PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Comparative Population Study: Naneum, Coleman, Cooke Creeks

BPA project number: 20039
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Washington Trout

Business acronym (if appropriate) WT

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
7.6, 7.6A, 7.6C, 7.1, 7.1I, 7.1B, 7.1E, 10.1, 10.2A1, 10.2C.

FWS/NMFS Biological Opinion Number(s) which this project addresses

Other planning document references

Short description
Measure/analyze resident trout population dynamics and measure/evaluate the effects of landscape/channel habitat dynamics on the dynamics of these populations in three subbasin tributaries of the upper Yakima R. subbasin.

Target species
Westslope cutthroat trout, brook trout, and redside trout.

Section 2. Sorting and evaluation

Subbasin
Yakima

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☐ Anadromous fish ☒ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☒ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
	Yakima Basin Fish-Habitat Population Studies
20006	Yakima Basin B-IBI
20039	Comparative Population Study: Naneum, Coleman, and Cooke Creeks.

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
	YSIS study of juvenile chinook gut-contents, % stomach fullness	Complementary; provides additional relevant data.
	YSIS salmon carcass "planting", nutrient-enrichment study	Complementary; provides additional relevant data on resident fish populations/habitat/food web relations.
	Yakima Basin Reaches Studies: Dr. Jack Stanford, USBR	Complementary; provides additional relevant data. Will engage in similar work on food web, habitat, and salmonid population dynamics in tributaries instead of mainstem.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Measure populations dynamics of local native and exotic resident salmonid populations in 3 streams.	a	Annual census of resident pops. and conduct spawning surveys in each of 2 study reaches in each stream.
		b	Annually assess age structureand growth rates each population.
		c	Monitor fish movement and habitat use, within and across seasons/years.
2	Assess relation between catchment habitat conditions/dynamics and local benthic invert. and fish pop. dynamics	a	Annually conduct Rosgen channel geometry surveys on each study reach.
		b	Measure discharge each stream three times/yr.. Develop local rule curves.
		c	Calculate each study catchment area; calculate annual precipitation and seasonal distribution.
		d	Measure vertical hydraulic gradient in each reach three times/yr. and determine lateral extent of hyporheos.
		e	Measure water and air temp. each reach year-round.
		f	Sample benthos of each reach annually.
		g	Enter all data into GIS database.
3	Compare population dynamics and delineate risk assessment factors for displacement of native westslope and redband by brook trout.	a	Based on all of the data over several years, develop/evaluate population models and risk factor matrices.

		f	

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	5/2000	10/2000	Population, spanwing, benthic data	Report 5/2001	%67.00
2	5/2000	9/2000	Hydraulic and channel geography measurements	Report 5/2001	0.00%
1	5/2000	3/2001	Analysis of data; Development of GIS maps/database	Report 5/2001	%33.0
2	5/2000	3/2001	analysis of data; development of GIS maps/databases.	Report 5/2001	
3	11/2000	3/2001	Tentative hypotheses re-brook trout risk. Final at end of 5 years.	Report 5/2001	
3	11/2000	3/2001	Tentative hypotheses re-brook trout risk. Final at end of 5 years.	Report 5/2001	
				Total	10000.0 0%

Schedule constraints
Run-off will affect timing of spawning surveys in Naneum and Cooke Creeks.

Completion date
5/2005

Section 5. Budget

FY99 project budget (BPA obligated):

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	Field surveys, data analysis, GIS, report writing, project planning and coordination	%22	11,400
Fringe benefits	Calculated at 25% on above total less sub-contracts (=15400)	%5	2,850

Supplies, materials, non-expendable property		%4	2,000
Operations & maintenance	Vechicle maintenance.	%2	1,000
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	Temperature loggers, piezometers, snorkelling equip.	%18	9,150
NEPA costs		%0	
Construction-related support		%0	
PIT tags	# of tags:	%0	
Travel	Mileage, food, lodging	%6	3,375
Indirect costs	20% of total costs incl. sub-contracts	%17	8,703
Subcontractor	Alan Johnson, Dr. John Orsborn, David Plume	%19	9740
Other	GIS data aquisition	%8	4000
TOTAL BPA FY2000 BUDGET REQUEST			$52,218

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
Alan Johnson	Donation Water Quality meter (temp, DO, cond., pH).	%3	1,500
Dr. Morris Ubelaker	GIS mapping, data aquisition	%0	undetermined
		%0	
		%0	
Total project cost (including BPA portion)			$53,718

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$48,000	$49,000	$50,000	$52,000

Section 6. References

Watershed?	Reference
☐	. Bailey, R.E., J.R. Irvine, F.C. Dalziel, and T.C. Nelson. 1997. "Evaluation of Visible Implant Fluorescent Tags for Marking Coho Salmon Smolts." North American Journal of Fisheries Management. Volume 18, Number 1, February 1998. Pp. 191-197.
☐	Bayley, P.B. and H.W. Li. 1994. "Riverine Fishes". In River Biota, selections from The Rivers Handbook (Petts, Geoffrey and Peter Calow, eds.) Blackwell

