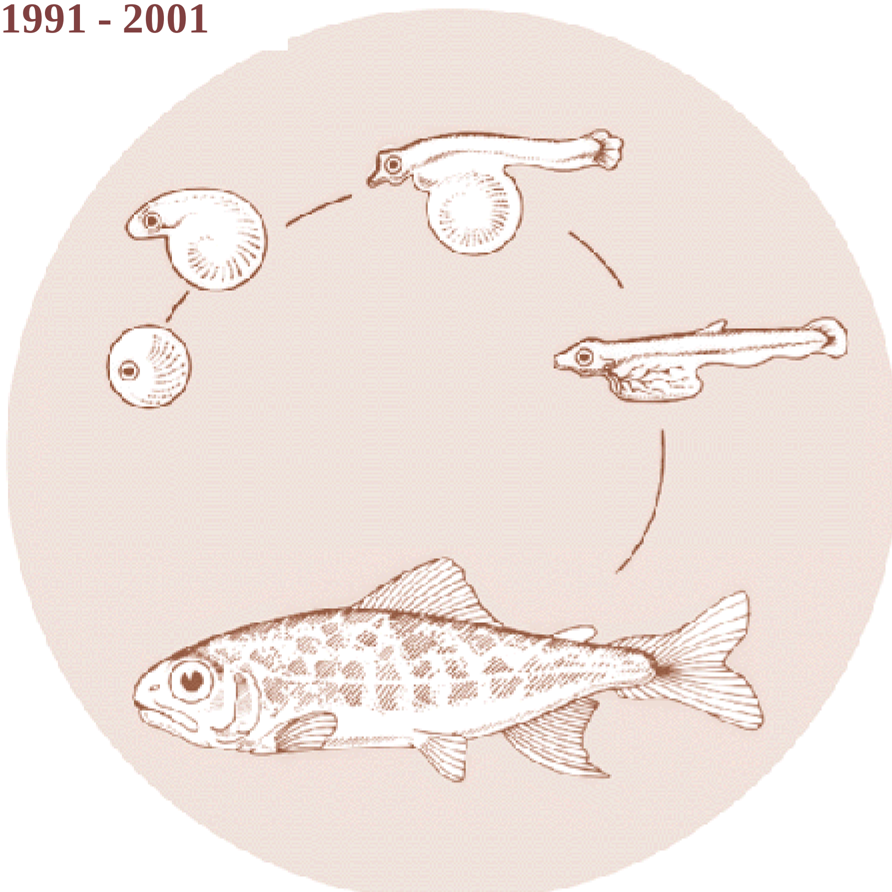
Evaluation and Statistical Review of Idaho Supplementation Studies

Technical Report
1991 - 2001



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FISHERY RESEARCH

EVALUATION AND STATISTICAL REVIEW OF IDAHO SUPPLEMENTATION STUDIES

1991—2001

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IDFG Report Number 03-16
March 2003

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March 2003

IDAHO FISH AND GAME
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Dirk Kempthorne / Governor
Steven Huffaker / Director

Mark Fritsch
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Dear Mr. Fritsch:

Enclosed is the Idaho Supplementation Studies statistical review that was completed through a collaborative effort among the four cooperating agencies of ISS: the Idaho Department of Fish and Game, the Nez Perce Tribe, the Shoshone-Bannock Tribes, and the U.S. Fish and Wildlife Service. Technical staff representing each agency was involved throughout the review process, from data compilation to final editing, and each are recognized in supporting the results and recommendations presented in the attached document.

The technical review and preliminary statistical treatment of ISS data were in response to concerns raised by ISRP during the BPA 2002 contract renewal process. The specific objectives of this report were developed to address the statistical integrity of the ISS study. The following text summarizes the results of our findings with specific reference to ISRP concerns and NPPC recommendations.

In section one of this report, technical review of the ISS provided a means to document the current state of study streams and the integrity of the data collected from each. We now have a better understanding of study deviations that complicate evaluation methods for the ISS study. From a programmatic approach, we demonstrated that despite being a cooperative project relying on data collection by multiple agencies, compilation of ISS data was feasible. Further, despite inconsistencies in data collection, we were able to combine data from multiple agencies into a form that compensated for these and allowed statistical analyses.

In section two, we addressed ISRP concerns regarding straying by first defining then enumerating strays as hatchery origin non-ISS chinook salmon in treatment streams and hatchery origin fish in control streams. We then examined stray effects by first constructing simple scatter plots of redds versus straying. Having established a positive relationship between straying and redds per kilometer, we determined that the slope of a simple regression did not differ significantly among streams. We then constructed a simple ANOVA, which suggested a significant relationship between straying and redd production. Application of a covariate (proportion of stray carcasses multiplied by the total redd count within a stream by year) did not significantly change the magnitude of that effect. In addition, the lack of a significant interaction

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term before and after the covariate was applied suggested that straying was equivalent among fully treated, partially treated, and control streams. Based on these results, we identified three scenarios that may be applied to straying: 1) since straying to this point has affected all ISS streams equally, straying can be ignored; 2) we can use the proportion of stray carcasses to estimate the contribution of strays to overall production; and 3) we could use the covariate to adjust the production means prior to analysis. In either case, we have demonstrated a statistically valid means to determine how straying affects our ability to evaluate treatment effects, which will have direct application through Phase III as more carcass data become available.

In section three, we satisfied the ISRP and NPPC concerns regarding the need for a complete statistical analysis verified by an independent statistician. Working with Professor Steinhorst at the University of Idaho, we completed a prototype (mixed randomized complete block unbalanced ANOVA) analysis capable of compensating for previous changes in study stream designations, varying levels of treatment effort, and geographic/habitat based effects on production. Despite the fact that adult returns from Phase II ISS treatments are incomplete, we detected a significant effect of treatment, primarily resulting from increased production in partially treated streams.

In section four, we addressed ISRP and NPPC concerns that changes in stream designations and a lack of agreement to cease treatments in some locations might decrease the statistical value of ISS results. Using a power analysis, we found that despite changes in stream designations and/or less than prescribed treatment levels, we maintained ample statistical power and sensitivity to detect treatment effects. We recommended that ISS treatments cease with brood year 2002, as treatment at this level will allow an increased number of replicates in the fully treated stream category. For purposes of responding to the comments of ISRP on the Johnson Creek Artificial Propagation Enhancement project, we scrutinized the potential affects of management decisions to continue supplementation in this stream during Phase III of the ISS study. We found that regardless of whether or not supplementation continues in Johnson Creek, it will still provide data as a control stream for Phase I and II ISS statistical comparisons. If supplementation continues in this location, dropping Johnson Creek entirely from Phase III analyses will not compromise the statistical power of the ISS study.

In section five, we addressed ISRP and NPPC concerns regarding the integrity of future statistical analyses for the ISS project. We demonstrated that the prototype analysis developed in section three of this report could be used as the primary data analysis method to address objectives for the remainder of the ISS study. We provided a stream specific protocol for ISS study components that includes broodstock management and release, chinook salmon escapement and weir management, and monitoring and evaluation. Finally, we reviewed data

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needs for Phase III and indicated which monitoring activities might require more rigorous treatment for the remainder of the ISS study.

If you have any technical questions, I may be reached at (208) 465-8404.

Sincerely,

Jeffrey Lutch
Project Coordinator, ISS

Enclosure

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INTRODUCTION

The Idaho Supplementation Studies (ISS) was developed to evaluate the utility of supplementation as a recovery tool for Snake River basin chinook salmon (Supplementation Technical Workgroup 1987), and to help define the potential role of supplementation in managing Idaho's anadromous fisheries (IDFG 1990; IDFG 1992). Supplementation as defined by the Regional Assessment of Supplementation Project group is the use of artificial propagation in the attempt to maintain or increase natural production while maintaining the long-term fitness of the target population (RASP 1992). Poor survival has led to the decline and continued depression of upriver chinook salmon stocks due to mainstem passage and mortality factors associated with the lower Snake and Columbia river dams. Although immediate efforts should focus on alleviating the poor passage and flow conditions, supplementation may concurrently be a viable tool to meet the Northwest Power Planning Council's interim goal of doubling anadromous fish runs in the Columbia River Basin (NPPC 1987) and avoiding short-term loss of spawning aggregates.

A robust experimental design for the ISS study was completed in 1991 (Bowles and Leitzinger 1991). The project represents a statewide research effort throughout the Salmon River and Clearwater River subbasins. Streams are split into two different categories to address supplementation-augmentation of existing chinook salmon populations and supplementation-restoration of extirpated populations. Streams are categorized as either treatment, which receive supplementation releases, or control, which are not supplemented. The ISS evaluation focuses on measuring response variables that are compared between the two categories to determine effects from supplementation on both natural production and productivity. All research activities are distributed among several study phases. In Phase I (broodstock development phase), baseline data were collected beginning in 1991 to measure the response to treatment concurrent with the development of supplementation broodstock that utilizes localized donor sources. Phase II (treatment phase) uses the returning adults to supplement natural origin recruits in treatment streams, and maintains supplementation broodstocks for juvenile production and release. In Phase III (evaluation phase), supplementation treatments are terminated and returning adults are allowed to supplement natural production. Monitoring and evaluation of response is continued throughout the duration of the study. Currently, the project is scheduled to transition between Phase II and III.

The ISS study and all related research activities are operated under an "umbrella" agreement among four cooperating agencies; 1) Idaho Department of Fish and Game (IDFG), 2) Nez Perce Tribe (NPT), 3) Shoshone-Bannock Tribes (SBT), and 4) U.S. Fish and Wildlife Service (USFWS). The IDFG represents the lead coordinating agency. All ISS cooperators adhere to the study design protocols and apply these to streams that were partitioned among each participating agency. These activities include broodstock development, supplementation treatment releases, and consistent monitoring and evaluation. All cooperating agencies are funded by the Bonneville Power Administration (BPA).

In fiscal year 2002, the Independent Scientific Review Panel (ISRP) provided comments and recommendations to BPA on the proposal submitted by ISS cooperators for funding. Their recommendation was not fundable until certain study design concerns were adequately addressed. The ISRP believed that the experimental design had not been adhered to throughout the duration of the study, and that there did not appear to be commitment to treatment durations, particularly to the Phase III portion of the study design where supplementation ceases and treatment effects are analyzed. Project funding was, therefore, considered conditional and contingent upon ISS proponents adequately addressing the following recommendations:

1. A written protocol for complete statistical analysis certified by an independent statistician team should be presented to Council during the contracting period. The ISRP is not comfortable with the implications that “problems” with the study design can be “fixed” during the statistical analysis stage. Considerable thought and effort should be placed in planning the statistical analyses of these potentially controversial data before final decisions are made on criteria for stopping supplementation and before data are available.

2. The protocol for statistical analysis must indicate how straying of hatchery fish into “control streams” and “partial treatments” will be analyzed. For example, the response to the ISRP preliminary review indicated that the straying rate of hatchery fish into the Secesh River from 1996-2001 varied from 0.83% to 14.71%. This is, in fact, de facto supplementation. It is unclear to the ISRP how partial treatment and de facto supplementation of control streams will be addressed in the statistical analysis of the ISS.

3. Development of a specific stream-by-stream protocol and timetable for implementation of Phase III of the ISS. Included in this is the immediate cessation of supplementation activities in Johnson Creek and inclusion of Johnson Creek once again as a control stream in the ISS experimental design.

All ISS cooperators recognize that monitoring and evaluation protocols described in the original study design have changed since the project was initiated in 1991. For example, summer parr monitoring was eliminated in most study streams after 1996 due to large variance around point estimates. Concurrently, adult spawning surveys were expanded beyond the original index reaches to increase precision of redd counts. Most decisions were coordinated at the project level so that any change would be standardized to enable statistical evaluation of supplementation effects. However, some level of deviation has occurred in supplementation treatment because the experimental design does not address the status of chinook salmon runs returning to Idaho. Development of ISS broodstock depends largely upon localized returns of adult chinook salmon to ISS study streams. However, low adult escapement has resulted in failure to meet ISS supplementation release goals in many study streams.

In order to address ISS study deviations and develop methods for robust evaluation during the final study phase, we focused our efforts in 2002 on performing a programmatic review of select ISS activities from 1991 through 2001. These included the current level of stream-specific treatment, the measured response in natural production, and the amount of study deviations that may have occurred due to the large scale and duration of the study. In order to respond directly to the ISRP recommendations, we completed a statistical evaluation of the ISS study through Phase II (1992-2001). In this report, we present sections one through five to address the following objectives:

1. Perform a programmatic review of the ISS project to compile existing data and review the status of each study stream to reflect current management activities.

2. Examine straying into ISS study streams to estimate how this affects our measured response in natural production, while providing statistical methods for more robust evaluation.

3. Perform a prototype analysis of select ISS data.

4. Perform a power and sensitivity analysis of ISS data and determine when to stop supplementation treatment.

5. Provide study recommendations to reflect phase transition and monitoring and evaluation of the ISS study.

Independent statistical consultation was provided through the University of Idaho Statistical Consulting Center.

SECTION ONE

Data Compilation

As a first step in the statistical review of the ISS project, all cooperators provided updated (through 2002) data to the IDFG (lead coordinating agency). Monitoring procedures were then examined on a stream-by-stream basis in order to document inconsistencies that might be reflected in the data. We compiled and reviewed five data sets for the purposes of this report: redd counts, carcass recoveries, weir counts, juvenile emigration/abundance, and parr density/abundance. Data were arrayed by stream and year to determine the geographic and temporal coverage of ISS monitoring data (Table 1.1). Prior to analysis we reviewed study deviations and treatment levels and determined which production measures would be most useful for the construction of a prototype analysis for the purposes of this report.

Study Deviations

Following the compilation and organization of data, we reviewed large-scale deviations from the original study design (Bowles and Leitzinger 1991). Study deviations were primarily limited to changes in stream designation, which resulted from either logistical constraints or inability to achieve designated levels of treatment.

Thirty-one study streams were defined in the original study design, including 20 treatment and 11 control streams. Currently, the ISS study maintains a total of 30 study streams, including 16 treatment and 14 control streams (Table 1.2 and Figure 1.1). Some changes occurred immediately and were limited primarily to different designations of control and treatment streams (Walters et al. 2001). Due to logistical constraints (travel and access for data collection), three control streams were removed from the design and replaced by three others. Johns and Bear creeks in the Clearwater subbasin and Camas Creek in the Salmon subbasin were dropped, and Eldorado and White Cap creeks (Clearwater) and the Secesh River (Salmon) were added as new control streams.

Subsequent changes in designation of study streams occurred due to low adult escapement, which prevented development of localized broodstocks and resulted in fewer treatments than prescribed in the original study design (Appendix 1.1). In the Clearwater subbasin, Crooked Fork Creek was reclassified from a treatment stream to a control stream in 1993 since low adult escapement precluded development of a localized broodstock, and only one release of 7,800 presmolts was completed (brood year 1992). In 1996, American River was changed to a control stream after receiving only one supplementation treatment. However, we reclassified this as a treatment stream since it received a significant number of supplementation fish (221,449 smolts) from Brood Year 1993. In the Salmon River subbasin, Slate Creek and the Lemhi River were changed to control streams after receiving no ISS treatments. Alturas Lake Creek was originally listed as a treatment stream, but is now included in the evaluation of the Upper Salmon River since it received no supplementation treatments and lacked adequate monitoring and evaluation data. For the current statistical review, Johnson Creek is considered a control stream; however, it will be classified as a treatment stream after 2001 due to supplementation beginning with brood year 1998 juvenile releases.

Treatment Level

Following the review of stream designations, it became clear that ISS study streams could not be cleanly compared simply as treated versus control replicates. For example, the South Fork Salmon River has received the prescribed number of ISS treatments since 1991. In contrast, the West Fork Yankee Fork of the Salmon River has been treated only once. For the purposes of statistical analysis, we created a partial treatment category consisting of those treatment streams that received less than 50% of the treatments prescribed in the original study design (Table 1.3). We believed that it would be unwise to assume that streams receiving only a few treatments were directly comparable to streams receiving nearly all prescribed treatments.

