3.5 Identification and Analysis of Limiting Factors/Conditions and Priority Areas for Action

3.5.1 Aquatic

3.5.1.1 EDT and QHA Modeling

Modeling approaches were used to provide quantitative measures of the impact of environmental factors on the abundance and productivity of the focal species in the subbasin. For salmon and steelhead the Ecosystem Diagnostic and Treatment Tool (EDT) was used to identify limiting factors, to prioritize geographic areas, and to examine the impact of restoration scenarios on steelhead and salmon abundance and productivity. Very briefly, EDT requires the division of a subbasin's streams into reaches (areas that are physically similar). Up to 46 environmental attributes are used to characterize each reach and these attributes take two values, a value based on current measurements/estimates and a value based on historic estimates. Based on these environmental attributes, the model compares estimates of historical abundance and productivity to current estimates and then defines which environmental factors are currently limiting populations and in which areas.

The Umatilla River subbasin was divided into 310 reaches. To make results easier to interpret, reaches are lumped into geographic areas (GAs). For the Umatilla River subbasin the 310 reaches were lumped in 46 GAs (Figure 123). EDT ranks GAs by restoration potential – which GAs will produce the greatest increase in productivity and abundance with restoration – and by protection value – which GAs are most important to maintain at their current state. Thus, EDT ranks the areas within a subbasin that are most important to restore and to protect (e.g., through conservation easements). EDT can also be used to examine the impact on focal species of different restoration scenarios, and thus provides an important tool to estimate the benefits of restoration and protection. Finally, EDT is also used to examine Properly Functioning Conditions (PFCs) and their impact on steelhead and salmon populations. PFCs represent the "best" possible state of the environment given the local economic, social, and political constraints and they can serve as a long-term goal (see Section 3.6.1). More information regarding EDT can be found at www.edthome.org.

Methodologies have not been developed for using EDT with non-anadromous species. Therefore, a simpler model, Qualitative Habitat Analysis (QHA), was used to determine limiting factors and priority reaches for bull trout. In addition, QHA was used to assess limiting factors and priority reaches for redband trout in Willow Creek. QHA is primarily for use on resident salmonids in stream habitats on a watershed scale. QHA requires the user to rate 11 attributes (riparian condition, channel stability, habitat diversity, fine sediment, high and low flow, oxygen, high and low temperature, pollutants, and obstructions) in both the current and reference (i.e., historic) conditions in each stream reach being rated. The user must then develop a hypothesis relating the importance of these attributes to a focal species on a reach-by-reach basis for each of four life stages (spawning/incubation, summer rearing, winter rearing, migration). QHA

produces a series of tables that describe the physical habitat and identify where restoration and/or protection activities may be the most productive.

Use of professional judgment (or expert opinion -- for our purposes the two concepts are synonymous) is often criticized for being subjective and lacking consistency. On the other hand, it is well recognized that a strictly quantitative approach may not always be possible, or even preferred. For example, using a quantitative approach may not make sense in areas where data are limited, when there is not enough time allotted to conduct a rigorous quantitative assessment, or where appropriate tools or expertise are not available. In these situations a more qualitative approach is indicated. The 2000 *Template for Subbasin Assessment*, for example, referenced the use of "opinions of local fish managers" as an analytical tool.

The QHA was designed to minimize problems associated with unstructured qualitative assessments. QHA is a "structured qualitative assessment." In other words, it is a systematic and objective assessment of species habitat relationships that relies principally on existing local professional knowledge and judgment but that "structures" the process by: (1) following a logical and replicable sequence, (2) using the best available quantitative data as the basis for decisions, (3) generating a product that is similar in form to products resulting from other more quantifiable approaches, and (4) documenting the decision process.

QHA relies on the same conceptual framework as the more technically sophisticated Ecosystem Diagnosis and Treatment (EDT) technique. There are, however, several significant differences. While each of the habitat characteristics used in QHA is also used in EDT, EDT considers many more habitat factors and seeks to link these directly to measurable data. QHA, by contrast, relies on the judgment of knowledgeable professionals to draw this link.

EDT relies on a set of biological rules derived from the technical literature to establish the link between a species and its habitat. Again, QHA relies on professional judgment to make this link. EDT uses a series of life history trajectories to model the movement of fish through its environment over several life stages. QHA collapse life history into fewer stages and treats each stream reach or small watershed as a static unit. Again, QHA relies on the knowledge of experts to think through these life history dynamics.

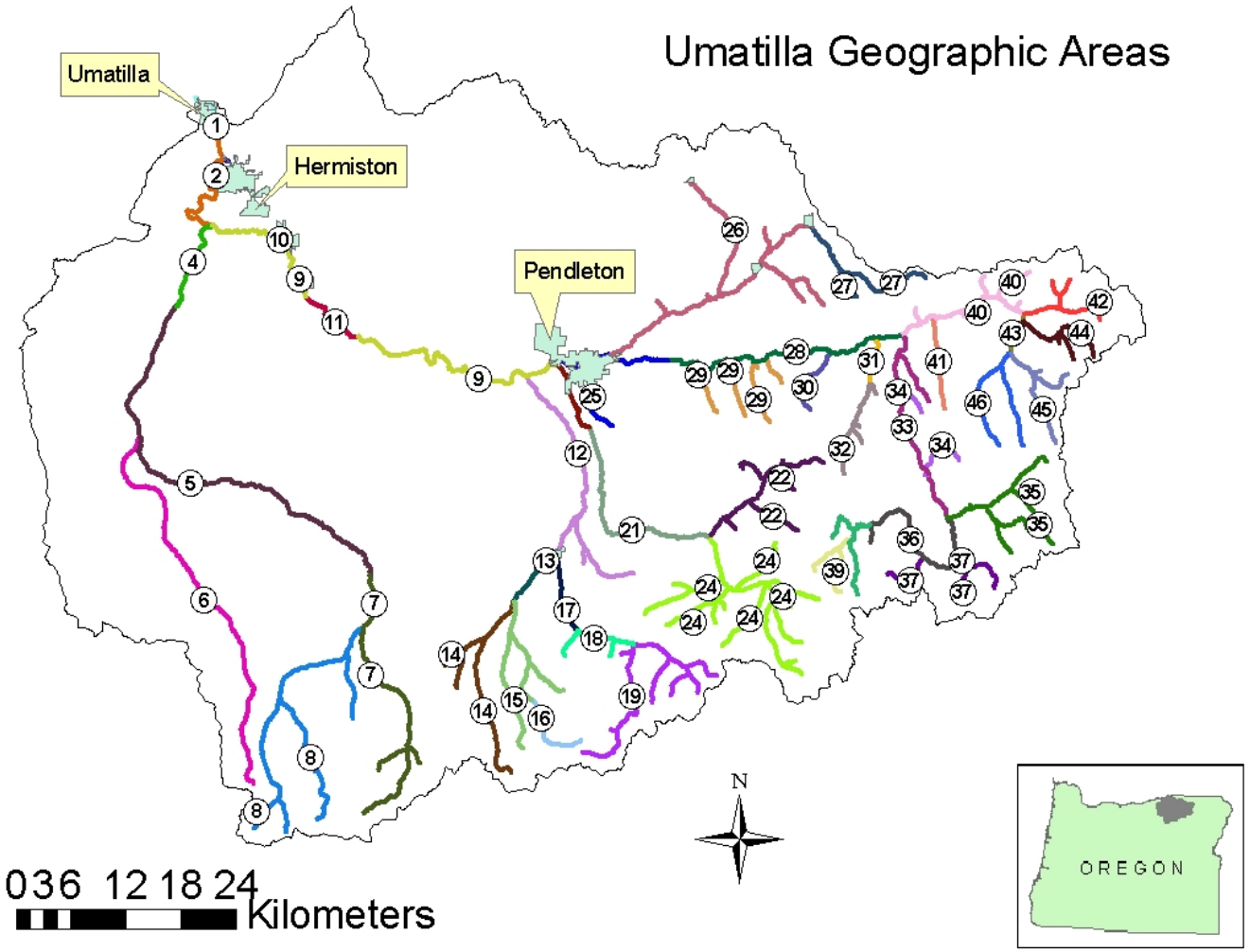

Figure 123. Geographic areas used in the EDT analysis for the Umatilla River subbasin.

EDT analysis can incorporate, or, more accurately, link to information on out-of-subbasin effects, i.e., survival outside of the natal subbasin. QHA relies on expert opinion to make this connection.

Lastly, EDT produces a series of numerical products that estimate productivity, abundance, and related factors that give an indication of how well habitat supports fish. As a qualitative technique QHA does not generate these outputs but rather produces a series of products that suggest directions for management but explicitly leaves the decision process up to experts.

More information on the QHA model can be found at www.nwcouncil.org/fw/subbasinplanning/admin/guides/qha.pdf.