	Scientific. Pp. 92-123.
☐	3. Downs, C.C., R.G. White, and B.B. Shepard. 1997. "Age at Sexual Maturity, Sex Ratio, Fecundity, and Longevity of Isolated Headwater Populations of Westslope Cutthroat Trout". North American Journal of Fisheries Management, Volume 17, Number 1, February
☐	4. Fausch, K.D., and M.K. Young. 1995. "Evolutionarily Significant Units and Movement of Resident Stream Fishes: A Cautionary Tale" In Nielsen (ed.), op.cit. pp. 360-371.
☐	5. Frissell, C.A., W.J. Liss, M.D. Hurley, and C.E. Warren. 1986. "A Hierarchical Framework for Stream Habitat Classification: Viewing Streams in a Watershed Context." Environmental Management 10: 199-214.
☐	6. Frissell, Christopher A., and David G. Lonzarich. 1996. "Habitat Use and Competition among Stream Fishes." Chapter 23 in Methods in Stream Ecology.
☐	7. Gelwick, Frances P., and William J. Matthews. 1996. "Trophic Relations of Stream Fishes". Chapter 22 in Methods in Stream Ecology.
☐	8. Grossman, Gary D., Jennifer Hill, and J.Todd Petty. 1995. "Observations on Habitat Structure, Population Regulation, and Habitat Use with Respect to Evolutionarily Significant Units: A Landscape Perspective for Lotic Systems." In Nielsen, Jennifer L. (
☐	9. Helfman, Gene S. 1983. "Underwater Methods". Chapter 19 in Fisheries Techniques. American Fisheries Society.
☐	10. Independent Scientific Review Panel. Document # 98-1. June 15, 1998. "Review of the Columbia River Basin Fish and Wildlife Program for Fiscal Year 1999 as Directed by the 1996 Amendment to the Northwest Power Act." P. 15, 16.
☐	11. Karr, James R. 1998. "Salmonweb Biological Monitoring Protocol." VHS tape available from salmonweb. Website address: www.salmonweb.org.
☐	12. Karr, James R., and Ellen W. Chu. 1997. "Biological Monitoring and Assessment: Using Multimetric Indexes Effectively." EPA 235-R97-001. University of Washington, Seattle.
☐	13. Kocovsky, C. Gowan, K.D. Fausch, and S.C. Riley. 1997. "Spinal Injury Rates in Three Wild Trout Populations in Colorado after Eight Years of Backpack Electrofishing". North American Journal of Fisheries Management, Volume 17, Number 2, May 1997. Pp. 3
☐	14. Li, Hiram W. and Judith L. Li. 1996. "Fish Community Composition". Chapter 18, in Methods of Stream Ecology (F.Richard Hauer and Gary A. Lamberti, eds.) Academic Press.
☐	15. Naiman, Robert, John J. Magnuson, Diane M. McKnight, and Jack A. Stanford. 1995. The Freshwater Imperative. Island Press.
☐	16. North American Journal of Fisheries Management, Volume 17, Number 4, November 1997. Special Section "Ecology and Management of Potomodromous Salmonids".
☐	17. Schlosser, I.J. and P.L. Angermeier. 1995. "Spatial Variation in Demographic Processes of Lotic Fishes: Conceptual Models, Empirical Evidence, and Implications for Conservation." In Nielsen (ed.), op.cit. pp.

	392-402.
☐	18. Trotter, Patrick C. 1987. Cutthroat: Native Trout of the West. Colorado Associated University Press.

PART II - NARRATIVE

Section 7. Abstract

A comparative study of physical habitat conditions and resident trout population dynamics would be undertaken on three closely-related second and third order streams draining the Colockum Hills and tributary to the Yakima River at Ellensburg. The three streams, Naneum, Coleman, and Cooke Creeks, appear to possess stable populations of native westslope cutthroat, introduced brook trout, and native redband trout, respectively, throughout their upper reaches which extend for lengths of 6 to 9 miles. The brook trout population appears to have recently displaced a previously existent population of westslope cutthroat.

Two separate, but related, objectives would be addressed. First, to assess and better understand the dynamics of small, refuge populations of native resident trout (westslope and redband) in tributary sub-basins of the mid-Columbia and to better define the relationship between physical habitat and hydrological variables and these population dynamics. Second, to compare these dynamics and relationships across the three species to determine unique features of brook trout population dynamics which allow them to successfully invade and displace established native resident trout populations.

A range of catchment-scale physical habitat data together with detailed channel measurements would be made and incorporated into a GIS system. Benthic invertebrate populations would be regularly measured. Resident trout populations would be regularly measured. An integrated analysis of within- and between-population response to changes in physical channel features, hydrologic variation, and benthic invertebrate population variation would be conducted as data accumulated over time.

This is conceived as a long-term study, one of the sort which a BioDiversity Institute of the sort mentioned in section 7.1I of the FWP would undertake as a matter of course.

Section 8. Project description

a. Technical and/or scientific background

Westslope cutthroat (*Onchorynchus clarki lewisi)*, redband rainbow (*O. mykiss gairdneri)*, and bull trout (*Salvelinus confluentis)* are the native resident trout of the Columbia Basin east of the Cascade Crest. Populations of these species have suffered reductions in both historic range and numbers in recent decades. These reductions have been caused in significant part by introduction of non-native con-specifics, introduction of exotic trout species (principally brook trout, *S. fontinalis)*, and loss and impairment of habitat (Gresswell, 1988, Behnke 1992, and several articles in the Special Section of NAJFM (v.17, #4). Most remaining indigenous resident native trout populations in the Columbia Basin are found in lower-order tributary subbasins, particularly headwater streams of first through third orders. Their stream habitats are both reduced and often

disconnected in comparison to the presumably normative conditions which existed prior to significant disturbance by euroamericans. They are thus particularly vulnerable to demographic and environmental stochasticities, and to deleterious competitive interactions with introduced non-natives.