Production Response

Following the compilation and review of ISS data sets, we selected redd counts as our response variable of interest for the purposes of this report. Redd counts provide the most complete data set, and hence were the best candidate for the construction of the prototype analysis formulated in section three of this document (Appendix 1.2).

The consistency of redd count data varied by stream. For example, many streams had consistent index area multiple pass redd counts, while other streams had a combination of aerial surveys and/or ground survey reaches of inconsistent length. To account for this variation, we expressed redd data as redds per kilometer for the purpose of statistical analyses.

Table 1.1. Data types available by year and stream for ISS study streams, 1991-2001. ND = no data.

	Production Response Variables				
Study Stream	**Redd Counts**	**Chinook Carcasses**	**Juvenile Emigration**	**Rack Returns**	**Parr Abundance**
Lemhi R.	1992-2001	1992-2001	1992-2001	1992-1993	1991-1997
Big Flat Ck.	1992-2001	1992-2001	ND	ND	1991-1996
Colt Killed Ck.	1992-2001	1992-2001	1998-2001	ND	1991-1996
Crooked R.	1991-2001	1992-2001	1992-2001	1992-2001	1991-1997
Pahsimeroi R.	1992-2001	1992-2001	1992-2001	1991-2001	1991-1993
Red R.	1991-2001	1992-2001	1992-2001	1991-2001	1991-1999
SF Salmon R.	1992-2001	1992-2001	1992-2001	1991-2001	1991-1996
Upper Salmon R.	1992-2001	1992-2001	1992-2001	1991-2001	1992-1996
Papoose Ck.	1992-2001	1992-2001	ND	ND	1992-1996
Squaw Ck.	1992-2001	1992-2001	ND	ND	1992-1993
Lolo Ck.	1992-2001	1992-2001	1992-2001	1997-2001	1992-1996
Newsome Ck.	1992-2001	1992-2001	1998-2001	1997-2001	1991-1996
WF Yankee Fk. Salmon R.	1992-2001	1992-2001	1998-2000	-	1991-1996
EF Salmon R.	1992-2001	1993-1999	1993-2001	1991-1997	1993-1996
Clear Ck.	1991-2001	1992-2001	1993-2000	1991-2001	1991-1996
Pete King Ck.	1991-2001	1992-2001	ND	ND	1991-1996
Brushy Fork Ck.	1992-2001	1992-2001	ND	ND	1991-1997
Crooked Fork Ck.	1992-2001	1992-2001	1992-2001	1998-2001	1991-1997
Marsh Ck.	1992-2001	1992-2001	1993-2001	1993-1994	1992-1997
Johnson Ck.	1991-2001	1992-2001	1998	1998-2001	1992-1995
NF Salmon R.	1991-2001	1992-2001	ND	ND	1991-1995
White Cap Ck.	1992-2001	ND	ND	ND	1992-1996
American R.	1992-2001	1992-2001	1998-2001	ND	1991-1999
Lake Ck.	1991-2001	1992-2001	1997-2001	1998-2001	1992-1996
Secesh R.	1991-2001	1992-2001	1997-2001	1997-1999	1992-1996
Slate Ck.	1991-2001	1992-2001	ND	ND	1992-1995
Bear Valley Ck.	1992-2001	1992-2001	ND	ND	1992-1996
Herd Ck.	1992-2001	1992-2001	ND	ND	1992-1996
Valley Ck.	1992-2001	1992-2001	ND	ND	1992-1996
Eldorado	1991-2001	1992-2001	ND	1998-2001	1992-1996

Table 1.2. Original and current designation of ISS study streams.

Stream	Original Study Design	Current Designation	Comments
Salmon River Drainage			
Slate Cr.	Treatment	Control	
SF Salmon R.	Treatment	Treatment	
Lemhi R.	Treatment	Control	No treatments through BY01
Pahsimeroi R.	Treatment	Treatment	
EF Salmon R.	Treatment	Treatment	
Herd Cr.	Control	Control	
WF Yankee Fork S.R.	Treatment	Treatment	
Upper Salmon R.	Treatment	Treatment	
Alturas Lake Cr.	Treatment	*	No treatments through BY01 data included in Upper Salmon R.
NF Salmon R.	Control	Control	
Valley Cr	Control	Control	
Marsh Cr.	Control	Control	
Bear Valley Cr.	Control	Control	
Camas Cr.	Control	*	Dropped due to logistical constraints
Lake Cr	Control	Control	
Secesh R.	*	Control	Added to original study design
Johnson Cr.	Control	Control [a]	
Clearwater Drainage			
Red R.	Treatment	Treatment	
Newsome Cr.	Treatment	Treatment	
Crooked R.	Treatment	Treatment	
Lolo Cr.	Treatment	Treatment	
Crooked Fk. Cr.	Treatment	Control	One treatment in 1992 Changed to control stream 1993
Clear Cr.	Treatment	Treatment	
American R.	Treatment	Treatment	One treatment through BY95 Changed to control stream 1996
Colt Killed Cr.	Treatment	Treatment	
Big Flat Cr.	Treatment	Treatment	
Pete King Cr.	Treatment	Treatment	
Squaw Cr.	Treatment	Treatment	
Papoose Cr.	Treatment	Treatment	
Brushy Fk. Cr.	Control	Control	
Johns Cr.	Control	*	Dropped due to logistical constraints
Bear Cr.	Control	*	Dropped due to logistical constraints
Eldorado Cr.	*	Control	Added to original study design
White Cap Cr.	*	Control	Added to original study design

* Streams not included in the original study design.
[a] Supplementation started with brood year 1998.

Table 1.3. Number of treatments completed to date in ISS study streams. Partial treatment refers to streams that have received <50% of annual treatments prescribed in the original study design.

Treatment Stream	Status through Brood Year 1999		
	Number of treatments	Percent treatment	Treatment designation
Clearwater Basin			
Lolo Creek	3	33	Partial
Newsome Creek	4	44	Partial
Crooked River	4	44	Partial
Red River	7	78	Treatment
Clear Creek	5	56	Treatment
Pete King Creek	3	33	Partial
Squaw Creek	4	44	Partial
Papoose Creek	3	33	Partial
Colt Killed Creek	4	44	Partial
Big Flat Creek	2	22	Partial
American River	1	11	Partial
Salmon Basin			
SF Salmon River	9	100	Treatment
Pahsimeroi River	7	78	Treatment
EF Salmon River	3	33	Partial
WF Yankee Fork	1	11	Partial
Upper Salmon River	9	100	Treatment

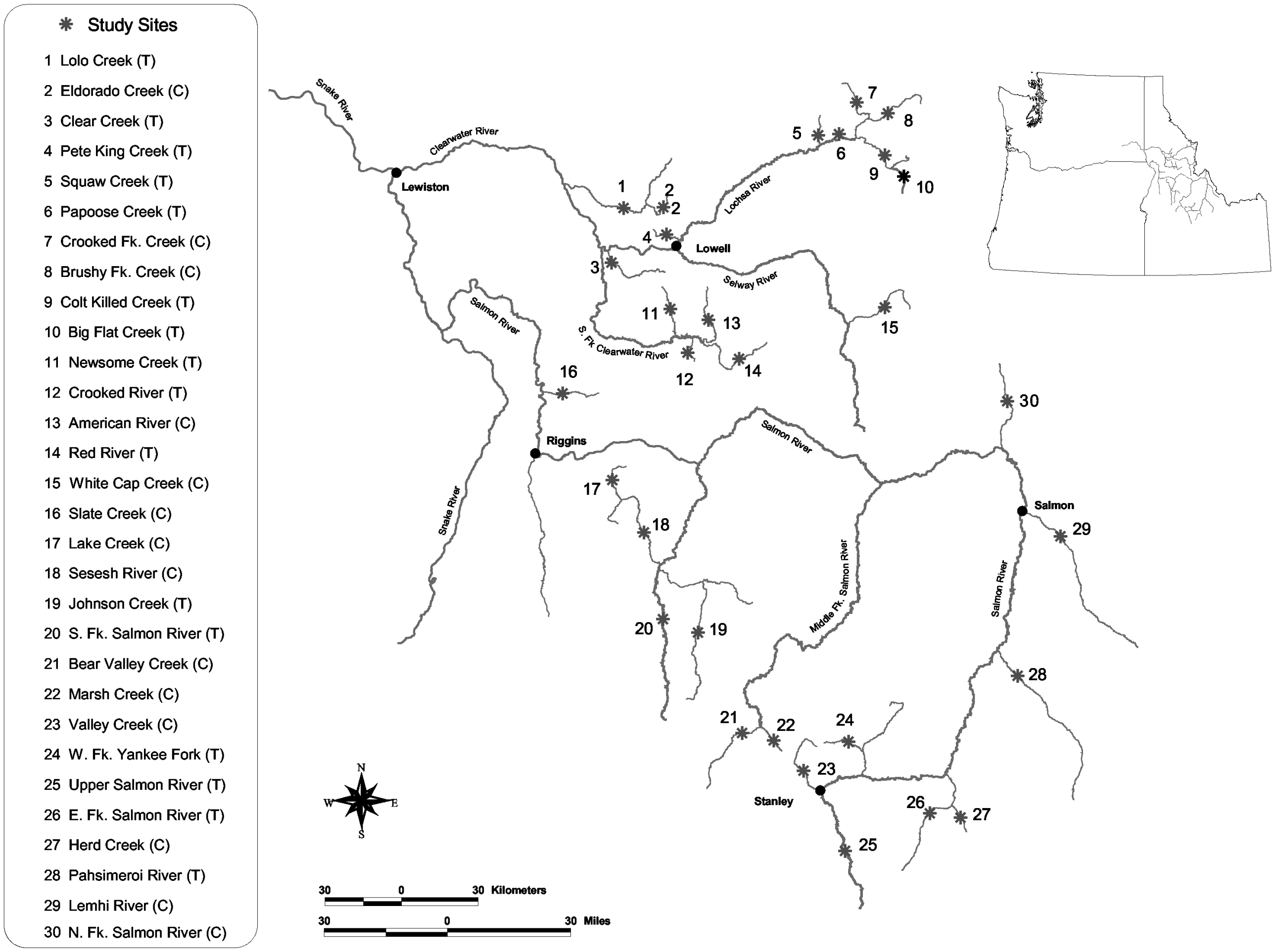

Figure 1.1 Current treatment and control streams for Idaho Supplementation Studies.

SECTION TWO

Straying

The ISS cooperators recognize that non-ISS chinook salmon stray into ISS study reaches. The majority of these fish are general production chinook salmon released locally from satellite hatchery facilities as part of the Lower Snake River Compensation Plan (LSRCP). In both the Salmon River and Clearwater River subbasins, all non-ISS strays occur as a direct result of 1) hatchery fish straying into ISS control streams without escapement weirs, 2) straying of hatchery fish into ISS control and treatment streams with escapement weirs that are less than 100% effective, and 3) direct release of adult chinook salmon into ISS study streams. Each of these scenarios makes it more difficult to accurately measure production response to treatment. To determine whether this will affect our ability to evaluate supplementation, we developed the best data set to address straying and applied this to the statistical analysis of ISS data.

Estimating Straying

To estimate the magnitude of straying, we examined the relative composition of chinook salmon origin types in adult carcass data collected annually beginning with 1995, which was the first year when marked adult chinook salmon from supplementation releases were expected to return. Three separate origin types that we identified were wild/natural adults, supplementation adults, and general production adults. Supplementation and naturally produced chinook salmon are considered part of the ISS experimental design. Stray adult chinook salmon were defined as non-ISS fish. In treatment streams, these were general production fish or other hatchery origin chinook salmon that escaped into ISS study reaches. This also included non-ISS adults that were outplanted from satellite hatchery facilities. In control streams, all hatchery origin chinook salmon (supplementation and general production) were considered strays.

The estimated proportion of non-ISS fish recovered annually in each stream suggests that substantial straying is occurring in many study reaches (Table 2.1). In the Salmon River subbasin, straying averaged more than 25% in two treatment streams. Treatment streams in the Clearwater River subbasin experienced even higher rates of straying, with estimates exceeding 50%. This is not surprising, since most treatment streams are located adjacent to satellite hatchery facilities that maintain LSRCP mitigation and other subbasin activities. Given the fact that installation of escapement weirs is often compromised by spring runoff, which enables non-ISS fish to enter ISS study reaches, we suspect that these estimates are fairly representative of the straying component to the ISS project.

Assuming that strays reproduce, we calculated redd production attributable to straying by multiplying total redd production by the percent stray carcasses found. Dividing stray redd production by stream segment length yields stray redds per kilometer, which were transformed using the log(X+1) transformation. This transformed variable was used as the covariate in analysis of covariance (ANCOVA).

Straying Analysis

American River, Brushy Fork Creek, Crooked Fork Creek, Crooked River, Johnson Creek, Lake Creek, Lolo Creek, Newsome Creek, Red River, Secesh River, and the South Fork

Salmon River have good carcass count data and a wide range of straying. These streams were selected for analysis of the effects of straying on our ability to detect effects of supplementation over time. Redd densities (log(Y+1) scale) were plotted as a function of straying (log(X+1) scale) for individual streams to see if a relationship exists.

There is a positive relationship between total redd production and straying. This was particularly evident in streams where the most complete carcass data was available, such as Crooked Fork Creek, Red River, and the SF Salmon River. Given these results, we compared an analysis of variance of the data with and without straying as a covariate. The basic design is a repeated measures or split-plot in time with six control streams, three partially treated streams and two treated streams. The assumption of equality of slopes was tested before proceeding with the ANCOVA. Attention is focused on the treatment by year interaction since its significance implies a differential response to supplementation among the control, partially treated, and treated streams. All analyses were performed in SYSTAT with the probability of a type I error set at 0.05.

Straying Effect Results and Conclusions

Results of the test of equality of slopes indicated that the treatment by stray interaction was not significant ($F_{2, 45} = 0.297$, $p = 0.774$), which suggests that the slopes of the lines across all study streams are equal. Proceeding with the ANCOVA, we found the covariate to be significant ($F_{1,47} = 40.26$, $p = 0.000$) and the interaction between treatment and time to be insignificant ($F_{12,47}=1.489$, $p=0.162$). When the covariate is omitted, the test of interaction is also insignificant ($F_{12,48}=1.191$, $p = 0.317$).

It is clear that although the 11 streams chosen for this analysis show a significant relationship between redd production and straying, there is no statistically significant effect on the treatment by time interaction. The insignificance could be a function of:

- Small sample size,
- Straying is highly variable across study streams,
- Straying may be balancing out among treated, partially treated, and control streams, which suggests that this may not affect our ability to evaluate treatment effects, or
- Strays were not successful at reproducing, and that the significant relationship between straying and production was the result of increased escapement of all chinook origin types.

During the final phase of study, we feel that more intensive monitoring of carcasses in ISS study streams is warranted. This will enable more robust analyses when making across stream and within stream comparisons. In addition, this will increase precision of our covariate estimates in Phase III, when we expect a relative change in chinook origin types returning to ISS study streams as supplementation treatments are phased out.

In summary, our analysis shows that increased straying is associated with increased redd production. With more intensive monitoring of carcasses through the end of Phase III, we will be able to develop a covariate adjustment that can be applied uniformly to all streams.

Table 2.1. Average proportion of non-ISS chinook salmon carcasses recovered in ISS study streams during carcass surveys. N = the number of years with covariate estimates out of a possible of seven. ND = no data.

