FRESHWATER HABITAT REARING PREFERENCES FOR JUVENILE CHINOOK, *ONCORHYNCHUS MYKISS*, AND BULL TROUT IN THE SKAGIT RIVER BASIN

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Synopsis of Proposal

This proposal is a joint application from the Upper Skagit Indian Tribe and Skagit River System Cooperative to the Skagit Non-Flow and Flow Coordinating Committee (NCC/FCC) to support research to examine juvenile and sub-adult freshwater habitat preferences for three Endangered Species Act (ESA) listed (or potentially listed) species: Chinook, Bull Trout, and *O. mykiss*.

This proposal focuses on identifying the seasonal rearing preferences of stream type Chinook, Bull Trout, and *O. mykiss* in freshwater habitat. The proposal will couple empirically derived preferences (obtained by snorkeling) with a GIS data layer of Skagit River basin habitats.

The proposal is phased. The first phase, in year 2007:

- assembles a habitat database of the Skagit River basin in GIS;
- refines field methods for fish observation;
- collects pilot level fish observation data to be used in power analysis; and
- conducts power analysis on several full implementation study designs.

Implementation of phase one will incorporate an oversight committee[1], an assemblage of relevant fishery researchers and interested NCC/FCC member, with the goal of providing technical and collaborative support throughout study implementation. General verbal progress reports will be provided to the FCC/NCC during regular meeting throughout the study. The second phase (spring of 2008 through spring of 2009) is a fully implemented field study. The selected study will be approved by the NCC/FCC based on their opinion regarding a balance between study cost and statistical power to detect differences in fish preferences by habitat type.

The cost of Phase I is $102,828. The cost of Phase II is unknown at this time but anticipated to be in the neighborhood of $100,000 to $250,000 depending on the statistical capability desired by the NCC/FCC.

Why is this study needed?

This study is needed to better understand the causes of decline in ESA listed (or potentially listed) species. For each of the three species, this study will answer the following questions:

[1] Per discussion at the March 2007 NCC/FCC meeting, the PI's will invite interested NCC/FCC members (Reed Glesne, Stan Walsh, Dave Pflug) and fisheries researchers (Ed Conner, Correigh Greene, George Pess, Roger Peters, Mark Downen, David Beauchamp) for participation on the oversight committee.

1. What habitat types are used by fish seasonally?
2. Where are fish located within the basin seasonally?
3. Where are habitats (by type) within the basin?

Habitat occupation by fish varies by season, due to environmental and ecological factors. Carrying capacity and survival of fish can vary by habitat type and season so it is important to know fish-habitat associations (preferences) by season. By linking our understanding of the fish (the answers to questions 1 and 2) to the location of habitat types (the answer to question 3), we gain a spatial and temporal understanding of the freshwater rearing period of each of the three species in the Skagit River basin.

Fishery managers are at different stages of recovery planning based on their scientific understandings of both the biological and ecological requirements of the three species. This research will help efforts underway for all three species. The study design will be effective at identifying seasonal habitat preferences for the three species (Chinook, Bull Trout, and *O. mykiss*) as well as all other fish species that are observed in the field work.

All three species need this data gap filled in order to provide a bigger picture understanding for other smaller scale (spatially) or differently scaled (ecological or environmental) studies.

Chinook Salmon: The NCC/FCC committee has been supportive in funding research to gain the current understanding of the different life history strategies displayed by Chinook populations in the Skagit River basin. These past efforts have been instrumental in developing the life history model used to develop the Chinook Recovery Plan. While the Skagit Chinook Recovery Plan does a good job at identifying the causes of decline for ocean type Chinook salmon, the Plan does a poor job in analyzing the status of stream type Chinook. Therefore, the Plan specifically lists research to identify habitat preferences for yearling Chinook as a high priority.

All six stocks of Chinook in the Skagit River basin exhibit the stream type life history. Stream type Chinook are yearling at smolt stage, spending over one year in the freshwater environment. The habitat preferences, production estimates, and identification of limiting factors for stream type Chinook have not been analyzed in detail to date. To answer these questions we must first gather data on the habitat preferences of stream type Chinook. There are no documented studies to draw from in the Puget Sound region that could explain habitat preferences of yearling Chinook.

The Puget Sound TRT has developed both qualitative and quantitative guidelines for recovery and delisting of Puget Sound Chinook. The diversity parameter was developed to ensure that the diverse life history characteristics of different Chinook populations represent the diversity displayed by historical stocks. The early run populations of Chinook are the most depressed throughout the evolutionary significant unit (ESU), and it is believed that most extinct populations were early run life history types. The Skagit River basin has the largest natural production of Chinook in Puget Sound, and all six

stocks include some proportion of their smolt population that is yearling. The three early run timed populations (springs) have a higher percentage of yearling smolts than other stocks (typically ~50% of the spawning escapement are yearling smolts). Therefore, the results of this research (should it be funded) has implications throughout the Puget Sound ESU. This may be the only location suitable for examining stream type Chinook in Puget Sound, due to the relatively healthy fish population sizes compared to other Puget Sound river basins.

