Level 2 Diagnosis and Project Inventory

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Level 2 Diagnosis

Table 1 summarizes the protection and restoration priorities, as well as the site-specific environmental problems, for Walla Walla steelhead by Geographic Area (GA). Table 1 shows site-specific impacts of decreases in the quality of "Level 2 environmental attributes" on productivity, and is therefore referred to as a "Level 2 Diagnosis". The table is broken into 48 distinct GA's based on environmental homogeneity and geographic proximity. The four columns to the right of the "Geographic Area" column represent the rank of a particular GA for either the tributary or mainstem Walla Walla steelhead population in terms of in terms of Restoration Potential and Protection Value. The environmental parameters printed vertically to the right of the Protection/Restoration ranks represent the specific environmental factors most responsible for depressing productivity in specific GA's. The darker the shading in an individual GA-by-attribute cell, the more the particular attribute is responsible for depressing current productivity from historical estimates. Therefore, in the absence of non-biological considerations to the contrary, an enhancement program should address darker shaded attributes first because the rate of steelhead production increase per degree of restoration is greater for such attributes than for those with lighter shading.

The following process was used to identify critical environmental attributes and their relative importance in depressing population-wide production. Historical values for each environmental attribute in turn were substituted for current values for every life stage occurring in each of the reaches comprising a GA. Species-specific EDT Rules were used estimate the change in productivity this substitution would cause for each life stage, and a weighted mean productivity change was estimated across all life stages[1]. This weighted mean change represents the change in productivity attributable to a specific kind of environmental degradation integrated across all life stages. The shaded cells in Table 1 are thus based on an estimated historical/current productivity differential. Explicitly, the lightest cells denote attributes that reduce productivity by at least 0.000001 and as much as 0.00001; the next darker shade represents attributes depressing population productivity from 0.00001 to 0.0001; and the darkest cells indicate attributes that depress productivity by more than 0.0001. White cells represent attributes that have no impact on a limiting life stage in a particular GA, but which do have a non-zero impact in some other GA.

The productivity intervals described above seem quite small, but this appearance is deceiving. It must be borne in mind that all of these decrements *collectively* determine population performance, that each decrement interacts with the others *multiplicatively*, and that there are a great many of them (1,488, to be exact).

The interpretation of Table 1 must be colored by the fact that recent and ongoing enhancement projects have already been reflected in the environmental ratings assigned to the existing habitat. Therefore, the particular "problem attributes" listed in Table 1 represent the environmental issues that remain after the benefits of recent enhancement projects have had an effect. In all probability a different set of environmental attributes would be emphasized if this analysis had been performed on the subbasin 10-15 years ago, before implementation of the relatively recent projects that will be summarized in the next section. Different environmental factors would have been more problematic a decade ago simply because a large number of projects have targeted them and reduced their severity.

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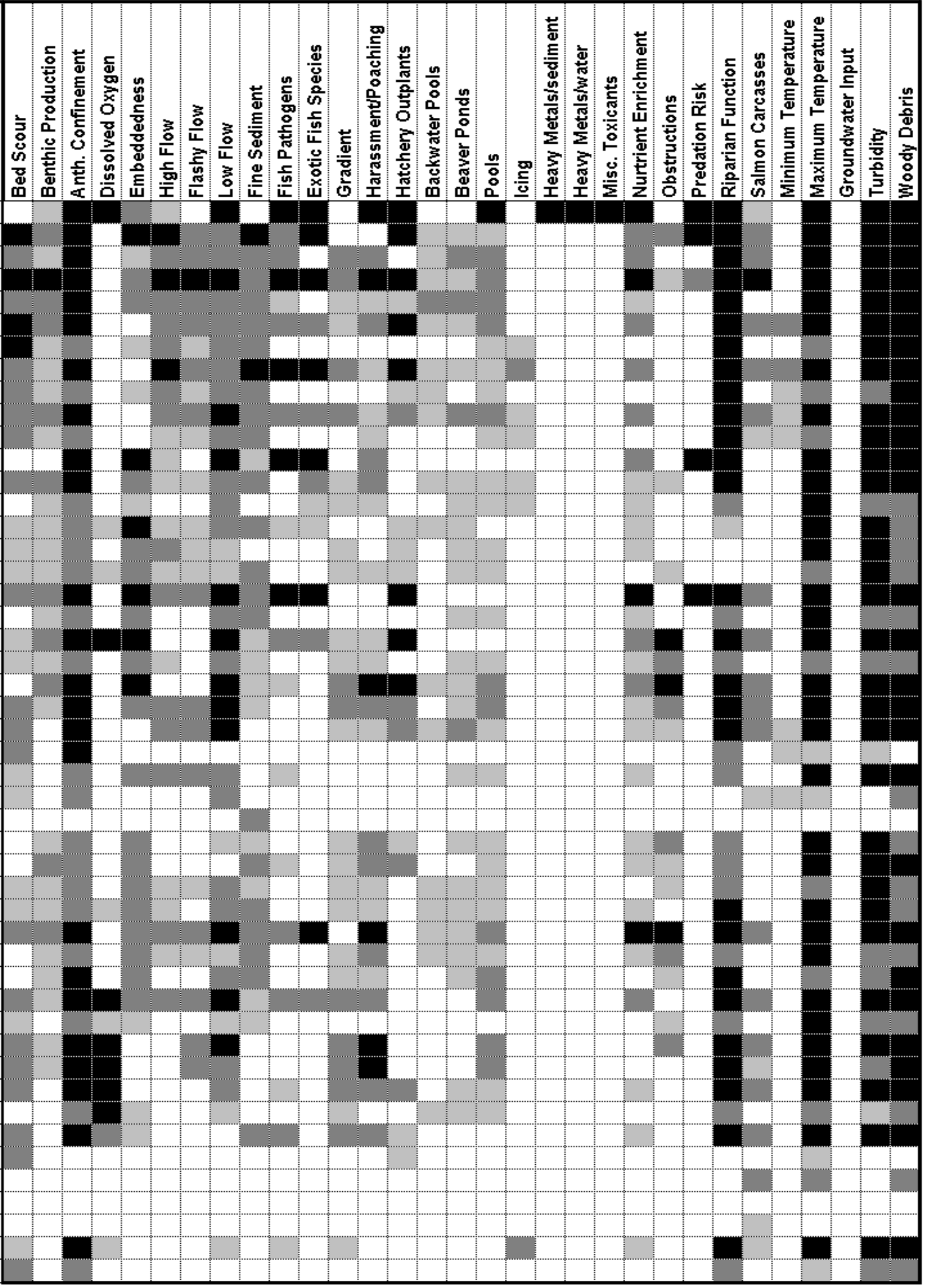
[1] The weighting factor was the product of the number of trajectories – or distinct life history patterns – that included life stage x in reach y, and the equilibrium abundance of the trajectory.

The Protection Value and Restoration Potential ranking of the mainstem Snake and Columbia Rivers are omitted in Table 1, which also excludes ocean impacts (the marine environment was held constant for both the Historical and Current simulations). Thus, the rankings in Table 1 represent the relative ability of an area to restore or protect steelhead when consideration is restricted exclusively to reaches inside the Walla Walla Subbasin.

Table 1 Level 2 diagnosis for Walla Walla summer steelhead. Relationship between Restoration and Protection rank and site-specific impact of specific environmental attributes. Impact of attributes expressed as the productivity change from historical to current conditions for a specific attribute.

