EVALUATION OF TUCANNON HABITAT RESTORATION OBJECTIVES
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"Active" restoration strategies were proposed for the geographic areas (GA's) with the largest practicable restoration potential for steelhead, spring chinook, fall chinook and bull trout, and "passive" measures were proposed for the GA's judged to have the greatest *protection* value for these species. In practice, this procedure resulted in passive measures being applied only to those top protection GA's that were not also ranked among the top restoration areas. As previously described, there were five GA's that were judged to be critical to restoring production for all focal species, all of which are located in the mainstem Tucannon River: Pataha Creek to Marengo, Marengo to Tumalum Creek, Tumalum Creek to the Hatchery, Hatchery to Little Tucannon and the Mountain Tucannon (Little Tucannon River to Sheep Creek). Although these areas were also top priorities for protection, they were targeted for active restoration on the basis of their restoration status. Only four GA's evaluated as critical to protecting current production were not also top restoration areas: Panjab Creek, Cummings Creek, Lower Tucannon, and the Headwaters. These four areas were the only areas targeted for passive restoration, and only Panjab, Cummings and Lower Tucannon were evaluated with the EDT model (the Headwaters GA represents bull trout habitat located upstream of the uppermost steelhead reaches covered by EDT).

Active restoration actions were intended to lessen the negative impact of the following environmental attributes, all of which were previously identified (Section xx) as significant limiting factors for the top five restoration areas: fine sediment, embeddedness, turbidity, woody debris, pools and pool tailouts, anthropogenic confinement, riparian function, temperature and bed scour. The Tucannon Subbasin Work Group attempted to identify the ultimate causes of these environmental problems, as well as specific restoration actions that would reduce their impact. They also estimated the maximum degree to which this group of limiting factors might be restored to normative conditions over a 15-year period given the likely measures at hand and the economic, social and ecological constraints of the Subbasin.

Table AA summarizes their findings and lists "strategic habitat objectives" by reach and environmental attribute. It should be clearly borne in mind that objectives are expressed in terms of the *percent restoration of normative (Historical) conditions*. Thus, a restoration objective of "75% restoration" for an environmental attribute rated "0" historically and "4" under current conditions implies a post-implementation value of "1". An important implication of using the "percent restoration of Historical conditions" metric to express habitat objectives is that two reaches can be identical in terms of % restoration yet differ considerably in terms of absolute improvement from current conditions. For example, the LWD habitat objective for both the Tucannon mainstem from Cummings Cr to the Hatchery (Tuc12) and the Tucannon from the Little Tucannon River to Panjab Cr (Tuc16) is 20% restoration. However, primarily because LWD loading was much higher Historically in Tuc 12 than Tuc 16 (30 pieces per channel width vs. 4 pieces per channel width, respectively), the absolute increase in wood loading needed for 20% restoration in Tuc 16 is much larger than in Tuc 16 – 1 piece per channel width vs. ~0.3 piece/channel width, respectively[1].

Strategic habitat objectives were evaluated for their impact on steelhead and chinook salmon production by running an EDT simulation in which they were substituted for Current values. The results presented below thus estimate the benefits to Tucannon fish populations that would be expected if the all of the specific reach-by-attribute objectives summarized in Table AA were achieved.

The "passive restoration" actions proposed for protection areas were intended permit natural regeneration of riparian corridors and upland areas, as well as protect them, and included such activities as CRP, CREP, direct seeding, riparian plantings, riparian easements, fenced exclosures and so on. Somewhat arbitrarily, full restoration of passage at all obstructions was included with the passive restoration group. This passage objective applied to all reaches in the Subbasin, regardless of their restoration or protection priority. The targeted environmental attributes and the assumed impact of these passive measures on them are

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[1] The difference between Historical estimates is not the entire explanation here, as Current ratings also differ and also enter the expression for percent restoration.

summarized in Table BB. The EDT model was also used to estimate the benefits to Tucannon steelhead and chinook salmon of successfully implementing the actions described in Table BB, as well as the combined impact of all active and of all passive restoration actions.

Table AA. Active habitat restoration objectives for the Tucannon Subbasin. Cells represent percent restoration of normative (Historical) conditions for specific reach-by-attribute combinations.

