PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Bull Trout Genetics, Habitat Needs, L.H., Etc. In Central And N.E. Oregon

BPA project number: 9405400
Contract renewal date (mm/yyyy): 3/2001 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Oregon Department of Fish and Wildlife

Business acronym (if appropriate) ODFW

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
10.1, 10.5A.2

FWS/NMFS Biological Opinion Number(s) which this project addresses
Endangered and threatened wildlife and plants; determination of threatened status for the Klamath River and Columbia River distinct population segments of bull trout(USFWS, 1998), project activities are covered by an agreement between ODFW and USFWS

Other planning document references
ODFW Metolius subbasin plan, ODFW Malheur subbasin plan, ODFW Bull trout status report, ODFW Oregon's trout plan, Confedrated tribes of the Warm Springs Reservation resource management plan

Short description
The goal of the project is to provide scientific information that will help develop a protection and recovery plan for bull trout in Oregon's proportion of the Columbia Basin.

Target species
Bull trout (Salvelinus confluentus)

Section 2. Sorting and evaluation

Subbasin
Deschutes, John Day, Grande Ronde, Umatilla, Walla Walla, Powder, Malheur, Pine, Imnaha, Hood

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
20514	John Day Subbasin Umbrella Proposal
	Grande Ronde Subbasin Umbrella Proposal
	subcontract-Confederated Tribes of Warm Springs Reservation-Terry Luther
	subcontract-USDA Forest Service- John Sanchez
	subcontract- University of Montana- Dr. Fred Allendorf

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9202604	Spring Chinook Early Life History Project	They provide information on bull trout encountered in sampling and capture fish for tagging studies.
940400	Willamette Bull Trout Study	We provide aid in sampling for genetics and participate in information exchange
8810808	STREAMNET	We provide information and maps for website and database
910799	Evaluate the life history of native salmonids in the Malheur Basin	We provide aid in planning, exchange data and provided training for radio telemetry studies.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1996	Completed sampling and DNA analysis of 46 populations of bull trout in Oregon, Washington and Idaho to describe genetic structure of bull trout populations.	yes
1997	Conducted distribution and habitat surveys of 17 streams with sympatric populations of bull trout and brook trout (began in 1996)	yes (ongoing)
1998	Completed fieldwork portion of enclosure study of bull trout/brook trout interactions, growth and feeding behavior	yes
1997	Conducted radio telemetry study of movements and habitat use of bull trout juveniles and adults	yes(ongoing)
1998	Conducted radio telemetry study of movements and habitat use of bull trout juveniles and adults	yes(ongoing)
1996	Collected summer temperature data from streams which contain bull trout and brook trout	yes (ongoing)
1997	Collected summer temperature data from streams which contain bull trout and brook trout	yes (ongoing)
1998	Collected of summer temperature data from streams which contain bull trout and brook trout (ongoing)	yes (ongoing)
1998	Conducted adult and juvenile movement studies in upper John Day and Walla Walla subbasins(ongoing)	yes (ongoing)
1996	Completed multiple pass spawning surveys of 3 streams, 3 exploratory surveys	yes (ongoing)
1997	Completed multiple pass spawning surveys of 3 streams, 2 exploratory surveys	yes (ongoing)
1998	Completed multiple pass spawning surveys of 3 streams, spawner population estimate of 1 stream, 1	yes (ongoing)

	exploratory survey(ongoing)	
1998	Completed thermal videography of Wenaha River (Grande Ronde subbasin)	yes
1997	Completed statewide bull trout distribution maps (entered into GIS system)	yes
1997	Made two presentations at the annual meeting of the Oregon Chapter, American Fisheries Society	n.a.
1998	Made two presentations at the annual meeting of the Oregon Chapter, American Fisheries Society	n.a.
1998	Made two presentations at the annual Salvelinus confluentus Curiosity Society workshop	n.a.
1998	Made two presentations at the special bull trout meeting of the North Pacific International Chapter, American Fisheries Society	n.a.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Determine the genetic characteristics of Oregon bull trout populations.	a	Collect samples from bull trout groups within the 11 Oregon river subbasins of the Columbia Basin.
		b	Conduct nuclear DNA analysis of those samples collected in task a
		c	Determine spatial relationships between populations between populations, metapopulation structure and estimates of genetic variation within and among those populations.
2	Determine distribution of juvenile and adult bull trout and habitats associated with that distribution in portions of the Grande Ronde, John Day, Deschutes and Walla Walla subbasins..	a	Identify areas where bull trout spawn
		b	Identify movement patterns of radio-tagged migratory juvenile bull trout.
		c	Identify movement patterns and

			characterize habitat use of radio-tagged adult bull trout.
		d	Map juvenile and adult distribution using the Geographic Information System (GIS).
3	Determine relationships between stream temperature and distribution of bull trout.	a	With thermographs, identify summer temperatures experienced by juvenile bull trout in selected streams.
		b	Primarily with thermistor telemetry identify seasonal temperatures experienced by adult bull trout in the Walla Walla, John Day, Deschutes and Grande Ronde subbasins
		c	With thermographs and telemetry, identify fall through spring temperatures experienced by migrant juvenile bull trout in selected streams of the John Day subbasin.
4	Determine fluvial and resident life history patterns in the upper John Day and Walla Walla subbasins.	a	Trap downstream migrant juvenile and subadult bull trout and implant them with PIT (passive integrated transponder) tags
		b	Trap upstream migrant adult bull trout, sample for PIT tags and mark them to permit visual identification.
		c	Collect scales and length data to determine length at age.
5	Characterize relationships among bull trout and sympatric species	a	Determine the distribution and habitat use of sympatric bull trout, westslope cutthroat trout, rainbow trout and brook trout populations
		b	Estimate the amount of hybridization between bull trout and brook trout by dorsal fin pigmentation and genetic analysis.
		c	Characterize invertebrate communities in bull trout and brook trout zonations
		d	Identify food habits and feeding behavior of bull trout alone and in sympatry with brook trout.
		e	Determine a basis for assessing the relative risk to bull trout by brook trout.

