October 1992

**Phase I Water Rental Pilot Project: Snake River
Resident Fish and Wildlife Resources and
and Management Recommendations**

DOE/BP-21416-1

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views of this report are the author's and do not necessarily represent the views of BPA.

This document should be cited as follows:

<i>Riggin, Stacey H., Wildlife Mitigation Specialist, H. Jerome Hansen, Project Leader, Idaho Department of Fish and Game, Bonneville Power Administration, Debbie Watkins, Project Manager, Project No. 91-067, Contract No. DE-BI79-91BP21416, 158 electronic pages (BPA Report DOE/BP-21416-1)</i>

This report and other BPA Fish and Wildlife Publications are available on the Internet at:

<http://www.efw.bpa.gov/cgi-bin/efw/FW/publications.cgi>

For other information on electronic documents or other printed media, contact or write to:

Bonneville Power Administration
Environment, Fish and Wildlife Division
P.O. Box 3621
905 N.E. 11th Avenue
Portland, OR 97208-3621

Please include title, author, and DOE/BP number in the request.

Phase I

Water Rental Pilot Project:

**Snake River Resident Fish
and Wildlife Resources
and Management Recommendations**

Prepared By

*Stacey H. Riggin, Wildlife Mitigation Specialist
H. Jerome Hansen, Project Leader*

Idaho Department of Fish and Game

Funded By

*Bonneville Power Administration
Debbie Watkins, Project Manager
P.O. Box 3621
Portland, Oregon 97208
Project No. 91-067
Contract No. DE-BI79-91BP21416*

October 1992

Table of Contents

Executive Summary	1
Introduction	3
Study Area	5
Background	7
Non-Treaty Storage Agreement (NTSA)	7
1980 Pacific Northwest Electric Power Planning and Conservation Act	7
Anadromous Fish/Flow Relationship	7
Northwest Power Council's Water Budget	8
Idaho Plan for Salmon Recovery	8
Northwest Power Council's Phase II and Phase III Amendments	9
Phase II Spring Migrant Flow Augmentation	9
Phase II Summer Migrant Temperature Reduction	
Threatened and Endangered Status of Salmon	
Reservoir Drawdown Effect on the Aquatic Environment	10
Stream Flow Effect on the Aquatic Environment	10
Idaho Water Law	11
Swan Falls Agreement	11
Snake River Adjudication	12
Water Rental Flow Augmentation Simulation	i3
Water Availability	15
Idaho Water Rental Pools	15
Background	15
Operating Guidelines	15
Water District 01	15
Water District 63	16
Water District 65	16
Rental Pool Restrictions	16
Historic Use	18
Water District 01	18
Water District 63	18
Water District 65	18
1991/92 Water Rental Releases for Salmon Flow Augmentation	19
Water District 01	
Water District 63	
Water District 65	19
Uncontracted Storage	19
Water District 63	19
Water District 65	22
Shoshone-Bannock Tribal Water	23
Upper Snake River System	25
Description of the Study Area	25
Palisades Reservoir and Jackson Lake	27
South Fork Snake River: Palisades to Henrys Fork Confluence	27
Island Park Reservoir	29
Henrys Fork Snake River: Island Park to Confluence	29