	Protection/Restoration Rank			
	Tributary Steelhead		Mainstem Steelhead	
Geographic Area	Protection	Restoration	Protection	Restoration
Lower Walla Walla (mouth to Touche)	31	1	17	6
Lower Touche (mouth to Coppei)	21	2	13	1
Coppei Drainage	12	7	17	19
Touche, Coppei to forks (plus Whiskey)	11	6	7	9
Pattit Drainage	13	9		
SF Touche Mainstem	5	12		
SF Touche Tribs	10	14		
NF Touche Mainstem	4	4		
NF Touche Tribs (excluding Wolf Fork)	6	23		
Wolf Fork, mouth to Coates (plus Robinson & Coates)	9	11		
Wolf Fork, Coates to access limit (plus Whitney)	5	19		
Walla Walla, Touche to Dry (plus Mud Cr)	35	7	17	13
Pine Cr mainstem (plus Swartz)	14	3	17	19
Dry Cr [Pine] Drainage	29	15		
Lower Dry Cr (mouth to Sapolil)	34	13	17	16
Upper Dry Cr (Sapolil to forks)	20	21		
Dry Cr Tribs (Mud[Dixie], Mud[Dry], NF Dry & SF Dry)	25	23		
Walla Walla, Dry to Mill	15	13	9	14
W Little Walla Walla Drainage (plus Walsh)	24	20	17	19
Mill Cr, mouth to start of Corps Project at Gose St	36	30	11	8
Lower Mill Cr Tribs (Doan & Cold)	27	28	16	18
Mill Cr, Gose Street to Bennington Dam	36	5	14	2
Mill Cr, Bennington Dam to Blue Cr (plusTitus)	33	32	6	5
Mill Cr, Blue Cr to Walla Walla water intake	32	33	2	3
Middle Mill Cr Tribs (Henry Canyon, Webb &Tiger)	32	34	12	16
Blue Cr Drainage (including L. Blue)	34	32	17	19
Mill Cr, Walla Walla water intake to access limit	30	35	3	10
Upper Mill Tribs (NF, Low, Broken, Paradise)	30	35		
Garrison Cr Drainage (plus Bryant)	33	18		
Yellowhawk mainstem (mouth to source)	17	29	17	19
Yellowhawk Tribs (Lassater, Russell, Reser & Caldwell)	18	17		
Cottonwood Cr Drainage (including NF, SF & MF)	16	12		
Walla Walla, Mill to E L. Walla Walla (plus MacAvoy & Springbranch)	17	16	8	7
Stone Cr Drainage	26	27	17	19
E Little Walla Walla Drainage (plus Unnamed Spring & Big Spring Br)	19	16	17	19
Walla Walla, E Little Walla Walla to Tumalum Bridge	11	22	5	12
Birch Creek Drainage	28	25	17	19
Walla Walla, Tumalum Bridge to Nursery Bridge	16	23	9	11
Walla Walla, Nursery Br to Little Walla Walla Diversion	22	24	15	15
Walla Walla, Little Walla Walla Diversion to forks	8	23		
Couse Creek Drainage	23	26		
SF Walla Walla, mouth to Elbow Creek	2	10		
Lower SF Walla Walla Tribs (Flume Canyon, Elbow)	8	31		
SF Walla Walla, Elbow to access limit	1	37		
Skiphorton & Reser Creek Drainages	7	36		
Upper SF Walla Walla tribs (excluding Skiphorton & Reser)	3	34		
NF Walla Walla, mouth to L. Meadows Canyon Cr (plus L. Meadows)	8	8		
NF Walla Walla, L. Meadows to access limit (plus Big Meadows)	8	27		



Finally, the information in Table 1 relates to summer steelhead specifically, and can be generalized to spring chinook only to a limited degree. The differences in spawn timing and the fact spring chinook spawners require larger streams than steelhead imply that different portions of the same drainage will have somewhat different value to summer steelhead and spring chinook. The relative protection and restoration rankings of Tucannon GA's to steelhead and spring chinook clearly indicate that larger, lower gradient reaches are more important to chinook than steelhead and vice versa. It is nevertheless true that juvenile steelhead and spring chinook residing in the same reach will usually benefit from the same enhancement measures, and that an enhancement program driven by steelhead needs will still confer considerable benefits on spring chinook. Such "collateral benefit" will be especially pronounced when the correction of problems -- such as sediment loading -- in headwater reaches preferred by steelhead propagates downstream to key spring chinook areas.

Critical Key Environmental Attributes in Key Geographic Areas

One of the fundamental lessons EDT teaches us is that problems are local and idiosyncratic. The corollary is that solutions must be site-specific as well. Therefore, to the degree one has faith in the insights offered by EDT, one should refrain from generalizing environmental problems across geographic areas -- unless this is clearly warranted by a similarity in the nature and severity of limiting factors among the areas.

The practical implication of limiting factors being site-specific is that a rigorously strategic restoration program would first allocate restoration effort in terms of the relative Restoration Potential among areas. Then, within a given GA, effort would be allocated among environmental attributes on the basis of their relative impact on productivity: in terms of the information in Table 1, it would mean most effort should be directed toward the back-shaded attributes, less to the "gray attributes" and least to the "light gray attributes".

Sometimes, however, a rigorously strategic restoration plan is neither possible nor entirely desirable. The current EDT analysis is the first ever on the Walla Walla, and a significant fraction of the input data had to be estimated by various means. Therefore the EDT results were taken as approximations and a rigorously prioritized application was not employed. As the first step in an iterative cycle of restoration, 15 high priority restoration areas were identified from the list of areas the EDT process highlighted. At least for the time being, it was decided to restrict active restoration actions to these areas, but not to prioritize among them until prioritization could be more soundly justified empirically.

The decision to restrict active restoration to a few equivalent areas does not imply that the effort directed at limiting factors within them should be indiscriminate. The EDT analysis of the designated restoration areas showed that the impact of some attributes was high across all high priority restoration areas, whereas the impact of other attributes was more site-specific. This analysis is summarized in Table 2, which lists environmental attributes, the sum of attribute-specific productivity changes over the high priority Restoration Areas, the normalized sum of productivity impacts, and the documented effort targeting a specific attribute over all Restoration Areas (more will be said about the effort data in a subsequent section). Table 2 shows the five attributes with a consistently high impact on relative historical/current productivity. In descending order of impact, these attributes were **maximum water temperature, turbidity, large woody debris, riparian function and anthropogenic confinement.** The relative impact of attributes across priority Restoration reaches was indexed by the sum of productivity changes across all 15 GA's. Clearly maximum temperature has the largest impact, more than doubling the impact of the next most significant factor, turbidity. Table 2 might be used as a guide for the intensity with which attribute-specific restoration actions might be applied within the high priority restoration areas generally.

Table 2 Relative impact of historical-to-current changes in attribute quality on steelhead productivity over the 15 designated high priority Restoration reaches in the Walla Walla Subbasin.

Attribute	Sum of Productivity Changes	Normalized Relative Impact	Effort (% Hits)
Maximum Water Temperature	-0.0296	1.00	2.6%
Turbidity	-0.0141	0.48	13.6%
Large Woody Debris	-0.0118	0.40	3.0%
Riparian Function	-0.0101	0.34	2.3%
Anthropogenic Confinement	-0.0083	0.28	0.0%

Other attributes were not so general in effect, but did have substantial impacts in one or more GA's. These attributes, the reaches they affect and the relative productivity changes they are estimated to have caused are summarized in Table 3.