Successful preservation and recovery of such populations requires preliminary identification of them and a thorough assessment of the conditions of their catchment habitats. In conjunction with this need for identification and assessment, preservation and recovery efforts are in need of better understanding of the population dynamics of such small and generally fragmented populations.

Despite the desire to protect and recover such populations, little is known about the numbers, much less the dynamics and community interactions of these much-reduced native populations. Knowledge of parameters such as age-structure, and recruitment dynamics is lacking; and little is known about the interactions of stream channel conditions and variables of the hydrologic regime at the reach scale with these population dynamics. Understanding of these relationships is also fundamental to an understanding of the nature of the competitive or other threats posed by exotic resident salmonids, particularly brook trout.

Specifically, in regard to most remaining headwater native westslope populations in the mid- and upper-Columbia Basin, we don't know whether or not they are at equilibrium populations sizes and age-structures, what the natural variances in populations size and age-structure are, and what temporary variations or changes in age-structure or population size threaten local extinction. We lack information and understanding of the extent of within-stream movement of resident trout populations and of immigration and of their role in the dynamics and persistence of local populations (cf. Fausch and Young. 1995; Grossman et al. 1995; and Schlosser and Angermeier. 1995). We know little about seasonal variation in habitat use at the channel unit and stream segment scales and how this is related to hydrologic variation and to annual population size.

We don't know the precise manner in which brook trout "out-compete" native resident westslope or redband where they do so; and where brook trout are encountered together with apparently-more-abundant native resident populations, we don't know whether all species are coexisting at a dynamic equilibrium or whether the brook trout are in the early stages of a soon-to-be-successful invasion and displacement. And where they do succeed, we appear to be unable to determine whether the brook trout merely filled a degraded niche to which the natives could not cling or whether the brook trout were simply more fit to occupy the majority of niches.(Conjectures regarding fall vs. spring spawning, greater tolerance for crowding, or, in the case of cutthroat displacement, greater tolerance for warm temperatures, are either untested or too vague to be convincing.)

Such understanding is hampered in large part by a dearth of long-term empirical data sets from well-designed studies (See, e.g., Bayley and Li, 1994, Schlosser and Angermeier, 1995.). Ecological data in general, and species level population data in particular, are notoriously "noisy", reflecting a significant amount of variance due to environmental variation quite apart from issues of variability due to measurement/sampling procedures (Bayley and Li, 1994.). This is no less true of these small headwater trout populations than it is of large mainstem anadromous populations,

although the geographic scale of the former makes it likely that a good deal of the noise can be separated from the underlying ecological processes provided studies are properly designed and executed and a significant time series of data derived.

These issues must be addressed and understood if adequate and cost-effective measures are to be successfully undertaken to preserve and recover the Basin's native resident trout populations. Washington Trout initiated a project in the summer of 1998 funded under the FWP (BPA Project #98-026) to identify many of these native resident populations, in part as a prelude to identifying specific preservation priorities and further specific research and assessment needs. The first year of this project was devoted to sampling populations in the Yakima and Naches River subbasins. The current proposal stems from stream populations and habitat conditions encountered in the course of this sampling and is aimed at addressing the sorts of issues enumerated above.

During our survey in the summer of 1998, we surveyed headwater segments of three (3) adjacent second- to third-order streams, Naneum, Coleman, and Cooke Creeks. All flow out of the Colockum Hills on the eastern border of the Wenatchee Mountains and onto the floor of the Kittitas Valley east of Ellensburg, Washington eventually joining to become part of the lower Wilson Creek system which enters the mainstem Yakima River at the head of the Yakima Canyon to the south of Ellensburg. The three streams are separated from one another by two north-south trending ridges which each average 2 to 3 miles in width.

The western-most, Naneum Creek, contains an apparently healthy population of westslope cutthroat throughout its upper length (roughly, 8 to 10 miles). Before reaching the valley floor it runs for approximately 2 miles though a canyon. Brook trout and hybrid rainbow/cutthroat, and redband rainbow are encountered from this point downstream.

Coleman Creek, across the next ridge to the east, runs for approximately 8 miles before entering the valley floor. Less than 2 miles before reaching the valley floor, the creek flows over a bedrock fault 60-80 feet high. Redband are found downstream of the falls. Westslope used to be found upstream. As recently as the early 1990's members of the Yakima Species Interaction Studies Team readily encountered westslope during a casual angling reconnaissance of the Wilson Creek system (Geoff McMichaels, personal communication, September, 1998). Washington Department of Fish and Wildlife stocking records indicate that brook trout were last officially planted in Coleman Creek in the early 1980s. During our survey upstream of the falls in July 1998 three skilled anglers were unable to find any westslope but had no difficulty catching any number of brook trout, including reaches upstream of two impassable perched road culverts. This suggests that recent downstream invasion has occurred within the past 8 years.