Snake River: Henrys Fork confluence to American Falls Reservoir	29
American Falls Reservoir	29
Snake River: American Falls Reservoir to Milner Dam	35
Ririe Reservoir	35
Fish Issues and Concerns	35
Palisades Reservoir and Jackson Lake	35
South Fork Snake River: Palisades to Henrys Fork Confluence	35
Island Park Reservoir	38
Henrys Fork Snake River: Island Park to Confluence	39
Snake River: Henrys Fork Confluence to American Falls Reservoir	40
American Falls Reservoir	40
Snake River: American Falls Dam to Milner Dam	40
Ririe Reservoir	40
Wildlife Issues and Concerns	41
South Fork Snake River: Palisades to Henrys Fork Confluence	41
Henrys Fork Snake River: Island Park to Confluence	41
American Falls Reservoir	42
Snake River: American Falls Reservoir to Milner Dam	42
Recreation Issues and Concerns	42
Potential Water Rental Impacts/Benefits	42
Results from Flow Augmentation Simulation	44
Recommendations for Protection and Enhancement of Resident Fish and Wildlife	44
Middle Snake River	49
Milner Dam to Brownlee Reservoir	49
Description of Study Area	49
Fish Issues and Concerns	59
Wildlife Issues and Concerns	57
Recreation Issues and Concerns	58
Potential Water Rental Impacts/Benefits	58
Results from Flow Augmentation Simulation	59
Recommendations for Protection and Enhancement of Resident Fish and Wildlife	59
Payette River System	61
North Fork Payette	61
Description of Study Area	61
Cascade Reservoir	61
Cascade Dam to Banks	64
Fish Issues and Concerns	64
Cascade Reservoir	64
Cascade Dam to Banks	66
Wildlife Issues and Concerns	67
Cascade Reservoir	67
Cascade Dam to Banks	67
Recreation Issues and Concerns	67
Cascade Reservoir	67
Cascade Dam to Banks	67
Potential Water Rental Benefits/Impacts	69
Cascade Reservoir	69
North Fork Payette	70
Results from Flow Augmentation Simulation	70
Cascade Reservoir.....	70
Recommendations for Protection and Enhancement of Resident Fish and Wildlife	72
South Fork Payette	72

Description of Study Area	72
Deadwood Reservoir	72
Deadwood River	72
South Fork Payette	75
Fish Issues and Concerns	75
Deadwood Reservoir	75
Deadwood River	75
South Fork Payette	76
Wildlife Issues and Concerns	76
Deadwood Reservoir and Deadwood River	76
Recreation Issues and Concerns	76
Deadwood Reservoir	76
Deadwood River	76
South Fork Payette	77
Potential Water Rental Benefits/Impacts	77
Deadwood Reservoir	77
Deadwood River	77
Results from Flow Augmentation Simulation	77
Deadwood Reservoir	77
Deadwood River	78
Recommendations for Protection and Enhancement of Resident Fish and Wildlife	78
Main Stem Payette	78
Description of Study Area	78
Middle Fork to Black Canyon	80
Black Canyon to Snake River	80
Fish Issues and Concerns	80
Middle Fork to Black Canyon	80
Black Canyon to Snake River	80
Wildlife Issues and Concerns	80
Middle Fork to Black Canyon	80
Black Canyon to Snake River	80
Recreation Issues and Concerns	80
Potential Water Rental Benefits/Impacts	81
Results from Flow Augmentation Simulation	81
Recommendations for Protection and Enhancement of Resident Fish and Wildlife	82
Boise River System	83
South Fork Boise	83
Description of Study Area	83
Anderson Ranch Reservoir	83
Anderson Ranch Dam to Arrowrock Reservoir	83
Fish Issues and Concerns	86
Anderson Ranch Reservoir	86
Anderson Ranch Dam to Arrowrock Reservoir	86
Wildlife Issues and Concerns	87
Anderson Ranch Reservoir	87
Anderson Ranch Dam to Arrowrock Reservoir	87
Recreation Issues and Concerns	87
Anderson Ranch Reservoir	87
Anderson Ranch Dam to Arrowrock Reservoir	88
Potential Water Rental Impacts/Benefits	88
Anderson Ranch Reservoir	88
South Fork Boise	88
Recommendations for Protection and Enhancement of Resident Fish and Wildlife	89

Main Stem Boise	89
Description of Study Area	89
Arrowrock Reservoir.....	89
Lucky Peak Reservoir.....	89
Lucky Peak Dam to Star	89
Star to Mouth.....	89
Fish Issues and Concerns	89
Arrowrock Reservoir.....	89
Lucky Peak Reservoir.....	93
Lucky Peak Dam to Star	93
Star to Mouth.....	94
Wildlife Issues and Concerns	94
Arrowrock Reservoir.....	94
Lucky Peak Reservoir.....	94
Lucky Peak Dam to Star	94
Recreation Issues and Concerns	95
Arrowrock Reservoir.....	95
Lucky Peak Reservoir.....	95
Lucky Peak Dam to Star	96
Potential Water Rental Benefits/Impacts.....	96
Recommendations for Protection and Enhancement of	
Resident Fish and Wildlife.....	96
Description of Study Area	97
Brownlee Reservoir	97
Fish Issues and Concerns	98
Wildlife Issues and Concerns	99
Recreation Issues and Concerns	99
Potential Water Rental Benefits/Impacts.....	100
Recommendations for Protection and Enhancement of	
Resident Fish and Wildlife.....	100
Dworshak Reservoir and the Lower Clearwater River.....	101
Description of Study Area	101
Dworshak Reservoir.....	101
Lower Clearwater River.....	101
Flow Augmentation	101
Spring Migrants.....	101
Fall Chinook.....	102
Fish Issues and Concerns	102
Dworshak Reservoir.....	102
Lower Clearwater River.....	102
Wildlife Issues and Concerns	104
Dworshak Reservoir.....	104
Lower Clearwater River.....	104
Critical Discharge Periods/Concerns	104
Dworshak Reservoir and Lower Clearwater River.....	104
Summary	107
Phase II Water Rental Goals and Objectives	113
References Cited	115