6	Establish guidelines to monitor the abundance of bull trout using spawning surveys	a	Identify variation in spawning distribution.
		b	Identify variation associated with life history form.
		c	Estimate variation among spawning surveyors
		d	Determine variation in spawning timing between years.
		e	Determine duration of redd visibility

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	5/1995	9/2000			1.60%
2	5/1995	9/2001			26.00%
3	5/1996	9/2001			14.70%
4	3/1997	9/2001			18.10%
5	5/1996	9/2001			22.80%
6	5/1996	9/2001			16.80%
				Total	100.00%

Schedule constraints
None known

Completion date
2001

Section 5. Budget

FY99 project budget (BPA obligated): $339,517

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	Permanent and seasonal	%34	142,656
Fringe benefits	at 36%	%12	51,356
Supplies, materials, non-expendable property		%4	15,227
Operations & maintenance		%1	4,687
Capital acquisitions or improvements (e.g. land,		%0	0

buildings, major equip.)			
NEPA costs		%0	0
Construction-related support		%0	0
PIT tags	# of tags:	%0	0
Travel		%7	28,589
Indirect costs	at 35.5%	%20	86,093
Subcontractor	Confederated Tribes of the Warm Springs Reservation (CTWSR)	%20	84,000
Subcontractor	USDA Forest Service	%3	12,000
Other		%0	0
TOTAL BPA FY2000 BUDGET REQUEST			$424,608

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
Forest Service	Salaries, supplies and capital	%8	48,000
ODFW	Salaries, supplies and capital	%24	151,821
CTWSR	Salaries, supplies and capital	%2	12,235
		%0	
Total project cost (including BPA portion)			$636,664

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$380,000			

Section 6. References

Watershed?	Reference
☐	Bellerud, B.L.,S.Gunckel, A.R. Hemmingsen, D.V. Buchanan and P.J. Howell. 1997. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon. U.S. Department of Energy, Bonneville Power Administration,Portland, OR
☐	Buchanan, D.V., S.V. Gregory. 1997. Development of Water Temperature Standards to protect and restore habitat for bull trout and other cold water species in Oregon. Proceeding of the friends of the bull trout conference.
☐	Buchanan, D.V., M.L. Hanson and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife. Portland, Oregon.
☐	Fausch, K. 1988. Tests of competition between native and introduced salmonids in streams: what have we learned? Canadian Journal of fisheries and Aquatic Sciences 45: 2238-2246.

☐	Fausch, K. and R. White. 1981 Competition between brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta) for positions in a Michigan Stream. Canadian Journal of Fisheries and Aquatic Sciences 38: 1220-1227.
☐	Hemmingsen, A.R., D.V. Buchanan and P.J. Howell. 1996. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.
☐	Houslet, B.S. and M.D. Riehle. 1997. Trends in juvenile bull trout abundance and habitat use in relation to temperature in tributaries to the Metolius River, Oregon. U.S. Forest Service, Sisters Ranger District.
☐	Howell, P.J. and D.V. Buchanan, editors. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.
☐	Kostow, K. 1995. Biennnial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife, Portland, OR. .
☐	Leary, R.F., F.W. Allendorf and S.H. Forbes. 1993. Conservation genetics of bull trout in Columbia and Klamath River Drainages. Conservation Biology 4, 856-865.
☐	Markle, D.F. 1992. Evidence for bull trout x brook trout hybrids in Oregon. pages 58-67 in P.J.Howell and D.V. Buchanan, editors. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society,.
☐	Meehan, W. and R. Miller. 1978. Stomach flushing:effectiveness and influence on survivial and condition of juvenile salmonids. Journal of the Fisheries Research Board of Canada 35:1359-1363.
☐	Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. USDA Forest Service, Ogden, UT.
☐	Spruell, P. and F.W. Allendorf. 1997. Nuclear DNA analysis of Oregon bull trout. Oregon Department of Fish and Wildlife Report 97/5. Portland Oregon.
☐	Spruel, P., A.R. Hemmingsen, N. Kanda, P.J. Howell and F.P. Allendorf. Submitted. Conservation genetics of bull trout-geographic distribution of variation at microsatellite loci.
☐	Theisfeld, S.L., A.M. Stuart, D.E. Ratliff and B.D. Lampman. 1996. Migration patterns of adult bull trout in the Metolius River and Lake Billy Chinook, Oregon.
☐	Williams, R.N., R.P. Evans and D.K. Shiozawa. 1997 Mitochondrial DNA diversity in bull trout form the Columbia Basin. Proceedings of the friends of the bull trout conference. Calgary, Alberta.
☐	United States Fish and Wildlife Service. 1998. Endangered and threatened wildlife and plants; determination of threatned status for the Klamath River and Columbia River distinct population segments of bull trout. Federal Register,vol.63 111:31647-31674.
☐	