Subbasin	Study Stream	Category	N	Proportion Stray
Clearwater River	American River	Treatment	7	0.61
	Big Flat Creek	Treatment	7	0.63
	Brushy Fork Creek	Control	7	0.44
	Clear Creek	Treatment	7	0.31
	Colt Killed Creek	Treatment	6	0.64
	Crooked Fork Creek	Control	7	0.58
	Crooked River	Treatment	7	0.30
	Eldorado Creek	Control	3	0.22
	Herd Creek	Treatment	4	0.08
	Lolo Creek	Treatment	7	0.38
	Newsome Creek	Treatment	5	0.44
	Papoose	Treatment	7	0.41
	Pete King Creek	Treatment	1	0
	Red River	Treatment	7	0.43
	Squaw Creek	Treatment	3	0.33
	White Cap Creek	Control		ND
Salmon River	Bear Valley Creek	Control	7	0
	EF Salmon River	Treatment	2	0
	Johnson Creek	Control	7	0.02
	Lake Creek	Control	7	0.05
	Lemhi River	Treatment	6	0
	Marsh Creek	Control	5	0.01
	NF Salmon River	Treatment	3	0
	Pahsimeroi River	Treatment	4	0.27
	Secesh River	Control	7	0.05
	Slate Creek	Control	3	0.21
	SF Salmon River	Treatment	7	0.67
	Upper Salmon River	Treatment	4	0
	Valley Creek	Treatment	6	0
	WF Yankee Fork	Treatment	2	0

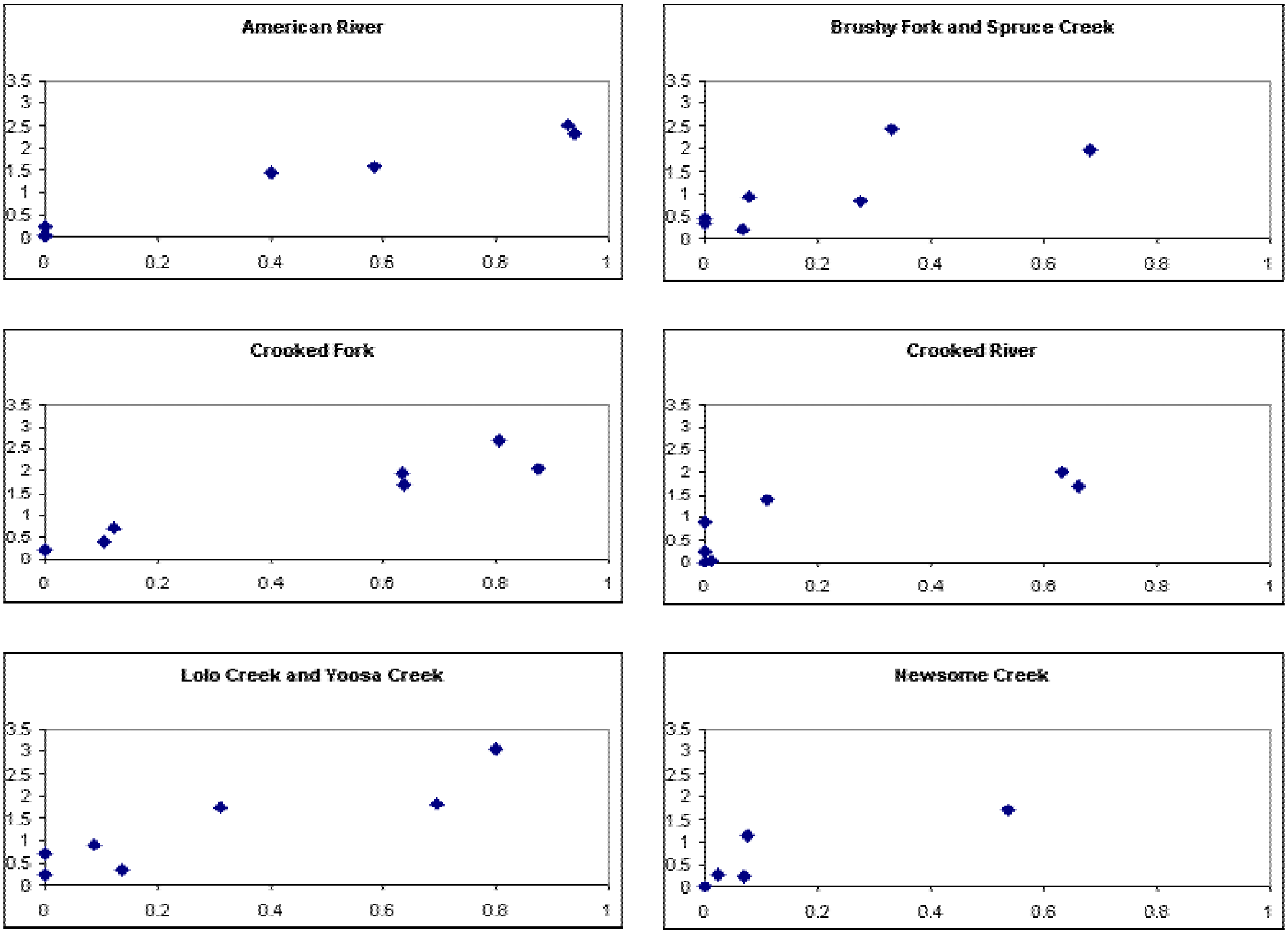

Figure 2.1. Plots of natural production/stray relationships for select ISS study streams. Log(strays +1) represented on the x axis and the log of redds/km +1 represented on the y axis.

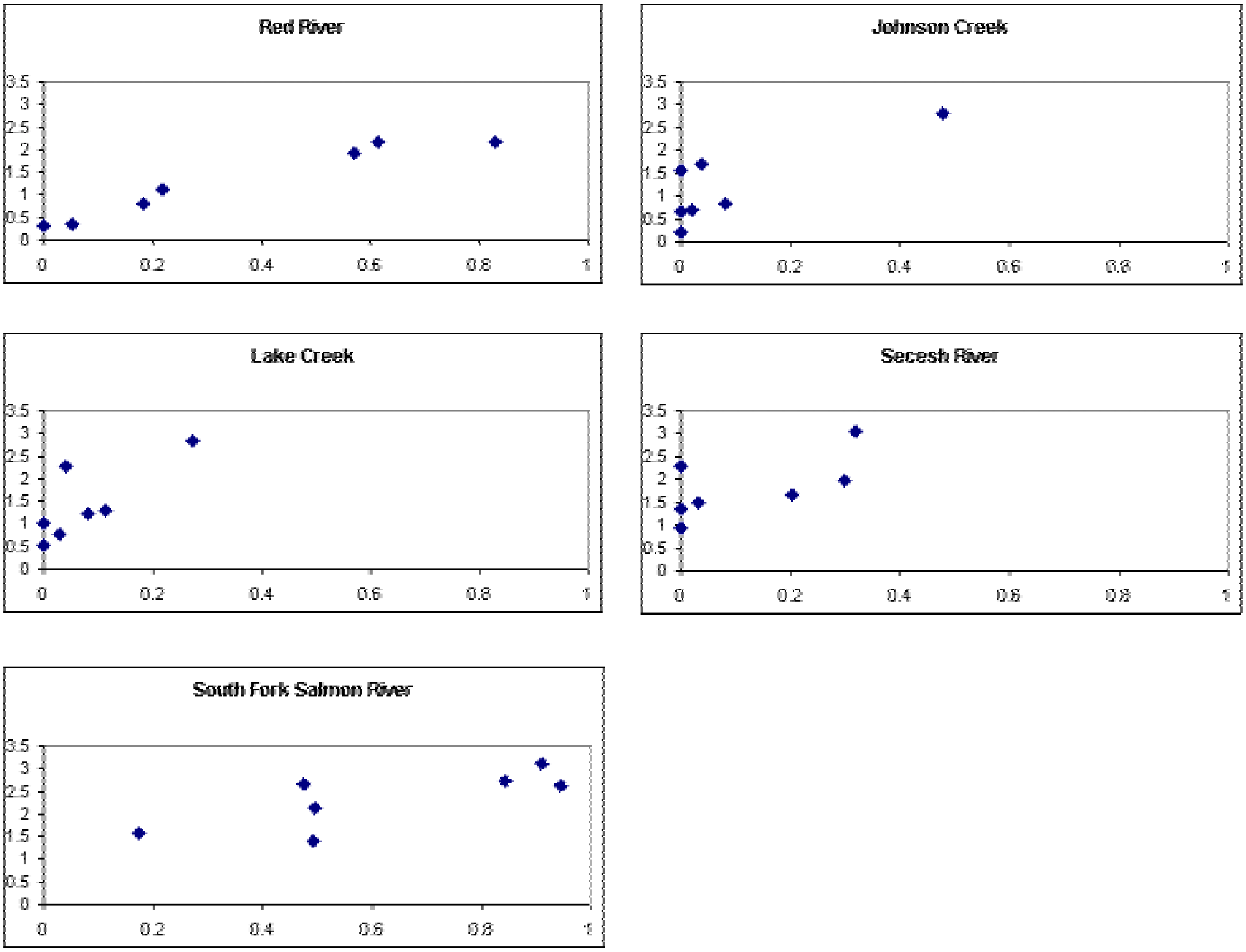

Figure 2.1   Continued.

SECTION THREE

Formulation of the ISS Prototype Statistical Analysis

The original ISS study design recommended a repeated measures analysis of variance (ANOVA) as the primary data analysis tool. We used repeated measures ANOVA with blocking of streams and adjustment of time scale as necessary. Redd counts, expressed as redds per kilometer, transformed to log(Y+1) were used as the response variable.

Stream Designations/Groupings

As discussed previously, streams were designated as full treatments if they received a minimum of 50% of the treatments prescribed in the original study design. Those streams receiving less than 50% of the prescribed treatments were designated as partial treatments. Control streams were defined as those streams in which ISS treatments did not occur, or occurred at a level that would be unlikely to result in a measurable response. For example, despite receiving one release of 7,800 ISS presmolts in calendar year 1992, Crooked Fork Creek is considered a control stream for these analyses.

An examination of the raw data expressed as redds per kilometer by year for each stream (Figure 3.1) suggested that responses in treated and partially treated streams were not independent of geography. This is not a surprising result given that study streams in the Clearwater subbasin were primarily designated as supplementation/restoration (i.e. reintroductions), while Salmon subbasin streams were primarily designated as supplementation/augmentation (had extant populations) in the original study design. Given the obvious discrepancy in potential productivity and historical response among the streams, we grouped (i.e. blocked) streams based on geographic proximity and habitat similarity (Figure 3.2).

Alternative Measure of Time

As documented previously, the ISS study suffered from difficulties in constructing local broodstocks and obtaining adequate broodstock to achieve prescribed ISS treatments. Therefore, treatments were not initiated simultaneously in all ISS streams, nor were treatments continuous in many cases. As a result, we discovered that calendar year is not a meaningful measure of time for statistical analyses. For example, in Lolo Creek, the first smolt treatment for the ISS study occurred in calendar year 1999, while in the South Fork Salmon River ISS smolts were first outplanted in calendar year 1993. In terms of a response in redd counts, we would expect to see the first ISS adults returning to Lolo Creek in 2001 versus 1995 for the South Fork Salmon River.

In order to compensate for differences in treatment schedules among ISS study streams, we defined Time I as those calendar years within a stream during which the ISS study could not have affected the response variable (e.g., 1991 through 2000 in Lolo Creek) and Time II as those calendar years within a stream during which the response variable could have been affected by the ISS study (e.g., 2001 and 2002 in Lolo Creek). Calendar years were recoded within Time I and Time II with the first year in which supplementation fish could have returned and reproduced as 1. The years in Time I thus are coded as –8, -7…-1, and 0, and the years in Time II are coded as 1, 2, 3…8 as needed. For example, in Lolo Creek calendar year 1998 was coded as -2, 1999 was coded as -1, 2000 was coded as zero, 2001 was coded as 1, 2002 was coded as 2 and so on. If treatment was interrupted, the year code was set as “missing” during those years when supplementation fish could not have returned to reproduce. For control streams, the designation of Time I and Time II was taken from adjacent treated streams.

Prototype Statistical Analysis

The prototype analysis runs as a mixed linear model in SAS© (2003 SAS Institute Inc., SAS Campus Drive, Cary, North Carolina 27513, USA). Log transformed redds per kilometer is assumed to be the dependent variable. Independent variables include group (geographic and habitat based groups of streams discussed above), treatment (control, partial, treatment—defined in section one), stream (all streams), time (Time I or II as discussed previously), and year (recoded as discussed above). Blocking by stream group results in an unbalanced randomized complete block repeated measures design with three treatments (control, partial treatment, and full treatment) arranged in blocks with various numbers of observations (streams) per treatment-block. All data used for the development of the prototype analysis are available in Appendix 3.1.

Streams, groups, and years are treated as random terms in the prototype model, while treatment and time are fixed effects. The general form and SAS code for the model are presented in Tables 3.1a and 3.1b.

Prototype Results and Interpretation

The Partial F tests of fixed effects yielded a highly significant treatment by time interaction, suggesting that supplementation affected production (Table 3.2). Scrutinizing the least squared means (Table 3.3) and differences between least squared means (Table 3.4), it is clear that the significance of the treatment by time interaction results largely from an increase in the partially treated category from Time I to Time II. In general, it appears that partially treated streams were less productive than control streams prior to supplementation, while fully treated streams were more productive than control streams at the inception of the ISS study. Thus far, it appears that supplementation increased production in partially treated streams, which now surpass production in control streams on average. Alternatively, production in control and fully treated streams appears to have increased slightly over time, although to a lesser extent on average in fully-treated versus control streams.

We caution that these results and interpretations are preliminary. Adults from ISS Phase II juvenile treatments will continue to return through calendar year 2007, and hence are not reflected in these data. The preliminary interpretations above are presented to demonstrate that we have formulated a viable prototype statistical analysis that is capable of handling the unique challenges associated with the ISS study (e.g., differing levels of treatment and timing of treatments), resulting from deviations from the original study design.

Table 3.1a. Classes, levels, and values considered in the prototype analysis.

Class	Levels	Values
Group	9	Lower Lochsa, Lower Salmon, Middle Salmon, Selway, South Fork Clearwater, South Fork Salmon, Slate Creek, Upper Lochsa, Upper Salmon
Treatment	3	Treated, Partial, Control
Stream	30	American River, Bear Valley Creek, Big Flat Creek, Brushy Fork Creek and Spruce Creek, Clear Creek, Colt Killed Creek, Crooked Fork Creek, Crooked River, East Fork Salmon River, Eldorado Creek, Herd Creek, Johnson Creek, Lake Creek, Lemhi River, Lolo Creek and Yoosa Creek, Marsh Creek, Newsome Creek, North Fork salmon River, Pahsimeroi River, Papoose Creek, Pete King Creek, Red River, Secesh River, Slate Creek, South Fork Salmon River, Squaw Creek, Upper Salmon River, Valley Creek, West Fork Yankee Fork Salmon River, White Cap Creek
Time	2	1, 2
Year	16	-8, -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8

Table 3.1b. General form (SAS code) of the mixed model prototype analysis.

```
Proc mixed method=ml
Class Group Treatment Stream Time Year;
Model Logredds (log of redds per kilometer plus 1) = Treatment Time Treatment * Time;
Random Group Stream (Group Treatment) Year(Time);
```

Table 3.2. Type 3 tests of fixed effects from the prototype analysis of ISS redds per kilometer data.

Effect	Numerator DF	Denominator DF	F-Value	Pr>F
Treatment	2	19	0.82	0.4572
Time	1	14	4.15	0.0610
Treatment x Time	2	240	18.11	<0.0001

Table 3.3. Least squared means associated with control, partial, and fully treated ISS streams during Time I and Time II of the ISS project.

Treatment	Time	Estimate	Standard Error	Degrees of Freedom	t value	Pr>|t|
Control	1	0.2420	0.1011	240	2.39	0.0175
Control	2	0.3416	0.09723	240	3.51	0.0005
Partial	1	0.1229	0.1084	240	1.13	0.2582
Partial	2	0.5605	0.1091	240	5.14	<0.0001
Treatment	1	0.3991	0.1314	240	3.04	0.0027
Treatment	2	0.4510	0.1219	240	3.70	0.0003

Table 3.4. Differences of Least Squared Means.