3.5.1.2 Limitations of the Current Analysis

Passage Barriers
There exists a lack of knowledge regarding passage barriers in the Umatilla/Willow subbasin both in terms of severity of potential known barriers and numbers of barriers (particularly in non-anadromous sections of the Umatilla River subbasin and throughout the Willow Creek subbasin). This lack of knowledge represents a limitation to both the EDT and QHA approaches and the consensus of the aquatic working group is that the severity of these passage problems has been underestimated by both models. In the Umatilla River subbasin, 36 barriers have been identified and these are listed, along with their priority for removal, in Table 1.

General Limitations of EDT
A number of problems associated with the EDT model were identified during the planning process. EDT is a useful tool that should serve well as the Columbia Basin habitat modeling standard. In general the model simulates habitat attributes and habitat change with sufficient precision and resolution to effectively plan restoration activities. However, the model has at least one significant habitat limitation, and at least one significant fish limitation.

EDT represents temperature and flow using two variables: a categorical description of the temperature and flow situation, and a monthly shaping and focus of the environmental regime. The shapings used in the model are counter intuitive and clumsy, and prevent the utilization of real data. Many subbasins have hydrograph and thermographs of their primary tributaries, and the Umatilla is no exception. Future versions of the model should be built to directly incorporate thermograph and hydrograph information.

EDT represents fish survival using an expanded Beverton-Holt model. Although EDT represents a leap forward by explicit representing fish-habitat relationships, it represents a leap backwards in terms of modeling fish populations. Decades of fishery management have made clear that although associative aggregated differential models of populations

Table 45. Barriers to upstream passage on streams in the Umatilla River subbasin.

Stream	River Mile	Barrier Type	Step Height Est. (m)	Degree	Recommended Action	Priority
Umatilla R.	1.5	Channel Mod.	0.7	Partial	Modify	L
Umatilla R.	2.0	Irrigation Dam	1.2	Partial	Modify	H
Umatilla R.	10.1	Hydro Dam	1.5	Partial	Modify/Remove	M
Umatilla R.	23.7	Irrigation Dam	1.5	Partial	Modify	M
Umatilla R.	27.5	Irrigation Dam	1.5	Partial	Modify	L
Umatilla R.	28.5	Irrigation Dam	2	Partial	Modify	H
Umatilla R.	49	Irrigation Dam	1.2	Partial	Remove	M
Butter Creek	7.9	Flash Boards	2.3	Complete	Modify	L
Butter Creek	27.2	Irrigation Dam	1.4	Complete	Modify	L
Butter Creek	43.0	Irrigation Dam	1.2	Complete	Modify	L
Johnson Cr. (Butter Trib)	0.3	Culvert	0.8	Partial	Modify	M
Birch Creek	0.5	Pipe Casing	1.4	Partial	Modify	M
Birch Creek	2.5	Irrigation Dam	1.5	Partial	Modify/Remove	H
Birch Creek	5.0	Irrigation Dam	1.2	Partial	Modify/Remove	H
Birch Creek	10.0	Irrigation Dam	1.0	Partial	Remove	M
Birch Creek	11.0	Irrigation Dam	0.7	Partial	Remove	L
Birch Creek	12.0	Irrigation Dam	1.0	Partial	Modify	M
Birch Creek	15.0	Irrigation Dam	1.7	Partial	Remove	H
West Birch Cr.	1.0	Irrigation Dam	?	Partial	Modify	M
West Birch Cr.	3.5	Irrigation Dam	2.1	Partial	Modify	H
West Birch Cr.	3.8	Bridge	1.2	Partial	Modify	H
West Birch Cr.	5.5	Irrigation Dam	1.4	Partial	Remove	H
West Birch Cr.	8.5	Irrigation Dam	1.5	Partial	Remove	H
Bridge Cr. (W Birch)	2.0	Culvert	?	Complete	Modify	H
East Birch Cr.	4.0	Irrigation Dam	0.7	Partial	Remove	L
East Birch Cr.	9.0	Irrigation Dam	1.0	Partial	Remove	L
Jungle/Windy Spr. (Pearson)	0.1	Culvert	0.15	Partial	Modify	L
Wildhorse Cr.	0.1	Irrigation Dam	0.7	Partial	Modify	L
Wildhorse Cr.	18.8	Bridge	1.0	Partial	Modify	L
Greasewood Cr.	0.4	Irrigation Dam	0.6	Partial	Modify	L
Mission Cr.	0.9	Bedrock Drop	0.5	Partial	Modify	M
Mission Cr.	3.3	Bridge/Culvert	0.7	Partial	Modify	M
Coonskin Cr.	0.3	Bridge	0.5	Partial	Modify	M
Coonskin Cr.	0.9	Pipe Casing	1.1	Partial	Modify	M
Whitman Spr.	0.1	Culvert	0.5	Complete	Modify	L
Red Elk Can.	0.2	Culvert	0.8	Partial	Modify	L
Minthorn Spr.	0.1	Culvert	0.5	Partial	Modify	L
Unnamed Trib to SF Umt. RM 1.5	0.1	Culvert	0.5	Complete	Modify	M
Camp Creek	0.25	Irrigation Dam	1.3	Partial	Remove	M
Unnamed trib to Umt R. RM 81.2	0.1	Culvert	0.6	Partial	Modify	L
Twomile Creek	1.25	Culvert	?	?	Modify	L

can represent density-dependent mortality relatively well at gross scales, mechanistic models of individuals are far more explanatory. The power of mechanistic models has been demonstrated in the life's work of D. Boisclair, S.A.L.M. Kooijman, E.E. Werner, J. Kitchell, and S. Carpenter, and is strongly related to their ability to represent physiological processes and the impacts of sub-lethal permutations on production and productivity. Future versions of EDT should be developed using individual based calculations of growth and production, and should have the capacity to represent metabolic processes including bioaccumulation and resource dependent growth.

Problems with the draft Umatilla EDT Model

The modelers attempted to fix problems with the Umatilla EDT model as they were discovered throughout the planning process. The draft Umatilla EDT model represents a best first effort to develop a functional representation of the Umatilla Subbasin, and is a work in progress. Two problems were discovered late in the planning process; too late to be rectified before the Subbasin Plan deadline. First, a routing error runs all migrating adults and juveniles through EDT reach #7 "NH Drain"; a small tributary in the lower Umatilla. The impacts of this routing error are unknown. Second, EDT temperature and flow curves were developed for the Umatilla many months ago. Since that time the methods for describing temperature and flow were finalized and codified. The routing, temperature, and flow curves for the Umatilla model should be updated prior to a finalization of the Umatilla Subbasin Plan. Although these changes may impact the absolute abundance estimates of the EDT model, it is not expected that they will impact the magnitude of change expected from restoration actions described in the management plan. In addition, as stated above, the impact of passage barriers have most likely been underestimated in the current analysis, for both EDT and QHA; much survey work is needed to map all potential passage barriers and to understand the degree to which each one impacts fish passage.

Finally, a number of habitat attributes (especially the ecological attributes and several water quality parameters such as bedscour, pesticides, total suspended solids, and others) were derived using professional judgment or simply left blank in the Umatilla EDT model. This information can be collected in the field using standardized methods, and should be addressed within five years following this plan. This will ensure that future permutations of the Umatilla EDT model are based more on real conditions, and less on the conjecture of scientists. Most of these parameters are not represented in ongoing monitoring and evaluation activities, and additional support from BPA or other funding agencies will be required before they can be addressed.

3.5.1.3 Identification of Limiting Factors

EDT

The EDT modeling approach provides a quantitative measure of the impact of 46 environmental attributes (see Appendix E pages 1-22) on the abundance and productivity of the four anadromous focal species – steelhead, spring Chinook, fall Chinook, and coho. These attributes are then grouped into 16 "survival" or "limiting" factors:

- Flow
- Channel stability
- Habitat diversity
- Key habitat quantity
- Obstructions
- Withdrawals
- Sediment load
- Oxygen
- Chemicals
- Temperature
- Food
- Competition (with hatchery fish)
- Competition (with other species)
- Predation
- Pathogens
- Harassment/Poaching

In a qualitative sense, limiting factors are ranked as having high (or large), medium, low, or no impact on focal species survival. To determine which factors are most pervasive in the subbasin in limiting the survival of anadromous focal species, the percentage of geographic areas (GAs) in which a factor is limiting was determined for each species. Figures 124 through 127 show the limiting factors that had a high impact on survival and the proportion of geographic areas (out of the total number that species is found in) in which they occurred.