Cooke Creek also runs for a length of about 8 miles before reaching the valley floor. Climate is slightly more xeric than Coleman, (which in turn is somewhat more xeric than Naneum) and evidently becomes sub-surface during mid-summer shortly after reaching the valley floor. Its upper 7 miles nonetheless contains a population of pure redband.

Land ownership in the upper reaches of the three creeks is a mixture of federal (Wenatchee National Forest) and state (Washington Department of Natural Resources), with a few private holdings along the lower mile of the foothills and on the valley floor.

We believe that the features of these three creeks herein described provide a logistically and ecologically unique set of conditions for undertaking a comparative study of resident trout populations in the mid-Columbia Basin directed at improving our understanding of the population dynamics of headwater populations and their interactions with physical habitat and hydrological conditions and with exotic competitors. We propose a minimum five-year study.

Much of value can be learned in this time, but we would endeavor to urge funding and commitment to such a project for a significantly longer time. Long-term data of the sort which this project will obtain and long-term study sites and projects of the sort we are herein proposing are increasingly recognized and advocated as necessities of sound ecosystem management (including the FWP itself cf. sections 7.1C, 7.1I, 7.6C; see also the Freshwater Imperative, Chapter 3, and references cited above). We believe that in five years' time we can demonstrate the fruitfulness of continued investment in the project, and will be able to involve others in broadening the project's research agenda and will be able to fruitfully link this project to other related projects not only under our umbrella proposal and not only within the Yakima Basin.

b. Rationale and significance to Regional Programs

Section 10 of the 1994 Fish and Wildlife Program (FWP) recognizes redband and westslope cutthroat trout, along with bull trout, as native resident fish species of concern. Preservation of existing native populations of these species and their habitats, and restoration of damaged habitat are recognized as goals and obligations of the FWP.

The FWP also emphasizes the need for proper assessment of watershed conditions "on a stream-reach-by-stream-reach basis" as a prerequisite to effective preservation and recovery efforts (Section 7.6A and 7.6C). This emphasis has been highlighted and reinforced by the Independent Science Advisory and Review Groups (ISAG and ISRP, respectively) in reviews of the current FWP and of recent funding decisions and project proposals (ISRP 98-1).

A significant aspect of assessing the impact of altered and impaired watershed conditions on native fish populations lies with improving our understanding of the interactions between local fish population dynamics and habitat conditions (including in-channel biotic conditions) at hierarchical spatial and temporal scales (Bayley and Li, 1994; Frissell et al., 1986; Grossman et al., 1995; Schlosser and Angermeier, 1995.). A comparative population study of the sort we propose to undertake is conceived to improve our understanding of these interactions.

The FWP also calls for the development of a Biodiversity Institute, which to the best of our knowledge has yet to take shape (Section 7.1I). This proposal is for precisely the sort of applied research in which a Biodiversity Institute would engage.

c. Relationships to other projects

The project was briefly discussed with Geoff McMichael of the Yakima Species Interaction Studies (YSIS) in September 1998 both to make sure that no similar projects were planned by YSIS and to determine whether Mr. McMichael could provide any obvious considerations against the project. Mr. McMichael was favorably disposed

toward the idea and confirmed that YSIS had no plans to engage in such a study. The project would be complementary to other YSIS projects.

The proposed project is part of a proposed "umbrella" project, "Yakima Basin Habitat-Fish Population Studies", which would integrate several projects regarding landscape habitat assessment, aquatic habitat evaluation, and salmonid fish population status. The only other related project proposed at this time under this new umbrella is to develop a Benthic Index of Biotic Integrity (B-IBI) for the Yakima/Naches Basin (FY2000 proposal "FY2000B-IBI"). The three streams that are the subject of the present proposal would be sampled under the B-IBI proposal. The information provided to the proposed project by a B-IBI would be significant and would be integrated with physical habitat measurements, hydrologic variables, and fish population census information to assist in accomplishing the goals of the proposed project.

The Proposed Project involves the participation of Dr. Pat Trotter and Mr. Bill McMillan who are also principals in WT's Native Trout Survey (BPA Project #98-026) which is also proposed for extended funding in FY2000 through 2002. The Project Director of that project would also be the Director of the proposed project and the related proposed project BPA2000B-IBI. No conflicts exist between these three projects, Efficiencies of coordination among them are envisioned and planned for in all proposals. The Project would complement and provide relevant information regarding tributary ecosystem processes/fish population interactions to Reach Studies along the Yakima and Naches River mainstems soon to be initiated under the direction of Dr. Jack Stanford, Director of the University of Montana's Flathead Lake Biological Station, under funding by the Bureau of Reclamation.

d. Project history (for ongoing projects)

(Replace this text with your response in paragraph form)

e. Proposal objectives

General, overall objectives.

1. Understand the population dynamics of local populations of native westslope cutthroat and redband trout, and non-native invading brook trout in headwater catchments representative of a gradient of environmental conditions found in the Yakima Basin in particular and throughout the mid- and upper-Columbia.
2. Determine significant differences between the ecology and population dynamics of non-native brook trout and resident native trout in the mid-Columbia, so as to better understand the threat which brook trout pose to the continued existence of native trout populations in this and similar regions.
3. Develop a detailed understanding of the relationships between resident salmonid population dynamics and landscape habitat conditions, including hydrological conditions at the catchment scale, including the impact of these conditions on benthic invertebrates and related components of resident salmonid food webs.
4. Initiate the development of a long-term local study whose ongoing results will be applicable across the mid-and upper-Columbia region at meaningful temporal and

spatial scales. Initiate the development of a significant time-series of data relevant to the continued refinement of our understanding of the issues in #s 1-3.