PART II - NARRATIVE

Section 7. Abstract

The goal of the project is to provide scientific information that will help develop a protection and recovery plan for threatened stocks of native bull trout in Oregon's proportion of the Columbia Basin. The factors addressed in the study (i.e., status, habitat needs, genetics, life history characteristics, interactions with exotic species and other limiting factors) have been identified by many authors as key factors in the survival and recovery of bull trout populations (Howell and Buchanan, 1992; Rieman and McIntyre, 1993; Kostow, 1995; Buchanan et al. 1997). From these considerations we have derived specific objectives:

1. Determine genetic characteristics of bull trout populations.
2. Determine distribution of juvenile and adult bull trout and associated habitats.
3. Determine relationships between stream temperature and bull trout distribution.
4. Determine fluvial and resident life history patterns in the upper John Day and Walla Walla subbasins.
5. Characterize interactions between bull trout and sympatric species.
6. Establish guidelines to monitor abundance of bull trout populations using spawning surveys.

Each of these objectives are addressed using established techniques including DNA analysis, systematic sampling of streams, habitat surveys, spawning surveys, radio telemetry, and trapping. Data are summarized and statistical analysis performed to test specific hypothesis. The results of our research will be used to develop guidance for fisheries managers and presented in the form of annual reports, presentations at professional meetings and publications in peer-reviewed journals.

Section 8. Project description

a. Technical and/or scientific background

Columbia and Klamath basin populations of bull trout were listed as "threatened" by the U.S. Fish and Wildlife under the Endangered Species Act June 10, 1998 (USFWS, 1998). It is estimated that bull trout occupy only 36% of their former range south of the Canadian border. Over 78 percent of the historic bull trout populations in the proposed study subbasins are classified as having a moderate or high risk of extinction or are probably extinct (Howell and Buchanan, 1992; Buchanan et al. 1997). Bull trout numbers have been severely impacted by harvest pressure, habitat degradation, passage barriers and interactions with exotic species. Past and current efforts to assess, protect and restore existing bull trout populations have been limited by the lack of basic information about bull trout ecology, life history and genetics (Howell & Buchanan, 1992; Rieman and McIntyre, 1993; Kostow, 1995; Rieman and McIntyre, 1995; Buchanan et al. 1997; Spruell and Allendorf, 1997). The intent of our study is to provide

scientific information in these areas. This will allow threats to existing bull trout populations to be correctly evaluated and management decisions pertaining to bull trout conservation and recovery to be effectively implemented and monitored.

b. Rationale and significance to Regional Programs

These studies directly address measures 10.1 and 10.5A.2 of the Columbia River Basin Fish and Wildlife Program by providing scientific information that will help protect and restore weak stocks of native bull trout in northeast Oregon. Like salmon and steelhead, bull trout stocks in Oregon have been impacted by hydroelectric development in the mainstem Columbia River, the mainstem Snake River, and various tributaries.

Migration barriers, which limit access to spawning and rearing habitats, and which reduce the prey base have impacted Bull trout populations. Hydroelectric dams have also isolated small bull trout populations and prevented genetic exchange among populations. This leads to increased risk of extinction of these populations from genetic factors and random events (Rieman and McIntyre, 1993). Other factors including over-harvest; non-native species introductions and habitat loss have also contributed to the decline of bull trout populations. The work of Spruell and Allendorf (1997) suggest that maintaining the genetic diversity of bull trout will require the continued existence of many populations throughout the Columbia Basin.

Our study also contributes to goals, research needs and objectives stated in the ODFW Metolius subbasin plan, ODFW Malheur subbasin plan, ODFW statewide bull trout status report and Resource management plan of the Confederated Tribes of the Warm Springs Reservation. By providing basic information on life history, ecology and genetics of bull trout the studies will contribute to management, preservation and restoration of bull trout populations all over the Columbia Basin.

c. Relationships to other projects

We have developed working relationships with a number of other projects and agencies during the course of our research. We receive data from the Lookingglass re-introduction project (Confederated Tribes of the Umatilla Indian Reservation, Lower Snake Restoration) and spring chinook early life history project (ODFW, BPA) in the Grande Ronde subbasin. We exchange data with the ODFW Willamette bull trout project, a USFS/ Idaho Department of Fish and Game bull trout study in the Rapid River, ID and a current USFS research project on bull trout in Lake Pend Orille, Idaho.

Our study also supports graduate research programs in conjunction with the Department of Fisheries and Wildlife at Oregon State University. We cooperate with the Walla Walla Ranger District of the U.S. Forest Service (USFS) in conducting spawning surveys and operating upstream and downstream migrant traps on the Mill Creek drainage (Walla Walla sub basin). We provide data from Mill Creek study to the Washington Department of Fish and Wildlife. The Confederated Tribes of The Warm Springs Reservation has been subcontracted to update distribution and relative abundance, spawning distribution and movement patterns of bull trout on and bordering their reservation lands. We also exchange data with many of the fishery management

biologists from tribes, ODFW and USFS in areas of Oregon and southeast Washington where bull trout occur.

