PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Evaluate A Mark-Resight Survey For Estimating Numbers Of Redds

BPA project number: 20055
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
U.S. Forest Service, Rocky Mountain Research Station

Business acronym (if appropriate) RMRS

Proposal contact person or principal investigator:

Name	William L. Thompson
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NPPC Program Measure Number(s) which this project addresses
2.1A, 4.2A, 4.3A, 7.13A, 7.14A, 7.1E

FWS/NMFS Biological Opinion Number(s) which this project addresses
Valid population estimates of Snake River Chinook Salmon are required to:
I.-B.-2) Evaluate the relevance of the environmental baseline to the species' current status
I.-B.-3) Determine the effects of proposed or continuing action on listed species

Other planning document references
1. Monitoring adult chinook spawning escapements is listed as a Critical Data Need by IDFG (1992)

Short description
We propose a pilot study to evaluate the use of a mark-resight survey for obtaining estimates of numbers of Snake River chinook salmon redds. If successful, our method would provide a statistically rigorous means of monitoring salmonid populations.

Target species

Section 2. Sorting and evaluation

Subbasin
Salmon

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

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9064	Analyze the Persistence and Spatial Dynamics of Snake River Chinook Salmon	Validation of methodology
9107300	Idaho Natural Production Monitoring/Evaluations	Collaborative, information sharing

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	Evaluate a mark-resight survey for estimating numbers of redds	a	Count and map redds via aerial and ground counts.
		b	Statistical analsis of data and assessment of methodology.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	9/2000	12/2000		X	100.00%
				Total	100.00%

Schedule constraints
If weather and water conditions are unsuitable for conducting redd counts during the scheduled time period, counts may have to be postponed until the following year.

Completion date
2000

Section 5. Budget

FY99 project budget (BPA obligated): $0

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	One month for two temporary Scientists to conduct redd counts; 3 months for permanent Scientist	%64	27,360
Fringe benefits	20.55%	%13	5,623
Supplies, materials, non-expendable property	Misc. equipment	%2	1,000
Operations & maintenance	Vehicle costs	%3	1,500
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	0
NEPA costs		%0	0
Construction-related support		%0	0
PIT tags	# of tags:	%0	0
Travel	Per diem	%2	1,000
Indirect costs	18%	%15	6,567
Subcontractor		%0	0
Other		%0	0
		TOTAL BPA FY2000 BUDGET REQUEST	$43,050

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
RMRS	2 months permanent biologist salary	%9	9,880
RMRS	Operations & Maintenance (helicopter surveys) - BPA Project 9064	%27	31,000
RMRS	Office space, administrative assistance	%7	8,400
RMRS	Computer hardware and software for data compilation, word processing, communicaton with cooperators, and analysis	%4	5,100
RMRS	GPS units for ground and aerial surveys, GPS and GIS software	%16	18,650
		Total project cost (including BPA portion)	$116,080