Table 3 Normalized impact of environmental attributes on steelhead productivity across the designated high priority Restoration Areas of the Walla Walla Subbasin. Cell contents are attribute-caused productivity changes divided by the largest productivity change estimated for any area-specific attribute impact (-0.0104 for maximum temperature in the Touchet, Coppei to forks GA). Gray-shaded areas represent attributes with substantial impacts across all or most priority areas; bold blue numbers represent significant area-specific attribute impacts; red number represent attributes which have increased in quality since historical times. Blank cells have normalized impacts < 0.01.

	Bed Scour	Benthic Production	Anth. Confinement	Dissolved Oxygen	Embeddedness	High Flow	Flashy Flow	Low Flow	Fine Sediment	Fish Community Richness	Fish Pathogens	Exotic Fish Species	Gradient	Harassment/Poaching	Hatchery Outplants	Backwater Pools	Beaver Ponds	Pools	Icing	Nurtrient Enrichment	Predation Risk	Riparian Function	Salmon Carcasses	Minimum Temperature	Maximum Temperature	Turbidity	Woody Debris
Coppei Drainage			0.02			0.01		0.01														0.05			0.10	0.01	0.05
NF Touchet Mainstem			0.08			0.01	0.01	0.01	0.01		0.01	0.01			0.03						-0.03	0.09			0.29	0.06	0.13
NF Touchet Tribs (excluding Wolf Fork)																						0.01				0.01	0.02
NF Walla Walla, mouth to L. Meadows Canyon Cr (plus L. Meadows)			0.02																			0.02			0.10	0.03	0.03
SF Touchet Mainstem	0.01	0.01	0.02			0.01		0.01	0.01						0.01						-0.01	0.05			0.12	0.02	0.05
SF Touchet Tribs	0.02		0.01					0.01	0.01													0.02				0.01	0.03
SF Walla Walla, mouth to Elbow Creek	0.01		0.07	0.01					0.01				0.01								-0.01	0.05		-0.01	0.07	0.02	0.09
Touchet, Coppei to forks (plus Whiskey)	0.01	0.02	0.25			0.05	0.02	0.04	0.01		0.05	0.04		0.05	0.11			0.01		0.02		0.27	0.01		1.00	0.11	0.31
Walla Walla, E Little Walla Walla to Tumalum Bridge			0.02	0.01				0.02						0.01							-0.02	0.03			0.20	0.22	0.04
Walla Walla, Little Walla Walla Diversion to forks			0.07	0.02									0.01	0.01							-0.01	0.06			0.11	0.03	0.08
Walla Walla, Mill to E L. Walla Walla (plus MacAvoy & Springbranch)			0.08			0.01		0.05			0.01	0.02		0.02				0.01		0.02	-0.03	0.11			0.71	0.74	0.10
Walla Walla, Nursery Br to Little Walla Walla Diversion			0.04	0.01									0.01	0.01							-0.01	0.05			0.01	0.01	0.03
Walla Walla, Tumalum Bridge to Nursery Bridge	0.01		0.07	0.02				0.02					0.01	0.02				0.01			-0.01	0.09			0.03	0.02	0.06
Wolf Fork, Coates to access limit (plus Whitney)	0.01		0.01																			0.02				0.01	0.03
Wolf Fork, mouth to Coates (plus Robinson & Coates)	0.01		0.04			0.01		0.01							0.01						-0.01	0.06			0.10	0.07	0.08

Table 3 summarizes normalized attribute impacts across the priority Restoration Areas. The values in the attribute-by-area cells have been normalized relative to the maximum attribute-specific impact seen in any area, -.0104 for maximum temperature in the "Touchet, Coppei to forks" GA. Blank cells are those for which the normalized productivity impact is less than 1%. Bold blue entries represent significant area-specific impacts, which were somewhat arbitrarily defined as a normalized impact > 0.02. The attributes with significant area-specific impacts include **bed scour, benthic production, dissolved oxygen, high flow, flashy flow, low flow, fish pathogens, exotic fish species, harassment/poaching, hatchery outplants, and nutrient loading**.

Tables 2-3 suggest that there are basically four tiers of limiting factors. Tier 1, the dominant factors, includes maximum water temperature (another factor, described below, is obstructions). Tier 2 factors -- riparian function, LWD, turbidity and maximum water temperature – are subdominant, with substantial impacts across all or most GA's. The Tier 3 factors include those attributes that cause a substantial impact in at least one GA, and were listed in the previous paragraph. Tier 4 factors are those that even collectively have a negligible impact or, as in the case of minimum water temperature, have actually improved since historical times.

Before leaving this issue, a major caveat is in order. At the time of this writing, technical difficulties precluded the inclusion of obstructions (dams, culverts, waterfalls, etc) in the Level 2 Diagnosis in a manner strictly comparable to the other environmental attributes (this difficulty will be overcome in the near future). Consequently, obstructions were not listed in Tables 2 or 3 for a rigorous comparison with other attributes. However, a general impression of the impact of obstructions on both steelhead and spring chinook production can be gained simply by comparing fish performance as estimated with all obstructions in place with a simulation in which all obstructions are removed (viz., in which 100% passage is assumed). As described in the section on evaluation of habitat restoration strategies, the removal of all obstructions increases the abundance of tributary steelhead, mainstem steelhead, SF Walla Walla spring chinook, Mainstem/NF Walla Walla spring chinook and Touchet spring chinook by 52%, 44% , 16%, 35% and 35%, respectively. Passage restoration increases the abundance of Mill Creek spring chinook from 0 to 25. Abundance increases of this order of magnitude resulting from the restoration of a single attribute can only be described as major. Therefore, the list of Tier 1 attributes for Walla Walla steelhead and spring chinook must include obstructions.

In summary, the EDT analysis indicates habitat work in the priority Restoration Areas should focus on the Tier 1 and Tier 2 factors: **obstructions, maximum water temperature, turbidity, large woody debris, riparian function and anthropogenic confinement**, with special emphasis on obstructions and temperature.

Changes in Habitat Quantity by Geographic Area: Role of Key Habitat Loss

While Table 1 summarizes changes in habitat quality from historical times to the present, Table 4 summarizes *quantitative* changes in habitat for the priority Restoration Areas. Specifically, Table 4 does three things:

- It shows the degree to which the productivity of successive freshwater life stages of steelhead and spring chinook have been depressed relative to historical estimates. In this prioritization scheme, the most severely depressed life stage is ranked 1.
- It estimates the loss, or gain, of life-stage-specific key habitat for all reaches inside the Walla Walla Subbasin used by the focal populations and for only those reaches within the priority Restoration Areas.
- It summarizes this information separately for tributary steelhead, mainstem steelhead and all Walla Walla spring chinook.

The most depressed life stage differs for the three focal populations, and this difference reflects a degradation of three fairly different kinds of habitat. The most depressed tributary steelhead life stage is incubation, suggesting qualitative degradation of physical loss pool tailouts and cobble/gravel riffles; the most impacted mainstem steelhead life stage is subyearling active rearing, suggesting problems with pools

Table 4 Summary of the relative depression of productivity by life stage and the relative loss of life-stage-specific key habitat[a]. Productivity decreases are relative to estimated historical conditions, with the most severely depressed life stage ranked 1. Key habitat loss is expressed in terms of percent historical key habitat area present now. Key habitat loss is estimated for all reaches used by the focal populations (Walla Walla tributary steelhead, Walla Walla mainstem steelhead and Walla Walla spring chinook) and for just those reaches comprising the priority Restoration Areas.