Effect	Treatment	Time	Treatment	Time	Estimate	Error	DF	t Value	Pr > |t|
Treatment x Time	Control	1	Control	2	-0.09961	0.1004	240	-0.99	0.3222
Treatment x Time	Control	1	Partial	1	0.1191	0.09942	240	1.2	0.232
Treatment x Time	Control	1	Partial	2	-0.3184	0.1354	240	-2.35	0.0195
Treatment x Time	Control	1	Treatment	1	-0.157	0.1161	240	-1.35	0.1773
Treatment x Time	Control	1	Treatment	2	-0.209	0.1416	240	-1.48	0.1413
Treatment x Time	Control	2	Partial	1	0.2187	0.1324	240	1.65	0.0997
Treatment x Time	Control	2	Partial	2	-0.2188	0.09705	240	-2.25	0.0251
Treatment x Time	Control	2	Treatment	1	-0.05743	0.1484	240	-0.39	0.6992
Treatment x Time	Control	2	Treatment	2	-0.1094	0.1067	240	-1.03	0.3062
Treatment x Time	Partial	1	Partial	2	-0.4376	0.1015	240	-4.31	<.0001
Treatment x Time	Partial	1	Treatment	1	-0.2762	0.1263	240	-2.19	0.0298
Treatment x Time	Partial	1	Treatment	2	-0.3281	0.1483	240	-2.21	0.0278
Treatment x Time	Partial	2	Treatment	1	0.1614	0.1577	240	1.02	0.3072
Treatment x Time	Partial	2	Treatment	2	0.1094	0.1194	240	0.92	0.3604
Treatment x Time	Treatment	1	Treatment	2	-0.05195	0.1133	240	-0.46	0.6469

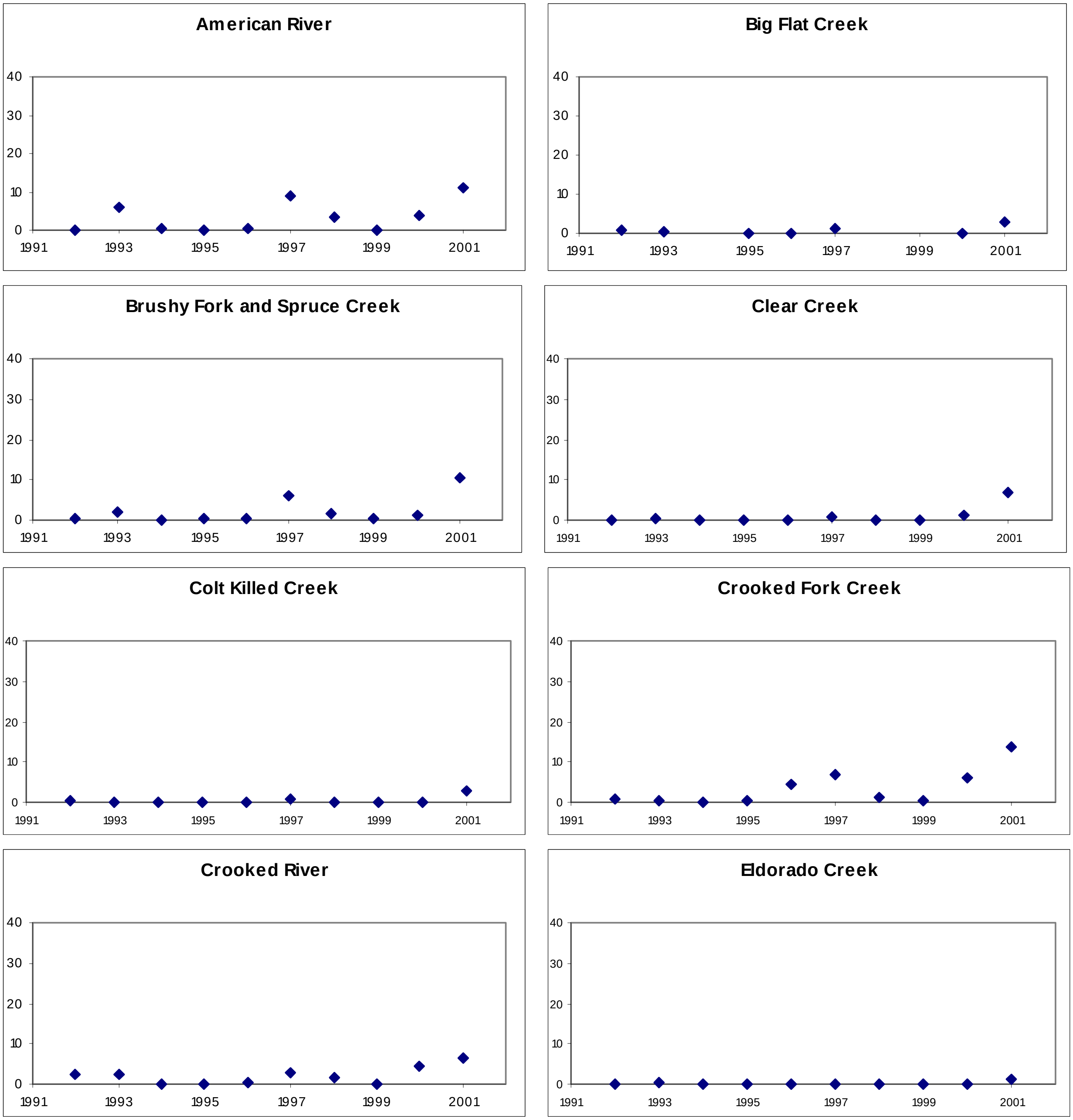

Figure 3.1. Plots of redds per kilometer by year for all ISS study streams.

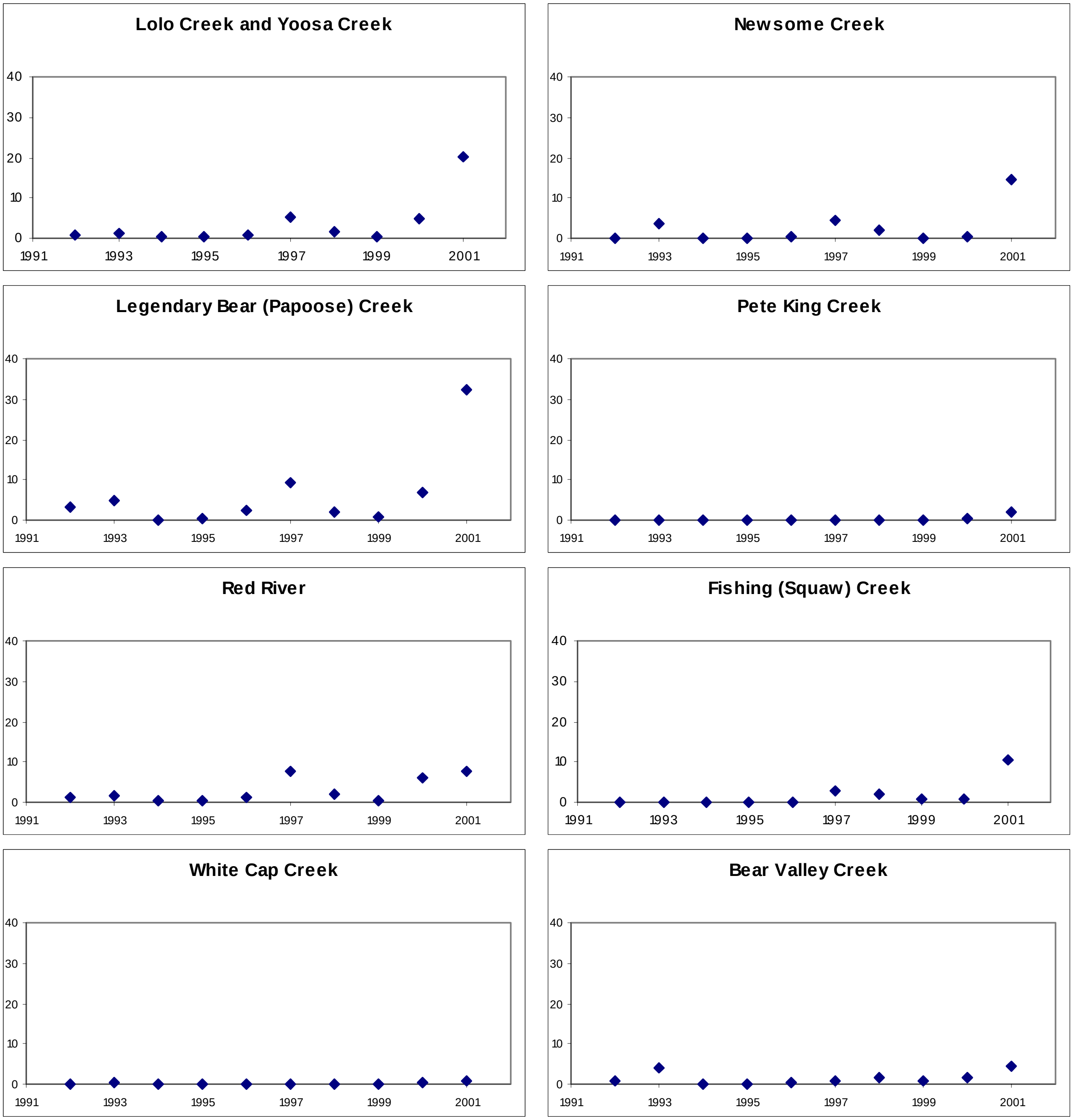

Figure 3.1 Continued.

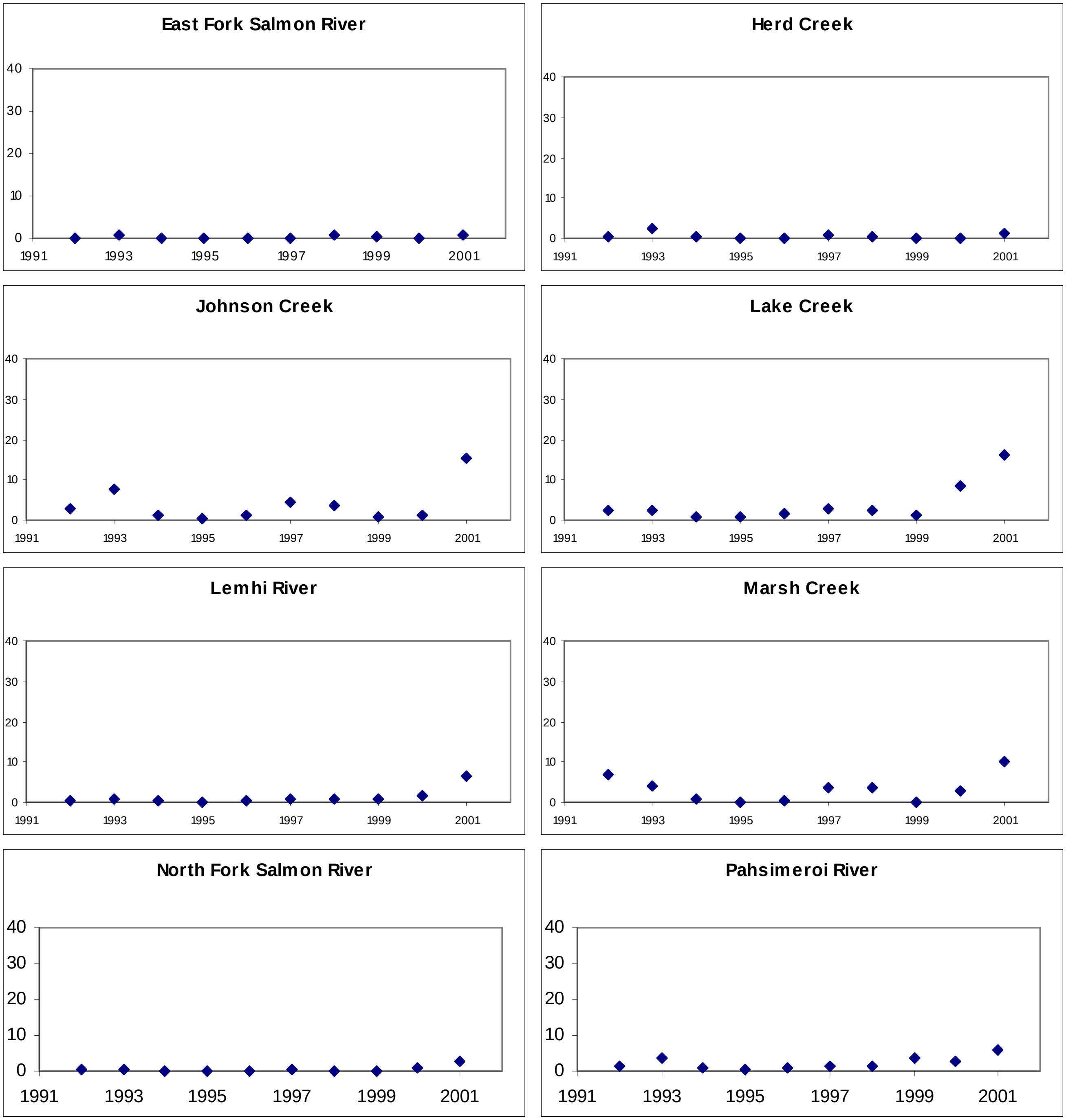

Figure 3.1 Continued.

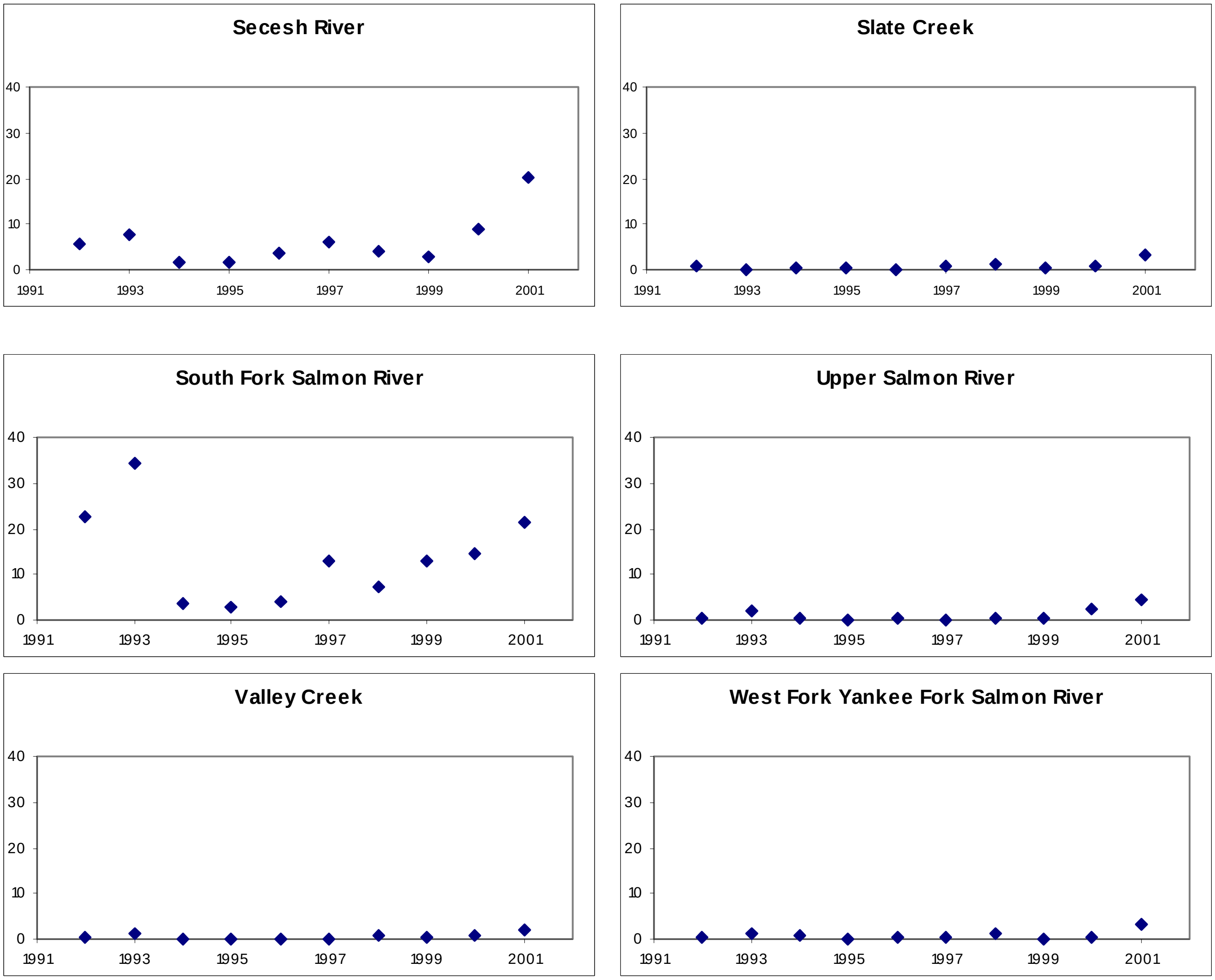

Figure 3.1 Continued.