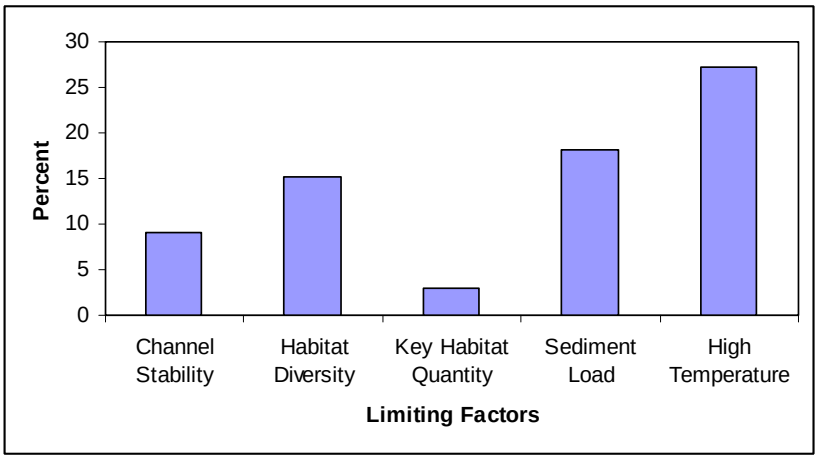

Figure 124. The percentage of all geographic areas in which the graphed limiting factors have a large impact on the survival of coho. Coho are found in a total of 32 GAs.

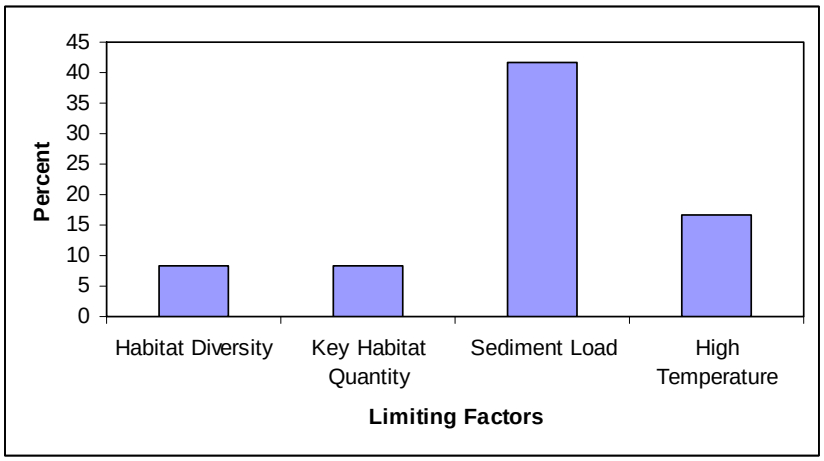

Figure 125. The percentage of all geographic areas in which the graphed limiting factors have a large impact on the survival of fall Chinook. Fall Chinook are found in a total of 12 GAs.

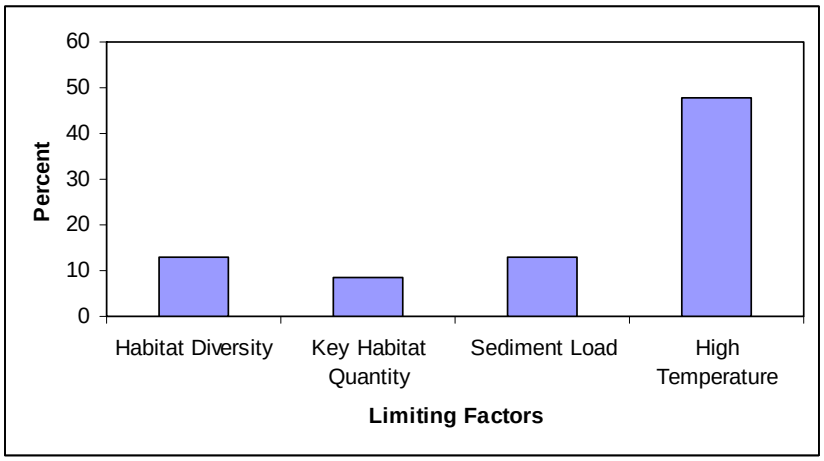

Figure 126. The percentage of all geographic areas in which the graphed limiting factors have a large impact on the survival of spring Chinook. Spring Chinook are found in a total of 22 GAs.

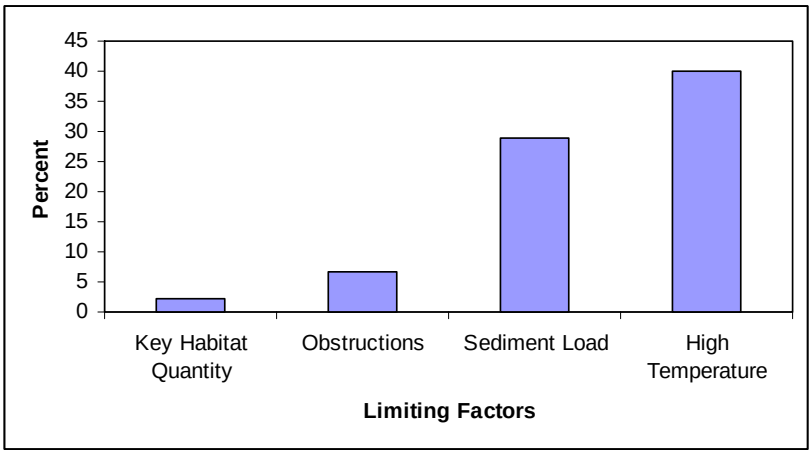

Figure 127. The percentage of all geographic areas in which the graphed limiting factors have a large impact on the survival of steelhead. Steelhead are found in a total of 44 GAs.

These figures reveal that the two most pervasive factors having a large impact on the survival of the four anadromous focal species are sediment load and high water temperature. High water temperature is the most pervasive factor that has a large impact on the survival of coho, spring Chinook, and steelhead; and sediment load is the second most pervasive factor for coho and steelhead. Sediment load was the most pervasive factor having a large impact on fall Chinook survival with high water temperature being second.

Figures 128 through 131 show the pervasiveness of limiting factors that had a medium impact on survival for each of the four species. As shown in these figures, habitat factors

become important in terms of limiting the survival, at a medium level, of the anadromous focal species.

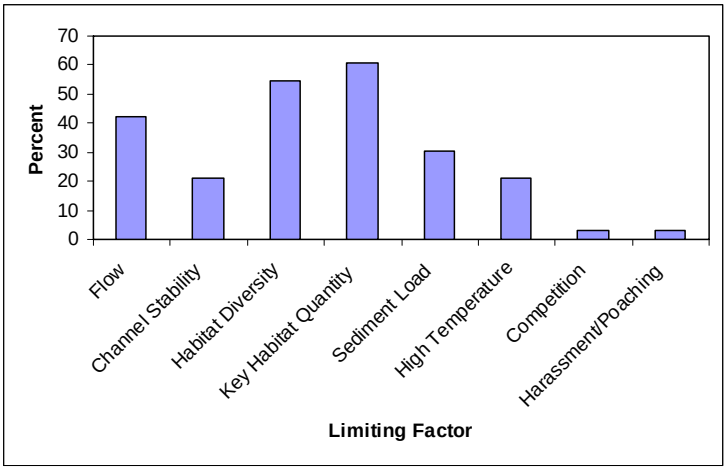

Figure 128. The percentage of all geographic areas in which the graphed limiting factors have a medium impact on the survival of coho. Coho are found in a total of 32 GAs.

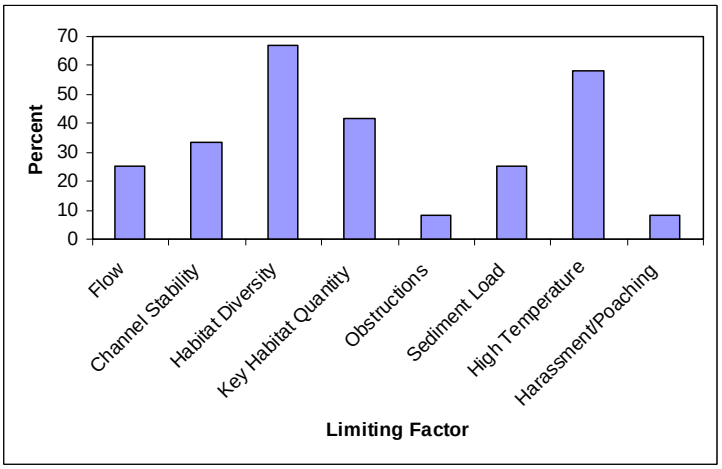

Figure 129. The percentage of all geographic areas in which the graphed limiting factors have a medium impact on the survival of fall Chinook. Fall Chinook are found in a total of 12 GAs.