List of Tables

Table	Page
1. Water rental costs	16
2. Water District 01 rental pool activity	18
3. Uncontracted storage supplies in upper Snake, Payette, and Boise River reservoirs.	22
4. Primary storage reservoirs in the upper Snake River	25
5. Elevations and reservoir volumes at which boat ramps in Upper Snake River reservoirs become inoperable	43
6. Recommended minimum streamflows for the middle Snake River between Milner Dam and Brownlee Reservoir	53
7. Middle Snake water quality output generated by EPA modeling effort	57
8. Flow velocity and island isolation in the Deer Flat National Wildlife Refuge	58
9. Reservoir space allocation in Cascade and Deadwood Reservoir	61
10. Approved minimum streamflows for fish spawning and egg incubation in the North Fork Payette	66
11. Elevations and reservoir volumes at which boat ramps at Cascade Reservoir become inoperable	68
12. Optimum streamflows for boating	68
13. Approved minimum streamflows for recreation and aesthetics in the North Fork Payette	68
14. Approved minimum streamflows in the South Fork Payette River	.76
15. Recommended streamflows in the main stem Payette River	82
16. Reservoir storage in Anderson Ranch, Arrowrock and Lucky Peak Reservoir	83
17. Elevations and reservoir volumes at which boat ramps at Anderson Ranch Reservoir become inoperable	88
18. Elevations and reservoir volumes at which boat ramps at Arrowrock Reservoir become inoperable	95
19. Elevations and reservoir volumes at which boat ramps at Lucky Peak Reservoir become inoperable	95
20. Elevations at which boat ramps at Brownlee Reservoir become inoperable	99

21.	Summary of water rental minimum pool and water rental release recommendations, including potential impacts to resident fish, wildlife, and related recreation	109

List of Figures

Figure	Page
1. Water rental study area	6
2. Water rental releases below Milner Dam, 1991/92.....	20
3. Water rental releases below Cascade Dam, 1991/92.....	21
4. Upper Snake River study area.....	26
5. Palisades Reservoir summary hydrograph and minimum daily contents.....	28
6. Heise natural flow and summary hydrograph	30
7. Irwin minimum daily flows.....	31
8. Island Park Reservoir summary hydrograph and minimum daily contents.....	32.
9. Henrys Fork natural flow and summary hydrograph..	.33
10. Henrys Fork minimum daily flows	34
11. American Falls Reservoir summary hydrograph and minimum daily contents.....	.36
12. Neeley summary hydrograph and minimum daily flows.....	37
13. Ririe Reservoir minimum daily contents	.38
14. Relationship of available habitat with discharge in the South Fork Snake River during the winter.....	39
15. Study comparison of Palisades Reservoir contents and South Fork Snake River flows near Irwin	45
16. Study comparison of American Falls Reservoir contents and Snake River flows near Neeley.....	46
17. Snake River drainage: Milner to C.J. Strike Reservoir.....	50
18. Snake River drainage: C.J. Strike Reservoir to Brownlee Reservoir..	.51
19. Milner and Murphy summary hydrographs.....	54
20. Snake River 1992: Weiser and Murphy (IDWR , 1992)	55
21. Study comparison of Snake River flows at Milner and Murphy	60
22. Payette River drainage... ..	62
23. Cascade Reservoir summary hydrograph and minimum daily contents.....	63