Steelhead: *O. mykiss* is a highly polymorphic species that exhibits both a freshwater resident form and an anadromous form. The freshwater form (rainbow trout) and the anadromous form (steelhead) are differentiated by adult behavior traits. Offspring of the two life history types can be either anadromous or resident. Understanding the mechanism that leads to a selection of life history type is largely unknown. Freshwater residency as juveniles and adults is highly variable. The National Marine Fisheries Service is currently reviewing a petition to list *O. mykiss* under the ESA. Understanding the distribution and habitat preference by juvenile *O. mykiss* will enable managers to initiate recovery planning efforts. Data on *O. mykiss* will be collected in fish size categories, given the morphological similarities between steelhead and rainbow trout. Information collected in this study will aid in the development of a life history model to evaluate the causes of declined productivity.

Other priority steelhead research has been proposed under another funding source to address hatchery reform recommendations. The proposed research includes components of:

- genetic analysis of outmigrating and returning Skagit steelhead to determine the influence of hatchery fish on wild populations
- diet analysis of outmigrating smolts to determine whether there are interactions between hatchery and wild steelhead and salmon
- wild and hatchery productivity analyses for Puget Sound, Georgia Strait, and the Washington coast to determine whether there is an influence on changes in survival attributable to changes in hatchery steelhead release levels.

Bull Trout: The Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout lists research and monitoring priorities. These include:

- Identify key habitat features and limiting factors with greater precision for bull trout in freshwater habitats to ensure that habitat protection, restoration, and enhancement activities address critical limiting factors. (page 233)

Our proposal, if funded, will address each of these priorities for the Lower Skagit Core Area. Since the Lower Skagit Core Area has a higher abundance of bull trout than other Puget Sound Core Areas, the results from this project could help shape hypotheses about habitat use of bull trout in other areas of the Puget Sound Management Unit.

Study Objectives

Given the size of the Skagit River basin and the complexity of working in it, we are proposing the phased approach to study implementation in order to ensure optimal sampling design and efficient use of funding.

The research is aimed at answering a simple question: *What are the habitat preferences of the listed juvenile fish during their freshwater rearing stage and migration to estuarine/marine environments?* Habitat preferences will be determined based on fish counts during snorkel surveys stratified by time and space throughout the basin. Information collected in this study will aid researchers in understanding the spatial and temporal occupation of freshwater habitats by stream type salmonids in the Skagit basin.

The first year includes the necessary planning steps to conduct both phases of the research project. Phase one (2007) is designed to assess the feasibility and statistical capabilities of the sampling design prior to implementing a more intensive approach during the second phase of the research. The first year (2007) tasks:

- Assemble a habitat database of the Skagit River basin in GIS;
- Use GIS data to select representative sampling reaches based on space (Figure 1), time of year (Table 1), and habitat type (Table 2);
- Refine field methods for fish observation;
- Procure relevant scientific literature on juvenile habitat preferences and sampling methodologies to be used in report analysis;
- Collect pilot level fish observation data, including fish abundance and individual size classes by species, to be used in power analysis; and
- Conduct power analysis on several full implementation study designs using pilot data, unpublished regional/local datasets, as well as literature review results. We will conduct power analysis to understand statistical limitation to all questions (where, when, what). The PI's and oversight committee will make a recommendation to the NCC/FCC for the scope and cost of phase 2.

The objectives for phase one are geared to developing a scientifically defensible approach for identifying habitat preferences for stream type salmonids during the second phase (spring of 2008 through spring of 2009) of this research project. Data collected in phase one will also be incorporated into the final report that will include distinct sections for Chinook, *O. mykiss*, and Bull Trout.

During the initial phase we will conduct snorkel surveys in both the summer and winter timeframes to assess the sampling biases and feasibility of the snorkeling methodologies. The collected data will be used as a measure of variability for power analysis. During this phase we also plan on conducting comparative sampling (snorkeling by various methods compared to each other and beach seine or electrofish methods) to assess biases between several different fish sampling techniques.

The current budget and tasks table (attached as Appendix 1) reflect phase one objectives, and with input from the oversight committee and other researchers a second set of tasks

and a budget request (phase two) will be presented to the NCC/FCC for funding considerations in February 2008. Conducting the research in a phased approach allows us to identify logistical problems with sampling design and to scrutinize budget and field work expectations.

Use of Study Results

It is imperative to understand the importance of this study while acknowledging scope of work limitations. The goal of this research is intended to identify freshwater habitat preferences of the three listed species. Chinook results will be used to identify habitat types in need of protection and restoration throughout the basin.