We provided technical assistance to the Burns Paiute Tribe for a BPA funded study in the Malheur subbasin, a cooperative study funded by the USFS and Idaho Public Power in the Pine Creek subbasin and an EPA-funded study being conducted by ODFW in the Umatilla subbasin. We have also served as scientific advocates for bull trout by encouraging interest in the species by fisheries managers and biologists and providing a source of information, such as our annual reports and the Oregon Bull Trout Status Report.

d. Project history (for ongoing projects)

The Project was initiated in late 1994. Beginning phases of the project included several cooperative meetings with local subbasin bull trout working groups comprising tribes, utilities, landowners, USFS, U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), and ODFW. Major cost-share funding from permanent positions and capital have been provided by ODFW, USFS and the Confederated Tribes of the Warm Springs Reservation. A Steering Committee with representatives of BPA, ODFW, Tribes, BLM, USFS, USFWS, Portland General Electric, Pacificorp and the Native Fish Society meets annually to technically review the project. Fieldwork and data collection began in spring 1995.

Publications:

Many monthly and quarterly reports

1995 Annual Report (Hemmingsen et al., 1996),

1996 Annual Report (Bellerud et al., 1997)

1997 Annual Report (in press),

1998 Annual Report (in progress)

Oregon Bull Trout Status Report (Buchanan et al., 1997),

Nuclear DNA Analysis of Oregon Bull Trout (Spruell and Allendorf, 1997)

Spruell, P., A.R. Hemmingsen, N. Kanda, P.J. Howell and F.P. Allendorf. (Submitted). Conservation genetics of bull trout-geographic distribution of variation at microsatellite loci.

This study collected data towards completion of all 23 of tasks listed in our work plan for the study.

1. We non-lethally sampled 46 bull trout populations for nuclear DNA analysis. These samples have been analyzed and the results are included in the 1996 annual report and in a special genetics report (Spruell and Allendorf, 1997) and has been submitted to a peer-reviewed journal (Spruell et al.).

2. Current and historical bull trout distribution data and status of current populations were compiled for Oregon's portion of the Columbia River system. A statewide status report on Oregon's bull trout was published in 1997 and distribution data were entered into ODFW Geographical Information System (GIS) bull trout database (Buchanan et al., 1997).

3. We conducted distribution and habitat surveys and sampled for the incidence of bull trout/brook trout hybrids in 17 streams with sympatric populations of brook trout and bull trout (1996 and continuing). Data summary and analysis was reported in the 1996 and 1997 annual report, the 1998 meeting of the Oregon chapter American Fisheries Society

and the 1998 *Salvelinus confluentus* Curiosity Society Workshop.
4. Collected three years of summer temperature data from streams with sympatric bull trout and brook trout populations (1996–1998 and continuing).
5. Collected three years of bull trout spawning data. This included intensive and extensive surveys of three selected watersheds to examine some of the assumptions inherent in spawning surveys (1996-98, continuing). Single exploratory surveys were also made to identify previously undocumented spawning areas. (Bellerud et al., 1997)
6. We radio-tagged and monitored movement of 80 adult and 90 juvenile bull trout in the Grande Ronde, Walla Walla and John Day subbasins 1997 and 1998 (continuing).
7. We determined a relationship between observed injuries and fish size in bull trout captured by electrofishing (Hemmingsen et al. 1996). These data were incidental to efforts for collection of samples for DNA analysis.
8. We collected data in 1997 and 1998 to describe the species composition of macroinvertebrates available to and consumed by both sympatric and allopatric bull trout and non-native brook trout in 2 streams within different subbasins.
9. We conducted an experiment during the summers of 1997 and 1998 to determine the effect of brook trout on the foraging behavior of bull trout. This information will be published in a Master's thesis at Oregon State University and in refereed journals.
10. We operated upstream and downstream traps in the John Day and Walla Walla subbasins.

e. Proposal objectives

Objective 1. Determine the genetic characteristics of Oregon bull trout populations. The null hypothesis associated with this objective is " H_o: There is no significant genetic difference among Oregon bull trout populations". This objective will result in a description and inventory of the genetic structure of Oregon bull trout populations (Spruell and Allendorf, 1997; Spruell et al., submitted). Knowledge of the limits of interbreeding populations is one of the cornerstones of scientific fisheries management. These data are also necessary to assess and maintain genetic diversity and integrity of bull trout populations (Spruell and Allendorf, 1997; Spruell et al., submitted) and could also be useful in providing an empirical basis for validation and application of the metapopulation theory to the conservation of the species (Rieman and McIntyre, 1993).

Objective 2.0 Determine distribution of juvenile and adult bull trout and habitats associated with that distribution. This will allow assessment and tracking of bull trout populations and guide efforts towards habitat protection, enhancement, and restoration. Such habitat information is necessary for the protection of existing critical habitat and any restoration efforts that my be undertaken. Bull trout distribution within a basin may vary widely depending on life history, life stage and season. The overall null hypothesis to be tested is "$H_{o:}$ There is no significant difference between observed bull trout distribution and a random distribution". Distribution maps from this objective have been made available to management biologists and posted on the Streamnet world wide web site (Buchanan et al., 1997).

Objective 3.0 Determine relationships between stream temperature and distribution of bull trout. This objective addresses one of the most critical habitat factors associated with bull trout in Oregon (Buchanan and Gregory, 1997; Houslet and Riehle, 1997). This will help to identify the role that temperature plays in shaping bull trout distribution. This information also relates to efforts to restore populations by habitat enhancement to lower instream temperatures. The null hypothesis associated with this project is: "H_o: Stream temperature has no significant correlation with the distribution of bull trout".

Objective 4.0 Determine fluvial and resident life history patterns in the upper John Day and Walla Walla subbasins. Knowledge of life history characteristics, such as spawning and migration behavior, is critical for assessing the status and risks to populations (Rieman and McIntyre, 1993), habitat protection and restoration efforts and strategies for monitoring populations. One of the components of this objective examines the role of non-migrant fish in otherwise migrant bull trout populations. The null hypothesis associated with this project is: "Ho: Fluvial and resident life history forms do not co-exist within a stream".