24.	North Fork Payette natural flow and summary hydrograph	65
25.	Study comparison of Cascade Reservoir contents and North Fork Payette River flows near Banks. . . . .*	71
26.	Deadwood Reservoir minimum daily contents	73
27.	Deadwood River natural flow and summary hydrograph . . . . .I.	74
28.	Study comparison of Deadwood Reservoir contents and Deadwood River flows.....	79
29.	Study comparison of Payette River flows near Emmett.....	81
30.	Boise River drainage.....	84
31.	Anderson Ranch Reservoir summary hydrograph and minimum daily contents.....	85
32.	South Fork Boise River summary hydrograph.....	86
33.	Arrowrock Reservoir summary hydrograph and minimum daily contents.....	90
34.	Lucky Peak Reservoir summary hydrograph and minimum daily contents.....	91
35.	Boise River natural flow and summary hydrograph.....	92
36.	Brownlee Reservoir summary hydrograph	97

List of Appendices

<u>Appendix</u>	<u>Page</u>
A. Upper Snake baseline/flow augmentation simulation results	122
B. Payette baseline/flow augmentation simulation results	123
C. Fish and wildlife species mentioned in text	124
D. Whitewater classifications	125

Acknowledgments

This project required the cooperation of many people. We would like to thank Bonneville Power Administration for providing the funding for the Water Rental Pilot Project. Debbie Watkins and Dan Daley provided administrative assistance.

Members of the Water Rental technical team provided direction and insight and contributed to reviewing the draft: Jim **Esch**, U.S. Fish and Wildlife Service; Fred Crase, U.S. Bureau of Reclamation; Mary Lucachick, Idaho Department of Parks and Recreation; Frank Sherman, Idaho Department of Water Resources; Lynn Tominaga, Idaho Water Users Association; Chris Randolph, Idaho Power Company; Norm Wassou, Nez **Perce** Tribe; Doug Taki, **Shoshone-Bannock** Tribes.

Technical assistance was provided by Alan Robertson at the Idaho Department of Water Resources. In addition to contributing substantially to our understanding of the Snake River and water management, Alan and his staff spent many hours refining the hydrologic model simulation and plotting all of the summary hydrograph information.

In addition to careful review provided by the technical team, we thank the following people for their insights and comments on the review draft: Dave **Tuthill**, Idaho Department of Water Resources; John Dooley, Earl Corless and Jerry Gregg, U.S. Bureau of Reclamation; Debbie Watkins, Bonneville Power Administration; Ron **Carlson**, Water District 01 Water-master.

Idaho Department of Fish and Game staff provided important fish and wildlife resource information. We thank the following: Will Reid, Cindy Robertson, Don Anderson, Scott Grunder, Terry Holubetz, Dick **Scully**, Fred Partridge, Al Van Vooren, Dexter **Pitman**, **Melo** Maiolie, Steve Elle, and Justin **Naderman**.

The following people provided hydrologic information: Ted Day and Karl Ames, U.S. Bureau of Reclamation; Lee **Sisco** and Helen Bivins, Watermasters for Water Districts 63 and 65; Bill **Harenberg**, U.S. Geological Survey.

Thanks also to John Yearsley of the Environmental Protection Agency for running the middle Snake River water quality simulation using his newly designed model.

Executive Summary

The Idaho Water Rental Pilot Project was implemented as a part of the Non-Treaty Storage Fish and Wildlife Agreement (NTSA) between Bonneville Power Administration and the Columbia Basin Fish and Wildlife Authority. The goal of the project is to improve juvenile and adult salmon and steelhead passage in the lower Snake River with the use of rented water for flow augmentation.

The primary purpose of this project is to summarize existing resource information and provide recommendations to protect or enhance resident fish and wildlife resources in Idaho with actions achieving flow augmentation for anadromous fish. Potential impacts of an annual flow augmentation program on Idaho reservoirs and streams are modeled. Potential sources of water for flow augmentation and operational or institutional constraints to the use of that water are identified. This report does not advocate flow augmentation as the preferred long-term recovery action for salmon. The state of Idaho strongly believes that annual **drawdown** of the four lower Snake reservoirs is critical to the long-term enhancement and recovery of salmon (Andrus 1990).