Life Stage Impact, All Relevant Reaches

Tributary Steelhead			Mainstem Steelhead			Spring Chinook		
Life Stage	Mean Rank	Rel Rank	Life Stage	Mean Rank	Rel Rank	Life Stage	Mean Rank	Rel Rank
Incubation	2.47	1.00	Subyearling Rearing	2.54	1.00	Adult Holding	2.50	1.00
Subyearling Rearing	3.49	1.41	Yearling Rearing	3.35	1.32	Fry	2.66	1.06
Fry	4.05	1.64	Fry	3.94	1.55	Subyearling Rearing	2.76	1.10
Yearling Rearing	4.76	1.93	Incubation	4.02	1.58	Incubation	4.13	1.65
Overwintering 0+	5.02	2.03	Overwintering 0+	4.47	1.76	Spawning	4.42	1.77
Yearling smolt	5.37	2.17	Yearling smolt	4.91	1.93	Overwintering 0+	5.73	2.29
Spawning	5.64	2.28	Overwintering 1+	6.06	2.38	Adult migrant	7.43	2.90
Overwintering 1+	6.54	2.65	Spawning	7.82	3.08	Yearling smolt	7.97	3.11
2+ smolt	8.16	3.30	2+ smolt	7.92	3.12	Yearling Rearing	8.10	3.24
Adult migrant	8.23	3.33	Adult migrant	8.71	3.43			
2+ Rearing	8.44	3.42	2+ Rearing	9.08	3.57			
Adult Holding	10.24	4.14	Overwintering 2+	11.97	4.71			
Overwintering 2+	10.72	4.34	Adult Holding	12.69	4.99			

Key Habitat Loss, All Relevant Reaches

Tributary Steelhead		Mainstem Steelhead		Spring Chinook	
Life Stage	Proportion Historical Key Habitat	Life Stage	Proportion Historical Key Habitat	Life Stage	Proportion Historical Key Habitat
Spawning	56%	Spawning	74%	Subyearling Rearing	44%
Incubation	56%	Incubation	73%	Overwintering 0+	48%
Fry	72%	Fry	54%	**Adult Holding**	**59%**
Subyearling Rearing	**86%**	**Subyearling Rearing**	**66%**	Yearling Rearing	63%
Overwintering 0+	150%	Overwintering 0+	98%	Fry	69%
Overwintering 1+	136%	Overwintering 1+	94%	Spawning	94%
Overwintering 2+	104%	Overwintering 2+	76%	Incubation	99%
Yearling Rearing	139%	Yearling Rearing	87%		
2+ Rearing	136%	2+ Rearing	95%		
Adult Holding	38%	Adult Holding	51%		

Key Habitat Loss, Inside Priority Restoration Areas Only

Tributary Steelhead		Mainstem Steelhead		Spring Chinook	
Life Stage	Proportion Historical Key Habitat	Life Stage	Proportion Historical Key Habitat	Life Stage	Proportion Historical Key Habitat
Spawning	15%	Spawning	25%	Spawning	40%
Incubation	15%	Incubation	24%	Incubation	42%
Fry	14%	Fry	19%	**Fry**	**29%**
Subyearling Rearing	**16%**	**Subyearling Rearing**	**25%**	Subyearling Rearing	23%
Overwintering 0+	15%	Overwintering 0+	29%	Overwintering 0+	25%
Overwintering 1+	14%	Overwintering 1+	28%	Yearling Rearing	24%
Overwintering 2+	8%	Overwintering 2+	14%	Adult Holding	26%
Yearling Rearing	15%	Yearling Rearing	28%		
2+ Rearing	14%	2+ Rearing	29%		
Adult Holding	7%	Adult Holding	16%		

a. Migrant life stages – smolts, adults on their spawning run – are considered to be relatively insensitive to habitat quantity or type.

and cobble/boulder riffles; and the most impacted life stage for spring chinook is adult holding, suggesting problems with pools. Interestingly, the next two most depressed life stages are either subyearling or yearling active rearing and fry. Actively rearing steelhead subyearlings or yearlings require similar kinds of habitat – structurally complex pools, glides and large substrate riffles ("pocketwater") – and spring chinook parr also prefer complex pools, glides and runs. Fry of either species require shallow, low velocity, structurally complex habitat, such as the backwater pool formed around and downstream of a root wad. A common thread to the habitat requirements of these most severely impacted life stages is pools and/or microhabitats associated with various kinds of pools.

The depression of a number of life stages most of which require pool habitat to some degree raises the question of whether the impact is primarily quantitative or qualitative. Certainly, as the second and third rows of Table 4 show, a quantitative loss of habitat area must have played a role as the data clearly indicate a loss of habitat for every life stage of every population except for overwintering tributary steelhead and active rearing for 2+ tributary steelhead. Even this exception is only partial, as it applies only to habitat accessible to tributary steelhead over the entirety of their range inside the Walla Walla Subbasin. When attention is restricted to the key habitat available within the priority Restoration Areas, the loss of key habitat for all life stages is striking. This loss applies to both species. Within the priority Restoration Areas, habitat loss ranges from 58% (spring chinook incubation) to 97% (tributary steelhead adult holding).

Even though physical loss of key habitat has clearly been extensive throughout much of the Subbasin, this fact does not mean that the diminished productivity of those life stages dependent on the lost habitat owe all or even a substantial fraction of their impairment to habitat loss. Many adult steelhead can hold in the mainstem Columbia; a great many fry can rear in small, widely distributed backwater pools, and so on.

A partial answer to this answer to this question is found in Table 3. Table 3 lists the relative impact of each environmental attribute on the productivity of steelhead within the priority Restoration Areas[2]. These attributes included all habitat types (pools, large substrate riffles, glides, etc) recognized by the EDT model. The only habitat types warranting inclusion in this table of limiting factors were backwater pools, beaver ponds and primary pools, and only the latter had an impact even 1% as great as the most significant qualitative limiting factor (Lower Touchet maximum water temperature).

It would therefore seem reasonable to conclude that habitat loss has been large, but that the majority of the lost production is attributable to a loss of quality in the remaining habitat. However, it is not true that habitat quantity is unimportant, or that increasing the quantity of habitat in relatively short supply will have no effect. Mean abundance clearly will increase if, for example, more primary pools or backwater pools are created, especially within the priority Restoration Areas. Equilibrium abundance for a population governed by Beverton-Holt dynamics (such as spring chinook or steelhead) is equal to $K(1 - 1/p)$, where K is adult carrying capacity and p is adult productivity (zero density returns/spawner). Therefore, so long as the habitat added is of high quality, and productivity remains the same or increases, the increase in equilibrium abundance will be at least directly proportional to the increase in capacity or, roughly speaking, to the quantity of habitat added. It is suggested that Table 4 be used to prioritize among habitat types, Geographic Areas and populations when opportunities to create new habitat present themselves.