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget				

Section 6. References

Watershed?	Reference
☐	Chapman, D. G. 1951. Some properties of the hypergeometric distribution with applications to zoological censuses. University of California Publications in Statistics 1:131-160.
☐	Dauble, D. D., and D. G. Watson. 1997. Status of fall chinook salmon populations in the mid-Columbia River, 1948-1992. North American Journal of Fisheries Management 17:283-300.
☐	Elms-Cockrum, T. J. 1997. Salmon spawning ground surveys, 1996. Idaho Department of Fish and Game Report 97-25, Boise, Idaho.
☐	Emlen, J. M. 1995. Population viability of the Snake River chinook salmon (Oncorhyncus tshawytscha). Canadian Journal of Fisheries and Aquatic Sciences 52:1442-1448.
☐	Federal Register. 1998. Endangered and threatened species: withdrawal of proposed rule to list Snake River spring/summer chinook and fall chinook salmon as endangered. Federal Register 63(7):1807-1811.
☐	Gilbert, R. O. 1973. Approximations of the bias in the Jolly-Seber capture-recapture model. Biometrics 29:501-526.
☐	Henny, C. J., and D. Anderson. 1979. Osprey distribution, abundance, and status in western North America III. The Baja California and Gulf of California population. Bulletin of the Southern California Academy of Sciences 78:89-106.
☐	Henny, C. J., M. M. Smith, and V. D. Stotts. 1974. The 1973 distribution and abundance of breeding ospreys in the Chesapeake Bay. Chesapeake Science 15:125-133.
☐	Idaho Department of Fish and Game (IDFG). 1992. Anadromous fish management plan 1992-1996. Idaho Department of Fish and Game, Boise, Idaho.
☐	Lee, D. C., and W. E. Grant. 1995. A hierarchical approach to fisheries planning and modeling in the Columbia River Basin. Environmental Management 19:17-25.
☐	Lee, D. C., J. R. Sedell, B. E. Rieman, R. F. Thurow, and J. E. Williams. 1997. Broadscale assessment of aquatic species and habitats. Volume III, Chapter 4. U.S. For. Serv., Gen. Tech. Rep. PNW-GTR-405, Portland.
☐	Magnusson, W. E., G. J. Caughley, and G. C. Grigg. 1978. A double-survey estimate of population size from incomplete counts. Journal of Wildlife Management 42:174-176.
☐	Marmorek, D. R., and C. N. Peters, editors. 1998. Plan for analyzing and testing hypotheses (PATH): retrospective and prospective analyses of

	spring/summer chinook reviewed in FY 1997. Compiled and edited by ESSA Technologies, Limited, Vancouver, BC.
☐	National Research Council. 1996. Upstream: salmon and society in the Pacific Northwest. National Research Council, Washington, D.C. Chapter 3:39-66.
☐	Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Washington, and Idaho. Fisheries 16(2):4-21.
☐	Northwest Power Planning Council (NWPPC). 1994. 1994 Columbia River Basin Fish and Wildlife Program. Portland, Oregon.
☐	Pollock, K. H., and W. L. Kendall. 1987. Visibility bias in aerial surveys: a review of estimation procedures. Journal of Wildlife Management 51:502-510.
☐	Rieman, B. E., and D. L. Myers. 1997. Use of redd counts to detect trends in bull trout (Salvelinus confluentus) populations. Conservation Biology 11:1015-1018.
☐	Seber, G. A. F. 1982. The estimation of animal abundance and related parameters. Second edition. MacMillan Publishing, New York, New York.
☐	Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, San Diego, California.
☐	White, G. C., D. R. Anderson, K. P. Burnham, and D. L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, LA-8787-NERP, Los Alamos, New Mexico.
☐	

PART II - NARRATIVE

Section 7. Abstract

The ability to detect an important trend in numbers of a fish population depends upon obtaining quality estimates of abundance and precision in a cost-efficient manner. Simply relying on a relative index, which is a count that has not been adjusted for undetected objects or individuals, may lead to misleading conclusions because of the unknown magnitude of the sampling bias. A common approach to estimating chinook samon populations is to use an index count of annual numbers of redds. The assumption is that these uncorrected counts represent a constant proportion of true numbers of redds across time, which is unlikely given the nonconstant detection rates of redds due to a myriad of environmental factors affecting their sightability. Further, an index count provides an single number with no measure of precision, i.e., it does not include sampling variation. Therefore, we propose a pilot study to evaluate the applicability, efficiency, and cost-effectiveness of a modified two-sample, Lincoln-Petersen mark-resight estimator for obtaining unbiased and precise abundance estimates of spring/summer chinook salmon redds in the Snake River drainage. If successful, this approach would provide a statistically rigorous means of monitoring salmonid populations by producing

an unbiased (or nearly unbiased) estimate of redd nnumbers with a valid measure of precision.