By way of example, results from this study could lead to specific support for using existing Settlement Agreement funds to purchase high priority habitats (i.e., places within the basin with a large amount or high percentage of the preferred habitat that is at risk of loss or degradation), or be used as a screening tool for the Skagit Watershed Council's review of SFRB applications. Through the GIS integration of collected fish data with habitat preferences we may determine some areas of the watershed are lacking habitat connectivity, or are important because multiple fish populations or species use the area for rearing.

This study will not measure factors causing fluctuations in yearling smolt population size. It is not a population dynamics study. However, the results from this study can be used with annual sub-basin flow data and annual smolt trap data to evaluate production estimates for the different Skagit Chinook populations (or Bull Trout and steelhead if estimates are made from WDFW smolt trap data) to help shape an understanding of mechanism(s) for life history type selection or factors that determine the percentages of yearlings in any population.

It is anticipated that results for Bull Trout and *O. mykiss* will be used in the same manner as those for Chinook salmon.

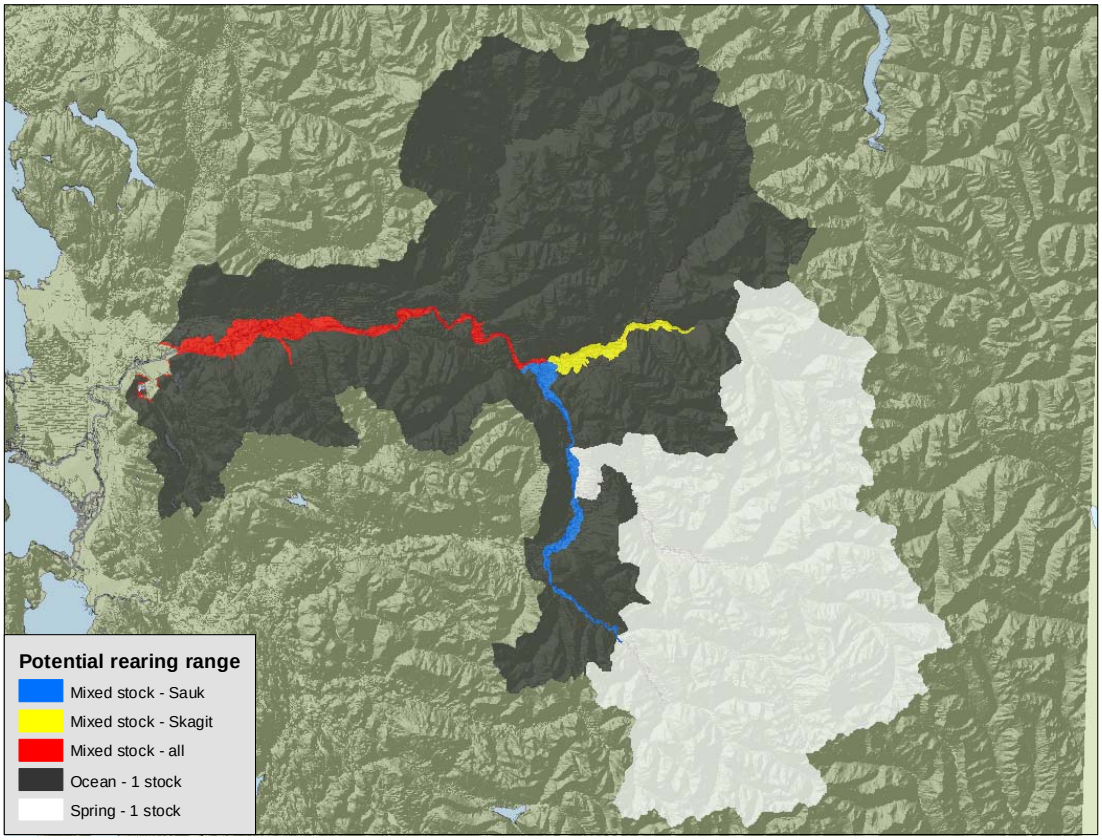

Figure 1. Proposed spatial strata based on the juvenile rearing ranges of 6 wild Chinook stocks in the Skagit River basin. These spatial strata also have some commonalities with watersheds that have regulated and unregulated hydrographs as well as basin hydrology characteristics that control flow and temperature regimes (snow v rain).

Table 1. Potential temporal strata based on differences environmental and ecological factors. Phase I of this study will only collect fish data from two time periods (end of summer and late winter). It is anticipated that Phase II of this study would collect fish data from all 6 time periods.

Spring	(May/early June)	ocean type fish have mostly migrated
End of summer	(Aug/early Sep)	low Q, higher temp
Fall	(Oct)	after flow and/or temps have redistributed fish
Winter with spawners	(Nov/Dec)	adult salmon spawners present in system
Late winter	(Feb/early Mar)	no adult salmon present, few carcasses remaining
Migration	(April)	stream type smolt migration

Table 2. Habitat types used in this study. Finer scale habitat types will be refined with oversight committee input.