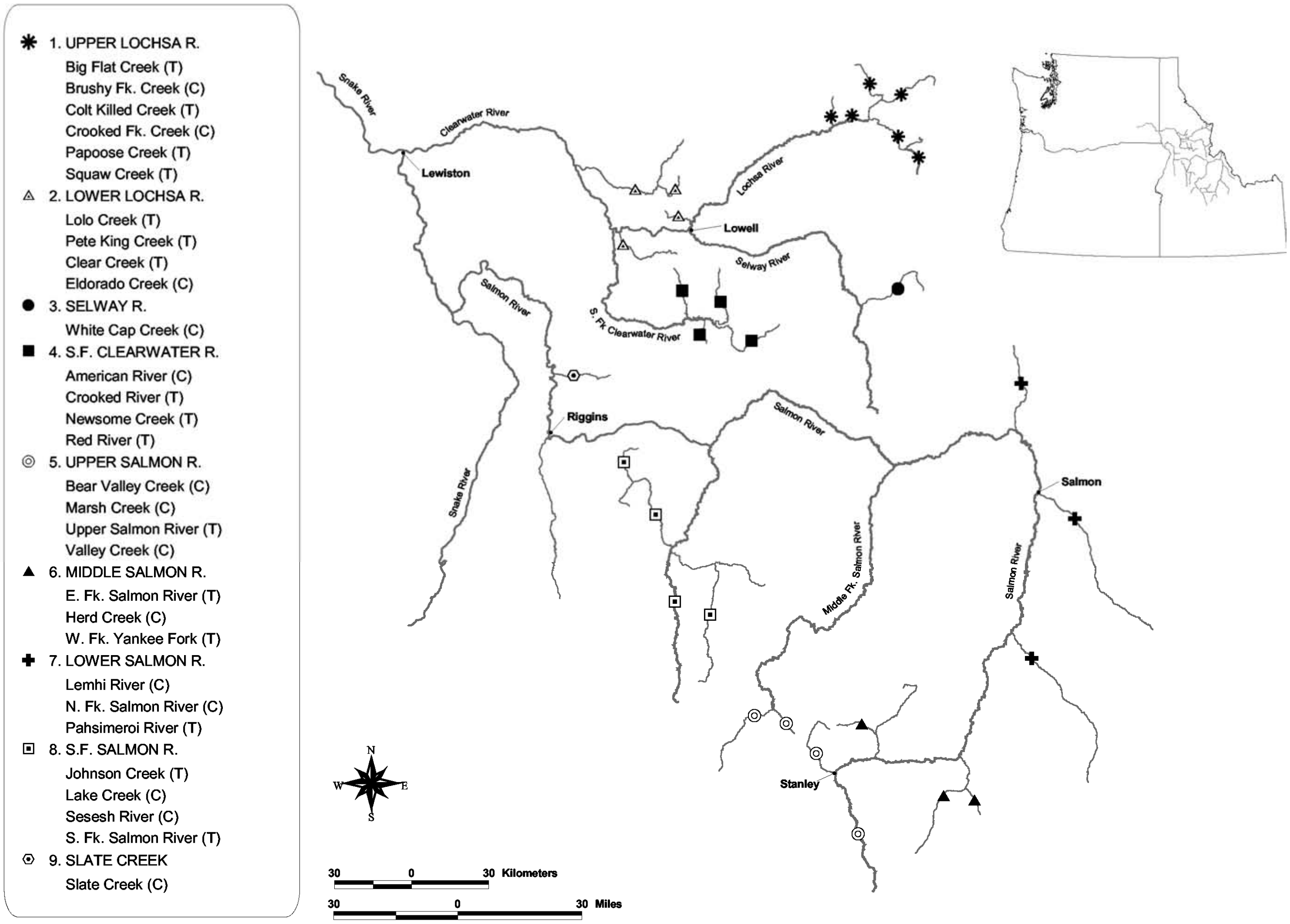

Figure 3.2. ISS groupings of treatment, partial, and control streams used for the prototype analysis.

SECTION FOUR

Power Analysis

The basic statistical design of the ISS study is a repeated measures or split-plot in time design with main plots (streams) arranged in groups (i.e. blocks). The principle evidence of an effect of supplementation is a significant treatment by time interaction. If such an interaction exists, then it documents a divergence in response between treated, partially treated, and control streams over time. The power of this test depends on sample size (number of stream-years in each treatment category) and effect size. If the straying covariate is significant, then power also depends on the rates at which straying occurs.

In the previous section, the significant treatment by time interaction was seen largely through an increase in natural production in the partial treatment category. As previously stated, the prototype analysis was presented to document a robust method to evaluate ISS under the confines of specific study deviations. One of the underlying assumptions was that sample sizes would be maintained. Presently, ISS cooperators recognize study deviations that occur under the basinwide research umbrella that encompasses four different management agencies. Specific to this are demands on study streams by other management projects that directly conflict with the ISS study (Venditti et al. 2000). In order to assess the effect of losing study streams, we performed a numerical power analysis by rerunning the prototype analysis after removing streams.

Sample Size Effects

Johnson Creek was originally classified as a control stream in the ISS study. However, it now receives supplementation treatments because of the Johnson Creek Artificial Propagation Enhancement project (Vogel and Hesse 2000). Supplementation releases are expected to continue through five chinook salmon generations. As a result, the utility of Johnson Creek as an ISS study stream is currently being evaluated. In the interim, we ran the prototype statistical analysis without Johnson Creek to determine if losing this stream impairs the sensitivity of the current study design. Johnson Creek was removed and the prototype analyses rerun with the significances compared.

The primary power analysis consists of four test simulations defined by randomly removing four treatment streams and three control streams. Analyses were run on each simulation by removing only the treatment streams, only the control streams, and both treatment and control streams. This results in 12 (four random scenarios by “treatments removed,” “controls removed,” and all streams removed) analyses. Results were then compared to the baseline prototype analysis.

Results and Discussion

Removing Johnson Creek from the study design did not affect the outcome of the prototype analysis. The treatment by year interaction is significant in both comparisons ($F_{2\ 240}$ = 18.11, p = <0.001 for the baseline comparison, and $F_{2\ 231}$ = 16.76, p = <0.001 without Johnson Creek). When analyses were run on each of the randomly removed treatment stream and control stream simulations, all treatment by time interactions remained significant (Table 4.1).

The ISS cooperators recommend removing Johnson Creek from Phase III analysis. Due to supplementation activities scheduled for several chinook salmon generations, it is clear that it can no longer function as an ISS control stream. Based on the results of the power analysis and the net increase in the number of control streams, we feel that losing Johnson Creek will not affect our ability to statistically evaluate the ISS study.

The results of the random numerical power analysis are somewhat surprising. Despite removing nearly twenty five percent of the study streams from the analysis, we were able to detect statistically significant differences in production between treated, partially treated, and control streams. This outcome differs from the results presented from a power and sensitivity analysis performed when the ISS experimental design was completed. However, we feel that running the prototype analysis with current ISS data provides a more realistic comparison. This in no way suggests that losing study streams will not ultimately affect the integrity of the experimental design. The ISS cooperators are committed to maintaining current samples sizes through the remainder of the study. Streams that may be complicated by other management activities will be intensely scrutinized. Any adjustments to the experimental design will be made cooperatively among all ISS participating agencies and will include some level of technical oversight.

Supplementation Treatment Duration

The ISS cooperators recommend ceasing development of supplementation broodstock for all treatment streams with Brood Year 2002 (Figure 4.1). Projected treatments through BY02 will increase the number of treated (i.e. >50% treated) streams compared to partially treated streams. This will enhance the overall analysis. In addition, forecasted low adult returns of wild/natural fish in the next few years will likely prevent creation of localized broodstock across all ISS treatment streams.

Rather than staggering treatment among selected streams over a specific period, we felt that ceasing treatment simultaneously will likely reduce annual variation and error associated with differences in mainstem passage and ocean productivity. Broodstock created through 2002 will be released into ISS treatment streams through spring 2004 as prescribed in the study design (Bowles and Leitzinger, 1991). Transition from Phase II (Supplementation) to Phase III (Evaluation) will occur once all brood year releases are completed.

Table 4.1. Results from power analysis from removing randomly selected streams.

	Treatment				Control				Combined		
Comparison	**Streams Removed**	***Error d.f.***	***F*-ratio**	***P***	**Streams Removed**	***Error d.f.***	***F*-ratio**	***P***	**n**	***F*-ratio**	***P***
Scenario 1	Squaw Cr Colt Killed Cr Pete King Cr Newsome Cr	207	17.05	<.0001	Johnson Cr Eldorado Cr Herd Cr	213	17.04	<.0001	180	16.88	<.0001
Scenario 2	Pete King Cr Red R Upper Salmon R EF Salmon R	205	24.63	<.0001	Brushy Fork Cr Marsh Cr NF Salmon R	213	15.40	<.0001	178	20.94	<.0001
Scenario 3	EF Salmon R Lolo Cr Newsome Cr Upper Salmon R	206	14.74	<.0001	Eldorado Cr Secesh R White Cap Cr	213	17.78	<.0001	183	15.05	<.0001
Scenario 4	American R EF Salmon R SF Salmon R Squaw Cr	206	15.74	<.0001	Herd Cr NF Salmon R Secesh R	213	14.80	<.0001	179	12.22	<.0001

Table 4.2. Current and expected levels of supplementation releases in ISS treatment streams from BY91–BY99. Partial treatment designation categorizes streams that have received <50% of annual treatments originally defined in the study design. * = no releases since BY93.

	Status Through BY99			Predicted Status Through BY02		
Treatment Stream	**Number of Treatments**	**Percent Treatment**	**Treatment Designation**	**Number of Treatments**	**Percent Treatment**	**Treatment Designation**
Clearwater Basin						
Lolo Cr	3	33	Partial	6	50	Treatment
Newsome Cr	4	40	Partial	7	54	Treatment
Crooked R	4	44	Partial	7	58	Treatment
Red R	7	78	Treatment	10	83	Treatment
Clear Cr	5	56	Treatment	8	67	Treatment
Pete King Cr	3	33	Partial	6	50	Treatment
Squaw Cr	4	44	Partial	7	58	Treatment
Papoose Cr	3	33	Partial	6	50	Treatment
Colt Killed Cr	4	44	Partial	7	58	Treatment
Big Flat Cr	2	22	Partial	2	17	Partial
Salmon Basin						
SF Salmon R	9	100	Treatment	11	92	Treatment
Pahsimeroi R	7	78	Treatment	10	83	Treatment
EF Salmon R	3	33	Partial	3*	25	Partial
WF Yankee Fork	1	11	Partial	1*	8	Partial
Upper Salmon R	9	100	Treatment	12	100	Treatment

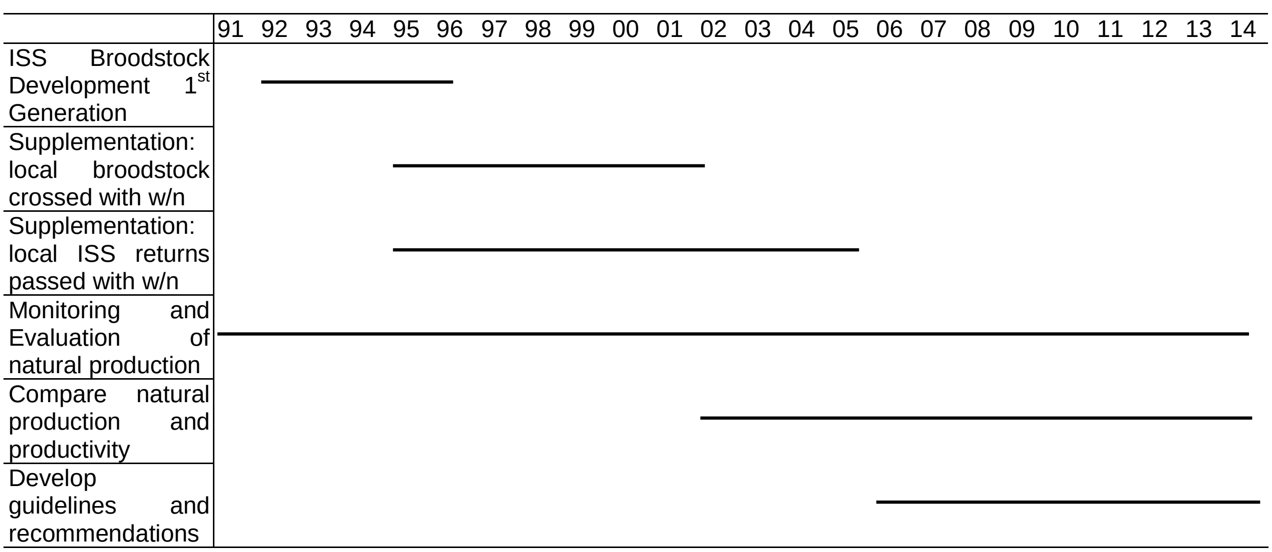

Figure 4.1. Revised timeline for reviewed tasks associated with Idaho Supplementation Studies.

SECTION FIVE

Phase III Analysis

We believe that the statistical methods presented in this document will enable a more robust statistical evaluation of the ISS study. The mixed model ANOVA (or ANCOVA) outlined above will provide a statistically valid analysis of the effects of supplementation through Phase III under the following conditions:

- Carcass counts are made for all streams for the years remaining,
- Groups (i.e. blocks) remain a good index of potential productivity,
- Treatments are categorized as control, partially treated, and treated,
- Years are coded relative to the onset of returning supplementation fish, and
- All cooperators adhere to agreed upon protocols where at all possible. Proposed deviations should be discussed and agreed upon by all participants.

Redd count data will be used as the main evaluation point for Phase III analysis, although other production measures such as juvenile abundance and weir counts will also be examined. As described in section three, groupings may be adjusted to reflect biologically meaningful comparisons more appropriately.

The carcass data set provided the best means for addressing straying in the statistical analysis of ISS. Whether or not ANCOVA for straying adjustment is necessary in Phase III depends on whether the covariate is significant in the final analysis after all data are collected. The partial data analyzed to date indicates that straying is significantly contributing to redd production. If this holds up, then ANCOVA can provide an adjustment for non-ISS production. The data set used in section two above augmented with data collected from now through the end of the study will provide a relatively complete carcass evaluation data set. We can estimate the coefficient of the covariate from this data set and apply the covariate adjustment to all stream years where straying data are available.

A stream specific protocol for ISS research components critical for Phase II transition and Phase III evaluation is presented in Table 5.1. These activities are highlighted below, and are formulated based on the original study design and the results of the current statistical review.

Monitoring and Evaluation

While reviewing these questions, it became clear that the ISS study must continue to rigorously pursue or perhaps increase monitoring activities. For example, formulating the carcass covariate in section two of this report required that carcass disposition (hatchery or natural origin) be recorded for all recovered fish. In some areas these data were not collected from all carcasses, potentially decreasing our ability to predict and compensate for the effects of strays.

Other monitoring and evaluation components for ISS production and productivity components will be maintained throughout the remainder of the study. Evaluation points for natural production include adult escapement, fall and spring out-migration, and smolt production. Productivity response variables will include estimating survival relationships, smolt-to-adult return rates, age structure, fecundity, and genetic structure.

Adult Escapement and Weir Management

Escapement and weir management protocols for the ISS study will be maintained according to strategies outlined in the study design (Bowles and Leitzinger 1991). In treatment streams, all wild/natural returning adults will be released upstream of escapement weirs. This will continue throughout the remainder of the study. The proportion of supplementation adults released upstream of weirs will not exceed that of naturally produced adults. These escapement criteria for supplementation adults will be applied until all of the adult chinook salmon return from the Brood Year 2002 supplementation release. We will also attempt to intercept general production adults before they enter ISS study reaches, and none of these fish will be released upstream.