Specific objectives related to project development.

1. Annually census and monitor resident trout populations from study reaches in Naneum, Coleman, and Cooke Creeks.
2. Annually assess age-structure and growth rates of three principal trout populations, one from each of the study streams: Naneum Creek, westslope cutthroat; Coleman Creek, brook trout; Cooke Creek, redband trout.
3. Monitor movement of marked individuals within and across seasons to assess range of habitat use, and to determine immigration into study reaches during annual censuses.
4. Annually conduct full Rosgen channel geometry surveys at two reaches in each stream and produce reach-length three-dimensional channel profiles.
5. Measure discharge at each study reach a minimum of three times annually and develop rule curves for determining discharge from channel wetted width.
6. Calculate catchment basin area for each creek and integrate regional precipitation data to calculate total precipitation input and seasonal distribution for each catchment. In conjunction with full channel profiles and discharge measurements/rule curves, develop rule curves correlating regional precipitation with discharge.
7. Each year, during or immediately after peak spring run-off and during September baseflow, measure vertical hydraulic gradient at select sites within reaches surveyed in #3.
8. At study reaches located in floodplains, determine the lateral extent of the hyporheic zone, to determine/estimate the contribution of the local hyporheos to baseflow discharge.
9. Develop a water mass balance for each stream segment.
10. Record water temperature year-round at all study sites.
11. Annually conduct sampling of benthic macroinvertebrates in at least one study reach per stream using standard protocols for the Benthic Index of Biotic Integrity.
12. Conduct literature and database searches to acquire habitat condition/use information relevant to accomplishing project objectives, especially GIS layering.

Objectives related to Hypothesis development/testing

1. (By or before the end of 5 years) Develop testable hypotheses regarding the relationships between channel morphology, local/regional hydrology and biotic condition as indicated by B-IBI sampling; and between these and resident trout population dynamics.
2. (By or before the end of five years) Describe any detectable differences between populations of benthic invertebrates and/or local trout populations among the three streams across similar gradients of physical habitat and hydrological conditions.
3. (By or before the end of five years) Describe differences in the age-composition, growth rates, and recruitment dynamics between the three study populations.

Develop hypotheses regarding species-specific responses to similar environmental and biotic condition.

4. (By or before the end of five years) Determine any differences that may become apparent between the population dynamics and response to environmental variables of brook trout in Coleman Creek and those of the native trout in Naneum and Cooke Creeks.
5. (By or before the end of five years) Based on #4, delineate risk assessment factors for displacement of native westslope (and redband) by brook trout.

Critical Assumptions

1. The project sites will be undisturbed by anthropogenic impacts relative to the aims of the project during the course of the project. Such disturbances as may be anticipated due to land management practices of state and federal landowners will either not occur, will be minimally disruptive of the sites for the purposes of the project, or will be disturbances of the type that the project is in part designed and concerned to be able to detect and assess.

f. Methods

Specific project objectives #s 1-3. Fish populations in each stream will be censussed in reaches whose length and number will be chosen to accommodate the requirements of Rosgen channel geometry surveys/reach profiles and to provide a meaningful index of fish population size and dynamics in the headwater segments of the study streams, approximately 20 to 30 bankfull channel widths. Naneum Creek is approximately 30 feet wide, Coleman and Cooke somewhat less. Reach length will accordingly be in the neighborhood of 200 to 300 meters. Two such study reaches per stream will be chosen.

Spawning surveys will be conducted in June and July in Naneum Creek, in Cooke Creek in May and June, and in Coleman Creek in September and October. Redds will be enumerated within study reaches and located on maps (see #s 4-5 below).

In order to avoid injury and undue mortality to fish in Cooke and Naneum, we will avoid electroshocking altogether. Based upon our experience in sampling these streams under BPA Project #98-026, population sampling will occur between mid-July and mid-August, prior to September baseflow. This is a time of high food abundance which minimizes emigration due to habitat supplementation. All three streams are essentially clear at this time. We will use and evaluate capture and removal protocols using dry fly angling as the capture method, followed by snorkeling to visually evaluate the capture efficiency. Catch-per-unit effort data will also be maintained. Study reaches will be blocked with seines at upstream and downstream ends during the sampling period.

Care and enumeration of captured fish will follow protocols used for BPA project #98-026. Fish will be held in 10 gallon plastic buckets lined with dark plastic trash bags and covered with Nytex netting and containing fresh stream water and carried to a central streamside location where they will be mildly anesthetized with a solution of Clove Oil and fresh water, weighed to the nearest gram and length measured to the nearest millimeter. Fish will then be placed in a separate bucket containing fresh

stream water and allowed to recover before being released to an in-stream holding pen, and then released to the study reach after the census is completed.