Objective 5.0 Characterize interactions between bull trout and sympatric species. Over 50% of Oregon bull trout populations are sympatric with introduced brook trout (Buchanan et al., 1997). Brook trout may directly compete with bull trout for habitat and food and have also been observed to hybridize with bull trout (Markle, 1992). It is also necessary to understand the relationships between bull trout and other native salmonids, such as westslope cutthroat trout, to understand how habitat use and behavior of bull trout have changed since the introduction of brook trout. Additionally, experiments will be performed to detect if competition actually occurs between bull trout and brook trout. Hypothesis to be tested include:

"H_o: the distribution of bull trout and brook trout in streams where they both occur is not significantly different than would be expected from a random distribution".

"H_o: There is no significant difference in habitat between areas inhabited by bull trout and areas inhabited by brook trout within the same stream" and :

" H_o: There is no significant difference in water temperature between areas inhabited by bull trout and areas inhabited by brook trout within the same stream"

"H_o: The presence of brook trout has no significant effect on the feeding behavior or growth of bull trout."

"H_o: The diet of bull trout does not change in the presence of brook trout".

Objective 6.0 Establish guidelines to monitor the abundance of Oregon bull trout using spawning surveys. Little information is available on bull trout abundance and population trends, particularly in Oregon (Rieman and McIntye, 1993). Bull trout are a rare and cryptic species so enumerating them is very difficult. Spawning surveys have been used with a number of salmonid species to monitor populations. This objective examines variability associated with using spawning surveys, provides baseline data for designing surveys and evaluates their utility as a monitoring tool. Without reliable monitoring of populations it is not possible to determine the effectiveness of recovery efforts. Hypothesis to be tested include:

"H_o: There is no significant difference between years in the distribution of redds within a

stream".
" H_o: There is no significant difference between redd counts by different surveyors".
" H_o: There is no significant difference between years in spawning timing".
"H_o: There is no significant difference in the variation of distribution of redds within a stream between resident and fluvial forms".
" H_o: There is no significant difference in variation redd counts by different surveyors between resident and fluvial forms".
" H_o: There is no significant difference in variation in spawning timing between fluvial and resident forms".

f. Methods

Methods for project work undertaken during 1995-98 are described in annual reports for the project for those years (see section d. Project history). The following discussion focuses on methods for tasks to be undertaken in FY 99-01. It should be noted that the previous work represents a substantial investment in time, effort, and funding. Funding in FY 99-01 is needed to complete the fieldwork, analyze the data, and report the findings so that the results can be applied and the benefits of those investments realized. For example, adult bull trout tagged in 1998 will require tracking through 2000.

The tasks in this study frequently integrate multiple objectives. For example, fish captured for radio-tagging and subsequent tracking provide data on length at age, life history, migration patterns, habitat and water temperature association, maturity, spawning locations, and growth when recaptured.

Objective 1.0
1.1 Genetic samples were collected from 46 bull trout populations in 11 subbasins in Oregon. Sampling sites were chosen to represent the range of bull trout in central and eastern Oregon. Several subbasins were selected for more intensive sampling. Collection methods are described in Hemmingsen et al. 1996. Collections in the lower Deschutes subbasin will be conducted in FY 99-00.
1.2 Tissue samples will be sent to the University of Montana for analysis by polymerase chain reaction and DNA sequencing techniques (Spruell and Allendorf 1997)
1.3 The results of this analysis will presented in a project reports (Spruell and Allendorf 1997; Spruell et al., submitted).

Objective 2.0.
2.1 Juvenile bull trout were captured in the Walla Walla and John Day subbasins on their downstream migration using screw and weir traps. Bull trout > 150 mm fork length in the Walla Walla subbasin and >120mm fork length in the John Day subbasin were PIT (passive integrated transponder) tagged (Bellerud et al. 1997). A subsample (n=90) was radio-tagged and tracked. Downstream trapping, tagging, and tracking will continue during FY98-01. Approximately 50 downstream migrants will be radio-tagged in FY 00.
2.2 Large (>900 g.), upstream migrating bull trout, assumed to be adults, were captured in 1997 and 1998 by angling and traps (Bellerud et al. 1997). Radio tags were surgically implanted in 80 fish. Tagged bull trout will be tracked through FY01.

2.3 Data on bull trout movement patterns and habitat associations will be compiled and entered into a computer database. Adult and juvenile bull trout distribution will then mapped using ArcInfo geographic information system (GIS) software.

Objective 3.0
3.1 Electronic temperature loggers were placed within surveyed streams in areas identified as bull trout zones, brook trout zones and where bull trout and brook trout distribution overlapped. At the end of the sampling season the temperature loggers were recovered and the data they contained downloaded to a PC for summary and analysis (Bellerud et al. 1997). Temperature and distribution monitoring will continue in FY 99-00.
3.2 We implanted thermistor (i.e., temperature-reporting) radio tags in fish > 450 mm fork length in the Walla Walla subbasin and in the Wenaha River (Grande Ronde subbasin). We will continue monitoring these tags through FY 99-01.
3.3 Water temperature and fish locations from radio tracking data will be entered into a computer database. This data will be used to create fish distribution and temperature map layers in ArcInfo.