GEOGRAPHIC AREA	REACH[a]	Fines	Embed	Turbidity	Passage[d]	Pools	Pool Tailouts	Carcass Loading	Benthic Production	Backwater Pools	LWD	Riparian Function	Temp Maximum	Bed Scour	Confine Hydro
Mouth Tucannon[c]	Tuc1[c]	11%	11%	11%	---	---	---	---	---	---	---	---	3%	---	---
Lower Tucannon[c]	Tuc2[c]	11%	11%	11%	---	---	---	---	---	---	---	---	22%	---	---
	Tuc3[c]	11%	11%	11%	---	---	---	---	---	---	---	---	41%	---	---
	Tuc5[c]	11%	11%	11%	---	---	---	---	---	---	---	---	47%	---	---
	Tuc6[c]	11%	11%	11%	---	---	---	---	---	---	---	---	74%	---	---
Tucannon River, Pataha Creek to Marengo	Tuc7	56%	56%	56%	---	41%	41%	8%[b]	20%[b]	20%[b]	40%	50%	100%	100%	9%
	Tuc8A	56%	56%	56%	---	38%	38%	8%b	20%[b]	20%[b]	40%	25%	100%	100%	9%
	Tuc9	56%	56%	56%	---	38%	38%	10%[b]	25%[b]	25%[b]	50%	25%	100%	100%	9%
	Tuc9A	56%	56%	56%	---	38%	38%	---	---	---	---	25%	100%	100%	9%
Tucannon River, Marengo to Tumalum Creek	Tuc10	---	---	---	---	38%	38%	---	---	---	---	---	63%	100%	9%
Tucannon River, Tumalum Creek to Hatchery	Tuc11	---	---	---	---	25%	25%	5%[b]	12.5%[b]	12.5%[b]	25%	17%	40%	---	---
	Tuc12	---	---	---	---	40%	40%	4%[b]	10%[b]	10%[b]	20%	40%	40%	---	---
Tucannon River, Hatchery to Little Tucannon River	Tuc14	---	---	---	---	20%	20%	5%[b]	12.5%[b]	12.5%[b]	25%	20%	---	---	20%
	Tuc14B	---	---	---	---	26%	26%	10%[b]	25%[b]	25%[b]	50%	20%	---	---	20%
	Tuc15	---	---	---	---	26%	26%	10%[b]	25%[b]	25%[b]	50%	25%	---	---	20%
Mountain Tucannon	Tuc16	---	---	---	---	44%	44%	8%[b]	10%[b]	10%[b]	20%	40%	---	---	20%
	Tuc17	---	---	---	---	20%	20%	8%[b]	10%[b]	10%[b]	20%	20%	---	---	---
	Tuc18	---	---	---	---	20%	20%	8%[b]	10%[b]	10%[b]	20%	20%	---	---	---

a. See Table XX for detailed reach description.

b. LWD addition assumed to increase carcass retention, benthic production and area of backwater pools.

c. The reaches Tuc2 - Tuc6 were targeted only by passaive restoration actions, and Tuc1 was not directly targeted by any kind of action. Nevertheless, the beneficial effects of upstream sediment loading and temperature reduction programs were assumed to propagate downstream into these reaches.

d. Although only three obstructions are listed in this table, all obstructions in the Subbasin are addressed, and the target for all is 100% passage..

Table BB. Passive restoration objectives the Tucannon Subbasin. Cells represent percent restoration of normative (Historical) conditions for specific reach-by-attribute combinations.

GEOGRAPHIC AREA	REACH[a]	Passage	Fines	Embed	Turbidity	Riparian Function	Temp Maximum	Pools	Pool Tailouts	Backwater Pools	Benthic Production	Predation Risk	Carcasses	LWD	High Flow	Low Flow	Flashy Flow
Lower Tucannon	Tuc2	---	15%	15%	15%	15%	15%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	Tuc3	---	15%	15%	15%	15%	15%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	Tuc4 (Starbuck Dam)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Tuc5	---	15%	15%	15%	15%	15%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	Tuc6	---	15%	15%	15%	15%	15%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Lower Pataha	Delaney culvert (RM 1.26)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Dodge Bridge obstruction (RM 10.83)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	20th St sewer line (obstruction) (RM 25.75)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bihmaier	Bihmaier dam (RM 1.08)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Upper Pataha	Davis shelf (Obstruction) (RM 35.22)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dry Pataha	Dry Pataha Dam (RM 0.36)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mountain Pataha	Steven's Ridge Culvert (Obstruction)(RM 43.81)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tucannon, Pataha - Marengo	Tucannon Falls (RM 16.02)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tucannon, Tumalum - Hatchery	Hatchery Dam (RM 38.41)	100%	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cummings	Cummings	---	15%	15%	15%	15%	15%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Panjab	Pan1	---	15%	15%	15%	15%	15%	5%	0.05	5%	5%	5%	5%	5%	5%	5%	5%
	Pan2	---	15%	15%	15%	15%	15%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	Meadow	---	15%	15%	15%	15%	15%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

a. See Table XX for detailed description of reach location.

Tables CC - EE show the results of EDT simulations for summer steelhead, spring chinook and fall chinook assuming achievement of the strategic habitat objectives summarized in Tables AA and BB.

Table CC. Performance of Tucannon River summer steelhead as estimated by EDT simulation under Current, Historical and PFC conditions, and after passive, active, and combined passive/active restoration as defined in Tables AA and BB.