If feasible, visual determination of sex will be made at Naneum and Cooke creeks until such time as it can be determined that population health will not be impacted if a statistically significant sub-sample of the populations are sacrificed for purposes of estimating sex ratio and reading otoliths for age determination. We would not expect this determination to be made until the third year of the Project. A sub-sample of brook trout from Coleman Creek will be taken and sacrificed for this purpose from the outset of the project. Fin-ray cross-sections will also be examined microscopically to determine the feasibility of age-determination with this method.

Visual marks/tags will be placed on a sub-set of censussed fish and movement of marked fish periodically monitored via snorkelling and/or angling to assess extent of range of habitat use on a seasonal basis and to determine the extent of immigration into study reaches. Consideration will be given to the use of Visible Implant Fluorescent Tags (as reported by Bailey et al. 1998), fin clips, or other marks/tags as may be recommended by managers/reviewers.

Specific project objectives # 4-5. Full reach-length Rosgen channel analyses will be conducted at each study reach under the direction of professional habitat biologist and hydrologist Alan Johnson of Aquatic Resource Consultants during baseflow conditions in September. Permanent benchmarks will be monumented at each study reach so that reaches can be accurately resurveyed during and after the project. Stream bed profiles and regular cross-sections will be surveyed with appropriate survey equipment including laser auto-level, and a detailed three-dimensional scale drawing of the entire reach produced and entered into a GIS database. This will facilitate the determination of year-to-year changes in channel morphology at channel unit (riffle, pool) and smaller scales.

Discharge will be measured in the spring during or immediately after run-off, again in early summer, and during baseflow conditions at selected cross-sections of the study reaches using flow meters and standard protocols for measuring discharge at a cross-section. At the time each such discharge measurement is made, stream wetted width will be measured at other cross-sections within the reach. This data will be integrated with channel profile data. This will permit within-year rule curves for wetted width-discharge to be constructed. Rule curves can be developed across years for cross-sections whose morphology has not substantially changed between years.

Specific project objective # 6. Current USGS 7.5 minute maps, recent aerial maps and regional GIS data of the area available at Central Washington University will be consulted and entered into a GIS system. Catchment area will be mapped and calculated for each segment of each study stream upstream of the downstream end of the lower-most study reach. USGS, National Weather Service, and/or USBR databases for regional precipitation and related climatological data will be queried to develop seasonal precipitation input patterns for each catchment. This is an essential component of developing a water mass balance for the study segments. In addition, in conjunction with the discharge and channel profile measurements, this will permit correlations between regional precipitation and stream discharge to be estimated/calculated.

Vegetation maps will acquired and integrated onto the GIS maps.

Specific project objective # 7-9. Piezometers will be installed at regularly-spaced intervals across the width of the bankfull channel at selected riffle cross-sections in the study reaches to measure the vertical hydraulic gradient. Placement and installation will be in accordance with standard methods illustrated by Dr. Jack Stanford at training workshops in ground water-surface water interactions conducted at the Flathead Lake Biological Station. (Piezometers will be designed so that they can be hand-pumped to sample the channel hyporheos for benthic invertebrates.) This will permit the identification of surface, hyporheic, and true ground water upwelling and downwelling zones along study reaches. Temperature loggers will be placed along the entire length of study reaches, including at identified upwelling sites, to develop channel temperature profiles, and along the riparian zone to record air temperature. This data will be integrated with the channel profile maps and placed on the GIS.

Shallow, capped monitoring wells will be drilled to identify the lateral extent of the hyporheic zone of study reaches which have wide floodplains associated with them. Temperature, dissolved oxygen, pH, and conductivity will be measured in the wells with standard meters. Wells will be pumped to sample for benthic macroinvertebrates. This phase of the project (objective #7) would not be undertaken until the second or third year of the project.

Specific project objective # 9. In addition to the sampling of the hyporheos indicated above, benthic invertebrate samples will be collected from one riffle at one study reach in each stream in accordance with the standard protocols for sampling benthic stream invertebrates for the purposes of developing a benthic index of biotic integrity (B-IBI). The protocol is described in Karr and Chu, 1997 and in Karr, 1998). The sites at each of the study streams will be sites for regular benthic invertebrate sampling under the related project proposed by Washington Trout for funding beginning in FY2000 (BPA2000B-IBI) to develop and evaluate a B-IBI for the Yakima Basin. This sampling would be funded under that project and is a specific overlap of the two proposed projects.

Specific project objective #12. Regional databases of natural resource management agencies and land-use planning authorities will be queried to assess the availability of local detail maps, including vegetation maps, and current and historical aerial photographs of the subject landscape at all relevant scales. The Project Director will likely be assisted in this task by Dr. Morris Ubelaker , Department of Geology and Director of the GIS Program at Central Washington University in Ellensburg, Washington. Dr. Ubelaker is in charge of an extensive local GIS database relevant to the project. Much of this work may be done as part of student course in GIS, which would be a match to the project by Dr. Ubelaker.

g. Facilities and equipment

Washington Trout possesses field vehicles fully adequate for the project. Washington Trout possesses a GIS system fully adequate for the project. All equipment necessary for stream channel and habitat measurement and for producing the channel profile maps is possessed by Mr. Alan Johnson who will be hired by Washington Trout for

this work. Other computers relevant to the conduct of the project are in the possession of Washington Trout, with the exception of a laptop PC which will facilitate logging GPS data in the field and downloading and setting temperature probes in the field as well as making project-related computer time available outside of the confines of the office. A laptop has been included in the budget for the related project proposal for FY2000 to develop a Benthic index of Biotic Integrity for the Yakima Basin (Washington Trout proposal "BPA2000B-IBI)". This laptop would be available for use on the present proposal as well and so is not included in the budget request for the present proposal, However, should the B-IBI not be recommended for funding, a laptop PC would have to be added to the budget request for the present proposal, as well as sampling equipment and supplies for benthic invertebrate sampling, a research microscope, and additional personnel time for sorting and identification of samples. In total this would add an additional $8,000 to the budget total, which would have to be appended to the current budget request for this proposal.