Objective 4.0
4.1 Juvenile bull trout were captured on their downstream migration using screw and weir traps and PIT tagged (Bellerud et al. 1997). A subsample (n=90) was radio-tagged and tracked. Large (>900 g.), upstream migrating bull trout assumed to be adults were captured in 1997 and 1998 by angling and traps (Bellerud et al. 1997). Trapping, tagging, and tracking will continue during FY-01 to establish fluvial migratory or resident life history patterns.
4.2 Scales and lengths of fish collected in traps will be taken and analyzed to determine age/length relationships (Bellerud et al. 1997).

Objective 5.0.
5.1 We surveyed streams identified as containing both bull trout and brook trout by one-pass electrofishing (Bellerud et al. 1997). Physical habitat surveys were conducted for comparison of bull trout and brook trout zones (Bellerud et al. 1997).
5.2 Fish collected during task 5.1 were examined to identify the presence of brook trout/bull trout hybrids. Hybrids were identified using the characters in Markle (1992): dark spots on the dorsal fin, vermiculation and tri-color ventral fins. Fin clips were also gathered from fish identified as hybrids for verification by genetic analysis.
5.3 Aquatic invertebrate samples were collected from the bull trout, sympatric and brook trout zones of streams. Benthic samples were collected from six pools in each zone and drift samples were collected from three pools in each zone. Macroinvertebrates samples were identified to family and enumerated. From these samples relative abundance was estimated for the benthic and drift communities. Non-lethal stomach samples (Meehan and Miller, 1978) were also collected from 10-20 bull trout and brook trout from each zone. Samples were identified and enumerated to identify macroinveribrate family and size composition consumed by each species in each reach.
5.4 Bull trout and brook trout were placed in enclosures in stream reaches where they

are sympatric (Fausch, 1988). Treatments included enclosures with only bull trout and bull trout with brook trout. Fish were marked to allow identification of individuals and observations of feeding behavior were conducted by weekly snorkel surveys (Fausch and White, 1981). After six weeks the fish were removed from the enclosure weighed and measured to estimate comparative growth and released. During the second season growth rates of fishes from the enclosures was compared with other fish in the stream. Data from this study will be analyzed and published in FY 99-01.

Objective 6.0
6.1 Spawning surveys have been conducted in Mill Creek (Walla Walla subbasin), the Little Minam River (Grande Ronde subbasin) and Silver Creek (Powder River subbasin) (Bellerud et al. 1997) to evaluate spawning survey methodology. Mill Creek has a population of large, migratory spawners and some resident spawners. The Little Minam has a relatively large population of resident fish. Silver Creek has a very depressed population of resident
fish. These streams will allow us to evaluate potential variation in life histories and spawning substrate relative to spawning surveys. Each creek will be surveyed 3-4 times between the end of August and the end of October during FY 99-00. By sampling the reaches multiple times during the spawning season we will be able to identify variation in spawning timing. Additionally, redds are evaluated for visibility to develop an estimate of the amount of time the redds remain visible (Bellerud et al. 1997), which can be used to help determine survey frequency.
6.2 All tributaries upstream of the lowest reach surveyed will be surveyed (Bellerud et al. 1997). From this data we will determine variation in spawning distribution within the drainage.
6.3 Selected reaches will be surveyed by experienced and inexperienced surveyors to estimate observer variation (Bellerud et al. 1997).
Spawning surveys will be continued in FY 99-00.

g. Facilities and equipment

The main facilities used in this study are the ODFW laboratory at Corvallis, Oregon, the ODFW headquarters and regional offices and the Pacific Northwest Research Station (USFS) at La Grande, Oregon and the Confederated Tribes of Warm Springs Reservation offices at Warm Springs, OR. We also receive support from other ODFW and U.S. Forest Service facilities.

The ODFW laboratory at Corvallis, Oregon includes office facilities, a computer network, library, and a scale reading laboratory. Many facilities at nearby Oregon State University are also available to ODFW personnel.

The ODFW headquarters office, located in Portland, Oregon, provides access to a mainframe computer and GIS facilities, office space, and administrative support. The location of the headquarters office allows access to local university libraries and other resources.

The research office at LaGrande, Oregon provides office space, computers, and limited lab space. There is also a site for equipment storage and other support available from the ODFW regional office. The facilities of Eastern Oregon University where the office is located are also available.

h. Budget

Increases in the budget proposed for FY 00 reflect increases in costs from three main sources; undertaking additional studies to address our stated tasks and objectives, annual merit and cost of living increases in our salaries and our subcontractors salaries, an increase in overhead charged by ODFW.

We will be undertaking studies of westslope cutthroat trout to better understand the relationship between bull trout and sympatric species of native salmonids. This information will allow us to contrast those relationships with the relationship between bull trout and brook trout (or other exotic species).

An additional cost to this project was caused by an increase in indirect costs charged by ODFW from 22.9% to 35.5% in 1998. In order to maintain levels of effort adequate to fulfill our stated objectives we require a budget increase to offset this increased charge.

Section 9. Key personnel

Dave Buchanan, ODFW, Principle Investigator, 0.25 FTE- no charge to BPA
Blane Bellerud, ODFW, Project Manager, 1.0 FTE
Alan Hemmingsen, ODFW, Principle Investigator, 0.5 FTE, 0.25 FTE no charge to BPA
Phil Howell, Project Manager, U.S. Forest Service, 0.25 FTE - no charge to BPA
Terry Luther, Program Manager, CTWSR 0.1 FTE - no charge to BPA
Chris Brun, Project Manager, CTWSR 1.0 FTE

David V. Buchanan
Project Leader, Oregon Department of Fish and Wildlife Bull Trout Project

Education:
B.S. in Fisheries Science, Oregon State University, 1967
M.S. in Fisheries Science, Oregon State University, 1970

Professional Experience:

1987-Present: ODFW, Research Project Leader, Native Trout Project, Corvallis, OR. Wrote proposal and conducted original research on several projects studying bull trout, rainbow trout and redband trout.