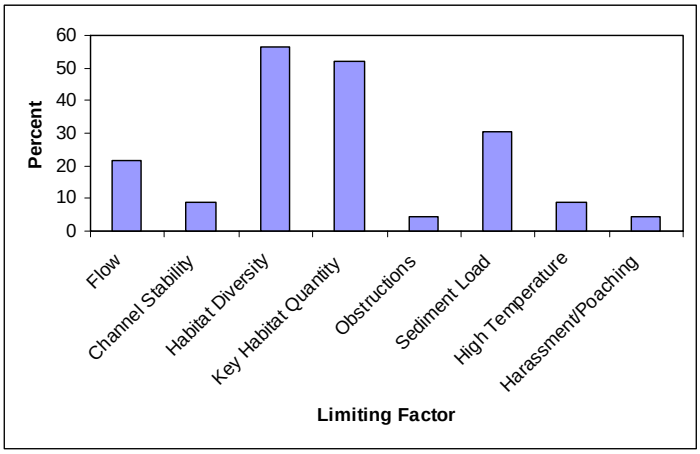

Figure 130. The percentage of all geographic areas in which the graphed limiting factors have a medium impact on the survival of spring Chinook. Spring Chinook are found in a total of 22 GAs.

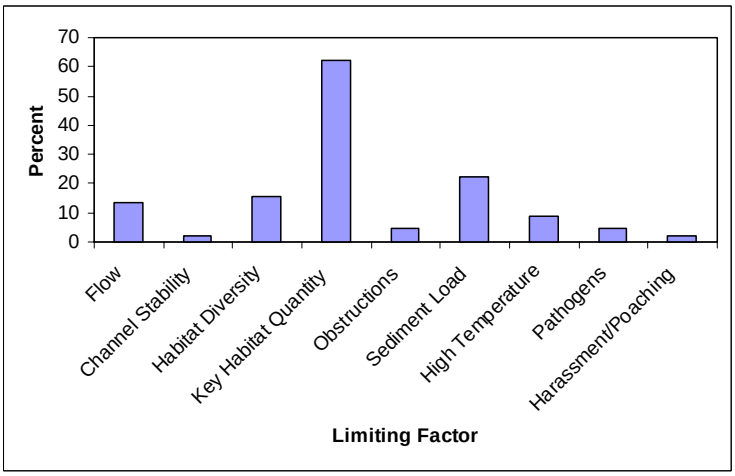

Figure 131. The percentage of all geographic areas in which the graphed limiting factors have a medium impact on the survival of steelhead. Steelhead are found in a total of 44 GAs.

The above graphs depicting limiting factors with a medium impact on survival reveal that both habitat diversity and habitat quantity are important limiting factors that are pervasive throughout the subbasin for all four anadromous focal species.

QHA

For QHA modeling, values for 11 environmental attributes are placed into the model and the model then determines which attributes are most important in each geographic area in terms of limiting the species of interest. Table 46 lists the 11 attributes and their definitions.

Table 46. Qualitative Habitat Analysis (QHA) attributes and definitions.

Attribute (abbreviation)	**Definition**
Riparian Condition (Rip Cond)	Condition of the stream-side vegetation, land form and subsurface water flow
Channel form (Ch form)	The condition of the channel in regard to bed scour and artificial confinement. Measures how the channel can move laterally and vertically and to form a "normal" sequence of stream unit types.
Channel complexity (Ch comp)	Diversity and complexity of the channel including amount of large woody debris (LWD) and multiple channels
Fine Sediment (F Sed)	Amount of fine sediment within the stream, especially in spawning riffles
High Flow (H Flow)	Frequency and amount of high flow events
Low Flow (L Flow)	Frequency and amount of low flow events
Oxygen (Oxygen)	Dissolved oxygen in water column and stream substrate
High Temperature (H Temp)	Duration and amount of high summer water temperatures that can be limiting to fish survival
Low Temperature (L Temp)	Duration and amount of low winter temperatures that can be limiting to fish survival
Pollutants (Poll)	Introduction of toxic (acute and chronic) substances into the stream
Obstructions (Obs)	Impediments to fish passage

The QHA for bull trout provided a ranking of stream reaches for both habitat protection and habitat restoration. Stream reaches are ranked high for protection where significant loss of production could occur if the habitat were degraded. Stream reaches ranked high for restoration are reaches where significant gains in fish production could be made by restoring habitat to historic conditions. However, it is not assumed nor necessarily intended that habitats will be restored to historic conditions. The QHA methodology simply provides a tool for prioritizing future efforts geographically to restore and protect fish habitat. Tables 47 and 48 show the approximately top 20 ranked restoration and protection reaches, respectively, for bull trout. In addition, QHA ranks the 11 habitat attributes in order of importance in limiting the population of interest. Table 47 shows the top 3 ranked attributes for each geographic area for bull trout. These are the attributes that, if improved, would provide the greatest restoration benefit. Generally, the Umatilla

River from Meacham Creek to the forks and Meacham Creek from the mouth to the North fork are the most important areas for restoration. These same areas plus the North Fork Umatilla and tributaries are the important areas for protection.

Table 47. Bull Trout Priority Reaches for Restoration

Reach	Reach Description	QHA Rank	Limiting Factors
Um 46	From Ryan Cr to StarveToDeath	1	Ch Comp, H Temp, Ch form
Um 47	From StarveToDeath to Hagar	1	Ch Comp, H Temp, Ch form
Um 48	From Hagar Cr to Bobsled Cr	1	Ch Comp, H Temp, Ch form
Um 49	From Bobsled Cr to fork in Bar M Road	1	Ch Comp, H Temp, Ch form
Um 50	From fork in Bar M Road to Rock Cr	1	Ch Comp, H Temp, Ch form
Um 51	From Rock Cr to Bear Cr	1	Ch Comp, H Temp, Ch form
Um 52	From Bear Cr to Lick Cr	7	Ch Comp, Ch Form, Rip Cond
Um 53	From Lick Cr to NF/SF	7	Ch Comp, Ch Form, Rip Cond
Meacham 5	From Duncan Canyon to NF	9	Ch Comp, Poll, Ch Form
Um 32	From McKay Cr to Tutuilla Cr	10	Rip Cond, Ch Comp, H Flow
Meacham 1	From mouth at Umatilla R to Boston Canyon	11	Ch Comp, Poll, H Flow
Meacham 2	From Boston Canyon to Line Cr	11	Ch Comp, Poll, H Flow
Meacham 3	From Line Cr to Camp Cr	11	Ch Comp, Poll, H Flow
Meacham 4	From Camp Cr to Duncan Canyon	11	Ch Comp, Poll, H Flow
Um 5	Threemile Dam	15	Obstr, H Flow, Ch Comp
Um 43	From Meacham Cr to Fred Gray's Bridge	16	Ch Comp, H Temp, H Flow
Um 44	From Fred Gray's Bridge to Hillbilly Cr	16	Ch Comp, H Temp, H Flow
Um 45	From Hillbilly Cr to Ryan Cr	16	Ch Comp, H Temp, H Flow

While the priority protection reaches shown in Table 4 were ranked by QHA, planners are not anticipated to actually set priorities for protection based on this ranking. Protection of each of these reaches is considered of equal priority, and actions to protect current habitat value should be taken whenever and wherever the opportunity exists. However, programs focused on implementing passive restoration projects should consider the QHA ranking with respect to project planning, and planners should target the highest ranked reaches first.

Table 48. Bull Trout Priority Reaches for Protection

Reach	Reach Description	QHA Rank
UM NF2	From Coyote Cr to Johnson/Woodward Cr	1
UM NF1	From confluence of Umatilla R SF to Coyote Cr	2
UM 52	From Bear Cr to Lick Cr	3
UM 53	From Lick Cr to NF/SF	3
UM 46	From Ryan Cr to StarveToDeath	5
UM 47	From StarveToDeath to Hagar	5
UM 48	From Hagar Cr to Bobsled Cr	5
UM 49	From Bobsled Cr to fork in Bar M Road	5
UM 50	From fork in Bar M Road to Rock Cr	5
UM 51	From Rock Cr to Bear Cr	5
Meacham NF 3	From Bear Cr to Pot Cr	11
UM NF 3	From Johnson/Woodward Cr to falls	12
Meacham NF 4	From Pot Cr to Falls at 3400 ft level	13
Pot Cr 1	From mouth at Meacham Cr to Canyon Cr	13
Meacham NF 2	From Sawmill Cr to Bear Cr	15
Meacham NF 1	From mouth at Meacham Cr to Sawmill Cr	16
Coyote 1	From mouth at Umatilla NF to WF/EF	17
UM 43	From Meacham Cr to Fred Gray's Bridge	18
UM 44	From Fred Gray's Bridge to Hillbilly Cr	18
UM 45	From Hillbilly Cr to Ryan Cr	18

The QHA for redband trout provided a ranking of stream reaches for both habitat protection and habitat restoration. Stream reaches are ranked high for protection where significant loss of production could occur if the habitat were degraded. Stream reaches ranked high for restoration are reaches where significant gains in fish production could be made by restoring habitat to historic conditions. However, it is not assumed nor necessarily intended that habitats will be restored to historic conditions. The QHA methodology simply provides a tool for prioritizing future efforts geographically to restore and protect fish habitat. The amount of restoration that actually occurs will be based primarily on the willingness of private landowners to work cooperatively with resource managers to improve habitat as most of the Willow Creek watershed is under private ownership.

