higher potential of performing than those that do not. Overhanging vegetation and undercut banks provide both temperature control and protection from predation. Large woody debris plays an important role in the Pacific Northwest, creating and enhancing fish habitat (Bisson et al. 1987).

Indicators: The presence of overhanging vegetation and undercut banks is characterized during the field visit based on presence/absence of certain characteristics as described in Part 2. Direct measures of the quantity and quality of decaying woody debris is not feasible for a rapid assessment method. A descriptive matrix of different sizes and decay levels of woody debris was developed as an indicator for the variable. The matrix is based on the assessment procedure developed for the TFW watershed assessment methods.

Scaling: AUs with both overhanging vegetation and undercut banks, and at least 6 categories of large woody debris are scored a [1]. AUs with fewer characteristics are scored proportionally, with each type of cover having a different weight (see Calculation Table 9.11.5). Large woody debris is weighted by a factor of 3 and undercut banks by a factor of 2 relative to overhanging vegetation. AUs with no types of cover are scored a [0].

V_{pow} – The percent of the AU that is covered by permanent open water.

Rationale: Ponded surface water is needed for fish. Wetlands that have permanent surface water present provide habitat the entire year rather than just during the wet season, thereby increasing the suitability of the AU as habitat.

Indicators: The variable is assessed by estimating the relative % of the AU that has permanent open water (Part 2).

Scaling: AUs that have 30% or more permanent open water are scored a [1]. Those with less are scored proportionally (%pow/30).

$V_{permflow}$ – There are channels or streams present in the wetland that have permanently flowing water.

Rationale: This variable is included for the function because flowing water is an important characteristic for cottids and dace in western Washington (Mongillo pers. comm.). These species tend to be found usually in flowing water.

Indicators: No indicators are needed for this variable in the summer because the presence of permanent flow in a channel can be established directly during the dry season. Indicators for the presence of permanent channel flow in the winter during the wet season, however, may be more difficult to establish. Users may have to rely on aerial photographs (usually taken in the summer) or other sources of information to determine if the flows in a channel are permanent.

Scaling: This is an "on/off" variable. An AU scores a [1] if permanent channel flow is present, and a [0] if it is not.

$V_{substrate}$ – The composition of surface layers present in the AU (litter, mineral, organic etc).

Rationale: Different types of surface layers present in a wetland provide different habitats for resident fish species in western Washington (Mongillo pers. comm.).

Indicators: No indicators are necessary to assess this variable. The types of substrate present can be determined during the site visit.

Scaling: Since each type of substrate provides a different habitat feature for resident fish, the scaling is based on the number of types of organic substrate present and cobbles and gravel. Wetlands with 5, or more, of the 8 types of substrate present score a [1]. Those with fewer are scaled proportionally (# types/5). AUs with no exposed substrate score a [0].

$S_{inverts}$ – The index for the function "Habitat Suitability for Invertebrates."

Rationale: Invertebrates are a major food source for both resident and anadromous fish. The index for the function is an indication of the potential food sources available to resident fish. Higher richness is indicative of a broader range of food sources and well as a more balanced availability of such food. Resident fish would not have to rely on only one or two species that could potentially be subject to large fluctuations.

Indicators: No indicators are needed for this variable since it is a index for another function.

Scaling: The index is already scaled from 0-10, and is re-normalized to a range of 0 - 1.

9.11.5 Calculation of Habitat Suitability
Riverine Impounding – Habitat Suitability for Resident Fish

Variable	Description of Scaling		Score for Variable	Result
Vwintersp	*Highest:*	Interspersion is high	If D38 = 3, enter "1"	
	Moderate:	Interspersion is moderate	If D38 =2, enter "0.67"	
	Low:	Interspersion is low	If D38 =1, enter "0.33"	
	Lowest:	No interspersion	If D38 =0, enter "0"	
Vwaterdepth	*Highest:*	All water depth categories present	If D12.1 + D12.2 + D12.3 = 3, enter "1"	
	High:	Water depths between 0-100 cm present	If D12.1 = 1 and D12.2 = 1, enter "0.8"	
	Medium High:	Water depths > 100 cm present	If D12.3 = 1 and D12.1 + D12.2 = 0, enter "0.7"	
	Low:	Depths between 0-20 cm present	If D12.1 = 1, enter "0.1"	
	Lowest:	No surface water present	If all D10 = 0, enter "0"	
Vcover	*Highest*	AU has overhanging veg., undercut banks, and 6 or more categories. of woody debris in perm. water	If D32 + D34 = 2 and D45 > = 6, enter "1"	
	Lowest:	No categories of cover present	If D32 + D34 + D45 = 0, enter "0"	
	Calculation:	Scaled as the number of categories with weights of: 1 for overhang, 2 for banks and 3 for LWD normalized to 6	Enter result of calculation	
	If D45 > = 6 calculate (D32 + 2 x D34 + 3)/6; if D45 < 6 calculate [D32 + 2 x D34 + (D45/6 x 3)]/6			
Vpow	*Highest:*	AU has > = 30% perm. open water	If D8.3 > = 30, enter "1"	
	Lowest:	AU has no permanent open water	If D8.3 = 0, enter "0"	
	Calculation:	Scaled as % open water/30	Enter result of calculation	
	If D8.3 < 30 calculate D8.3/30 to get result			
Vpermflow	*Highest*	Perm. flowing channel or stream	If D4.1 = 1, enter "1"	
	Lowest	AU has no permanent channel	If D4.1 = 0, enter "0"	
Vsubstrate	*Highest:*	AU has at least 5 types of substrate	If calculation > = 1, enter "1"	
	Lowest:	AU has no exposed substrate	If calculation > = 0, enter "0"	
	Calculation:	Scaled as # of gravel, cobbles and organic substrate types / 5	Enter result of calculation	
	Calculate [sum (D46.1 - D46.5)]/5 to get result			
Sinverts	*Score is scaled*	Index for Habitat Suitability for Invertebrates	Index of function/10	
			Total of Variable Scores:	
Index for Habitat Suitability for Resident Fish = Total for variables x 1.52 rounded to nearest 1				
			FINAL RESULT:	