Future ISS Review

As we transition from Phase II into Phase III, ISS cooperators will programmatically address statistical evaluation of productivity. In the current review, we used a measure of natural production for evaluating a response to supplementation through most of the second study phase. The more important measure of the ISS study will be evaluating changes in productivity relative to the response in natural production. Presently, we have identified stream years of data specific to other research questions raised in the study design. We are currently in the process of developing a cooperative ISS committee that will include outside technical expertise to examine phase specific and stream specific productivity analyses (quantitative and/or qualitative). We anticipate a follow-up report that will document these additional Phase III evaluation measures.

From a programmatic standpoint, we have made significant progress toward coordination and integration of ISS activities through cooperative BPA work statements, database management, and reporting. We feel that this provides a more solid foundation for addressing problematic issues during the final phase of the ISS study.

Table 5.1. Stream specific protocol for broodstock management, escapement, and monitoring and evaluation that will be completed for all ISS study streams through the remainder of the study.

		Phase II Supplementation and Adult Escapement				Phase III Mgt & Escapement Response Variables			
Study Stream	**Category**	**Final BY Treatment**	**Final ISS Release**	**Life Stage**	**Weir Mgt**	**Redd Counts**	**Chinook Carcass**	**Juvenile Emigration**	**Rack Returns**
Colt Killed Cr	Treatment	2002	2003	Parr		X	X	X	
Big Flat Cr	Treatment					X	X		
Crooked R	Treatment	2002	2003	Presmolt	X	X	X	X	X
Pahsimeroi R	Treatment	2002	2004	Smolt	X	X	X	X	X
Red R	Treatment	2002	2003	Presmolt	X	X	X	X	X
SF Salmon R	Treatment	2002	2003-04	Parr/Smolt	X	X	X	X	X
Upper Salmon R	Treatment	2002	2004	Smolt	X	X	X	X	
Papoose Cr	Treatment	2002	2004	Smolt	X	X	X		
Squaw Cr	Treatment	2002	2003	Parr	X	X	X		
Lolo Cr	Treatment	2002	2004	Smolt	X	X	X	X	X
Newsome Cr	Treatment	2002	2004	Smolt	X	X	X	X	X
WF Yankee Fk	Treatment					X	X	X	
EF Salmon R	Treatment					X	X	X	X
Clear Cr	Treatment	2002	2004	Smolt	X	X	X	X	X
Pete King Cr	Treatment	2002	2003	Parr		X	X		
American R	Treatment	—[b]				X	X	X	
Johnson Cr	Control[a]				X[c]	X	X	X	X
Lemhi R	Control	—				X	X	X	X
Brush Fork Cr	Control	—				X	X		
Crooked Fork Cr	Control	—			X	X	X	X	X
Marsh Cr	Control	—				X	X	X	X
NF Salmon R	Control	—				X	X		
White Cap Cr	Control	—				X			
Lake Cr	Control	—				X	X	X	
Secesh R	Control	—				X	X	X	
Slate Cr	Control	—				X	X		
Bear Valley Cr	Control	—				X	X		
Herd Cr	Control	—				X	X		
Eldorado Cr	Control					X	X		
Valley Cr	Control	—				X	X		

[a] Johnson Creek will be removed from Phase III prototype analysis, but monitoring and evaluation will completed through JCAPE.
[b] Supplementation treatments will continue through the duration of the ISS study.
[c] Will not use ISS protocols for weir management and adult escapement.

ACKNOWLEDGEMENTS

The ISS project is a cooperative effort that would not be possible without the continued support of many personnel. For data transfer, compilation, and review of this report, we thank the following contributors: Kim Apperson, Jody Brostrom, Arnie Brimmer, Brian Leth, and Sam Sharr from the Idaho Department of Fish and Game, Jay Hesse and Jerry Lockhart from the Nez Perce Tribe, Jill Olson and Justin Bretz from the U.S. Fish and Wildlife Service, and Andy Kohler and Doug Taki from the Shoshone-Bannock Tribes. Julie Bednarski, Carl Stiefel, and Tim Klucken provided further assistance in data compilation and preparation of figures and tables. Report formatting was completed by Cheryl Leben, and stream maps were created by Paul Bunn, Idaho Department of Fish and Game. We appreciate the efforts of the fish hatchery managers and their crews from all cooperating agencies for managing adult escapement, supplementation broodstock, and outplanting activities. We also thank the many field personnel representing each cooperating agency for field data collections. The Bonneville Power Administration provides funding support for this project.

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APPENDICES

Appendix 1.1. Brood year specific supplementation releases for the Idaho Supplementation Studies in the Clearwater and Salmon drainages, brood years 1991-1999. Mark: RV = right pelvic fin clip, LV = left pelvic fin clip, E = elastomer injection, AD = adipose fin clip, CWT = coded wire tag. Broodstock sources: RPR = Rapid River, CRR = Crooked River, POW = Powell, SFS = South Fork Salmon River, PAR = Pahsimeroi River (summer run), SAL = Salmon River, LOOKGL = Looking Glass, SFC = South Fork Clearwater, RDR = Red River, DWO = Dworshak. * = Crooked Fork Creek changed to a control stream.

Stream	Brood Year	Proposed Annual Treatment BY91–BY99	Date Released	Life Stage Released	Number Released	Number PIT Tagged	Mark	Average FL (mm)	Brood Stock Source
Clearwater Basin									
American R.	1993	128,000 smolts	4/5-10/95	smolt	221,449	1,199	RV	112	RPR
Big Flat Cr.	1993	40,000 parr	7/6-8/94	parr	49,954	997	RV	78	POW
	1992		8/5-6/93	parr	40,875	1,000	LV	103	POW
Clear Creek	1998	49,000 smolts	4/9/00	smolt	84,304	750	RV	131	Kooskia
	1997		4/9/99	smolt	50,030	502	LV	145	Kooskia
	1996		4/14/98	smolt	33,681	500	RV	146	Kooskia
	1994		4/12/96	smolt	49,674	503	LV	142	Kooskia
	1993		4/12/95	smolt	49,319	494	RV	105	Kooskia
Colt Killed Cr	1997		7/15-8/5/98	parr	299,079	2,100	AD		POW
	1993		7/6-8/94	parr	99,808	998	RV	78	POW
	1992		8/4-5/93	parr	79,988	1,000	LV	103	POW
	1991		7/23-1992	parr	90,125	1,399	RV	65	RPR
Crooked Fork Ck.*	1991		9/5/92	presmolt	7,800	0	LV	120	POW
Crooked R.	1999	400,000	9/1/00	presmolt	105,507	499	RV		LOOKGL
	1998	presmolt	9/28/99	parr	89,298	0	LV		POW
	1997		9/24/98	presmolt	162,119	0	RV		SFC
	1993		9/19/94	presmolt	199,255	1,000	RV	108	CRR
Lolo/Yoosa Ck.	1999	175,000 presmolt	3/27/2001	smolt	155,195		CWT		LOOKGL
	1998		?	parr	250,200		CWT		LOOKGL
	1997		3/31-4/2/99	smolt	147,194	0	CWT		SFC
Newsome Creek	1999	100,000 presmolt	?	smolt	155,140		CWT		LOOKGL
	1998		?	parr	50,200		CWT		DWO
	1997		3/19/1999	smolt	74,109	0	CWT		RPR
	1993		4/10/1995	smolt	189,612	1,200	RV	130	RPR
Papoose Ck.	1997	50,000 smolts	4/7/99	smolt	47,950	1,499	AD	134	?
	1993		4/5/95	smolt	55,300	499	RV	120	RPR
	1992		4/15/94	smolt	16,110	499	LV	150	POW
Pete King Ck.	1997	13,000 parr	7/20/98	parr	12,889	0	CWT	114	POW
	1993		7/5/94	parr	15,080	998	RV	78	POW
	1992		8/6/93	parr	12,000	1,000	LV	104	POW
Squaw Ck.	1997	12,000 parr	7/29/98	parr	12,827	990	CWT	107	POW
	1993		7/5/94	parr	14,977	1,001	RV	78	POW
	1992		8/5/93	parr	12,000	998	LV	103	POW
	1991		7/23/92	parr	10,126	699	RV	65	RPR
Red R.	1999	80,000 presmolt	9/1/00	presmolt	68,684	500	LV		LOOKGL
	1998		9/27/99	presmolt	74,981	0	RV		POW
	1997		10/5/98	presmolt	66,114	0	LV		SFC
	1996		4/13/98	smolt	29,585	0	RV		RDR
	1996		4/7-9/98	smolt	21,623	0	LV		RDR

Appendix 1.1 Continued

Stream	Brood Year	Proposed Annual Treatment BY91–BY99	Date Released	Life Stage Released	Number Released	Number PIT Tagged	Mark	Average FL (mm)	Brood Stock Source
Red R.	1993		9/23/94	presmolt	79,747	1,000	LV	96	RDR
	1992		10/12/93	presmolt	7,971	300	RV	119	RDR
	1992		10/12/93	presmolt	14,275	700	RV	119	RDR
	1991		10/19/92	presmolt	6,000	954	LV	132	RDR
<u>Salmon Basin</u>									
EF Salmon R.	1993	173,000 smolts	3/28/95	smolt	48,845	499	LV	126	EFS
	1992		4/8/94	smolt	12,368	387	RV	111	EFS
	1991		4/20/93	smolt	34,822	350	LV	122	EFS
SF Salmon R.	1999		3/27-29/01	smolt	87,558	599	LV		SFS
			9/7-11/2/00	parr	54,243	600	CWT		SFS
	1998	173,000 smolts	4/3-4/6/00	smolt	194,686	600	RV		SFS
	1997		4/5-8/99	smolt	126,937	594	LV		SFS
			8/3/98	parr	48,376	967	CWT		SFS
	1996		7/7-10/97	parr	24,990	44	RV		SFS
			3/29-4/6/98	smolt	22,982	0	E		SFS
	1995		3/19-21/97	smolt	63,355	14,108	E		SFS
	1994		4/11-12/96	smolt	234,314	0	LV		SFS
	1993		8/12/1994	parr	51,163	1,001	LV		
			4/6-8/95	smolt	310,893	499	RV	118	SFS
	1992		4/9-10/94	smolt	235,439	498	LV	117	SFS
	1991		4/21-22/93	smolt	132,750	500	RV	130	SFS
Pahsimeroi R.	1999	134,000 smolts	4/15-26/01	smolt	85,939	500	CWT		PAR
	1998		4/13-17/00	smolt	53,837	500	AD		PAR
	1997		4/14-19/00	smolt	135,699		AD		PAR
	1995		4/18/97	smolt	122,017	5,206	AD		PAR
	1993		4/11-14/95	smolt	147,429	493	RV	126	PAR
	1992		4/8-12/94	smolt	46,473	998	LV	117	PAR
	1991		4/14-19/93	smolt	83,953	600	LV	143	PAR
Upper Salmon R.	1999	500,000 smolts	4/18/01	smolt	57,134	500	CWT		SAL
	1998		4/12/00	smolt	123,425	1,004	CWT		SAL
	1997		4/16/99	smolt	105,951	0	CWT		SAL
	1996		4/21/98	smolt	43,161	0	AD		SAL
	1995		4/17/97	smolt	4,650	1,440	AD		SAL
	1994		3/26/96	smolt	24,319	763	AD	126	SAL
	1993		3/27/95	smolt	103,507	779	RV	131	SAL
			10/24/94	presmolt	102,086	811	RV	131	SAL
	1992		4/9/94	smolt	72,300	562	LV	111	SAL
	1991		4/20/93	smolt	51,819	800	RV	119	SAL
			10/2-7/92	presmolt	31,820	800	RV	129	SAL
			10/2-7/92	presmolt	58,534	800	RV	119	SAL
			10/2-7/92	presmolt	104,890	800	RV	112	SAL
WF Yankee Fork	1993	61,000 smolts	10/19/94	presmolt	25,025	1,000	AD	97	SAL

Appendix 2.1. Proportions of non-supplementation chinook salmon carcasses for the Idaho Supplementation Studies streams in the Clearwater River and Salmon River subbasins, adult return years 1995-2001. Covariate calculated by dividing total number of carcasses with known rearing by the number of non-ISS supplementation carcasses. All hatchery fish were treated as non-ISS supplementation carcasses in control streams. NC = no carcass data. X = streams used in the straying analysis.

Stream	Category	Year	# Carcasses	# of Adults	Proportion
Clearwater Basin					
X American River	Control	2001	197	130	0.659
	Control	2000	127	96	0.755
	Control	1999	0		
	Control	1998	47	22	0.468
	Control	1997	56	48	0.857
	Control	1996	0		
	Control	1995	0		
Big Flat Creek	Treatment	2001	4	3	0.75
	Treatment	2000	0		
	Treatment	1999	0		
	Treatment	1998	0		
	Treatment	1997	2	1	0.5
	Treatment	1996	0		
	Treatment	1995	0		
X Brushy Fork Creek	Control	2001	46	5	0.108
	Control	2000	3	2	0.666
	Control	1999	3	2	0.666
	Control	1998	8	1	0.125
	Control	1997	61	38	0.622
	Control	1996	0		
	Control	1995	0		
Clear Creek	Treatment	2001	178	149	0.837
	Treatment	2000	16	0	0
	Treatment	1999	1	1	1
	Treatment	1998	1	0	0
	Treatment	1997	46	46	1
	Treatment	1996	10	0	0
	Treatment	1995	0		
Colt Killed Creek	Treatment	2001	33	17	0.515
	Treatment	2000	2	2	1
	Treatment	1999	0		
	Treatment	1998	0		
	Treatment	1997	13	10	0.769
	Treatment	1996	0		
	Treatment	1995	0		
X Crooked Fork Creek	Control	2001	186	72	0.387
	Control	2000	101	55	0.544
	Control	1999	16	9	0.562
	Control	1998	19	6	0.315

Appendix 2.1. Continued.

	Stream	Category	Year	# Carcasses	# of Adults	Proportion
X	Crooked Fork Creek	Control	1997	88	83	0.943
		Control	1996	71	52	0.732
		Control	1995	0		
X	Crooked River	Treatment	2001	111	56	0.504
		Treatment	2000	83	67	0.807
		Treatment	1999	4	2	0.5
		Treatment	1998	14	0	0
		Treatment	1997	41	4	0.097
		Treatment	1996	4	0	0
		Treatment	1995	0		
	Eldorado Creek	Control	2001	56	12	0.214
		Control	2000	0		
		Control	1999	0		
		Control	1998	0		
		Control	1997	0		
		Control	1996	0		
		Control	1995	0		
X	Lolo Creek	Treatment	2001	1234	322	0.260
		Treatment	2000	299	66	0.22
		Treatment	1999	8	7	0.875
		Treatment	1998	20	3	0.15
		Treatment	1997	134	102	0.761
		Treatment	1996	2	0	0
		Treatment	1995	2	0	0
X	Newsome Creek	Treatment	2001	443	306	0.690
		Treatment	2000	143	24	0.167
		Treatment	1999	0		
		Treatment	1998	22	2	0.09
		Treatment	1997	49	27	0.551
		Treatment	1996	3	2	0.666
		Treatment	1995	0		
	Papoose Creek	Treatment	2001	94	4	0.042
		Treatment	2000	19	10	0.526
		Treatment	1999	1	0	0
		Treatment	1998	4	0	0
		Treatment	1997	55	17	0.309
		Treatment	1996	1	0	0
		Treatment	1995	1	1	1
	Pete King Creek	Treatment	2001	5	0	0
		Treatment	2000	0		
		Treatment	1999	0		
		Treatment	1998	0		
		Treatment	1997	0		
		Treatment	1996	0		
		Treatment	1995	0		

Appendix 2.1. Continued.