1986-1987: ODFW, Assisted in developing Oregon's statewide trout plan.

1979-1988: ODFW, Research Project Leader, Restoration of the Native Winter Steelhead Run on the South Santiam River above Foster Dam, Corvallis, OR.

1974-1979: ODFW, Assistant Project Leader, Willamette River Steelhead, Development and assessment in the Willamette River Basin, Corvallis, OR.

1972-1974: Oregon State University: Research Assistant, Toxicity of 13 pesticides to Dungeness crab, OSU Marine Science Center, Corvallis, OR.

1970-1972: Alaska Department of Fish and Game, Regional shellfish biologist, studied king crab, Dungeness crab, pink shrimp, pink salmon and steelhead, Petersburg, AK.

Relevant Publications:

Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Proceedings of the friends of the bull trout conference. Calgary, Alberta.

Buchanan, D.V., M.L. Hanson and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife. Portland, Oregon.

Bellerud, B.L., S.Gunckel, A.R. Hemmingsen, D.V. Buchanan and P.J. Howell. 1997. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon, 1996 Annual Report. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Currens, K.P., A.R. Hemmingsen, R.A. French, D.V. Buchanan, C.B. Schreck, and H.W. Li. 1997. Introgression and susceptibility to disease in a wild population of rainbow trout. North American Journal of Fisheries Management. 17:1065-1078.

Howell, P.J. and D.V. Buchanan, editors. 1992. Proceeding of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Blane L. Bellerud Ph.D.
Fisheries Research Biologist, Oregon Department of Fish and Wildlife

Education:
B. S. in Marine Biology, Western Washington University, 1983
M.S. in Aquatic Biology, Central Washington University, 1989
Ph.D. in Aquatic Parasitology, Mississippi State University, 1994

Professional Experience:

Assistant Project Leader, ODFW Bull Trout Project, 6/96 to present.
Develop experimental strategies, protocols and plans, supervise seasonal employees, conduct sampling, summarize and analyze data, write reports.

Assistant Project Leader, ODFW Elk Creek Dam Project, 8/95-6/96
Develop experimental strategies, protocols and plans, supervise seasonal employees, conduct sampling, move spawning salmon by truck, summarize and analyze data, write reports.

Research Biologist, National Biological Service, 1/94 - 8/95
Develop experimental strategies, protocols and plans, supervise seasonal employees, conduct sampling, summarize and analyze data, write reports.

Relevant Publications:

Bellerud, B.L., S.Gunckel, A.R. Hemmingsen, D.V. Buchanan and P.J. Howell. 1997. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon, 1996 Annual Report. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Bellerud, B.L., S.Gunckel, A.R. Hemmingsen, D.V. Buchanan and P.J. Howell. In press. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon, 1997 Annual Report. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Bellerud, B.L., S.Gunckel, A.R. Hemmingsen, J. Shappart, D.V. Buchanan and P.J. Howell. In Progress. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon, 1998 Annual Report. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Alan R. Hemmingsen
Fisheries Research Biologist, Oregon Department of Fish and Wildlife.

Education:
BS Fisheries and Wildlife Biology, Iowa State University, 1971,

Professional Experience:

1988 - Present:
Oregon Department of Fish and Wildlife, Assistant Project Leader, Native Trout Investigations.

Qualifications:

Since 1988 I have conducted or assisted various investigations on native trout in Oregon. Those investigations were designed to describe the diversity among native trout, determine threats to their sustainability, and foster awareness of their value. Specific projects involved genetic characterization of populations, description of life history traits, definition of migration patterns, and identification of critical habitat needs. Through these investigations I have obtained biological knowledge and field skills that can be directly applied to research efforts on Oregon bull trout.

Relevant Publications:

Currens, K.P., A.R. Hemmingsen, R.A. French, D.V. Buchanan, C.B. Schreck, and H.W. Li. 1997. Introgression and susceptibility to disease in a wild population of rainbow trout. North American Journal of Fisheries Management. 17:1065-1078.

Spruell, P., A.R. Hemmingsen, N. Kanda, P.J. Howell and F.P. Allendorf. Submitted. Conservation genetics of bull trout-geographic distribution of variation at microsatellite loci.

Bellerud, B.L., S.Gunckel, A.R. Hemmingsen, D.V. Buchanan and P.J. Howell. 1997. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon, 1996 Annual Report. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Hemmingsen, A.R., D.V. Buchanan, and P.J. Howell. 1996. Bull trout life history, genetics, habitat needs, and limiting factors in central and northeast Oregon. Annual Report 1995. Prepared for the U.S. Department of Energy, Bonneville Power Administration. Project Number 94-54. Portland, Oregon.

Hemmingsen, A.R., R.A. French, D.V. Buchanan, D.L. Bottom, and K.P. Currens. 1992. Native trout project. Oregon Department of Fish and Wildlife, Fish Research Project F-136-R, Portland.