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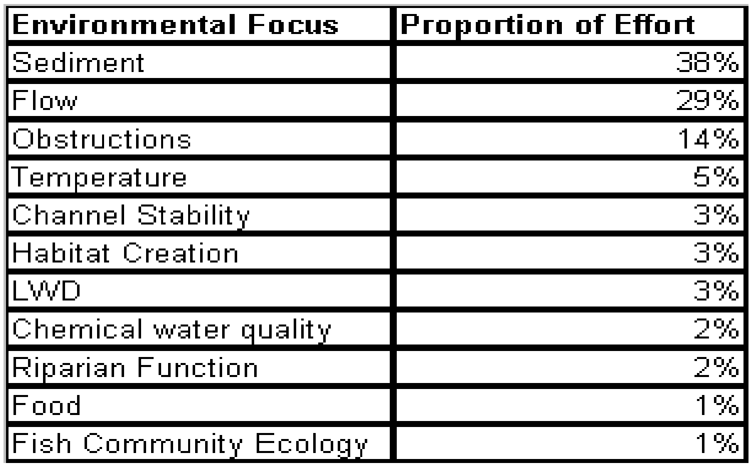
[2] To be precise, it lists the all environmental attributes with a *non-zero* impact on productivity; attributes with zero impact were omitted.

Project Inventory

During the preparation of this report, information was received on 716 projects related to fish habitat that have been implemented in the Walla Walla Subbasin since 1996. Only four of these projects, which dealt with monitoring, did not affect habitat directly. Although it is not clear that the project data received was complete for the time period, it did at least comprise a wide range of activities and probably represents a good index of the allocation of fish habitat work by reach and by environmental attribute.

The projects analyzed are quite diverse, both in kind and in scale (see Appendix XX). In very general terms, the projects can be broken down into four categories: Upland (65%), passage (14%), Instream (13%), and riparian (8%). In very approximate terms, over half of this effort was intended, intentionally or as a beneficial side effect, to reduce sediment problems and to restore a measure of normative instream flow. Table 5 summarizes the approximate allocation of effort across all categories.

Table 5 General focus of fish habitat projects in the Walla Walla Subbasin, 1996 – present.



Environmental Focus	Proportion of Effort
Sediment	38%
Flow	29%
Obstructions	14%
Temperature	5%
Channel Stability	3%
Habitat Creation	3%
LWD	3%
Chemical water quality	2%
Riparian Function	2%
Food	1%
Fish Community Ecology	1%

The actual activities these projects entail are extremely diverse and are listed in Appendix XX. At this point it is sufficient simply to describe the range of activities, which, in alphabetical order, include: conservation easements, constructed habitat (pools/wetlands/off-channel habitat), debris removal, direct seeding, erosion control (critical area planting, grassed waterways, conservation cover), exclosures/fencing, fish screen and fish ladder installation, instream structures (J-hooks, rock vanes and barbs, log weirs, etc), meander construction, reforestation/tree planting, spawning gravel addition, purchase or lease of water rights and woody debris addition.

Congruence of Effort and High Priority Geographic Areas

It is to some degree instructive to analyze the “fit” between the current diagnosis and these projects. Useful guidance for future enhancement actions can be found by examining the degree to which recent projects have targeted the key GA’s and critical attributes in within key GA’s.

It is, however, possible to make too much of such a comparison. This is so partly because of the temporal disjunction between project implementation and the current analysis. Most of the projects were conceived a decade or more ago, when the diagnostic picture was probably quite different. The projects analyzed here may well have fit the diagnosis for 1984 quite well. It is useful to examine the congruence between existing habitat needs and recent habitat restoration work to guard against becoming locked into a static picture of environmental needs in the subbasin. Such an analysis will facilitate an updating of the diagnosis and the appropriate "treatments" by highlight the work that remains to be done. Put another way, it is important to know when specific treatments have outlived their usefulness.

However useful, it must be emphasized that it is difficult to assess the true degree to which recent habitat restoration efforts have matched current habitat needs. In addition to the fact recent projects have probably changed the diagnosis (they may, for example, have reduced the severity of sedimentation considerably), it is difficult to quantify the effectiveness of a particular project and the relative effectiveness across projects. Very few habitat restoration projects have been monitored or, which amounts to the same thing, very few evaluations of habitat restoration projects have been published. Consequently, it is impossible to determine from existing data how well a particular project actually "worked", how much habitat it affected, or even the specific environmental attributes that were impacted. An illustration of the latter difficulty can be seen in the analysis of riparian projects, specifically of riparian revegetation projects. Riparian revegetation projects can potentially affect a large number of attributes. This analysis assumed such projects would have some (unspecified) beneficial impact on fine sediment, embeddedness, riparian function, maximum and minimum temperature, turbidity, woody debris, carcass retention and benthic production. The same is true of almost every other kind of project: multiple environmental attributes are at least potentially affected. Therefore the number of attributes assumed to be affected by the 716 projects analyzed is much larger then the number of projects. In this case, there are 3,059 "hits" – potentially impacted attributes inside the footprint of the project – for 716 projects.

The geographic congruence between the current diagnosis and the last nine years' projects is shown in Table 6. Table 6 shows the correspondence between habitat effort, as indexed by the proportion of total hits, and the Restoration Potential and Protection Value of all Walla Walla Tributary Steelhead, Walla Walla Mainstem Steelhead and Walla Walla Spring Chinook. This information is ordered by GA, and the rankings exclude the Columbia mainstem and estuary. It is immediately apparent that recent projects have not targeted the high priority Restoration Areas (indicated by gray shading). Indeed, less than 20% of the total effort has been directed at the high priority areas. As Figure 1 indicates, the correlation between effort and rank, either for restoration or protection, does not improve much if the geographic scope is broadened to include all GA's. This is so even though the single most intensively targeted area, the lower Touchet, ranked 2, 1 and 1 in terms of Restoration Potential for tributary steelhead, mainstem steelhead and spring chinook, respectively.

Although it is true that the "hits" metric is very imprecise and the completeness of the project data analyzed is suspect, it would appear that either recent habitat work in the Walla Walla Subbasin has been unfocussed or that the principle underlying the prioritization scheme is very different from that employed by EDT.

Table 6 Relationship between Restoration and Protection Rank for Walla Walla Steelhead and Spring Chinook and fish habitat restoration effort by Geographic Area. Gray-shaded rows are designated high priority Restoration Areas.