Priority reaches for restoration of redband trout habitat in Willow creek ranked from 1 to 19 are shown in Table 49 (more than 19 reaches are listed because some were assigned equal ranking by QHA) and the top twenty reaches for protection are listed in Table 50.

QHA also ranked the 11 habitat attributes in order of importance for each Reach. The top three ranked attributes are listed for priority restoration reaches in Table 49. These are considered the primary limiting factors to be addressed by restoration projects.

While the priority protection reaches shown in Table 6 were ranked by QHA, this list of reaches is not prioritized. Protection of each of these reaches is considered of equal priority, and actions to protect current habitat value should be taken whenever and wherever the opportunity exists. However, programs focused on implementing passive restoration projects should consider the QHA ranking with respect to project planning, and planners should target the highest ranked reaches first.

Table 49. Priority Reaches for Redband Trout Habitat Restoration in Willow Creek.

Geographic Area	Geographic Area Description	QHA Rank	Primary Limiting Factors
Willow 14	From top of Willow Cr. Reservoir to Skinner Fork	1	Ch Form, Rip Cond, F Sed
Willow 15	Willow Cr., Skinner Fork to North fork	2	Ch Form, Rip Cond, F Sed
Rhea 2	Rhea Cr., McKinney Cr. to Balm Canyon	3	Rip Cond, Poll, Ch Comp
Willow 10	Willow Cr., Lower Heppner to Willow Cr. Dam	4	Rip cond, F Sed, Poll
Balm Can. 1	Balm Canyon, mouth to Road Canyon	5	Rip Cond, Ch Comp, Poll
Willow 3	Weir in mid section 23	6	Obstruction
Willow 9	Willow Cr., Rhea Cr. to lower Heppner	7	Rip Cond, F Sed, Ch Comp
McKinney 2	McKinney Cr., Porcupine Canyon to 3320 ft. level	8	Rip Cond, F Sed, Ch Comp
McKinney 1	Mckinney Cr., mouth to Porcupine Canyon	9	Rip Cond, F Sed, Ch Comp
Rhea 3	Rhea Cr., Balm Canyon to Thorn Cr.	10	Ch Form, Rip Cond, Ch Comp
Eightmile Canyon	Mouth to spring/forks in section 34	11	Poll, L Temp, Rip Cond
Rhea 1	Rhea Cr., mouth to Mckinney Cr.	12	Rip Cond, F Sed, Poll
Road Can.	Mouth to 3000 ft. level	13	Rip Cond, Ch Form, L Flow
Thorn 1	Thorn Cr., mouth to Jug Cr.	14	Ch Form, Rip cond, Ch Comp
NF Willow 2	North Fork Willow Cr., culvert at Willow Cr. Rd. to 4300 ft. level	15	Ch Form, H Flow, Ch Comp
Willow 17	Willow Cr., unnamed tributary in SE corner section 9 to unnamed tributary	16	H Temp, Rip Cond, H Flow
Willow 16	Willow Cr., North fork to unnamed tributary in SE corner section 9	17	Rip Cond, H Flow, L Flow
Rhea 4	Rhea Cr., Thorn Cr. to Rutabaga Cr.	18	Ch Form, Rip Cond, Ch Comp
Willow 2	Willow Cr., from John Day Reservoir to middle section 23	19	Rip Cond, F Sed, Ch Comp
Willow 4	Willow Cr., Weir in middle section 23 to Eightmile canyon	19	Rip Cond, F Sed, Ch Comp
Willow 5	Willow Cr., Eightmile Canyon to weir at section line 1/6	19	Rip Cond, F Sed, Ch Comp
Willow 7	Willow Cr., weir at section1/6 to McNab Rd. Bridge	19	Rip Cond, F Sed, Ch Comp
Willow 8	Willow Cr., McNab Rd. Br. to Rhea Cr.	19	Rip Cond, F Sed, Ch Comp

Table 50. Priority Reaches for Redband Trout Habitat Protection in Willow Creek.

QHA Reach	Geographic Area Description
Rhea 5	Rhea Cr., Rutabaga Cr. to Wilson Cr.
Rhea 6	Rhea Cr., Wilson Cr. to Copple Cr.
Rhea 7	Rhea Cr., Copple Cr. to 4000 ft. level
Willow 16	Willow Cr., North fork to unnamed tributary in SE corner section 9
Rhea 4	Rhea Cr., Thorn Cr. to Rutabaga Cr.
Thorn 2	Thorn Cr., Jug Cr. to 4000 ft. level
Wilson 1	Wilson Cr., mouth to Caplinger Cr.
Caplinger	Caplinger Cr., mouth to 4550 ft. level
Wilson 2	Wilson Cr., Caplinger Cr. unnamed tributary below 3700 ft. level
Wilson Trib 1	Mouth to unnamed tributary below 3700 ft. level
Wilson Trib Trib	Unnamed trib below 3900 ft. level to 4350 ft. level
Wilson Trib 2	Unnamed tributary just below 3700 ft. level to unnamed tributary below 3900 ft. level
Wilson 3	Wilson Cr., Unnamed tributary just below 3700 ft. level to 4500 ft.
Copple	Copple Cr., mouth to 3950 ft. level
Rutabaga	Rutabaga Cr., mouth to 4120 ft. level
Rhea 3	Rhea Cr., Balm Canyon to Thorn Cr.
Balm Canyon 2	Balm Canyon, Road Canyon to 3000 ft. level
NF Willow 2	North Fork Willow Cr., culvert at Willow Cr. Rd. to 4300 ft. level
Willow 18	Willow Cr., unnamed tributary in NE corner section 36 to Shaw Cr.
Willow 17	Willow Cr., unnamed tributary in SE corner section 9 to unnamed trib

The results of the limiting factors analysis reveal that many of the same factors impact the different focal species in both the Umatilla River and its tributaries and Willow Creek and its tributaries. In summary, in the Umatilla/Willow subbasin the factors most important in limiting the survival of steelhead, spring Chinook, fall Chinook, and coho are high water temperature, sediment load, habitat diversity, and the quantity of appropriate habitat. Similar limiting factors are important for bull trout in the Umatilla River subbasin, and these are habitat diversity, habitat quantity, and high temperatures. Finally, redband trout in the Willow Creek subbasin are limited mainly by habitat quantity, habitat diversity, and sediment.

In the subbasin, high water temperatures result from low flows, lack of riparian vegetation, lack of groundwater exchange, and channel form. Sediment load results from upland erosion and runoff, bank erosion and downcutting of stream channels; these factors can be ameliorated by improving upland practices and restoring proper riparian function and the connection between the channel and its floodplain. The lack of appropriate habitat diversity reflects the loss of woody debris throughout much of the subbasin. As with temperature and sediment, the restoration of good riparian function provides a long-term solution to this limiting factor. Finally, the lack of enough appropriate habitat reflects a lack of pool habitat and gravel dominated riffles. This

effect stems mostly from poor channel form and function resulting from straightened and incised channels.

Appendix E shows a detailed breakdown of the limiting factors by GA for each species (pages 23-26) and by species within each GA (pages 27-116). In addition to the limiting factors, the attributes contributing to the limiting factors are also shown.

3.5.1.4 Priority Reaches for Restoration and Protection – Areas in Which Human Intervention can Enhance Focal Species Populations

As stated above, both EDT and QHA prioritize geographic areas or reaches based on their importance to the focal species being examined. EDT ranks geographic reaches based on their priority for restoration and their priority for protection. A high restoration ranking indicates that with improvements to habitat, water quality, and/or passage with on-the-ground projects a relatively large increase in abundance and/or productivity of a given focal species will occur. A high protection ranking indicates that any further degradation to that geographic area will result in large decreases in current abundance and/or productivity; therefore efforts should be made to protect that area and maintain it at its current state. In both restoration and protection cases, ranking is based upon the relative impact on salmonid populations that actions in that geographic area will have. The relative contributions resulting from restoration or from further degradation for coho, steelhead, spring Chinook, and fall Chinook are shown in figures 132-135. These figures show two methods of ranking the GAs. The "Category" column is a ranking based on four groups: "A" indicates high priority, "B" and "C" indicate medium piority, and "D" indicates low priority. The "rank" column is an actual numeric ranking from 1 (top priority) to N (where N is the largest number and indicates the lowest priority).