Philip J. Howell
Fisheries Biologist/Aquatic Ecologist
USDA Forest Service, Pacific Northwest Research Station

Education:

B.A. Rockhurst College, 1972
M.A. University of Missouri, 1976

Professional Experience

1992-Present, U.S. Forest Service, Interior Columbia Ecosystem Management Project-Science Team, project design and development, assistance with field work, data analysis and reporting, coordination with Forest Service.

1979-1992, Oregon Department of Fish and Wildlife, Project Leader, Corvallis, OR.

1979-1982, Oregon State University, Instructor, Corvallis, OR

Expertise:

I currently provide aquatic science oversight for the development of a management plan for federal lands in the interior Columbia Basin, which will address the habitat management needs of bull trout and other aquatic species. For that project I completed and assessment of the status, distribution and management of bull trout and other aquatic species east of the Cascades. I have also been a program manager of the BPA-Funded study of bull trout genetics, life history, habitat needs and limiting factors in eastern Oregon since the project began. In 1992 I completed the first assessment of bull trout distribution, status and management in Oregon.

Relevant publications:

Spruell, P., A.R. Hemmingsen, N. Kanda, P.J. Howell and F.P. Allendorf. Submitted. Conservation genetics of bull trout-geographic distribution of variation at microsatellite loci.

Lee, D.C., J.R. Sedell, B.R. Rieman, R.F. Thurow, J.E. Williams, P.J. Howell and 15 co-authors. 1997. Broadscale assessment of aquatic species and habitats. pages 1057-1496 *in* Quigley, T.M., S.J. Arbelidae, editors. An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins. USDA Forest Service, Pacific Northwest Research Station. Portland, Oregon.

Bellerud, B.L., S.Gunckel, A.R. Hemmingsen, D.V. Buchanan and P.J. Howell. 1997. Bull trout life history, genetics habitat needs, and limiting factors in central and northeast Oregon, 1996 Annual Report. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Stowell, R.P., P.J. Howell., B. Rieman and J. McIntyre. 1994. An assessment of the conservation needs for bull trout. USDA Forest Service. Missoula, Montana.

Ratliff, D.E. and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in Howell, P.J. and D.V. Buchanan, editors. proceeding so the Gearhart Mountain bull trout workshop. American Fisheries Society, Corvallis, Oregon.

Terry A. Luther
Fish, Wildlife and Parks Manager
Confederated Tribes of the Warm Springs Reservation of Oregon

Education:

B.S. Wildlife Science, Oregon State University, 1976

Currently responsible for the management and supervision of fisheries, wildlife and parks programs on and off the reservation. This involves oversight of 18 different projects and contracts including two cede area offices in Hood River and John Day, Oregon. Other responsibilities involve; timber harvest impacts to fish and wildlife resources, development and implementation of integrated plans for fish and wildlife resources, FERC coordination, wildlife mitigation efforts, bull trout research and spotted owl project monitoring.

Christopher V. Brun
Resident Fisheries Biologist
Confederated Tribes of Warm Springs Reservation of Oregon

Education:
B.S. Environmental Studies, Lewis and Clark College, 1988.
Post. Bac. Fisheries Course Work. Oregon State University, 1991.

Currently bull trout project leader for CTWSRO on Reservation and ceded lands. Responsible for researching bull trout distribution, abundance, life history and habitat needs in Reservation waters. Provide technical input to the Metolius and Hood River Bull Trout Working Groups.

Professional Experience:

Fisheries Biologist, USFS, Mt. Hood National Forest. 5/90-4/96
Developed and implemented stream restoration projects. Provided fisheries input in timber sale and grazing allotment planning. Assisted with bull trout monitoring in the Hood River.

Fish and Wildlife Biologist, USFS, Mendocino National Forest. 4/96-8/96
Wrote Biological Assessments and Evaluations for threatened and endangered species including coho salmon and spotted owls. Provided fisheries input in timber sale planning.

Resident Fisheries Biologist, Confederated Tribes of Warm Springs Oregon. 8/96-3/98.
Provided fisheries input in timber sale planning. Monitored bull trout in Reservation waters and participated in the Metolius bull trout working group.

Relevant Publications:

Brun, C.V. (unpublished). Juvenile bull trout distribution and spawning areas in the Warm Springs Reservation, Oregon.

Section 10. Information/technology transfer

Information from this research will be distributed by publications, presentations, and other means. The primary publications of this project will be annual reports distributed to ODFW, USFS and other agencies. These reports are available to other interested parties on request. We have also published special reports such as the Oregon Bull Trout Status Report (Buchanan et al., 1997) and Nuclear DNA Analysis of Oregon bull Trout (Spruell and Allendorf, 1997) Articles will also be published in peer-reviewed journals. We have, and continue to make presentations at intra-agency and interagency meetings. We recently held an information meeting for ODFW management biologists with bull

trout in their districts. Presentations have also been made at professional meetings such as the Oregon, North Pacific International chapters of the American Fisheries Society (1997-1998), and the *Salvelinus confluentus* Curiosity Society (1998). Dave Buchanan (Principal Investigator) gave a talk for the Blue Mountain Natural resources Council that was broadcast on television throughout northeast Oregon. Phil Howell presented the study design and preliminary results to Forest Service biologists and program managers from areas throughout Oregon and Washington. Alan Hemmingsen and other project personnel made a presentation to visiting fisheries biologists from British Columbia. We have also done outreach activities with local groups such as schools, high school teachers and the cub scouts. We have also developed a web page for the internet.

Data from our research will be used in development of management policy and programs concerning bull trout. The gathering of information to develop such policies is the key reason for undertaking this research project.

Congratulations!