Largest Scale (randomly selection basis)	Intermediate Scale (classify in field, map in GIS)	Unit Scale (basis of fish count records)	Finest Scale (attached to each record)
Large mainstems (> 50 m bfw)	Mid-channel	Pool Riffle Glide	Temperature Substrate embeddedness Turbidity LWD count Depth classes Cover type (e.g, complex wood, simple wood, cobble, boulder, deepwater, riprap, etc) Substrate Type (e.g., sand, gravel, cobble, boulder, rubble, riprap, etc)
	Edge	Bar (edge) Backwater Bank − natural Bank − modified	
Small mainstems or tributaries (< 50 m bfw)	Pool riffle channel	Pool Riffle Glide Pond	
	Forced pool riffle / plane bed channel		
	Step pool or steeper channel		
Floodplain channels (non-mainstems in large mainstem floodplains)	Blind – channel starts in the floodplain and is not connected to the river at its inlet	Pool Riffle Glide Pond	
	Primary river – channel is connected to river at its inlet		
	Secondary river – channel is connected to another floodplain channel at its inlet		
	Tributary – channel in the floodplain with its primary source water as hillslope tributary		

Appendix 1. Matrix of tasks and budget request for Upper Skagit Tribe and Skagit River System Cooperative

Tasks	*Upper Skagit (SCL request)*	*SRSC (SCL request)*	*Notes*	*Timeline*
Planning Steps:				
Task 1: Assemble GIS version of habitat inventory using existing edge habitat inventory for edge habitats and imagery for mid-channel units. Follow methods of Beechie et al. 2005 for large mainstems (channels > 50 m bfw) and Montgomery et al 1999 for anadromous salmonid tributaries. Use existing GIS for defining the limits of anadromous Chinook habitat.				
Task 2. Select reaches throughout the Skagit River Basin to snorkel sample for fish based on a stratified (space and habitat type) random design. (All fish species will be recorded but the report will focus on juvenile (stream-type) Chinook, bull trout, and *O. mykiss* (steelhead) presence/absence and relative density)				
Task 3: Safety training preparation, field training (fish id and size recognition) and logistics planning.				
Planning phase costs	$1,500	$13,000	3 months of Karen (GIS work) with input from Eric and Jon-Paul	March 07 - July 07
Fieldwork:				
Task 4. Snorkel selected reaches on a monthly basis each of the two time periods, winter and summer . Use 1 crew of 4 people (3 snorkelers, 1 recorder) consisting of 3 USIT and 1 SRSC staff to sample selected reaches. Cost based on salaries with 3 days a week for 4 weeks.	$14,000	$6,133		
End of Summer (daylight hours)			Samples fish in summer rearing habitat, when flows are typically lowest and temperatures are highest	Aug/early Sep 07
Winter (night hours)			Samples fish use in winter rearing habitat	Dec 07/Jan 08
Task 5. Compare sampling methods for habitat type and time periods where appropriate:	$7,000	$3,067	Allocate one month of the crew's time to conduct gear comparison tests	Aug 07 - Jan 08
snorkeling in daylight v night periods			sample large mainstem edge and tributaries habitat during summer and winter periods	
electrofishing v snorkeling			sample large mainstem edge and tributaries habitat during summer and winter periods	
beach seining v snorkeling v electrofishing			sample large mainstems and backwater habitat during summer and winter periods	
single snorkeler v multiple snorkelers			sample large mainstem edge and tributaries habitat during summer and winter periods	
Non-salary costs related to fieldwork				
Supplies	$9,000	$3,000	dry suits, snorkel gear, etc.	
Rental and O/M for GSA vehicles	$2,095	$500		
Boat use	$1,200			
Analysis/report:				
Task 6. Data entry and QA/QC	$270	$1,000		Aug 07 - Feb 08
Task 7. Critique sampling approach identify changes. Compare and analyze comparative sampling techniques	$1,500	$500		Jan 08 - Feb 08
Task 8. Calculate the relative density (CPUE equivalent) of fish by habitat type for each season sampled (report focus on Chinook, O. mykiss, and bull trout).	$500	$1,000		Jan 08 - Feb 08
Task 9. Power Analysis	$0	$8,000		Jan 08 - Feb 08
Task 10. Review and discussions with planning subcommittee	$1,000	$1,000		Mar 08
Task 11. Draft outline and proposal for full study implementation	$500	$500		Mar 08
Total w/o indirect	$38,565	$37,700		
INDIRECT (43.03% for USIT; 26.44% for SRSC)	$16,595	$9,968		
Grand Total	**$55,160**	**$47,668**		