Umatilla Coho

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit		Change in Abundance with				Change in Productivity with			
	Category/rank		Category/rank		Degradation		Restoration		Degradation		Restoration	
GA1	D	24	C	12								
GA11	D	22	A	10								
GA12	C	14	A	8								
GA13	D	20	C	15								
GA14	A	2	D	19								
GA15	C	12	C	13								
GA17	A	3	C	17								
GA18	A	4	D	21								
GA19	A	9	C	13								
GA2	D	21	A	3								
GA20	D	21	D	22								
GA21	D	18	A	8								
GA22	D	20	C	16								
GA24	A	5	C	14								
GA25	D	17	A	6								
GA26	D	24	A	8								
GA28	A	6	A	4								
GA3	D	19	D	25								
GA30	C	15	C	18								
GA31	A	6	C	18								
GA32	A	8	D	20								
GA33	A	2	A	9								
GA35	A	7	D	22								
GA4	D	21	A	7								
GA40	A	1	C	11								
GA42	A	10	D	24								
GA43	C	12	D	23								
GA46	D	23	D	26								
GA5	D	16	A	1								
GA7	C	13	A	5								
GA8	C	11	A	3								
GA9	D	17	A	2								
					-260% 0% 260%				-260% 0% 260%			
					Percentage change				Percentage change			

Figure 132. Priority ranking of reaches and the relative contributions of degradation and restoration for fall Chinook.

Umatilla Summer Steelhead

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit		Change in Abundance with		Change in Productivity with	
	Category/rank		Category/rank		Degradation	Restoration	Degradation	Restoration
GA1	D	19	D	23				
GA11	D	29	E	32				
GA12	D	20	A	1				
GA13	E	32	A	8				
GA14	A	9	D	19				
GA15	C	14	A	6				
GA16	C	15	E	29				
GA17	D	24	C	14				
GA18	C	11	C	17				
GA19	A	5	C	12				
GA2	C	12	C	18				
GA20	D	21	C	13				
GA21	E	38	A	7				
GA22	E	38	E	35				
GA24	E	38	E	35				
GA25	D	26	E	30				
GA26	E	33	E	34				
GA27	D	28	C	11				
GA28	D	17	A	3				
GA29	E	31	C	13				
GA3	E	31	E	33				
GA30	D	25	D	24				
GA31	D	30	D	25				
GA32	D	22	A	9				
GA33	A	9	A	5				
GA34	D	16	D	20				
GA35	A	4	A	10				
GA36	C	13	A	7				
GA37	A	8	E	27				
GA38	D	23	D	26				
GA39	D	25	E	28				
GA4	E	37	C	15				
GA40	A	2	A	4				
GA41	D	18	E	31				
GA42	A	1	C	15				
GA43	A	7	C	15				
GA44	A	3	D	22				
GA45	A	9	C	17				
GA46	A	6	D	23				
GA5	E	35	A	2				
GA6	D	27	C	16				
GA7	E	36	D	25				
GA8	E	34	D	21				
GA9	A	10	C	15				

Figure 133. Priority ranking of reaches and the relative contributions of degradation and restoration for steelhead.

Umatilla Spring Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit		Change in Abundance with		Change in Productivity with	
	Category/rank		Category/rank		Degradation	Restoration	Degradation	Restoration
GA1	C	14	C	18				
GA11	C	12	C	15				
GA12	C	15	A	3				
GA13	D	18	A	10				
GA17	A	8	A	6				
GA18	A	6	C	13				
GA2	C	11	C	11				
GA20	A	6	A	8				
GA21	D	17	A	2				
GA24	A	9	A	6				
GA25	A	10	A	7				
GA28	A	7	A	1				
GA3	D	16	D	19				
GA31	A	9	C	12				
GA32	C	13	C	15				
GA33	A	3	A	4				
GA35	A	2	A	9				
GA40	A	1	A	5				
GA42	A	4	C	17				
GA43	A	4	C	14				
GA46	A	6	C	16				
GA9	A	5	A	10				

Figure 134. Priority ranking of reaches and the relative contributions of degradation and restoration for spring Chinook.

Umatilla Fall Chinook

Relative Importance Of Geographic Areas For Protection and Restoration Measures

Geographic Area	Protection benefit		Restoration benefit		Change in Abundance with		Change in Productivity with	
	Category/rank		Category/rank		Degradation	Restoration	Degradation	Restoration
GA1	E	11	A	4				
GA11	A	9	A	5				
GA12	A	7	A	6				
GA2	A	10	A	3				
GA20	A	5	A	9				
GA21	A	4	A	7				
GA25	A	6	A	5				
GA28	A	2	A	2				
GA3	A	9	A	10				
GA33	A	3	A	7				
GA40	A	1	A	8				
GA9	A	8	A	1				

Figure 135. Priority ranking of reaches and the relative contributions of degradation and restoration for fall Chinook.

EDT ranks all geographic areas in which a particular species was present historically, regardless of its current status. From this list an arbitrary number of the top ranked reaches were selected as for each species for both restoration and protection. The aquatic work group determined that the following number of reaches would be selected for restoration and protection of habitat separately: 15 each for steelhead, 10 each for spring Chinook, 10 each for coho and 5 each for fall Chinook. The arbitrary number of reaches for each species was selected based on the extent of distribution of each species. The species with the broadest distribution, steelhead, has the most GAs targeted for restoration and protection and the species with the smallest distribution, fall Chinook, has the least number of GAs selected.

As stated above, EDT examines all geographic areas in which a species was historically present, regardless of its current status. From this, a perspective of historic production by each of the EDT focal species and geographic area was gained. However, significant portions of the Umatilla/Willow subbasin are no longer habitat for anadromous fish such as McKay Creek, which is blocked to passage by McKay Dam, and Butter Creek, which is blocked by numerous passage barriers and severe water withdrawal. McKay Dam is a complete passage barrier to fish and the severity of passage conditions in Butter Creek is not fully understood as a comprehensive survey has not been conducted in that region. While many reaches that are blocked to anadromous fish use in McKay and Butter creeks ranked high for protection or restoration, these reaches are not included as priority areas as restoring these systems is not at this time economically or socially feasible. In addition, other reaches were removed from consideration as current priorities for reasons such as current lack of use of the species, Wilderness Areas being ranked high for restoration, etc. Reaches that ranked high for either restoration or protection, but are not identified as current priorities are shown in Appendix E (pages 117-119) along with the rationale. Therefore, our ranking of priority reaches does not necessarily completely coincide with EDT rankings (e.g., see table 136).

EDT focal species priority restoration and protection GAs are shown in Tables 136 through 143. Restoration areas were prioritized by rank, but protection areas are considered to be equal in priority. Loss of productive capacity through degradation of any of the priority protection areas, while restoration is actively pursued in other areas, is considered of equal importance for all priority protection GAs because any significant loss in current abundance and/or productivity is considered equally important to address. While the Priority restoration areas are ranked, this ranking is considered preliminary and draft in nature. As discussed elsewhere, a number of problems are known to exist with EDT inputs. Thus, outputs of the model are not necessarily expected to be accurate and precise. The current plan of the aquatic working group is to continue to conduct EDT analyses through the summer of 2004 to fine tune the model and the data and to conduct additional restoration scenarios. It is anticipated that by the fall of 2004, EDT outputs with a higher quality/confidence level will be incorporated into the subbasin plan.

Table 136. Priority Geographic Areas for Coho Habitat Restoration

Geographic Area	Geographic Area Description	EDT Rank	Restoration Priority
GA 9	Umatilla R., Butter Cr. to Westland Dam & Stanfield Dam to McKay Cr.	2	1
GA 28	Umatilla R., Mission Bridge to Meacham Cr.	4	2
GA 25	Umatilla R., McKay Cr. to Mission Bridge	6	3
GA 26	Wildhorse Cr., mouth to Athena including tributaries	8	4
GA 33	Meacham Cr., mouth to North fork	9	5
GA 11	Umatilla R., Westland Dam to Stanfield Dam	10	6
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	11	7

Table 137. Priority Geographic Areas for Coho Habitat Protection

Geographic Area	Geographic Area Description	EDT Rank
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	1
GA 31	Squaw Cr., mouth to Bachelor Canyon	6
GA 35	North Fork Meacham Cr. and tributaries	7
GA 32	Squaw Cr., Bachelor Canyon to headwaters including tributaries	8
GA 42	North Fork Umatilla R., mouth to headwaters including tributaries	10
GA 12	Birch Cr., mouth to Forks including Stewart Cr.	14
GA 30	Buckaroo Cr.	15

Table 138. Priority geographic areas for steelhead habitat restoration.