9.12 Habitat Suitability for Wetland-associated Birds — Riverine Impounding Wetlands

Note: Please read the introduction to the assessment models (Chapter 2) before using these models. It describes several basic assumptions used in modeling that will help you better understand how to use and apply the methods.

9.12.1 Definition and Description of Function

Habitat Suitability for Wetland-associated Birds is defined as the environmental characteristics in a wetland that provide habitats or life resources for species of wetland-associated birds. Wetland-associated bird species are those that depend on aspects of the wetland ecosystem for some part of their life needs: food, shelter, breeding, resting. The guilds of wetland-associated birds used as the basis for building the assessment model includes waterfowl, shorebirds, and herons.

In general, the suitability of a wetland as bird habitat increases as the number of appropriate habitat characteristics increase. Another assumption used in developing the model is that wetlands that provide habitat for the greater number of wetland-associated bird species are scored higher than those that have fewer. **The assessment models are focused on species richness, not on the importance of a wetland to a specific threatened or endangered species or to a specific regionally important guild.**

If the AU is a habitat type that appears to be critical to a specific species, another method is needed in order to determine the habitat suitability of that AU (e.g. USFWS Habitat Evaluation Procedures (HEP), USFWS 1981).

9.12.2 Assessing this Function for Riverine Impounding Wetlands

The suitability of wetlands in the riverine impounding subclass as habitat for wetland-associated birds is modeled based on the plant structure, physical components, and the condition of the buffers around the AU. In addition, the models include the indices for other habitat functions that represent prey of birds: namely the habitat suitability index for amphibians, invertebrates, and fish.

AUs that have a closed canopy are judged to have a reduced level of performance because access for waterfowl is limited. The Assessment Teams also judged that the presence of invasive or non-native birds may reduce the suitability of an AU. A variable for this factor was not included in the model because reproducible data on invasive or non-native birds could not be collected during one site visit.

Size is not used as a variable in the equation although it is often cited as an important characteristic of wetlands that provide bird habitat (Richter and Azous in preparation). The question of size is a vexing one, and no satisfactory size thresholds have been identified in

9.15.5 Calculation of Potential Performance
Riverine Impounding – Primary Production and Organic Export

Variable	Description of Scaling		Score for Variable	Result
Vvegcover	*Highest:*	AU is100% vegetated	If calculation =1, enter "1"	
	Lowest:	AU has minimal vegetation cover	If calculation = <0.05, enter "0"	
	Calculation:	Scaling is set as % vegetated/100	Enter result of calculation	
	Calculate [sum (D14.1 to D14.6)] /100 to get result			
Vnonevergreen	*Highest:*	100% of AU has cover of non-evergreen vegetation	If calculation = 1, enter "1"	
	Lowest:	AU has only evergreen vegetation	If calculation = 0, enter "0"	
	Calculation:	Scaled as a fraction based on % area	Enter result of calculation	
	Calculate (D14.2 + D14.4 + D14.5 + D14.6) / 100 to get result			
Vunderstory	*Highest:*	AU has 100% herbaceous understory	If calculation = 1.0 enter "1"	
	Lowest:	AU has no understory	If D16 = 0, enter "0"	
	Calculation:	Scaling based on understory as % of the total area of AU	Enter result of calculation	
	Calculate (0.01 x D16) x (D14.1 + D14.2 + D14.3 + D14.4)/100 to get result			
			Total of Variables for Primary Production:	
Vout	*Highest:*	Slightly or unconstricted	If D13.1 = 1 enter "1"	
	High:	Moderately constricted	If D13.2 = 1, enter "0.8"	
	Moderate:	Severely constricted	If D13.3 = 1, enter "0.5"	
	Lowest::	No outlet	If D13.4 = 1, enter "0.1"	
Vorg	*Highest:*	AU has no organic soils	If D47.1 + D47.2 = 0, enter "1"	
	Moderate:	AU has some organic soils but < 50%	If D47.1 + D47.2 < = 1, enter "0.8"	
	Low:	AU has > 50% and < 95% organic soils	If D47.1 or D47.2 = 2, enter "0.3"	
	Lowest:	AU has > 95% organic soils	If D47.1 or D47.2 = 3, enter "0"	
			Total of Variables for Export:	
Index for Primary Production and Export = (Total for production x total for export) x 1.85 rounded to nearest 1				
			FINAL RESULT:	