The use of piezometers is not part of Mr. Johnson's regular professional habitat assessment work, and Washington Trout does not presently possess them. Accordingly, the budget includes funding for their acquisition and construction. Other necessary equipment and supplies not in Washington Trout's possession are included in the budget and discussed in section "h" below, as necessary.

h. Budget

Personnel costs are included for the following tasks:

Annual fish population census of 2 reaches on each of 3 streams. Discharge would be measured and piezometers placed in channel cross-sections at these times as well to measure vhg.. This would involve three persons.~190 hours at $20/hr.

2 spawning surveys per stream (2 study reaches) per year. Discharge would be measured at each stream during one of the surveys, vhg measured during the other. This would involve 2 persons. ~140 hours at $20/hr.

Alan Johnson's professional services in the field and for data analysis and processing, approximately 100 hours, including all equipment, supply, and travel expenses:$6240.00.

Dr. John Orsborn's professional services for hydrological analysis and modelling of the study catchments: $1500.00. .

One person to assist Alan Johnson in the field. ~70 hours at $20/hr.

Project consulting and fish population data analysis and Report writing by Dr. Pat Trotter is estimated to be 40 hours at $25/hr.

Project Director, Nick Gayeski: Project Design and Coordination, data analysis, and report writing: ~120 hours @ $20/hr.

GIS consulting and assistance: Mr. David Plume, $2000. Mr. Plume is an independent consultant and a graduate student of Dr. Morris Ubelaker in the landscape geology program at Central Washington University. The retention of Mr. Plume for the proposed project was strongly urged by Dr. Ubelaker during preliminary discussion of the GIS requirements and objectives of the proposed project.

Total Sub-contract costs include the professional services of Mr. Plume, Mr. Johnson, and Dr. Orsborn. Total: $9740.00. This is included on the budget line for "Subcontractor", but is also included in the sub-total upon which Indirect Costs are calculated. All of these sub-contracts include coordination by the Project Director, and Alan Johnson's work involves a significant amount of field time included assistance from at least one field crew person.

Data Acquisition Costs:

For acquisition of GIS spot image and other data, Dr. Ubelaker recommended budgeting up to $4000.

Capital Equipment Costs:

Materials and labor to construct 10 steel piezometers; purchase of 1 suction pump for bailing piezometers. $1000.

Fine scale spring balances for weighting fish: est.$200.

Optic Stowaway 32k Temperature Loggers: 6 per reach for 6 study reaches. This would permit season-long and year-round monitoring of water and local air temperature. 36 loggers at ~$200 each. Total: $7200.

2 wetsuits related snorkeling equipment: $700.

Supplies:

Field notebooks, flagging, aquarium dipnets, 4 mesh seines for blocking sample stream sections and recovery enclosures during fish censuses; office and computer supplies, film and film processing. Approximately $2000.

Travel:

Mileage: Based upon roundtrip mileage from Seattle to the location of each sample stream of ~300 miles, and inter-basin distances of ~30 miles. Approximately 12 field visits, plus visits by the Project Director to Central Washington University for data sharing and consulting with Dr. Ubelaker and Mr. Plume. Estimated total of 4500 miles At $0.35/mile. Total: $1575.

Lodging: Camping is possible at some of the study sites for no fee and at nearby campgrounds for $10/night. An additional 10 days motel time is included, at a double-occupancy rate of $60. Total $800.

Food Costs: estimated at $20 per day for 50 person-days. Total $1000.

Section 9. Key personnel

The Project Director, Nick Gayeski, would engage in all aspects of the field work, as well as provide general project coordination and oversight. He would be involved in consultation on all aspects of project design with Dr. Trotter (fish population assessment and data analysis), Alan Johnson (channel reach measurements and habitat analysis and mapping), and Dr. Morris Ubelaker and Mr. David Plume (mapping and GIS database development). Mr. Gayeski has a Masters Degree in Philosophy from the University of Washington where his primary area of interest was the philosophy of science. He has had a longstanding avocational interest in aquatic biology, including macroinvertebrate

ecology, salmonid life history, and population biology. He is well-acquainted with the professional peer-reviewed literature in these fields and in related fields of aquatic biology and fisheries management, and maintains currency with this literature. He has extensive experience in the collection of freshwater macroinvertebrates and has taught numerous field courses in macroinvertebrate identification for fly anglers for professional fly-fishing retail stores in the Northwest.

For the past three years he has been employed fulltime by Washington Trout, where his primary duties have been grant writing and public fisheries and landscape management policy evaluation. He is the Director for BPA Project #98-026, which has proposed to photo-document native resident trout populations throughout the mid- and upper-Columbia Basins in Washington State and to collect tissue samples from these populations for nuclear DNA analysis.