Existing water level management includes balancing the needs of hydropower production, irrigated agriculture, municipalities and industries with fish, wildlife and recreation. Reservoir minimum pool maintenance, water quality and **instream** flows are issues of public concern that will be directly affected by the timing and quantity of water rental releases for salmon flow augmentation,

The potential of renting water from Idaho rental pools for salmon flow augmentation is complicated by institutional impediments, competition from other water users, and dry year shortages. Water rental will contribute to a reduction in carryover storage in a series of dry years when salmon flow augmentation is most critical. Such a reduction in carryover can have negative impacts on reservoir fisheries by eliminating shoreline spawning beds, reducing available fish habitat, and exacerbating adverse water quality conditions. A reduction in carryover can lead to seasonal reductions in **instream** flows, which may also negatively affect fish, wildlife, and recreation in Idaho.

The Idaho Water Rental Pilot Project does provide opportunities to protect and enhance resident fish and wildlife habitat by improving water quality and **instream** flows. Control of point sources, such as sewage and industrial discharges, alone will not achieve water quality goals in Idaho reservoirs and streams. Slow, continuous releases of rented water can increase and stabilize **instream** flows, increase available fish and wildlife habitat, decrease fish displacement, and improve water quality. Island integrity, requisite for waterfowl protection from mainland predators, can be maintained with improved timing of water releases.

Rebuilding Snake River salmon and steelhead runs requires a cooperative **commitment** and increased flexibility in system operations to increase flow velocities for fish passage and migration. Idaho's resident fish and wildlife resources require judicious management and a willingness by all parties to liberate water supplies equitably.

Introduction

The Idaho Water Rental Pilot Project is a three-year pilot project designed to examine the feasibility of renting surplus water from Idaho rental pools to improve anadromous fish migration in the lower Snake River below **Brownlee** Reservoir. The project has been implemented under terms of the 1990 **Non-Treaty Storage (NTS) Fish and Wildlife Agreement** between Bonneville Power Administration (BPA) and members of Columbia Basin Fish and Wildlife Authority (CBFWA).

The NTS Fish and Wildlife Agreement contains a variety of goals and objectives designed to ensure that the operation of NTS will not adversely impact fish and wildlife. The agreement also contains provisions to improve anadromous fish flows below **Brownlee** Reservoir, including the release of rented water from Idaho rental pools. The purpose of this project is to identify resident fish and wildlife issues, concerns, and resources in the Snake River system, estimate impacts, and provide management recommendations to protect and enhance those resources during implementation of the Water Rental Pilot Project. Specific objectives of this project include:

1. Identify existing resident fish and wildlife resources, programs and habitat conditions in the Snake, Payette and Boise River systems.
2. Provide information on boating access and other recreation related concerns in the Snake, and Payette, and Boise River systems.
3. Identify expected changes in habitat conditions in each river system resulting from actions achieving anadromous fish migration improvements.
4. Relate expected changes in habitat conditions to potential impacts/benefits to resident fish and wildlife resources and programs.
5. Summarize existing resident fish and wildlife resource information **from Dworshak** Reservoir and the lower Clearwater River and document seasonal periods when changes in river flows or reservoir levels are most

likely to impact resident fish and wildlife resources.

6. Develop water release strategies that will protect or provide enhancement for resident fish and wildlife resources and programs.

This study is considered the first of three phases under the Water Rental Pilot Project in Idaho. Objectives for Phase II are outlined at this end of this report. Phase III is expected to include implementation of the monitoring plan.

Participants of the Water Rental Technical Committee included the U.S. Bureau of Reclamation, Bonneville Power Administration, U.S. Fish and Wildlife Service, Idaho Power Company, Nez **Perce** Tribe, Shoshone-Bannock Tribes, Idaho Department of Water Resources, Idaho Parks and Recreation, and Idaho Department of Fish and Game. The study was funded by BPA (Project 91-067).

Study Area

The primary water rental study area includes the Snake, Payette, and Boise River systems and **Brownlee** Reservoir (Figure 1). Because Dworshak and **Brownlee** Reservoir operations are closely coordinated, and because storage **from** both reservoirs provides an important component of the salmon flow augmentation program, Dworshak and the lower Clear-water River have been included as a secondary study area in the report (Figure 1).