	Tributary Steelhead Rank		Mainstem Steelhead Rank		Spring Chinook Rank		Effort Allocation (% Hits)
Geographic Area	Protection	Restoration	Protection	Restoration	Protection	Restoration	
Lower Walla Walla (mouth to Touchet)	31	1	13	6	16	6	1.99%
Lower Touchet (mouth to Coppei)	21	2	6	1	13	1	38.33%
Pine Cr mainstem (plus Swartz)	14	3	14	11			0.56%
NF Touchet Mainstem	4	4			11	11	0.00%
Mill Cr, Gose Street to Bennington Dam	36	5	9	2	19	4	1.13%
Touchet, Coppei to forks (plus Whiskey)	11	6	2	4	9	3	4.31%
Walla Walla, Touchet to Dry (plus Mud Cr)	35	7	12	9	15	5	4.05%
Coppei Drainage	12	7	14	15			9.90%
NF Walla Walla, mouth to L. Meadows Canyon Cr (plus L. Meadows)	8	8			12	10	0.56%
Pattit Drainage	13	9	14	15			0.00%
SF Walla Walla, mouth to Elbow Creek	2	10			4	2	1.54%
Wolf Fork, mouth to Coates (plus Robinson & Coates)	9	11			10	11	0.00%
SF Touchet Mainstem	5	12			2	8	0.00%
Walla Walla, Dry to Mill	15	13	7	6	6	9	1.09%
Lower Dry Cr (mouth to Sapolil)	34	13	14	15			14.18%
SF Touchet Tribs	10	14					0.00%
Dry Cr [Pine] Drainage	29	15					0.00%
Walla Walla, Mill to E L. Walla Walla (plus MacAvoy & Springbranch)	17	16	4	3	8	7	1.24%
E Little Walla Walla Drainage (plus Unnamed Spring & Big Spring Br)	19	16	14	15			0.00%
Yellowhawk Tribs (Lassater, Russell, Reser & Caldwell)	18	17					1.01%
Garrison Cr Drainage (plus Bryant)	33	18	14	15			1.20%
Wolf Fork, Coates to access limit (plus Whitney)	5	19			5	14	0.00%
W Little Walla Walla Drainage (plus Walsh)	24	20					0.34%
Cottonwood Cr Drainage (including NF, SF & MF)	16	21					0.98%
Upper Dry Cr (Sapolil to forks)	20	21					1.31%
Walla Walla, E Little Walla Walla to Tumalum Bridge	11	22	1	8	3	13	0.45%
Walla Walla, Tumalum Bridge to Nursery Bridge	16	23	5	8	13	12	0.26%
Walla Walla, Little Walla Walla Diversion to forks	8	23			9	12	0.98%
NF Touchet Tribs (excluding Wolf Fork)	6	23					0.00%
Dry Cr Tribs (Mud[Dixie], Mud[Dry], NF Dry & SF Dry)	25	23					4.50%
Walla Walla, Nursery Br to Little Walla Walla Diversion	22	24	3	7	14	15	0.08%
Birch Creek Drainage	28	25	14	15			0.00%
Couse Creek Drainage	23	26					1.61%
Stone Cr Drainage	26	27	14	15			0.23%
NF Walla Walla, L. Meadows to access limit (plus Big Meadows)	8	27			7	15	0.00%
Lower Mill Cr Tribs (Doan & Cold)	27	28	11	14			0.00%
Yellowhawk mainstem (mouth to source)	17	29	14	15			0.83%
Mill Cr, mouth to start of Corps Project at Gose St	36	30	8	5	14	10	2.89%
Lower SF Walla Walla Tribs (Flume Canyon, Elbow)	8	31					0.00%
Mill Cr, Bennington Dam to Blue Cr (plusTitus)	33	32	11	12	18	16	0.00%
Blue Cr Drainage (including L. Blue)	34	32	13	13			1.13%
Mill Cr, Blue Cr to Walla Walla water intake	32	33	10	10	17	17	2.96%
Middle Mill Cr Tribs (Henry Canyon, Webb &Tiger)	32	34	14	15			0.00%
Upper SF Walla Walla tribs (excluding Skiphorton & Reser)	3	34					0.00%
Mill Cr, Walla Walla water intake to access limit	30	35	12	15	18	18	0.38%
Upper Mill Tribs (NF, Low, Broken, Paradise)	30	35	14	15			0.00%
Skiphorton & Reser Creek Drainages	7	36					0.00%
SF Walla Walla, Elbow to access limit	1	37			1	19	0.00%
							100.00%

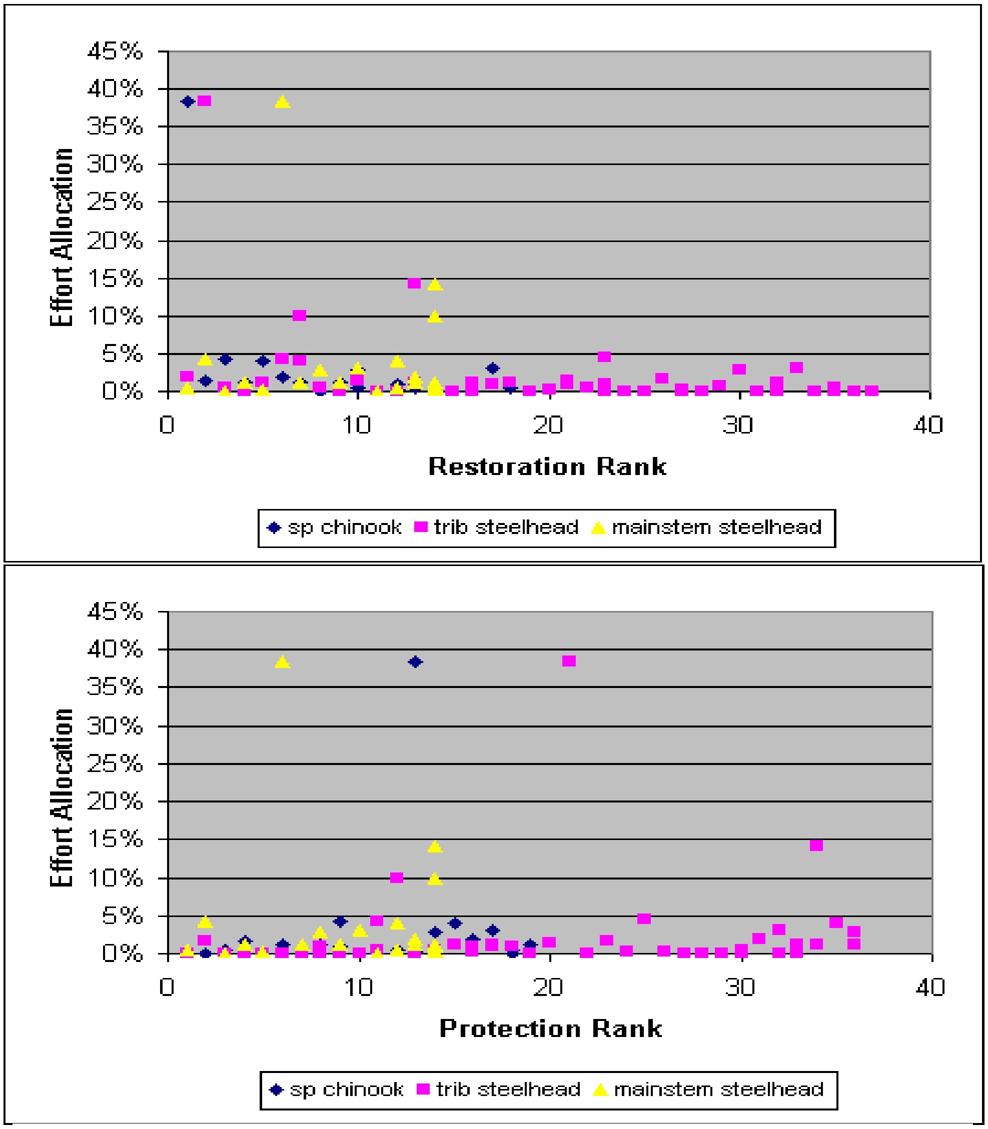


Fig 1 Relationship between restoration and protection rank and habitat effort, Walla Walla Subbasin, for tributary steelhead, mainstem steelhead and spring chinook.

Congruence between Effort and Limiting Environmental Attributes

Just as it was useful to examine the correspondence between high priority places and effort, so it is useful to examine the correspondence between high priority attributes and effort.

This attribute/effort comparison is made in Table 7, which covers the high priority Restoration Areas and is similar to Table 2 but more inclusive in terms of attributes. Like the place/effort analysis, there are clear indications of misplaced effort. Only 35.5% of total effort targeted Tier 1 and 2 attributes – 25.5% for the non-passage attributes listed in Table 7 and additional 14% for passage work (see previous section). Moreover, effort allocation seems to be disproportionately high for some attributes (e.g., fine sediment and turbidity) and disproportionately low for others (e.g., temperature, anthropogenic confinement).