Recent additional experience and training includes the following:

Organizing and hosting a day-long public/scientific forum on "Addressing Risk and Uncertainty in Salmonid Harvest Management" held in Olympia, Washington in January of 1998;

Participation in the "Aquatic Oligochaete Workshop" held in Logan, Utah in September of 1997 and conducted by Drs. Deedee Kathman and Ralph Brinkhurst of Aquatic Resources Center in Franklin, Tennessee. The Workshop was co-sponsored by the Whirling Disease Initiative for the National Partnership on Management of wild and Native Cold Water Fisheries, and included field training in the collection of aquatic oligochaete worms and laboratory training in slide preparation of oligochaetes and the use of microscope and key to identify them to genus and species.

Participation in a training course on "Ground Water-Surface Water Interaction" held in September of 1998 at the University of Montana's Flathead Lake Biological Station and conducted by Dr. Jack Stanford, Director of the Biological Station.

Dr. Pat Trotter is a self-employed fisheries science consultant. He has a PhD. In Chemistry from Lawrence University in Appleton, Wisconsin. He has written extensively about cutthroat trout and is the author of a major monograph on them, "Cutthroat: Native Trout of the West". (Trotter. 1987) Dr. Trotter has extensive professional experience in conducting fish habitat and population assessments, and will engage in and oversee the fish population census field work and provide consultation in the overall design of the project and interpretation and reporting of its results.

Alan Johnson owns the professional fish habitat consulting service Aquatic Resource Consultants. He has a BA in Biology/Chemistry and a Master of Science in Fisheries Biology/Statistics from the University of Minnesota. He has more than 20 years of professional experience in stream habitat analysis and management. Past work experience includes permit review and issuance, resource inventories and evaluations, habitat modification design and review, bank stabilization, and construction management for both governmental agencies and private sector interests.

Alan has also developed short courses and training sessions on various subjects including stream ecology, monitoring, and designing and implementing habitat modifications for salmon and trout. He developed, conducted and directed evaluations ranging from micro-habitat to large-scale stream inventories. These studies range from simple physical inventories to complex modeling and analysis of fish habitat and stream information. He is equipped to collect and analyze physical data (plan, profile and cross

section), biological conditions (snorkel, electrofishing, macroinvertebrates) and general water quality.

He provides consulting services in freshwater ecology and stream resource management. He also specializes in the inventory and analysis of fish habitat, development of restoration and revegetation options, monitoring and data analysis, and instruction and training.

Dr. John F. Orsborn is a Consulting Engineer (P.E.) and Professor Emeritus in the Department of Civil and Environmental Engineering from Washington State University, currently residing in Port Townsend, Washington. He has been a consultant on about 100 projects to: consulting firms; county, state, and federal agencies; private citizens; National Water Commission; United Nations; power companies; EPA; NARF; USFWS; USFS; WDOF; WDNR; WDOW; Office of Surface Mining; ODF&W; Tribes; Alaska Aquaculture Associations; Oak River National Laboratory; Missouri Department of Conservation.

Together with Alan Johnson, he has developed and taught Washington Trout's "Culvert College" field course and 175-page manual.

The principal member of the field crew, assisting Mr. Johnson, Mr. Gayeski, and Dr. Trotter will be Mr. Bill McMillan, who will also be the principal photographer for the project. Mr. McMillan is a gifted naturalist and fisheries field worker, and an experienced and outstanding nature photographer. Among his relevant experience is the initiation of systematic and still ongoing wild summer steelhead snorkel surveys on the Wind and Washougal Rivers in the late 1970s. Recently, in 1995 and 1996 he was the leader of a remote camp on the Kamchatka peninsula of Russia for the Wild Salmon Center's Kamchatka Steelhead Project, a scientific joint venture between the Wild Salmon Center and Moscow State University (Russia) which also involves Dr. Robert Behnke of Colorado State University.

In 1996/97 Mr. McMillan led a two-person field crew in a systematic survey of tributaries of the Tolt and Snoqualamie Rivers in order to assess fish presence and stream type classification, and culvert problems. This work involved a minimum of four 10-hour days per week from late October through June and requires excellent woodsmanship and map-reading skills. It also involves accurately transcribing field data onto Washington State Forest Practice Base Maps which must be submitted to the Department of Natural Resources to document change of stream type.

In 1998 he was a principal field researcher together with Dr. Trotter in the initiation of Washington Trout's project to document native resident trout populations in the mid- and upper-Columbia basin in Washington State, BPA Project #98-026, which was conducted throughout the upper Yakima and Naches River basins. Mr. McMillan and Dr. Trotter will be in the field under this project in the Coleville National Forest and environs during the summer of 1999.

Section 10. Information/technology transfer

Information and results from the project will be provided in the form of progress and semi-annual "milestone reports to CBFWA/NPPC, peer-reviewed scientific journal articles, reports in Washington Trout's newsletter, the Washington Trout Report, and on Washington Trout's website. Informational slide-show presentations will be developed

and presented to regional managers in the Yakima and other subbasins, and at meetings of professional organizations such as American Fisheries Society and the North American Benthological Society. Data will be placed in an Access data base where it can be incorporated into the regional Columbia Basin database. Data will also be incorporated into Washington Trout's GIS system, where it can also be made available to interested parties/regional databases.

Congratulations!