	Stream	Category	Year	# Carcasses	# of Adults	Proportion
X	Red River	Treatment	2001	1106	804	0.726
		Treatment	2000	136	62	0.455
		Treatment	1999	4	0	0
		Treatment	1998	39	12	0.307
		Treatment	1997	161	64	0.397
		Treatment	1996	16	7	0.437
		Treatment	1995	3	1	0.333
	Squaw Creek	Treatment	2001	28	0	0
		Treatment	2000	1	0	0
		Treatment	1999	0		
		Treatment	1998	0		
		Treatment	1997	2	2	1
		Treatment	1996	0		
		Treatment	1995	0		
	White Cap Creek	Control	2001	NC		
		Control	2000	NC		
		Control	1999	NC		
		Control	1998	NC		
		Control	1997	NC		
		Control	1996	NC		
		Control	1995	NC		
Salmon Basin						
	Bear Valley Creek	Control	2001	156	0	0[a]
		Control	2000	8	0	0[a]
		Control	1999	8	0	0[a]
		Control	1998	28	0	0[a]
		Control	1997	39	0	0[a]
		Control	1996	28	0	0
		Control	1995	1	0	0
	EF Salmon River	Control	2001	NC		
		Control	2000	NC		
		Control	1999	NC		
		Control	1998	5	0	0[a]
		Control	1997	3	0	0[a]
		Control	1996	0		
		Control	1995	0		
	Herd Creek	Control	2001	10		0.08[a]
		Control	2000	2		0.08[a]
		Control	1999	1		0.08[a]
		Control	1998	0		
		Control	1997	3		0.08[a]
		Control	1996	0		
		Control	1995	0		
X	Johnson Creek	Control	2001	873	115	0.131
		Control	2000	38	6	0.157
		Control	1999	22	0	0
		Control	1998	98	0	0

Appendix 2.1. Continued.

	Stream	Category	Year	# Carcasses	# of Adults	Proportion
X	Johnson Creek	Control	1997	154	3	0.019
		Control	1996	20	1	0.05
		Control	1995	2	0	0
X	Lake Creek	Control	2001	405	22	0.054
		Control	2000	178	2	0.011
		Control	1999	17	1	0.058
		Control	1998	23	2	0.086
		Control	1997	27	3	0.111
		Control	1996	24	0	0
		Control	1995	3	0	0
	Lemhi River	Treatment	2001	64	0	0
		Treatment	2000	20	0	0
		Treatment	1999	3	0	0
		Treatment	1998	3	0	0
		Treatment	1997	4	0	0
		Treatment	1996	0		
		Treatment	1995	1	0	0
	Marsh Creek	Control	2001	124	2	0.016
		Control	2000	26	1	0.038
		Control	1999	0		
		Control	1998	34	0	0
		Control	1997	8	0	0
		Control	1996	4	0	0
		Control	1995	0		
	NF Salmon River	Control	2001	29	0	0
		Control	2000	5	0	0
		Control	1999	0		
		Control	1998	2	0	0
		Control	1997	0		
		Control	1996	0		
		Control	1995	0		
	Pahsimeroi River	Treatment	2001	26	0	0
		Treatment	2000	10	0	0
		Treatment	1999	13	0	0
		Treatment	1998	1	0	0
		Treatment	1997	0		
		Treatment	1996	0		
		Treatment	1995	0		
X	Secesh River	Control	2001	316	17	0.053
		Control	2000	63	0	0
		Control	1999	23	0	0
		Control	1998	21	3	0.142
		Control	1997	75	12	0.16
		Control	1996	44	1	0.022
		Control	1995	23	0	0

Appendix 2.1. Continued.

	Stream	Category	Year	# Carcasses	# of Adults	Proportion
	Slate Creek	Control	2001	7	1	0.142
		Control	2000	0		
		Control	1999	0		
		Control	1998	2	0	0
		Control	1997	2	1	0.5
	Slate Creek	Control	1996	0		
		Control	1995	0		
X	SF Salmon River	Treatment	2001	804	270	0.335
		Treatment	2000	221	92	0.416
		Treatment	1999	303	184	0.607
		Treatment	1998	66	19	0.287
		Treatment	1997	395	60	0.151
		Treatment	1996	94	12	0.127
		Treatment	1995	77	54	0.701
	Upper Salmon River	Treatment	2001	110	0	0
		Treatment	2000	54	0	0
		Treatment	1999	31	0	0
		Treatment	1998	4	0	0
		Treatment	1997	0		
		Treatment	1996	0		
		Treatment	1995	0		
	Valley Creek	Control	2001	11	0	0[a]
		Control	2000	8	0	0[a]
		Control	1999	1	0	0[a]
		Control	1998	15	0	0[a]
		Control	1997	7	0	0[a]
		Control	1996	1	0	0
		Control	1995	0		
	W.F. Yankee Fork	Treatment	2001	0		
		Treatment	2000	1	0	0[a]
		Treatment	1999	0		
		Treatment	1998	0		
		Treatment	1997	4	0	0[a]
		Treatment	1996	0		
		Treatment	1995	0		

[a] Estimated based on data from other years.

Appendix 3.1. Data used to develop the ISS prototype analysis. Year code provides an alternative input to calendar year in which the zero value corresponds to the calendar year prior to an expected response resulting from ISS treatments. Years before an ISS response are sequentially negatively numbered starting with zero; years following an expected ISS response are sequentially positively numbered. Time values of one correspond to calendar years for which a change in the response variable could not have been the result of ISS treatments (i.e., there were no treatments in the previous generation). Time values of two correspond to calendar years in which a change in the response variable could have been the result of ISS treatments. Year code and time values denoted by an X indicate likely gaps in changes to the response variable due to missed ISS treatments in the previous generation. Group denotes the nine groupings into which streams were placed based on habitat similarity and geographic proximity.

Stream	Basin	Treatment	Year	Year Code	Time	Group	Redds / Kilometer
Clear Creek	Clearwater	Treatment	1992	-2	1	Lower Lochsa	0.055
Clear Creek	Clearwater	Treatment	1993	-1	1	Lower Lochsa	0.385
Clear Creek	Clearwater	Treatment	1994	0	1	Lower Lochsa	0.055
Clear Creek	Clearwater	Treatment	1995	1	2	Lower Lochsa	0
Clear Creek	Clearwater	Treatment	1996	2	2	Lower Lochsa	0.165
Clear Creek	Clearwater	Treatment	1997	3	2	Lower Lochsa	0.659
Clear Creek	Clearwater	Treatment	1998	4	2	Lower Lochsa	0.055
Clear Creek	Clearwater	Treatment	1999	5	2	Lower Lochsa	0
Clear Creek	Clearwater	Treatment	2000	6	2	Lower Lochsa	1.044
Clear Creek	Clearwater	Treatment	2001	7	2	Lower Lochsa	6.978
Eldorado Creek	Clearwater	Control	1992	-8	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	1993	-7	1	Lower Lochsa	0.571
Eldorado Creek	Clearwater	Control	1994	-6	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	1995	-5	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	1996	-4	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	1997	-3	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	1998	-2	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	1999	-1	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	2000	0	1	Lower Lochsa	0
Eldorado Creek	Clearwater	Control	2001	1	2	Lower Lochsa	1.143
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1992	-8	1	Lower Lochsa	0.900473934
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1993	-7	1	Lower Lochsa	1.137440758
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1994	-6	1	Lower Lochsa	0.331753555
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1995	-5	1	Lower Lochsa	0.28436019
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1996	-4	1	Lower Lochsa	0.995260664
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1997	-3	1	Lower Lochsa	5.213270142
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1998	-2	1	Lower Lochsa	1.469194313
Lolo Creek & Yoosa Creek	Clearwater	Treatment	1999	-1	1	Lower Lochsa	0.426540284
Lolo Creek & Yoosa Creek	Clearwater	Treatment	2000	0	1	Lower Lochsa	4.739336493
Lolo Creek & Yoosa Creek	Clearwater	Treatment	2001	1	2	Lower Lochsa	20.28436019
Pete King Creek	Clearwater	Treatment	1992	-3	1	Lower Lochsa	0
Pete King Creek	Clearwater	Treatment	1993	-2	1	Lower Lochsa	0
Pete King Creek	Clearwater	Treatment	1994	-1	1	Lower Lochsa	0
Pete King Creek	Clearwater	Treatment	1995	0	1	Lower Lochsa	0
Pete King Creek	Clearwater	Treatment	1996	1	2	Lower Lochsa	0
Pete King Creek	Clearwater	Treatment	1997	2	2	Lower Lochsa	0.125
Pete King Creek	Clearwater	Treatment	1998	3	2	Lower Lochsa	0
Pete King Creek	Clearwater	Treatment	1999	X	X	Lower Lochsa	0
Pete King Creek	Clearwater	Treatment	2000	4	2	Lower Lochsa	0.25
Pete King Creek	Clearwater	Treatment	2001	5	2	Lower Lochsa	2.125
White Cap Creek	Clearwater	Control	1992	-2	1	Selway	0.101
White Cap Creek	Clearwater	Control	1993	-1	1	Selway	0.303
White Cap Creek	Clearwater	Control	1994	0	1	Selway	0.101

Appendix 3.1 Continued.

Stream	Basin	Treatment	Year	Year Code	Time	Group	Redds / Kilometer
White Cap Creek	Clearwater	Control	1995	1	2	Selway	0
White Cap Creek	Clearwater	Control	1996	2	2	Selway	0.152
White Cap Creek	Clearwater	Control	1997	3	2	Selway	0
White Cap Creek	Clearwater	Control	1998	4	2	Selway	0.202
White Cap Creek	Clearwater	Control	1999	5	2	Selway	0
White Cap Creek	Clearwater	Control	2000	6	2	Selway	0.404
White Cap Creek	Clearwater	Control	2001	7	2	Selway	0.96
American River	Clearwater	Partial	1992	-4	1	SF Clearwater	0.15
American River	Clearwater	Partial	1993	-3	1	SF Clearwater	6.04
American River	Clearwater	Partial	1994	-2	1	SF Clearwater	0.26
American River	Clearwater	Partial	1995	-1	1	SF Clearwater	0
American River	Clearwater	Partial	1996	0	1	SF Clearwater	0.26
American River	Clearwater	Partial	1997	1	2	SF Clearwater	8.988
American River	Clearwater	Partial	1998	2	2	SF Clearwater	3.237
American River	Clearwater	Partial	1999	X	X	SF Clearwater	0.029
American River	Clearwater	Partial	2000	X	X	SF Clearwater	3.757
American River	Clearwater	Partial	2001	5	2	SF Clearwater	11.272
Crooked River	Clearwater	Treatment	1992	-4	1	SF Clearwater	2.466
Crooked River	Clearwater	Treatment	1993	-3	1	SF Clearwater	2.466
Crooked River	Clearwater	Treatment	1994	-2	1	SF Clearwater	0.183
Crooked River	Clearwater	Treatment	1995	-1	1	SF Clearwater	0
Crooked River	Clearwater	Treatment	1996	0	1	SF Clearwater	0.274
Crooked River	Clearwater	Treatment	1997	1	2	SF Clearwater	2.967
Crooked River	Clearwater	Treatment	1998	2	2	SF Clearwater	1.435
Crooked River	Clearwater	Treatment	1999	X	X	SF Clearwater	0.048
Crooked River	Clearwater	Treatment	2000	X	X	SF Clearwater	4.45
Crooked River	Clearwater	Treatment	2001	5	2	SF Clearwater	6.507
Newsome Creek	Clearwater	Treatment	1992	-4	1	SF Clearwater	0.132
Newsome Creek	Clearwater	Treatment	1993	-3	1	SF Clearwater	3.642
Newsome Creek	Clearwater	Treatment	1994	-2	1	SF Clearwater	0
Newsome Creek	Clearwater	Treatment	1995	-1	1	SF Clearwater	0
Newsome Creek	Clearwater	Treatment	1996	0	1	SF Clearwater	0.265
Newsome Creek	Clearwater	Treatment	1997	1	2	SF Clearwater	4.437
Newsome Creek	Clearwater	Treatment	1998	2	2	SF Clearwater	2.119
Newsome Creek	Clearwater	Treatment	1999	X	X	SF Clearwater	0
Newsome Creek	Clearwater	Treatment	2000	X	X	SF Clearwater	0.331
Newsome Creek	Clearwater	Treatment	2001	5	2	SF Clearwater	14.636
Red River	Clearwater	Treatment	1992	-2	1	SF Clearwater	1.023
Red River	Clearwater	Treatment	1993	-1	1	SF Clearwater	1.792
Red River	Clearwater	Treatment	1994	0	1	SF Clearwater	0.535
Red River	Clearwater	Treatment	1995	1	2	SF Clearwater	0.395
Red River	Clearwater	Treatment	1996	2	2	SF Clearwater	1.202
Red River	Clearwater	Treatment	1997	3	2	SF Clearwater	7.783
Red River	Clearwater	Treatment	1998	4	2	SF Clearwater	2.104
Red River	Clearwater	Treatment	1999	5	2	SF Clearwater	0.354
Red River	Clearwater	Treatment	2000	6	2	SF Clearwater	5.934
Red River	Clearwater	Treatment	2001	7	2	SF Clearwater	7.873
Big Flat Creek	Clearwater	Partial	1992	-3	1	Upper Lochsa	1
Big Flat Creek	Clearwater	Partial	1993	-2	1	Upper Lochsa	0.5
Big Flat Creek	Clearwater	Partial	1994	-1	1	Upper Lochsa	
Big Flat Creek	Clearwater	Partial	1995	0	1	Upper Lochsa	0
Big Flat Creek	Clearwater	Partial	1996	1	2	Upper Lochsa	0
Big Flat Creek	Clearwater	Partial	1997	2	2	Upper Lochsa	1.458
Big Flat Creek	Clearwater	Partial	1998	3	2	Upper Lochsa	
Big Flat Creek	Clearwater	Partial	1999	X	X	Upper Lochsa	
Big Flat Creek	Clearwater	Partial	2000	5	2	Upper Lochsa	0
Big Flat Creek	Clearwater	Partial	2001	6	2	Upper Lochsa	2.917
Brushy Fork & Spruce Creek	Clearwater	Control	1992	-2	1	Upper Lochsa	0.579
Brushy Fork & Spruce Creek	Clearwater	Control	1993	-1	1	Upper Lochsa	2.066

Appendix 3.1 Continued.