Section 8. Project description

### a.	Technical and/or scientific background

Low numbers of Snake River spring/summer chinook salmon (*Oncorhynchus tshawytscha*) prompted its listing as a threatened species under the Endangered Species Act in 1992 and its emergency listing as an endangered species in 1994. Although Snake River stocks have not improved, a proposal to continue their endangered status was recently withdrawn; hence, they are currently listed as threatened (Federal Register 1998). Factors thought to be driving this decline include the deleterious effects of hydroelectric dams on upstream access and downstream passage, loss or degradation of freshwater spawning and rearing habitats, overexploitation by commercial fisheries, and detrimental effects of hatchery fish on wild populations (Nehlsen et al. 1991, National Research Council 1996, Lee et al. 1997).

An effort has been undertaken by various federal, state, and tribal agencies to restore populations of anadromous salmonids within the Columbia River Basin in the northwestern United States (Lee and Grant 1995). Further, an interagency group of scientists is presently attempting to develop a formal decision analysis for evaluating alternative hypotheses and management options for restoration of threatened and endangered spring/summer chinook salmon, fall chinook salmon, and steelhead (*Oncorhyncus mykiss*) stocks in the Columbia River Basin, a process referred to as PATH (Plan for Analyzing and Testing Hypotheses) (Marmorek and Peters 1998). With respect to Snake River chinook salmon, the Council’s Fish and Wildlife Program (NWPPC 1994), the Salmon Subbasin Plan, and Idaho Department of Fish and Game (IDFG) call for long-term monitoring of their populations. These efforts require reliable data on population numbers for both long-term monitoring and short-term assessments of management actions implemented to improve their population status. However, because of costs and difficulties associated with sampling mobile individuals, relative indices often are used to assess population status and trends. The fundamental assumption is that these index counts represent a constant proportion of the true counts across time. In general, the usefulness of any population survey depends upon obtaining unbiased, or nearly unbiased, and precise parameter estimates in a cost-efficient, logistically feasible manner (Thompson et al. 1998).

Agencies and researchers often have used annual numbers of redds as an index to salmonid population trends (e.g., see Emlen 1995, Dauble and Watson 1997, and Rieman and Myers 1997) because of the difficulties with sampling individuals. For instance, IDFG has been conducting annual ground counts of spring/summer chinook salmon redds during the peak spawning period in selected areas of Idaho since 1957 (Elms-Cockrum 1997). In addition, the U.S. Forest Service Rocky Mountain Research Station has been conducting aerial surveys of chinook redds in a much more extensive area, some of which overlaps with the IDFG ground counts, but after all spawning has occurred.

Unfortunately, both of these surveys lack a measure of bias and precision for their estimates. That is, the number of observed redds is treated as if it was the true number, i.e., the total number of redds is assumed to be known without error. Without a correction for missed redds, the bias must be assumed to be constant across space and time. This is highly unlikely given the variety of factors potentially affecting detectability of redds. Further, failure to include a measure of precision, or sampling variance, for each estimate results in an underestimate of the true variability in counts within and across years. Inadequately accounting for bias and/or precision may lead to misleading conclusions about population trends (Thompson et al. 1998).

A method that shows promise for providing valid estimates of bias and precision for chinook salmon redds is a combination ground/aerial survey based on a modification of the two-sample, Lincoln-Petersen estimator (Seber 1982). This method is based on independent mapping and counting of redds during both aerial and ground counts over the same area during a specific time period. Although traditionally applied to mobile populations, this estimator is actually better suited to studies of immobile objects, like redds, because of the difficulties in meeting the estimator's restrictive assumptions. To our knowledge this approach has never been applied to counting redds, but it has been used to estimate numbers of nests for ospreys (*Pandion haliaetus*) (Henny et al. 1974, Henny and Anderson 1979) and crocodiles (*Crocodylus acutus*) (Magnusson et al. 1978). Therefore, we propose a pilot study to assess the feasibility and cost-effectiveness of using a modified Lincoln-Petersen estimator for obtaining unbiased, or nearly unbiased, and precise estimates of spring/summer chinook salmon redds.