Specific reservoirs and stream reaches in the entire study area include:

Reservoirs

Palisades and Jackson	Cascade
Island Park	Deadwood
Ririe	Anderson Ranch
American Falls	Arrowrock
Brownlee	Lucky Peak
Dworshak	

Stream Reaches

South Fork Snake: Palisades to confluence with Henrys Fork
Henrys Fork: Island Park to confluence with South Fork Snake
Main Stem Snake River: Confluence of Henrys Fork and South Fork to American Falls
Main Stem Snake River: American Falls to Milner Dam
Middle Snake River: Milner Dam to **Brownlee** Reservoir
North Fork Payette River: Cascade Dam to Banks
Deadwood River: Deadwood Dam to South Fork Payette
South Fork Payette: Deadwood River to Middle Fork Payette
Main Stem Payette: Middle Fork Payette to Snake River
South Fork Boise River: Anderson Ranch Dam to Arrowrock Reservoir
Main Stem Boise River: Lucky Peak Dam to Snake River
Lower Clear-water River: Dworshak Dam to Snake River

Background

Non-Treaty Storage Agreement (NTSA)

Coordination of the BPA and British Columbia (B.C.) Hydro power systems began with the ratification of the Columbia River Treaty in 1964. Under the Treaty, B.C. Hydro was required to construct 15.5 million acre-feet (**MAF**) of storage in the Mica, Arrow, and Duncan projects in Canada, and BPA was **allowed** to construct 5 MAF of storage at the Libby project on the U.S./Canadian border. B.C. Hydro also built storage on the Columbia River in addition to that required by the Treaty, including Revelstoke and an additional 5 MAF at Mica.

The ability to store and release water from non-Treaty storage in Mica affects all downstream hydroelectric project operations on the Columbia River. Therefore, BPA is currently entering into separate Non-Treaty Storage Agreements (**NTSA's**) with both B.C. Hydro and the Mid-Columbia utilities. The Agreements are designed to provide operational flexibility for the 5 MAF of non-Treaty storage in Mica and to enhance the opportunity for hydroelectric power production on both the U.S. and B.C. Hydro systems.

Because of concerns that implementation of the NTSA could adversely affect fish and wildlife in the Columbia River Basin, BPA and the members of the CBFWA worked cooperatively to complete the 1990 NTS Fish and Wildlife Agreement, which included provisions to improve anadromous fish flows through the Water Rental Pilot Project. The agreement was entered into by BPA, in part, to **fulfill** obligations under the provisions of the 1980 Pacific Northwest Electric Power Planning and Conservation Act. Upon completion of the **three-year** Water Rental Pilot Project and a **positive evaluation of anadromous fish migration benefits**, continuation of the Project may be integrated into the Columbia Basin Fish and Wildlife Program.

1980 Pacific Northwest Electric Power Planning and Conservation Act

The Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act) of 1980 directed the Northwest Power Planning Council (Power Council) to develop a program to “protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries.” The Power Council is composed of two members from each of the four states in the Columbia River Basin, including Idaho, Washington, Oregon, and Montana.

The Northwest Power Act and the Power Council’s subsequent Columbia Basin Fish and Wildlife Program were developed in response to decades of declining runs of anadromous fish, due mainly to the development of the Columbia River Basin hydroelectric system. BPA is identified as the funding source for implementation of the Columbia Basin Fish and Wildlife Program.

Anadromous Fish/Flow Relationship

Anadromous fish, including salmon and steelhead trout, spawn or are artificially produced in freshwater, mature in saltwater and return to freshwater to reproduce. Steelhead, chinook salmon, **coho** salmon, and sockeye salmon are all found in the Columbia River Basin. Construction and operation of hydroelectric dams on the **mainstem** Columbia River and Snake River and their tributaries have had detrimental impacts on Snake River salmon and steelhead populations.

Chinook salmon are the largest in size of the five species of Pacific salmon. There are three races of chinook salmon in the Columbia River Basin:

1. Spring chinook adults migrate up river from February through May.

2. Summer chinook adults migrate upriver from June through August.

3. Fall chinook adults migrate upriver from mid-August through October.

Spring and summer chinook spawn in small tributaries and upstream reaches of principle tributaries to the Snake River in Idaho, and the juveniles spend the first year in freshwater prior to migrating. Snake River spring and summer chinook juveniles migrate from Idaho to the Pacific Ocean from early April through June.