Geographic Area	Geographic Area Description	**EDT Rank**	**Restoration Priority**
GA 12	Birch Cr., mouth to Forks including Stewart Cr.	1	1
GA 28	Umatilla R., Mission Bridge to Meacham Cr.	3	2
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	4	3
GA 33	Meacham Cr., mouth to North fork	5	4
GA 15	West Birch Cr., Bear Cr. to top of gorge, including tributaries	6	5
GA 13	West Birch Cr., mouth to Bear Cr.	8	6
GA 32	Squaw Cr., Bachelor Canyon to headwaters including tributaries	9	7
GA 35	North Fork Meacham Cr. and tributaries	10	8
GA 19	East Birch Cr., Pearson Cr. to headwaters including Pearson Cr.	12	9
GA 17	East Birch Cr., mouth to California Gulch	14	10
GA 18	East Birch Cr., California Gulch to Pearson Cr.	17	11
GA 14	Bear Cr. and tributaries (West Birch)	19	12
GA 34	Meacham, tributaries from mouth to North fork	20	13
GA 30	Buckaroo Creek	24	14
GA 38	Meacham Cr., Sheep Cr. to Headwaters	26	15

Table 139. Priority geographic areas for steelhead habitat protection.

Geographic Area	Geographic Area Description	EDT Rank
GA 42	North Fork Umatilla R., mouth to headwaters including tributaries	1
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	2
GA 44	Buck Cr. and tributaries	3
GA 35	North Fork Meacham Cr. and tributaries	4
GA 19	East Birch Cr., Pearson Cr. to headwaters including Pearson Cr.	5
GA 46	South Fork Umatilla R., Thomas Cr. to headwaters including Shimmiehorn Cr.	6
GA 43	South Fork Umatilla R., mouth to Thomas Cr.	7
GA 37	East Meacham Cr. and Butcher Creek and tributaries	8
GA 45	Thomas Cr. and tributaries (South Fork Umatilla)	9
GA 9	Umatilla R., Butter Cr. to Westland Dam & Stanfield Dam to McKay Cr.	10
GA 18	East Birch Cr., California Gulch to Pearson Cr	11
GA 2	Umatilla R., Three Mile Dam to Butter Cr.	12
GA 36	Meacham Cr., North fork to Sheep Creek	13
GA 15	West Birch Cr., Bear Cr. to top of gorge, including tributaries	14
GA 16	West Birch Cr., gorge to headwaters	15

Table 140. Priority geographic areas for spring Chinook habitat restoration

Geographic Area	Geographic Area Description	EDT Rank	Restoration Priority
GA 28	Umatilla R., Mission Bridge to Meacham Cr.	1	1
GA 33	Meacham Cr., mouth to North fork	4	2
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	5	3
GA 25	Umatilla R., McKay Cr. to Mission Bridge	7	4
GA 35	North Fork Meacham Cr. and tributaries	9	5
GA 9	Umatilla R., Butter Cr. to Westland Dam & Stanfield Dam to McKay Cr.	10	6
GA 2	Umatilla R., Three Mile Dam to Butter Cr.	11	7
GA 31	Squaw Cr., mouth to Bachelor Canyon	12	8
GA 43	South Fork Umatilla R., mouth to Thomas Cr.	14	9
GA 11	Umatilla R., Westland Dam to Stanfield Dam	15	10

Table 141. Priority geographic areas for spring Chinook habitat protection.

Geographic Area	Geographic Area Description	EDT Rank
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	1
GA 35	North Fork Meacham Cr. and tributaries	2
GA 33	Meacham Cr., mouth to North fork	3
GA 42	North Fork Umatilla R., mouth to headwaters including tributaries	4
GA 43	South Fork Umatilla R., mouth to Thomas Cr.	4
GA 9	Umatilla R., Butter Cr. to Westland Dam & Stanfield Dam to McKay Cr.	5
GA 46	South Fork Umatilla R., Thomas Cr. to headwaters including Shimmiehorn Cr.	6
GA 28	Umatilla R., Mission Bridge to Meacham Cr.	7
GA 25	Umatilla R., McKay Cr. to Mission Bridge	10
GA 2	Umatilla R., Three Mile Dam to Butter Cr.	11
GA 11	Umatilla R., Westland Dam to Stanfield Dam	12

Table 142. Priority geographic areas for fall Chinook habitat restoration.

Geographic Area	Geographic Area Description	EDT Rank	Restoration Priority
GA 9	Umatilla R., Butter Cr. to Westland Dam & Stanfield Dam to McKay Cr.	1	1
GA 28	Umatilla R., Mission Bridge to Meacham Cr.	2	2
GA 2	Umatilla R., Three Mile Dam to Butter Cr.	3	3
GA 11	Umatilla R., Westland Dam to Stanfield Dam	5	4

Table 143. Priority geographic areas for fall Chinook habitat protection.

Geographic Area	Geographic Area Description	EDT Rank
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	1
GA 28	Umatilla R., Mission Bridge to Meacham Cr.	2
GA 33	Meacham Cr., mouth to North fork	3
GA 25	Umatilla R., McKay Cr. to Mission Bridge	6
GA 12	Birch Cr., mouth to Forks including Stewart Cr.	7

To simplify the priority listing of GAs and to make sure that the ESA listed species, bull trout, was given equal consideration with steelhead (the other listed species), the priority

reaches for bull trout generated by QHA have been incorporated into priority GAs for steelhead and salmon generated by EDT. This combining makes sense, many of the same factors that limit steelhead and salmon (particularly habitat diversity and habitat quantity) also limit bull trout and it allows, in a very simple fashion, to identify priority areas that contain both listed species. The priority GAs for bull trout restoration and protection are shown in tables 144 and 145, respectively.

Table 146 shows GAs that are high restoration priority for multiple species. These areas, particularly the two GAs (33 and 40) that are priority for both listed species, bull trout and steelhead, will be given high consideration for restoration, and perhaps the highest. This makes sense given the individual high priority of the two shared areas for each species. GA 40 (the Umatilla River from Meacham Creek confluence to the forks and including all tributaries except Ryan Creek) received the highest priority for bull trout and was ranked 4th for steelhead shared by these species. GA 33 (Meacham Creek, from the mouth to the North Fork) was ranked 2nd in priority for bull trout and 5th for steelhead.

Table 144. Priority Geographic Areas for Bull Trout Habitat Restoration

Geographic Area	Geographic Area Description	Restoration Priority
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	1
GA 33	Meacham Cr., mouth to North fork	2

Table 145. Priority geographic areas for bull trout habitat protection.

Geographic Area	Geographic Area Description	Restoration Priority
GA 42	North Fork Umatilla, mouth to headwaters including tributaries	1
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	2
GA 35	North Fork Meacham Cr. and tributaries	3

Table 146. Geographic areas with restoration priority for multiple species. Areas highlighted in blue contain both ESA listed species, bull trout and steelhead. ChF = fall Chinook, ChS = spring Chinook, Co = coho, StS = summer steelhead, and BT = bull trout.

Geographic Area	Geographic Area Description	Species
GA 2	Umatilla R., Three Mile Dam to Butter Cr.	ChF, ChS
GA 9	Umatilla R., Butter Cr. to Westland Dam & Stanfield Dam to McKay Cr.	ChF, Co, ChS
GA 11	Umatilla R., Westland Dam to Stanfield Dam	ChF, Co, ChS
GA 28	Umatilla R., Mission Bridge to Meacham Cr.	ChF, Co, ChS, StS
GA 33	Meacham Cr., mouth to North fork	BT, Co, ChS, StS
GA 35	North Fork Meacham Cr. and tributaries	ChS, StS
GA 40	Umatilla R., Meacham Cr. to forks including all tributaries except Ryan Creek	BT, Co, ChS, StS

QHA also provided ranking of reaches in terms of restoration and protection for redband trout in Willow Creek and its tribuatries. While the QHA tool is less rigorous than EDT, it at least provides a method for prioritization of efforts. Prioritization of reaches for restoration and protection of redband trout habitat are listed in Tables 147 and 148, respectively.

Table 147. Priority reaches for restoration of redband trout habitat in Willow Creek and its tributaries.