Stream	Basin	Treatment	Year	Year Code	Time	Group	Redds / Kilometer
Brushy Fork & Spruce Creek	Clearwater	Control	1994	0	1	Upper Lochsa	0
Brushy Fork & Spruce Creek	Clearwater	Control	1995	1	2	Upper Lochsa	0.588
Brushy Fork & Spruce Creek	Clearwater	Control	1996	2	2	Upper Lochsa	0.413
Brushy Fork & Spruce Creek	Clearwater	Control	1997	3	2	Upper Lochsa	6.116
Brushy Fork & Spruce Creek	Clearwater	Control	1998	4	2	Upper Lochsa	1.57
Brushy Fork & Spruce Creek	Clearwater	Control	1999	5	2	Upper Lochsa	0.248
Brushy Fork & Spruce Creek	Clearwater	Control	2000	6	2	Upper Lochsa	1.322
Brushy Fork & Spruce Creek	Clearwater	Control	2001	7	2	Upper Lochsa	10.496
Colt Killed Creek	Clearwater	Treatment	1992	-2	1	Upper Lochsa	0.261
Colt Killed Creek	Clearwater	Treatment	1993	-1	1	Upper Lochsa	0.167
Colt Killed Creek	Clearwater	Treatment	1994	0	1	Upper Lochsa	0.038
Colt Killed Creek	Clearwater	Treatment	1995	1	2	Upper Lochsa	0.038
Colt Killed Creek	Clearwater	Treatment	1996	2	2	Upper Lochsa	0.038
Colt Killed Creek	Clearwater	Treatment	1997	3	2	Upper Lochsa	0.712
Colt Killed Creek	Clearwater	Treatment	1998	4	2	Upper Lochsa	0
Colt Killed Creek	Clearwater	Treatment	1999	5	2	Upper Lochsa	0
Colt Killed Creek	Clearwater	Treatment	2000	6	2	Upper Lochsa	0.077
Colt Killed Creek	Clearwater	Treatment	2001	7	2	Upper Lochsa	2.911
Crooked Fork Creek	Clearwater	Control	1992	-2	1	Upper Lochsa	0.667
Crooked Fork Creek	Clearwater	Control	1993	-1	1	Upper Lochsa	0.606
Crooked Fork Creek	Clearwater	Control	1994	0	1	Upper Lochsa	0
Crooked Fork Creek	Clearwater	Control	1995	1	2	Upper Lochsa	0.242
Crooked Fork Creek	Clearwater	Control	1996	2	2	Upper Lochsa	4.545
Crooked Fork Creek	Clearwater	Control	1997	3	2	Upper Lochsa	6.909
Crooked Fork Creek	Clearwater	Control	1998	4	2	Upper Lochsa	1.03
Crooked Fork Creek	Clearwater	Control	1999	5	2	Upper Lochsa	0.485
Crooked Fork Creek	Clearwater	Control	2000	6	2	Upper Lochsa	6.061
Crooked Fork Creek	Clearwater	Control	2001	7	2	Upper Lochsa	13.879
Papoose Creek	Clearwater	Treatment	1992	-3	1	Upper Lochsa	3.333
Papoose Creek	Clearwater	Treatment	1993	-2	1	Upper Lochsa	5
Papoose Creek	Clearwater	Treatment	1994	-1	1	Upper Lochsa	0
Papoose Creek	Clearwater	Treatment	1995	0	1	Upper Lochsa	0.333
Papoose Creek	Clearwater	Treatment	1996	1	2	Upper Lochsa	2.333
Papoose Creek	Clearwater	Treatment	1997	2	2	Upper Lochsa	9.118
Papoose Creek	Clearwater	Treatment	1998	3	2	Upper Lochsa	1.912
Papoose Creek	Clearwater	Treatment	1999	X	X	Upper Lochsa	0.667
Papoose Creek	Clearwater	Treatment	2000	5	2	Upper Lochsa	6.833
Papoose Creek	Clearwater	Treatment	2001	6	2	Upper Lochsa	32.333
Squaw Creek	Clearwater	Treatment	1992	-2	1	Upper Lochsa	0.167
Squaw Creek	Clearwater	Treatment	1993	-1	1	Upper Lochsa	0
Squaw Creek	Clearwater	Treatment	1994	0	1	Upper Lochsa	0
Squaw Creek	Clearwater	Treatment	1995	1	2	Upper Lochsa	0
Squaw Creek	Clearwater	Treatment	1996	2	2	Upper Lochsa	0.167
Squaw Creek	Clearwater	Treatment	1997	3	2	Upper Lochsa	2.833
Squaw Creek	Clearwater	Treatment	1998	4	2	Upper Lochsa	1.833
Squaw Creek	Clearwater	Treatment	1999	5	2	Upper Lochsa	0.667
Squaw Creek	Clearwater	Treatment	2000	6	2	Upper Lochsa	0.667
Squaw Creek	Clearwater	Treatment	2001	7	2	Upper Lochsa	10.667
Lemhi River	Salmon	Control	1992	-2	1	Lower Salmon	0.29
Lemhi River	Salmon	Control	1993	-1	1	Lower Salmon	0.716
Lemhi River	Salmon	Control	1994	0	1	Lower Salmon	0.387
Lemhi River	Salmon	Control	1995	1	2	Lower Salmon	0.174
Lemhi River	Salmon	Control	1996	2	2	Lower Salmon	0.561
Lemhi River	Salmon	Control	1997	3	2	Lower Salmon	0.967
Lemhi River	Salmon	Control	1998	4	2	Lower Salmon	0.793
Lemhi River	Salmon	Control	1999	5	2	Lower Salmon	0.928
Lemhi River	Salmon	Control	2000	6	2	Lower Salmon	1.799
Lemhi River	Salmon	Control	2001	7	2	Lower Salmon	6.557
NF Salmon River	Salmon	Control	1992	-2	1	Lower Salmon	0.326

Appendix 3.1 Continued.

Stream	Basin	Treatment	Year	Year Code	Time	Group	Redds / Kilometer
NF Salmon River	Salmon	Control	1993	-1	1	Lower Salmon	0.462
NF Salmon River	Salmon	Control	1994	0	1	Lower Salmon	0.082
NF Salmon River	Salmon	Control	1995	1	2	Lower Salmon	0.027
NF Salmon River	Salmon	Control	1996	2	2	Lower Salmon	0.136
NF Salmon River	Salmon	Control	1997	3	2	Lower Salmon	0.272
NF Salmon River	Salmon	Control	1998	4	2	Lower Salmon	0.082
NF Salmon River	Salmon	Control	1999	5	2	Lower Salmon	0.054
NF Salmon River	Salmon	Control	2000	6	2	Lower Salmon	0.724
NF Salmon River	Salmon	Control	2001	7	2	Lower Salmon	2.772
Pahsimeroi River	Salmon	Treatment	1992	-2	1	Lower Salmon	1.208
Pahsimeroi River	Salmon	Treatment	1993	-1	1	Lower Salmon	3.818
Pahsimeroi River	Salmon	Treatment	1994	0	1	Lower Salmon	1.067
Pahsimeroi River	Salmon	Treatment	1995	1	2	Lower Salmon	0.667
Pahsimeroi River	Salmon	Treatment	1996	2	2	Lower Salmon	0.788
Pahsimeroi River	Salmon	Treatment	1997	3	2	Lower Salmon	1.438
Pahsimeroi River	Salmon	Treatment	1998	4	2	Lower Salmon	1.573
Pahsimeroi River	Salmon	Treatment	1999	5	2	Lower Salmon	3.427
Pahsimeroi River	Salmon	Treatment	2000	6	2	Lower Salmon	2.584
Pahsimeroi River	Salmon	Treatment	2001	7	2	Lower Salmon	5.959
EF Salmon River	Salmon	Partial	1992	-2	1	Middle Salmon	0.037
EF Salmon River	Salmon	Partial	1993	-1	1	Middle Salmon	0.704
EF Salmon River	Salmon	Partial	1994	0	1	Middle Salmon	0.185
EF Salmon River	Salmon	Partial	1995	1	2	Middle Salmon	0
EF Salmon River	Salmon	Partial	1996	2	2	Middle Salmon	0.074
EF Salmon River	Salmon	Partial	1997	3	2	Middle Salmon	0
EF Salmon River	Salmon	Partial	1998	4	2	Middle Salmon	0.778
EF Salmon River	Salmon	Partial	1999	5	2	Middle Salmon	0.296
EF Salmon River	Salmon	Partial	2000	6	2	Middle Salmon	0.074
EF Salmon River	Salmon	Partial	2001	7	2	Middle Salmon	0.926
Herd Creek	Salmon	Control	1992	-2	1	Middle Salmon	0.213
Herd Creek	Salmon	Control	1993	-1	1	Middle Salmon	2.515
Herd Creek	Salmon	Control	1994	0	1	Middle Salmon	0.234
Herd Creek	Salmon	Control	1995	1	2	Middle Salmon	0
Herd Creek	Salmon	Control	1996	2	2	Middle Salmon	0
Herd Creek	Salmon	Control	1997	3	2	Middle Salmon	0.819
Herd Creek	Salmon	Control	1998	4	2	Middle Salmon	0.585
Herd Creek	Salmon	Control	1999	5	2	Middle Salmon	0.175
Herd Creek	Salmon	Control	2000	6	2	Middle Salmon	0.175
Herd Creek	Salmon	Control	2001	7	2	Middle Salmon	1.287
WF Yankee Fork Salmon R	Salmon	Partial	1992	-4	1	Middle Salmon	0.517
WF Yankee Fork Salmon R	Salmon	Partial	1993	-3	1	Middle Salmon	1.207
WF Yankee Fork Salmon R	Salmon	Partial	1994	-2	1	Middle Salmon	0.776
WF Yankee Fork Salmon R	Salmon	Partial	1995	-1	1	Middle Salmon	0
WF Yankee Fork Salmon R	Salmon	Partial	1996	0	1	Middle Salmon	0.603
WF Yankee Fork Salmon R	Salmon	Partial	1997	1	2	Middle Salmon	0.517
WF Yankee Fork Salmon R	Salmon	Partial	1998	2	2	Middle Salmon	1.034
WF Yankee Fork Salmon R	Salmon	Partial	1999	X	X	Middle Salmon	0
WF Yankee Fork Salmon R	Salmon	Partial	2000	X	X	Middle Salmon	0.345
WF Yankee Fork Salmon R	Salmon	Partial	2001	5	2	Middle Salmon	3.103
Johnson Creek	Salmon	Control	1992	-2	1	South Fork Salmon	2.777
Johnson Creek	Salmon	Control	1993	-1	1	South Fork Salmon	7.869
Johnson Creek	Salmon	Control	1994	0	1	South Fork Salmon	1.203
Johnson Creek	Salmon	Control	1995	1	2	South Fork Salmon	0.231
Johnson Creek	Salmon	Control	1996	2	2	South Fork Salmon	1.018
Johnson Creek	Salmon	Control	1997	3	2	South Fork Salmon	4.536
Johnson Creek	Salmon	Control	1998	4	2	South Fork Salmon	3.791
Johnson Creek	Salmon	Control	1999	5	2	South Fork Salmon	0.948
Johnson Creek	Salmon	Control	2000	6	2	South Fork Salmon	1.303
Johnson Creek	Salmon	Control	2001	7	2	South Fork Salmon	15.284

Appendix 3.1 Continued.

Stream	Basin	Treatment	Year	Year Code	Time	Group	Redds / Kilometer
Lake Creek	Salmon	Control	1992	-2	1	South Fork Salmon	2.415
Lake Creek	Salmon	Control	1993	-1	1	South Fork Salmon	2.471
Lake Creek	Salmon	Control	1994	0	1	South Fork Salmon	0.674
Lake Creek	Salmon	Control	1995	1	2	South Fork Salmon	0.674
Lake Creek	Salmon	Control	1996	2	2	South Fork Salmon	1.741
Lake Creek	Salmon	Control	1997	3	2	South Fork Salmon	2.649
Lake Creek	Salmon	Control	1998	4	2	South Fork Salmon	2.408
Lake Creek	Salmon	Control	1999	5	2	South Fork Salmon	1.156
Lake Creek	Salmon	Control	2000	6	2	South Fork Salmon	8.622
Lake Creek	Salmon	Control	2001	7	2	South Fork Salmon	16.233
Secesh River	Salmon	Control	1992	-2	1	South Fork Salmon	5.546
Secesh River	Salmon	Control	1993	-1	1	South Fork Salmon	7.647
Secesh River	Salmon	Control	1994	0	1	South Fork Salmon	1.765
Secesh River	Salmon	Control	1995	1	2	South Fork Salmon	1.513
Secesh River	Salmon	Control	1996	2	2	South Fork Salmon	3.445
Secesh River	Salmon	Control	1997	3	2	South Fork Salmon	6.218
Secesh River	Salmon	Control	1998	4	2	South Fork Salmon	4.202
Secesh River	Salmon	Control	1999	5	2	South Fork Salmon	2.857
Secesh River	Salmon	Control	2000	6	2	South Fork Salmon	8.739
Secesh River	Salmon	Control	2001	7	2	South Fork Salmon	20.084
SF Salmon River	Salmon	Treatment	1992	-2	1	South Fork Salmon	22.475
SF Salmon River	Salmon	Treatment	1993	-1	1	South Fork Salmon	34.356
SF Salmon River	Salmon	Treatment	1994	0	1	South Fork Salmon	3.762
SF Salmon River	Salmon	Treatment	1995	1	2	South Fork Salmon	3.02
SF Salmon River	Salmon	Treatment	1996	2	2	South Fork Salmon	3.861
SF Salmon River	Salmon	Treatment	1997	3	2	South Fork Salmon	13.069
SF Salmon River	Salmon	Treatment	1998	4	2	South Fork Salmon	7.376
SF Salmon River	Salmon	Treatment	1999	5	2	South Fork Salmon	12.822
SF Salmon River	Salmon	Treatment	2000	6	2	South Fork Salmon	14.356
SF Salmon River	Salmon	Treatment	2001	7	2	South Fork Salmon	21.287
Slate Creek	Salmon	Control	1992	-2	1	Slate	0.723
Slate Creek	Salmon	Control	1993	-1	1	Slate	0.181
Slate Creek	Salmon	Control	1994	0	1	Slate	0.362
Slate Creek	Salmon	Control	1995	1	2	Slate	0.542
Slate Creek	Salmon	Control	1996	2	2	Slate	0
Slate Creek	Salmon	Control	1997	3	2	Slate	0.904
Slate Creek	Salmon	Control	1998	4	2	Slate	1.085
Slate Creek	Salmon	Control	1999	5	2	Slate	0.362
Slate Creek	Salmon	Control	2000	6	2	Slate	0.723
Slate Creek	Salmon	Control	2001	7	2	Slate	3.255
Bear Valley Creek	Salmon	Control	1992	-2	1	Upper Salmon	0.728
Bear Valley Creek	Salmon	Control	1993	-1	1	Upper Salmon	3.866
Bear Valley Creek	Salmon	Control	1994	0	1	Upper Salmon	0.112
Bear Valley Creek	Salmon	Control	1995	1	2	Upper Salmon	0.084
Bear Valley Creek	Salmon	Control	1996	2	2	Upper Salmon	0.336
Bear Valley Creek	Salmon	Control	1997	3	2	Upper Salmon	0.84
Bear Valley Creek	Salmon	Control	1998	4	2	Upper Salmon	1.793
Bear Valley Creek	Salmon	Control	1999	5	2	Upper Salmon	0.728
Bear Valley Creek	Salmon	Control	2000	6	2	Upper Salmon	1.653
Bear Valley Creek	Salmon	Control	2001	7	2	Upper Salmon	4.286
Marsh Creek	Salmon	Control	1992	-2	1	Upper Salmon	6.735
Marsh Creek	Salmon	Control	1993	-1	1	Upper Salmon	4.091
Marsh Creek	Salmon	Control	1994	0	1	Upper Salmon	0.818
Marsh Creek	Salmon	Control	1995	1	2	Upper Salmon	0
Marsh Creek	Salmon	Control	1996	2	2	Upper Salmon	0.545
Marsh Creek	Salmon	Control	1997	3	2	Upper Salmon	3.455
Marsh Creek	Salmon	Control	1998	4	2	Upper Salmon	3.727
Marsh Creek	Salmon	Control	1999	5	2	Upper Salmon	0
Marsh Creek	Salmon	Control	2000	6	2	Upper Salmon	2.727

Appendix 3.1 Continued.

Stream	Basin	Treatment	Year	Year Code	Time	Group	Redds / Kilometer
Marsh Creek	Salmon	Control	2001	7	2	Upper Salmon	10
Upper Salmon River	Salmon	Treatment	1992	-2	1	Upper Salmon	0.458
Upper Salmon River	Salmon	Treatment	1993	-1	1	Upper Salmon	2.153
Upper Salmon River	Salmon	Treatment	1994	0	1	Upper Salmon	0.373
Upper Salmon River	Salmon	Treatment	1995	1	2	Upper Salmon	0
Upper Salmon River	Salmon	Treatment	1996	2	2	Upper Salmon	0.237
Upper Salmon River	Salmon	Treatment	1997	3	2	Upper Salmon	0.136
Upper Salmon River	Salmon	Treatment	1998	4	2	Upper Salmon	0.424
Upper Salmon River	Salmon	Treatment	1999	5	2	Upper Salmon	0.237
Upper Salmon River	Salmon	Treatment	2000	6	2	Upper Salmon	2.475
Upper Salmon River	Salmon	Treatment	2001	7	2	Upper Salmon	4.356
Valley Creek	Salmon	Control	1992	-2	1	Upper Salmon	0.211
Valley Creek	Salmon	Control	1993	-1	1	Upper Salmon	1.396
Valley Creek	Salmon	Control	1994	0	1	Upper Salmon	0.092
Valley Creek	Salmon	Control	1995	1	2	Upper Salmon	0
Valley Creek	Salmon	Control	1996	2	2	Upper Salmon	0.021
Valley Creek	Salmon	Control	1997	3	2	Upper Salmon	0.151
Valley Creek	Salmon	Control	1998	4	2	Upper Salmon	0.994
Valley Creek	Salmon	Control	1999	5	2	Upper Salmon	0.542
Valley Creek	Salmon	Control	2000	6	2	Upper Salmon	0.693
Valley Creek	Salmon	Control	2001	7	2	Upper Salmon	1.832

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