Fall chinook spawn in larger mainstem rivers in October and November. Fry emerge in March and April and begin their seaward migration within a few weeks. In Idaho, fall chinook only spawn in the lower Snake River below the Hells Canyon hydroelectric complex.

Seasonal flow manipulations to maximize hydropower production eliminate the comparatively high spring river flows upon which fish migrating downstream have historically depended.

Because juvenile salmon (smolts) rely on the current to be flushed downstream, a reduction in what were once natural river flows and the creation of slackwater pools behind the dams increases the time it takes the smolts to make the transition from freshwater to saltwater. **Slow-moving** or often stagnant water confuses and threatens the migrating smolts by thwarting their urge to migrate. The longer they are delayed, the greater their exposure to predation and disease.

Salmon and steelhead returning to upstream spawning areas must successfully pass a series of eight hydroelectric dams on the lower Snake and Columbia Rivers. Although each of these dams is equipped with fish ladders, operational practices can seriously affect the percentage of fish that **successfully** pass upstream (Blumm 1986).

In addition to the problems the dams themselves present to adult salmon, migration is also hampered by low flows and warm water temperatures. Migrating fall chinook prefer water temperatures from **51-67°F**. At higher temperatures, migration is impeded. At **77°F** and above chinook do not survive.

Northwest Power Council's Water Budget

The hydroelectric projects on the Snake and Columbia River have greatly altered natural river flows. Spring runoff is now stored in reservoirs to be used for irrigation, power generation, and flood control. The Power Council established the Columbia Basin Fish and Wildlife Program (Program) Water Budget in 1982 in an attempt to improve travel times and reduce mortality of juvenile spring migrants. The Water Budget identified 1.19 MAF of Snake River water to enhance **mainstem** flows during the April 15 - June 15 peak migration period for Snake River juvenile salmon and steelhead. Although not spelled out in the Program, this amount of water was intended to come first from uncontrolled runoff, second from Dworshak Reservoir, and third from **Brownlee** Reservoir (Brendecke and Mann 1991). From 1984 to 1990, the amount of water actually allocated in the Snake River ranged from 0.44 to 0.48 MAF (NMFS 1992).

In addition to an inadequate volume of water available for flow augmentation, other portions of the Water Budget have limited its effectiveness, including: 1) implementation is limited to the April 15 to June 15 period, which does not cover the entire migration period of juvenile Snake River sockeye and spring/summer **chinook nor most of the Snake River fall chinook** salmon migration period; 2) there are no guaranteed flow levels; and 3) changing priorities of the federal project operators and regulators constrain in-season implementation (NMFS 1992).

Idaho Plan for Salmon Recovery

In response to continuing declines of Snake River sockeye, spring, summer, and fall chinook, and the extinction of **coho**, the state of Idaho developed strategies for the recovery of Snake River salmon (Andrus 1990). Near term recovery actions (within one to two years) identified to enhance main stem passage include modified operations at eight main stem dams to increase streamflow velocity through the reservoirs and the augmentation of streamflow during critical migration periods. Increased streamflow

velocities through operational changes would include **drawdown** of the main stem reservoirs (Andrus 1990). Flow augmentation would be provided through changes in power production, flood control rule curves, and the acquisition of reservoir storage space.

The critical long term recovery action recommended in the Idaho plan is the permanent modification of system operations of the federal dams on the Columbia and Snake River through annual drawdowns. Construction of new storage facilities and financed irrigation efficiency improvements in the Snake River Basin above **Brownlee** Reservoir are suggested as additional long term recovery actions to enhance streamflows (Andrus 1990).

Northwest Power Council's Phase II and Phase III Amendments

In December 1991, the Power Council, in response to requests from the Northwest governors, the Congressional delegation and the National Marine Fisheries Service (NMFS), completed the second phase of a regional salmon and steelhead rebuilding plan (Phase II Amendments). The Phase II Amendments called for lower Snake River reservoirs to be operated at near minimum pools, major storage contributions from Dworshak, Brownlee, and other Snake River reservoirs not only to augment flows for Snake River spring migrants but also to address water temperature problems for Snake River adult fall chinook (NPPC 1991). Elements of the Phase II Amendments related to water supply in the Snake River above **Brownlee** follow:

Phase II Spring Migrant Flow Augmentation

1. Use uncontracted storage space in Idaho reservoirs operated by the U.S. Bureau of Reclamation (**USBR**) to supply 90 thousand acre-feet (KAF) for spring migrants.
2. Secure at least 100 KAF from the Snake River Basin for spring migrants. Of this amount, half should be secured by **the USBR**, and half should be secured with financial

incentives provided by Bonneville Power (through the Idaho Water Rental Pilot Project).