b. Rationale and significance to Regional Programs

This project seeks to enhance monitoring efforts focused on Snake River chinook salmon populations by evaluating and possibly improving current methodology used for enumerating redds. Population monitoring efforts are only as good as the data they are based upon; valid, precise, and cost-efficient sampling methods are vital to our ability to detect a population trend. However, current methodology for counting redds lacks a firm statistical foundation and an adequate measure of precision. Further, The Fish and Wildlife Program (NWPPC 1994), IDFG (1992), and Salmon River Subbasin Plan all indicate a need for long-term monitoring of Snake River chinook salmon. This project seeks to address this need in a more rigorous fashion. The survey method potentially developed in this project may be used by other groups and agencies currently conducting redd counts, such as the Nez Perce Tribe, Shoshone-Bannock Tribe, IDFG, and U.S. Forest Service. In addition, this method may be applied to other salmonids, such as bull trout (*Salvelinus confluentus*).

c. Relationships to other projects

This project will be conducted in conjunction with aerial counts of chinook salmon redds being conducted by the U.S. Forest Service under BPA proposal 9064. It also will complement information gathered for the Idaho Natural Production Monitoring/Evaluations under BPA project 9107300.

d. Project history (for ongoing projects)

N/A

e. Proposal objectives

Objective 1: To evaluate the applicability, efficiency, and cost-effectiveness of a modified two-sample, Lincoln-Petersen estimator for obtaining unbiased and precise abundance estimates of spring/summer chinook salmon redds in the Snake River drainage. This is a methodological assessment and hence there is not a specific research hypothesis that we are testing. Assumptions underlying the Lincoln-Petersen estimator include: 1) sightings are independent between sampling occasions; 2) each object has the same probability of being sighted within each sampling occasion; 3) objects are correctly identified; 4) sighted objects are accurately mapped; and 5) the population of objects remains the same across both sampling occasions and is contained within a well-defined area (Seber 1982, Pollock and Kendall 1987).

Product: A report or refereed publication describing the applicability, efficiency, and cost of our proposed method.

f. Methods

Objective 1: Our proposed two-sample, Lincoln-Petersen method will consist of independent air and ground counts of chinook salmon redds within selected spawning streams in the Middle Fork Salmon River. Each detected redd will be mapped and its location recorded via geographical positioning system (GPS) equipment. The aerial survey will be conducted by the co-principal investigator as part of BPA project 9064, whereas the ground survey will be conducted under this project by two trained and experienced personnel. The count that we believe will yield the most valid detections (very likely the ground survey) will be treated as the initial sample or “mark” (White et al. 1982). The other count will be treated as a second sample; those redds counted during both samples will be “resights,” i.e., there will typically be both “marked” and “unmarked” redds in this second sample. (Note: If the aerial count fails to produce additional redds, then we will investigate the use of the misclassification rate as a bias correction factor.) These three quantities will be incorporated into Chapman’s (1951) modification of the Lincoln-Petersen estimator and used to generate a population estimate with a measure of precision. We will estimate costs via a cost function (Thompson et al. 1998), and assess logistical difficulties while conducting counts.

Proper application of the Lincoln-Petersen, mark-resight estimator requires a survey design that both minimizes potential violation of its underlying model assumptions (i.e., minimize bias) and maximizes the potential number of samples during each sample (i.e., maximizes precision). Therefore, we describe these assumptions, discuss likely sources of their violation, and offer ideas on how we may avoid these violations. Then, we discuss how we will maximize our precision via our design.

Model Assumptions

Sightings are independent between sampling occasions. Independence of counts requires that a different survey method and observer are used for each sampling occasion. Employing the same method for both surveys creates a bias analogous to a "gear selectivity" problem in sampling fish, where a portion of the population will be essentially uncatchable due to various individual and habitat factors. For redd surveys, using ground counts exclusively will limit the number of recordable redds to those that can be sighted from the ground. However, there may be other redds that may only be sighted from the air; the likelihood of this will depend on the thoroughness of the ground counts. Primary reasons for missing redds from the air include poor lighting conditions and adjacent lateral cover. Further, redds constructed during a previous year may be mistaken for ones from the current year.