Reach	Reach Description	QHA Priority
Willow 14	Top of Reservoir to Skinner Fork	1
Willow 15	Skinner Fork to North Fork	2
Rhea 2	McKinney Cr. to Balm Canyon	3
Willow 10	Lower Heppner to Willow Cr. Dam	4
Balm Canyon 1	Mouth at Rhea Cr. to Road Canyon	5
Willow 3	Weir in the middle of section 23	6
Willow 9	Rhea Cr. to lower Heppner	7
McKinney 2	Porcupine Canyon to 3320 ft. elevation	8
McKinney 1	Mouth at Rhea Cr. to Porcupine Canyon	9
Rhea 3	Balm Canyon to Thorn Cr.	10
Eightmile Canyon	Mouth at Willow Cr. to Spring/Forks in section 34	11
Rhea 1	Mouth at Willow Cr. to McKinney Cr.	12
Road Canyon	Mouth at Balm Canyon to 3000 ft. elevation	13
Thorn Cr. 1	Mouth at Rhea Cr. to Jug Cr.	14
NF Willow 2	Mouth/culvert of Willow Cr. Road to 4300 ft. elevation	15
Willow 16	NF to unnamed trib in SE corner of section 9	17
Rhea 4	Thorn Cr. to Rutabaga Cr.	18
Willow 2	Top of bay to weir in the middle of section 23	19
Willow 4	Weir in the middle of section 23 to Eightmile Canyon	19
Willow 5	Eightmile Canyon to weir at section line 1/6	19
Willow 7	Weir at section line 1/6 to McNab Road Bridge	19
Willow 8	McNab Road Bridge to Rhea Cr.	19

Table 148. Priority reaches for protection of redband trout habitat in Willow Creek and its tributaries.

Reach	Reach Description	QHA Priority
Rhea 5	Rutabaga Cr. to Wilson Cr.	1
Rhea 6	Wilson Cr. to Copple Cr.	2
Rhea 7	Copple Cr. to 4000 ft. elevation	3
Willow 16	NF to nnnamed trib. in SE corner of section 9	4
Rhea 4	Thorn Cr. to Rutabaga Cr.	5
Thorn 2	Jug Cr. to 4000 ft. elevation	6
Wilson 1	Mouth at Rhea Cr. to Caplinger Cr.	6
Caplinger	Mouth at Wilson Cr. to 4550 ft. elevation	6
Wilson 2	Caplinger Cr. to unnamed trib. below 3700 ft. elevation	6
Wilson Trib 1	Unnamed trib to unnamed trib. below 3900 ft. elevation	6
Wilson Trib trib	Unnamed trib below 3900 ft. elevation to 4350 ft. elevation	6
Wilson Trib 2	Unnamed trib below 3700 ft. elevation to unnamed trib. below 3900 ft. elevation	6
Wilson 3	Unnamed trib. below 3700 ft. elevation to 4500 ft. elevation	6
Copple	Mouth at Rhea Cr. to 3950 ft. elevation	6
Rutabaga	Mouth at Rhea Cr. to 4120 ft. elevation	15
Rhea 3	Balm Canyon to Thorn Cr.	16
Balm Canyon 2	Road Canyon to 3000 ft. elevation	17
NF Willow 2	Mouth/culvert at Willow Cr. road to 4300 ft. elevation	18
Willow 18	Unnamed trib. in NE corner of section 16 to Shaw Cr.	19
Willow 17	Unnamed trib. in SE corner of section 9 to unnamed trib.	20

3.5.2 Factors Leading to the Decline of Terrestrial Focal Species and Habitats

Although wildlife species can be strongly affected by non-anthropogenic disturbances in certain circumstances, most declines in wildlife species and destruction and degradation of habitat in the Umatilla/Willow subbasin are directly related to human activity within the subbasin. Descriptions of important human activities that occur in the subbasin and their general effect on the ecology of the subbasin are described in Sections 3.1.1.9 and 3.1.3.2. Information from those sections and from Appendices C and D were combined to create the following lists of limiting factors for each habitat type. It should be noted the term "limiting factor" is used more generally in the wildlife assessment than in the aquatic assessment. Limiting factors for wildlife are generally described in terms of activities or conditions that are believed to negatively impact wildlife primarily through their effect on habitat (e.g., timber harvest, the invasion of exotic vegetation). These activities or conditions are believed to impact focal and obligate wildlife species via a variety of mechanisms that affect key environmental correlates.

Mixed Conifer Forest: The quality of mixed conifer forest in the Umatilla/Willow subbasin is believed to have declined due to timber harvest, altered fire regimes, ponderosa pine encroachment, development, outbreaks of western spruce budworm and Douglas-fir tussock moth, and exotic plant invasion. These factors have resulted in direct loss of old growth habitat and fragmentation and degradation of remaining mixed conifer forest. Loss of old growth habitat has occurred primarily because of timber harvesting, while habitat degradation is primarily associated with altered fire regimes. Fire suppression has promoted less fire-resistant, shade-tolerant trees, and led to mixed conifer forests with low snag density, high tree density, and stands dominated by smaller and more shade-tolerant trees.

Ponderosa Pine Forest: The quality of ponderosa pine forest habitat is believed to have declined due to mixed forest encroachment, altered fire regimes and stand-replacing fires, timber harvest, exotic plant invasion, outbreaks of western spruce budworm and Douglas-fir tussock moth, livestock grazing, development, and recreational activities (see Section 3.5.2 for more description). Two of the major factors responsible for habitat loss and degradation of functional ponderosa pine forest are harvest of late and old structure pine and the encroachment of Douglas-fir and grand fir into ponderosa pine dominated habitats. The encroachment is due primarily to fire suppression and intense, stand-replacing wildfires; the latter results from high fuel loads associated with increases in brushy species and the establishment of ladder fuels from encroaching shade tolerant understory trees.

Quaking Aspen Forest: The major factors affecting aspen habitat in the Umatilla/Willow subbasin are intensive grazing by livestock and native ungulates, fire suppression, and the invasion of coniferous species.

Western Juniper Woodlands: The most important limiting factors of juniper woodlands, especially of mature trees or stands associated with shrub-steppe or grasslands, are agricultural conversion, altered fire regimes, overgrazing, and exotic plant invasions.

Shrub-Steppe: Major factors affecting both low and higher elevation shrub-steppe habitat in the Umatilla/Willow subbasin are agricultural conversion (including the conversion of CRP lands back into croplands), exotic plant invasion, alteration of fire regimes, purposeful seeding of non-native grasses, and livestock grazing (see Section 3.6.2). These factors result in habitat loss, fragmentation, and degradation. Historically, the single largest factor responsible for shrub-steppe habitat loss in the Umatilla/Willow subbasin is conversion to agriculture. Remaining shrub-steppe habitat continues to be threatened by agricultural conversion, but of even greater concern is the proliferation of exotic weeds. Cheatgrass is especially problematic, as described in Section 3.1.1.9, because it increases the frequency and severity of range fires, which can lead to the replacement of sagebrush, bitterbrush, and other native shrubs with cheatgrass. The invasion of exotic plants is facilitated by the loss of cryptogamic crusts resulting from soil disturbances associated with tillage and inappropriate livestock grazing practices. Non-native animal species, including nest competitors (e.g., European Starlings, House Sparrow), nest parasites (e.g., Brown Headed Cowbirds), and domestic predators (e.g., cats, dogs) also negatively affect obligate species in this habitat. The effects of non-native species are magnified by habitat fragmentation. Additionally, shrub-steppe habitats in proximity to agricultural, recreational, and residential areas may be subject to high levels of human disturbance.

Interior Grasslands: Major factors affecting grassland habitat in the Umatilla/Willow subbasin are agricultural conversion (including the conversion of CRP back into cropland), exotic weed invasion, purposeful seeding of non-native grasses, overgrazing, and human-altered fire regimes. These factors result in direct habitat loss, fragmentation, and degradation. The single largest factor in habitat loss is conversion to agriculture. The largest factor in habitat degradation is the proliferation of annual grasses and exotic weeds, such as cheatgrass and yellow starthistle, which either replace or radically alter native bunchgrass communities. This invasion of exotic plants is facilitated by the loss of cryptogamic crusts, resulting from soil disturbances associated with tillage and livestock grazing. Non-native animal species, including nest competitors (e.g., European Starlings, House Sparrow), nest parasites (e.g., Brown Headed Cowbirds), and domestic predators (e.g., cats, dogs) also impact native species productivity. The effects of non-native species are magnified by habitat fragmentation. Additionally, grassland habitats in proximity to agricultural and recreational areas may be subject to high levels of human disturbance.

Herbaceous Wetlands: Major factors that have led to the destruction and degradation of herbaceous wetlands in the Umatilla/Willow subbasin are habitat conversion and draining, lowering of ground water level, separation of floodplain from the stream channel due to dikes and levees, exotic plant and animal invasions, and livestock grazing.

Riparian Wetlands: Major factors affecting riparian wetlands in the Umatilla/Willow subbasin are agricultural and urban development, exotic weed invasion, timber harvest, livestock grazing, transportation corridors, hydropower, and recreational activities. Hydropower, agricultural, urban, and transportation corridor development have led to habitat loss through conversion and channelization, have resulted in the separation of the floodplain from the stream, and have contributed to the degradation and fragmentation of remaining riparian habitat. Most of the extensive cottonwood galleries once found in riparian wetlands of the subbasin have been harvested. Existing riparian wetlands also continue to be degraded by exotic plant invasions and livestock grazing.