Scenario	Mean Adult Abundance	Adult Productivity	Adult Carrying Capacity	Life History Diversity	Mean Smolt Production	Productivity (smolts/spawner)	Smolt Carrying Capacity
Current	634	1.84	1,392	26%	62,123	167	150,049
Historical	26,680	26.72	27,718	100%	277,663	274	288,638
PFC	1,316	2.48	2,207	83%	124,825	216	222,355
Passive Restoration	681	1.85	1,482	27%	65,152	167	152,325
Active Restoration	767	2.04	1,503	36%	75,212	184	160,718
Passive + Active Restoration	815	2.06	1,586	37%	78,132	185	162,456

Table DD. Performance of Tucannon River spring chinook as estimated by EDT simulation under Current, Historical and PFC conditions, and after passive, active, and combined passive/active restoration as defined in Tables AA and BB

Scenario	Mean Adult Abundance	Adult Productivity	Adult Carrying Capacity	Life History Diversity	Mean Smolt Production	Smolt Productivity (smolts/spawner)	Smolt Carrying Capacity
Current	235	1.49	712	69.0%	39,190	232	140,069
Historical	12,215	26.86	12,688	100.0%	362,376	463	387,161
PFC	1,769	3.75	2,412	95.0%	208,300	342	317,529
Passive Restoration	260	1.54	743	72.0%	43,980	241	146,832
Active Restoration	532	2.24	962	90.0%	75,828	282	153,197
Passive + Active Restoration	564	2.30	999	91.0%	81,247	292	160,188

Table EE. Performance of Tucannon River fall chinook as estimated by EDT simulation under Current, Historical and PFC conditions, and after passive, active, and combined passive/active restoration as defined in Tables AA and BB

Scenario	Mean Adult Abundance	Adult Productivity	Adult Carrying Capacity	Life History Diversity	Mean Smolt Production	Smolt Productivity (smolts/spawner)	Smolt Carrying Capacity
Current	83	1.18	543	17.0%	15,523	190	748,522
Historical	8,167	23.41	8,531	100.0%	840,283	776	968,785
PFC	844	4.16	1,111	57.0%	298,376	513	961,305
Passive Restoration	151	1.36	568	22.0%	30,334	210	757,813
Active Restoration	138	1.32	567	21.0%	28,745	217	771,561
Passive + Active Restoration	197	1.50	591	25.0%	44,184	238	780,295

Out-of-Subbasin harvest rates of 0, 7 and 38% are assumed for steelhead, spring chinook and fall chinook, respectively. Genetic fitness rates (relative to a hypothetical endemic stock) of 90%, 90% and 85% are also assumed for, respectively, steelhead, spring chinook and fall chinook under Current conditions.

The impacts of the strategic habitat objectives summarized in Tables CC – EE are consistent with the geographic areas targeted and the life histories of the focal species. The majority of Tucannon fall chinook spend the entirety of their freshwater life cycle in the lower Tucannon, and benefit only from passive restoration and a progressively diminishing impact of upstream temperature and sediment reduction actions. The most important elements of the fall chinook simulation are that adult productivity and life history diversity remain very low – 1.5 adult returns/spawner and 25%, respectively – even under the maximum restoration scenario. Such an unproductive and geographically inflexible population is not likely to be self-sustaining. The mean number of fall chinook spawning in the lower Tucannon would probably increase under the combined active/passive strategy, but only so long as the population was sustained by an infusion of strays from the core population in the Snake River.

Because steelhead are much more likely to spawn and rear in small tributaries than either race of chinook salmon, and because all restoration actions targeted only the Tucannon mainstem, mainstem-spawning steelhead benefit from the proposed restoration actions much more than tributary spawners. An exclusive focus on mainstem steelhead is entirely appropriate in light of existing production areas and the obstacles to meaningful habitat restoration in most of the tributaries. Even so, a consequence of this emphasis on the practicable is the fact that only 37% of the Historical life history patterns are viable under combined active/passive mainstem restoration. This fact emphasizes the importance of smaller tributaries to steelhead production in the Tucannon, and suggests a steelhead-specific program, should one ever be proposed, should probably have a somewhat broader focus.

Too much weight should not be given to the preceding caveat on steelhead benefits. Mean steelhead abundance is predicted to increase 30%, from 634 to 815 adults, while productivity and life history diversity increase 12 and 42%, respectively. The absolute increase in adult productivity from 1.8 to 2.1 is perhaps more important than the proportional increase, because a productivity less than 2.0 is all too frequently associated with populations in serious decline. The same kind of thing can be said of the increase in life history diversity from 26 to 37%: each percent of improvement in productivity and life history diversity is vital to a seriously depressed population.

Spring chinook is clearly the major beneficiary of the current strategy. Such a result was expected as both current and historical production areas coincide perfectly with the footprint of the strategic habitat objectives. Equilibrium abundance increases by a factor of 2.4, from 235 to 564 adults. The estimated improvements in spring chinook productivity, however, might result in a qualitative status change for the population. If natural productivity under the combined active/passive strategy does in fact increase from a value like 1.5 to one on the order of 2.3, it would not be implausible to suggest that Tucannon spring chinook would become at least marginally self-sustaining. The estimated increase in life history diversity from 69% to 91% buttresses such a contention considerably. A concrete illustration of the likely significance of the benefits forecast for Tucannon spring chinook is that spring chinook productivity under active/passive restoration is 25% greater than steelhead productivity under current conditions, and 11% greater than steelhead productivity even under active/passive restoration.