Different counts conducted by the same observer incurs bias due to the inherent dependency associated with using a single observer. This is true even if different survey methods are used. That is, results obtained during the first survey will influence, either consciously or subconsciously, those obtained during the second. Once an object has been located, there may be a tendency to record it during the second survey, even if the object is not visible from the new vantage point. Further, knowledge of its location may cause the observer to focus on locating it during the second survey, while paying less attention to locating other, previously undetected objects. In general, knowledge of the locations of objects prior to a survey violates the assumption that all objects have an equal probability of being seen (see below).

We will use a combination of aerial and ground surveys, with different observers participating in each, to ensure independence of counts. If the aerial survey fails to produce additional redds from those located during the ground count, we will use the ground count results to generate a bias correction for the aerial count (i.e., correct for redds missed or misclassified) in lieu of the Lincoln-Petersen estimator.

Each object has the same probability of being sighted within each sampling occasion. Considerable bias may occur if objects are not equally detectable (i.e., visible) within each survey (Seber 1982, Thompson et al. 1998). However, differences in visibility rates are allowable between surveys. For redd counts, variations in structure and complexity of surrounding habitats will cause some redds to be more visible than others. Characteristics of the redds themselves also may contribute to different sightability rates. A redd with a well-defined outline and form will likely be more visible than a less defined one. Also, timing of redd construction will affect their detectability, i.e., more recent redds are easier to detect than older ones. Other violations of constant detectability assumptions include using different observers during a single sampling occasion and having prior knowledge of the locations of the surveyed population.

This assumption is impossible to meet due to the factors just mentioned. However, if detection rates are high (>0.5), then the effects of bias should be unimportant (Gilbert 1973). Based on previous redd surveys, we believe that detection rates will be higher (likely much higher) than the minimum of 50% suggested by Gilbert (1973). Thus, relative bias due to nonconstant detectability among redds should be minor.

Objects are correctly identified. Mistakenly recording an object that does not exist will result in biased estimates. For instance, bed scour or similar stream features may be misidentified as redds. Also, misclassifying a steelhead redd as a chinook salmon redd will lead to biased estimates. Proper training and experience of observers is required to limit these errors. In addition, redds from a previous year must either be absent or distinguishable from the current year's redds or counts will be biased upward.

We will only use trained personnel with extensive (>10 years) experience for counting chinook salmon redds, both from the air and the ground, in the study streams. Further, personnel conducting ground counts will assess whether a detected redd is from the present year or a previous year. This can be done via checking the substrate characteristics within the "tail" of each redd. Identifying and mapping previous year's redds will enable us to assess, estimate, and adjust for the number of previous year's redds included in the aerial count.

Sighted objects are accurately mapped. Identification of the previously detected or "marked" redds within the second sample requires accurate location and mapping of redds within both samples. Inaccurate locations could be caused by errors in reading maps or aerial photographs. Also, if a GPS unit is used, one must account for errors associated with each reading. If this error is larger than the distance between adjacent objects, then there is potential for two objects sighted in separate surveys (i.e., one in each survey) to be recorded as a single object. This would generate an underestimate of population size.

We will be using personnel trained in mapping and in the use of GPS units. Also, our GPS units allow for greater accuracy via differential correction and hence should minimize the possibility of adjacent redds being recorded as a single one.

The population of objects remains the same across both sampling occasions and is contained within a well-defined area. This is the closed population assumption. For redd counts, surveys should be conducted as close together in time as possible to minimize the potential for new redds being constructed between sampling occasions. The area of interest must be well-delineated so that there is an identifiable and fixed population during some unit of time. Otherwise, it would be unclear to which population one was making inferences.

We will be overlapping our ground and aerial counts in time as closely as possible and after all spawning has been completed. We also have well-defined study streams that have had both ground and aerial redd counts conducted on them previously.