Table 7 Congruence between effort directed at specific environmental attributes and the relative importance of attributes as limiting factors in

Environmental Attribute	Normalized Relative Impact on Productivity	Percent Restoration Effort (% Hits)
Maximum Water Temperature	**1**	**2.59%**
Turbidity	0.4756	13.58%
Large Woody Debris	0.3975	3.04%
Riparian Function	0.3421	2.33%
Anthropogenic Confinement	**0.2820**	**0.00%**
Low Flow	0.0649	11.03%
Hatchery Outplants	0.0575	0.00%
Harassment/Poaching	0.0415	0.00%
High Flow	0.0335	10.88%
Bed Scour	0.0307	3.71%
Exotic Fish Species	0.0290	0.00%
Dissolved Oxygen	0.0282	2.59%
Fish Pathogens	0.0266	0.00%
Fine Sediment	**0.0192**	**15.38%**
Nutrient Enrichment	0.0186	0.00%
Flashy Flow	0.0177	10.88%
Gradient	0.0142	0.00%
Salmon Carcasses	0.0136	0.75%
Pools	0.0113	2.33%
Benthic Production	0.0105	0.75%
Embeddedness	**0.0030**	**14.93%**
Icing	0.0019	0.00%
Beaver Ponds	0.0017	0.00%
Backwater Pools	0.0009	1.01%

95.76%

As shown in Figure 2, there appears to be almost an inverse correlation between the impact of an attribute and the effort it receives.

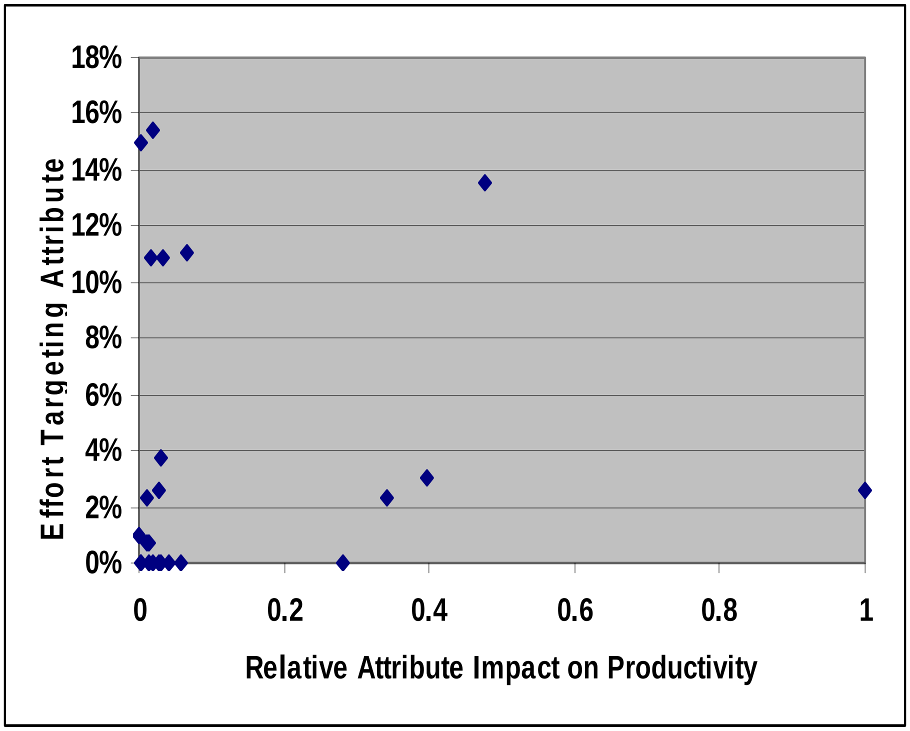


Fig 2. Relationship between relative impact on steelhead productivity in priority Restoration Areas by environmental attribute and the proportion of total restoration effort targeting the attribute. Walla Walla Subbasin EDT analysis, March, 2004.

It is possible that the lack of congruence between recent restoration effort and key Restoration Areas and attributes is an example of an “outmoded diagnosis”. To be more specific, it is possible that the impact of certain attributes (e.g., fine sediment) in certain areas was in fact much more severe in the recent past, and that it was then entirely appropriate to allocate much of the restoration effort to such attributes and areas. Under this theory, a failure to monitor the success of restoration projects caused managers to fail to recognize that they had been successful, and that the top environmental priorities had changed as a result.

Congruence between Effort, Environmental Attributes and Priority Geographic Areas

The final assessment of the fit between effort allocation and site-specific habitat needs is simultaneously to look at Geographic Areas, their relative environmental problems, and effort allocation. This is what is done in Table 8, which summarizes virtually all of the information discussed in this section. It is suggested that Table 8 be referred to whenever an issue involving site-specific limiting factors and/or a more strategic allocation of restoration effort between areas and attributes arises.

Table 8 Relationship between effort allocation and productivity change by environmental attribute, Walla Walla summer steelhead. Productivity change is site-specific and represents the decrease in productivity when between Historical and Current conditions for s specific attribute in a specific Geographic Area. Darker cells indicate are/attributes with greater productivity loss. Numbers in cells represent proportion of all effort in WallaWalla Subbasin allocated to area and attribute. Column totals are total percent effort by Attribute; row totals are tot al percent effort by Geographic Area.