Maximizing Number of Samples

Chinook salmon stocks are dynamic so number of redds could vary greatly from one year to the next. Based on previous count data, redd numbers will likely be low during FY2000. Thus, we have selected three stream segments to survey that have had adequate numbers of redds in previous low years to obtain a precise abundance estimate via the modified Lincoln-Petersen estimate. Only areas containing suitable habitat, and hence suitable numbers of redds, will be surveyed within these streams. However, in order to obtain an estimate of the area and costs required to survey areas containing low densities of redds, we also will survey a fourth stream segment that has low redd densities.

g. Facilities and equipment

This research will be performed through the Rocky Mountain Research Station in Boise, ID. This facility provides permanent office space and associated administrative assistance and services (e.g., copying, mailing), computer hardware (IBM personal computers, Unix network, laser printers, and scanners), and software for wordprocessing (MS Word, WordPro), database management (MS Excel, Lotus 1-2-3), graphics (MS PowerPoint, Freelance), internet access (MS Internet Explorer), electronic mail (Applix Mail), data analysis (SAS), GPS file correction (Pfinder), and GPS plotting (ArcInfo, ArcView). RMRS has purchased two GPS units with antennae and internal data recorders, which will used in ground and aerial surveys of redds. A leased vehicle will be required to travel to and from the study area.

h. Budget

Monies requested in Section 5 are based on actual costs from redd counts in previous years. 1) Personnel: Permanent salaries include 3 months for the principal investigator and 1 month for two scientists conducting the ground counts. Salary for the co-principal investigator, who will be conducting the aerial counts, will be generated through cost sharing with BPA Project 9064. 2) Fringe benefits are set by the U.S. Forest Service. 3) Supplies and materials will mainly consist of miscellaneous equipment needed to conduct field work, and record and analyze data. Major equipment needs have already been provided through RMRS (e.g., GPS units, computing facilities, office space, etc.). 4) The main operations and maintenance costs will be associated with vehicle rental and associated costs for travelling to and from the study area. Helicopter rental for aerial surveys will be provided through an on-going, BPA-funded project (see cost sharing, Project 9064). 5) Travel expenses are composed of per diem costs for scientists conducting the field work. 6) Indirect costs are set by the U.S. Forest Service.

Section 9. Key personnel

William L. Thompson is principal investigator and a Research Biologist for the U.S. Forest Service, Rocky Mountain Research Station in Boise, Idaho. His expertise is in designing survey methods for sampling biological populations, developing and evaluating methods for monitoring population trends, and modeling biological data. He is senior author of a book that outlines and describes how to design and conduct monitoring programs for detecting important trends in fish and wildlife populations over space and time. In his present position, Dr. Thompson has been using state-of-the-art model selection techniques to investigate relationships between landscape habitat variables and production and parr densities of chinook salmon and steelhead trout in the Columbia River Basin as part of the PATH process. He also is co-writing a software manual for the program BayVAM (written be D. C. Lee), which is used to assess the viability of resident salmonid populations in the Intermountain West.

Education:

Ph.D., Biological Sciences, Montana State University, 1993 (Minor: Statistics)
M.S., Fish and Wildlife Sciences, Pennsylvania State University, 1987
B.S., Wildlife and Fisheries Biology, University of Vermont, 1984

Recent Employment:

8/97-Present; Research Biologist, US Forest Service, RMRS, Boise, ID
7/96-6/97; Postdoctoral Research Fellow, Dept. of Fishery and Wildlife Biology, CO State Univ., Fort Collins, CO.
1/95-6/96; Postdoctoral Research Fellow, Dept. of Fishery and Wildlife Biology, CO State Univ., Fort Collins, CO.
2/94-11/94; Environmental Research Consultant (Co-founder), M.T. Inc., Bozeman, MT.
10/93-11/93; Statistical Consultant, Lostwood National Wildlife Refuge, Kenmare, ND.
10/93-11/93; Fisheries Technician, MT Cooperative Fisheries Research Unit, MT State Univ., Bozeman, MT.
7/93-8/93; Environmental Consultant (subcontracted), Morrison-Maierle Environmental, Bozeman, MT.

Relevant Publications:

Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, San Diego, California.
Anderson, D. R., K. P. Burnham, and W. L. Thompson. Null hypothesis testing in ecological studies: Problems, prevalence, and an alternative. Submitted to *Ecology*.
Thompson, W. L., and D. C. Lee. Relationships between landscape habitat variables and chinook salmon production in the Columbia River Basin. Passed USFS internal and external reviews; submitted to *Ecological Applications*.
Thompson, W. L., and D. C. Lee. Relationships between landscape habitat variables and relative densities of chinook salmon and steelhead trout parr in Idaho. Submitted

for USFS preliminary review; will be submitted to the *North American Journal of Fisheries Management*.

Thompson, W. L., and D. C. Lee. Comparative efficiencies of three methods for selecting plots across time. *In prep*.

Russell F. Thurow is co-principal investigator and a Research Fishery Biologist for the U.S. Forest Service, Rocky Mountain Research Station in Boise, Idaho. He serves as a member of a team of scientists investigating fish population dynamics, habitat relationships, and factors influencing persistence. The mission of the team is to provide new information and techniques for understanding, conserving, and restoring fish populations and critical habitats in the Intermountain West. He has extensive experience with anadromous salmonids and with the techniques employed in this research. He has already completed annual redd surveys for chinook salmon during 1995-1998, and has mapped potential chinook spawning patches in several tributaries. He is intimately familiar with the study area.

Education:

M.S., Fisheries Resources, University of Idaho, 1976
B.S., Fisheries, University of Wisconsin-Stevens Point

Recent Employment:

1990-Present; Research Fishery Biologist, US Forest Service, RMRS, Boise, Idaho
1977-1990; Fisheries Research Biologist, Idaho Department of Fish and Game

Recent Relevant Publications:

Thurow, R. 1985. Middle Fork Salmon River fisheries investigations. Job Completion Report, Federal Aid in Fish Restoration Project F-73-R-6, Idaho Department of Fish and Game, Boise. 100pp.

Thurow, R. F., and J. G. King. 1994. Attributes of Yellowstone cutthroat trout redds in a tributary of the Snake River, Idaho. Transactions of the American Fisheries Society 123:37-50.

Magee, J. P., T. E. McMahon, and R. F. Thurow. 1996. Spatial variation in spawning habitat of cutthroat trout in a sediment-rich basin. Transactions of the American Fisheries Society 125:768-779.

Lee, D. C., J. R. Sedell, B. E. Rieman, R. F. Thurow, and J. E. Williams. 1997. Broadscale assessment of aquatic species and habitat. An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins. Volume III, Chapter 4. US Forest Service, General Technical Report PNW-GTR-405.

Thurow, R. F., D. C. Lee, and B. E. Rieman. 1997. Distribution and status of seven native salmonids in the interior Columbia River basin and portions of the Klamath River and Great basins. North American Journal of Fisheries Management 17:1094-1110.

Thurow, R. F., D. C. Lee, and B. E. Rieman. (In Press). Status of chinook salmon and steelhead in the interior Columbia River basin and portions of the Klamath River basin. Pages 00-00 *in* E. E. Knudsen, C. S. Steward, D. D. MacDonald, J. E. Williams, and D. W. Reiser, editors. Sustainable fisheries management: balancing conservation and use of Pacific salmon. Ann Arbor Press, Ann Arbor, Michigan.

Section 10. Information/technology transfer

If successful, this pilot study would result in a publishable contribution to fish research and management by offering a more statistically rigorous method for obtaining estimates of redd numbers than is currently being used. This approach then could be implemented in relevant projects being conducted in Idaho and throughout the Intermountain West. Such information could be distributed via contract reports, peer-reviewed publications, oral presentations at professional meetings, and informal meetings with interested parties.

Congratulations!