Geographic Area	Bed Scour	Benthic Richness	Anthropogenic Confinement	Dissolved Oxygen	Embeddedness	High Flow Impacts	Flashy Flow Impacts	Low Flow Impacts	Fine Sediment	Fish Pathogens	Exotic Fish Introductions	Gradient	Harassment	Hatchery Fish Outplants	Backwater Pools	Beaver Ponds	Primary Pools	Icing	Heavy Metals - Sediments	Heavy Metals - Water Column	Misc Toxic Substances	Nutrient Enrichment	Obstructions	Predation Risk	Riparian Function	Salmon Carcasses	Minimum Temperature	Maximum Temperature	Cool Groundwater	Turbidity	Woody Debris	TOTAL EFFORT BY AREA
Lower Walla Walla (mouth to Touchet)	0.08%				0.34%	0.26%	0.26%	0.30%	0.34%																0.08%					0.34%		2.0%
Lower Touchet (mouth to Coppei)	0.64%	0.11%		0.38%	6.19%	5.55%	5.55%	5.55%	6.19%						0.11%		0.23%							0.11%	0.41%	0.11%	0.38%	0.38%		5.96%	0.49%	38.3%
Coppei Drainage	0.90%	0.11%		0.60%	1.31%	0.49%	0.49%	0.49%	1.35%						0.19%		0.60%				0.04%			0.11%	0.41%	0.11%	0.60%	0.60%		0.90%	0.60%	9.9%
Touchet, Coppei to forks (plus Whiskey)	0.23%	0.11%		0.11%	0.60%	0.38%		0.41%	0.60%						0.11%		0.11%							0.11%	0.11%	0.11%	0.11%	0.11%		0.49%	0.23%	4.3%
Pattit Drainage																																
SF Touchet Mainstem																																
SF Touchet Tribs																																
NF Touchet Mainstem																																
NF Touchet Tribs (excluding Wolf Fork)																																
Wolf Fork, mouth to Coates (plus Robinson & Coates)																																
Wolf Fork, Coates to access limit (plus Whitney)																																
Walla Walla, Touchet to Dry (plus Mud Cr)					0.68%	0.68%	0.68%	0.68%	0.68%																					0.68%		4.1%
Pine Cr mainstem (plus Swartz)	0.04%			0.04%	0.08%	0.04%	0.04%	0.04%	0.08%																0.04%		0.04%	0.04%		0.08%	0.04%	0.6%
Dry Cr [Pine] Drainage																																
Lower Dry Cr (mouth to Sapolil)	0.34%			0.23%	2.29%	1.95%	1.95%	1.95%	2.29%								0.11%								0.23%		0.23%	0.23%		2.18%	0.23%	14.2%
Upper Dry Cr (Sapolil to forks)	0.04%	0.04%		0.04%	0.19%	0.11%	0.11%	0.11%	0.19%						0.04%		0.04%							0.04%	0.04%	0.04%	0.04%	0.04%		0.15%	0.08%	1.3%
Dry Cr Tribs (Mud[Dixie], Mud[Dry], NF Dry & SF Dry)	0.08%			0.08%	0.71%	0.64%	0.64%	0.64%	0.71%																0.08%		0.08%	0.08%		0.71%	0.08%	4.5%
Walla Walla, Dry to Mill	0.19%	0.04%		0.04%	0.19%			0.04%	0.19%						0.04%		0.08%							0.04%	0.04%	0.04%	0.04%	0.04%		0.04%	0.08%	1.1%
W Little Walla Walla Drainage (plus Walsh)	0.04%			0.04%	0.04%				0.04%																0.04%		0.04%	0.04%		0.04%	0.04%	0.3%
Mill Cr, mouth to start of Corps Project at Gose St	0.34%	0.04%		0.19%	0.38%	0.04%	0.04%	0.08%	0.38%						0.11%		0.15%							0.04%	0.19%	0.04%	0.19%	0.19%		0.23%	0.30%	2.9%
Lower Mill Cr Tribs (Doan & Cold)																																
Mill Cr, Gose Street to Bennington Dam	0.04%			0.11%	0.11%	0.04%	0.04%	0.04%	0.11%						0.08%		0.15%				0.04%				0.04%		0.11%	0.11%		0.08%	0.04%	1.1%
Mill Cr, Bennington Dam to Blue Cr (plusTitus)																																

Table 8 (cont.) Relationship between effort allocation and productivity change by environmental attribute, Walla Walla summer steelhead. Productivity change is site-specific and represents the decrease in productivity when between Historical and Current conditions for s specific attribute in a specific Geographic Area. Darker cells indicate are/attributes with greater productivity loss. Numbers in cells represent proportion of all effort in WallaWalla Subbasin allocated to area and attribute. Column totals are total percent effort by Attribute; row totals are tot al percent effort by Geographic Area.

Geographic Area	Bed Scour	Benthic Richness	Anthropogenic Confinement	Dissolved Oxygen	Embeddedness	High Flow Impacts	Flashy Flow Impacts	Low Flow Impacts	Fine Sediment	Fish Pathogens	Exotic Fish Introductions	Gradient	Harassment	Hatchery Fish Outplants	Backwater Pools	Beaver Ponds	Primary Pools	Icing	Heavy Metals - Sediments	Heavy Metals - Water Column	Misc Toxic Substances	Nutrient Enrichment	Obstructions	Predation Risk	Riparian Function	Salmon Carcasses	Minimum Temperature	Maximum Temperature	Cool Groundwater	Turbidity	Woody Debris	TOTAL EFFORT BY AREA
Mill Cr, Blue Cr to Walla Walla water intake	0.23%	0.08%		0.11%	0.34%	0.23%	0.23%	0.23%	0.38%						0.08%		0.19%						0.08%	0.08%	0.08%	0.08%	0.11%	0.11%		0.23%	0.15%	3.0%
Middle Mill Cr Tribs (Henry Canyon, Webb &Tiger)																																
Blue Cr Drainage (including L. Blue)					0.19%	0.19%	0.19%	0.19%	0.19%																					0.19%		1.1%
Mill Cr, Walla Walla water intake to access limit					0.04%	0.04%	0.04%	0.04%	0.11%																					0.11%		0.4%
Upper Mill Tribs (NF, Low, Broken, Paradise)																																
Garrison Cr Drainage (plus Bryant)	0.11%	0.04%		0.08%	0.15%				0.15%						0.04%		0.15%							0.04%	0.08%	0.04%	0.08%	0.08%		0.08%	0.11%	1.2%
Yellowhawk mainstem (mouth to source)	0.11%	0.08%			0.11%				0.11%						0.08%		0.11%							0.08%		0.08%					0.08%	0.8%
Yellowhawk Tribs (Lassater, Russell, Reser & Caldwell)					0.19%	0.15%	0.15%	0.15%	0.19%																					0.19%		1.0%
Cottonwood Cr Drainage (including NF, SF & MF)	0.15%	0.04%		0.04%	0.15%				0.15%						0.04%		0.11%							0.04%	0.04%	0.04%	0.04%	0.04%		0.04%	0.08%	1.0%
Walla Walla, Mill to E L. Walla Walla (plus MacAvoy & Springbranch)	0.15%	0.08%		0.04%	0.19%				0.19%						0.11%		0.11%							0.08%		0.08%	0.04%	0.04%		0.04%	0.11%	1.2%
Stone Cr Drainage					0.04%	0.04%	0.04%	0.04%	0.04%																					0.04%		0.2%
E Little Walla Walla Drainage (plus Unnamed Spring & Big Spring Br)																																
Walla Walla, E Little Walla Walla to Tumalum Bridge					0.08%	0.08%	0.08%	0.08%	0.08%																					0.08%		0.5%
Birch Creek Drainage																																
Walla Walla, Tumalum Bridge to Nursery Bridge				0.04%													0.04%						0.04%		0.04%		0.04%	0.04%		0.04%		0.3%
Walla Walla, Nursery Br to Little Walla Walla Diversion																							0.08%									0.1%
Walla Walla, Little Walla Walla Diversion to forks				0.08%	0.11%				0.11%														0.26%		0.08%		0.08%	0.08%		0.11%	0.08%	1.0%
Couse Creek Drainage	0.04%			0.19%	0.11%				0.19%								0.08%						0.04%		0.23%		0.19%	0.19%		0.23%	0.15%	1.6%
SF Walla Walla, mouth to Elbow Creek				0.15%	0.15%				0.26%								0.04%						0.15%		0.11%		0.15%	0.15%		0.26%	0.11%	1.5%
Lower SF Walla Walla Tribs (Flume Canyon, Elbow)																																
SF Walla Walla, Elbow to access limit																																
Skiphorton & Reser Creek Drainages																																
Upper SF Walla Walla tribs (excluding Skiphorton & Reser)																																
NF Walla Walla, mouth to L. Meadows Canyon Cr (plus L. Meadows)				0.04%					0.11%								0.04%						0.19%				0.04%	0.04%		0.11%		0.6%
NF Walla Walla, L. Meadows to access limit (plus Big Meadows)																																
TOTAL EFFORT BY ATTRIBUTE	3.7%	0.8%		2.6%	14.9%	10.9%	10.9%	11.0%	15.4%						1.0%		2.3%				0.1%		0.8%	0.8%	2.3%	0.8%	2.6%	2.6%		13.6%	3.0%	100.0%