This makes a total of 190 KAF from the upper **Snake River** Basin to be used for spring migrants.

Phase II Summer Migrant Temperature Reduction

1. Provide up to 137 KAF to refill **Brownlee** Reservoir in August.
2. Provide 100 KAF to reduce water temperatures for adult fish passage. Half should be secured by the **USBR**, and half should be secured on a matching basis using financial incentives provided by Bonneville Power (through the Idaho Water Rental Pilot Project).

This makes a total of 237 KAF from the upper Snake River Basin to be used for temperature reduction for fall chinook. The total amount of water to be used from the upper Snake River Basin as called for in the Power Council's Phase II Amendments is 427 KAF (190 KAF for spring migrants and 237 KAF for fall chinook temperature reduction).

In September 1992, **the Power** Council passed the Phase III Amendments. The Phase III Amendments provide further program goals, biological objectives, and performance standards. Phase III also addresses fish production, habitat, and passage in areas not covered under Phases I or II. Phase III incorporates but does not change the Snake River flow augmentation measures outlined in Phase II.

Threatened and Endangered Status of Salmon

Because of continuously declining runs, the Snake River sockeye salmon was listed as endangered by NMFS in November 1991. The Snake River spring and summer chinook salmon and Snake River fall chinook salmon were listed as threatened by NMFS in the spring of 1992.

The final action by NMFS called for lumping spring and summer chinook together. The listing triggers Section 7 of the Endangered Species

Act (ESA) which requires any federal agency whose actions may affect a listed salmon species to consult with NMFS in advance of the action (Bowler, IDFG, pers. comm. 1992). The ESA also requires that recovery plans are prepared for all listed species. Completion of recovery plans for sockeye and chinook salmon is expected during 1992 and 1993, respectively.

Reservoir Drawdown Effect on the Aquatic Environment

Renting water for salmon flow augmentation can impact the aquatic environment in a number of reservoirs across Idaho. Altered timing of reservoir releases and seasonal reductions in reservoir levels can preclude the establishment of wetland and riparian vegetation, disrupt spawning activities of resident fish populations and dewater reaches, decrease the littoral (shallow water) benthic populations, reduce available fish habitat, reduce water quality, reduce the overall productivity of reservoirs, and increase fish competition and predation.

Reservoir drawdowns can also affect recreational opportunities by reducing access to boat ramps, impact aesthetics by increasing exposed shoreline, and reduce angler catch rates.

Stream Flow Effect on the Aquatic Environment

Renting water for salmon flow augmentation can also impact seasonal **instream** flows in the Snake River. Stalnaker and Arnette (1976) and Hillet al. (1991) have summarized methodologies and ecological concepts for determining flow requirements of fish. Healthy fish populations are dependent upon flow variations that provide habitat integrity. Fish habitat results from an interaction among a stream, its floodplain, riparian and upland vegetation, climate, and the geology and geography of the watershed. Both **instream** and out-of-channel flows are necessary to maintain a productive fish habitat.

“High spring flows determine the shape of the channel rather than the average or low flows. Lack of these high flows which are needed for scouring and channel maintenance may be especially important in maintaining fish and aquatic insect populations” (Holden 1979 in CBFWA 1990).

Recommendations which focus solely on **instream** flow can result in degradation or loss of riparian habitat; in turn, loss of fish habitat and fish populations may result. Ideal flows would resemble natural flow regimes, including **bankfull** and out- of-channel flows.

Discharge determines velocity characteristics as well as the stream's physical dimensions, such as width and depth. **Instream** flow regimes are critical to the reproductive, migratory, food and shelter needs of fish. Water temperature patterns critical to fish production, from initiating spawning behavior to egg survival, are often the direct result of particular flows.

Water depth and velocity are the most fundamental limiting factors during the various life stages of aquatic organisms. Velocity is significant for maintaining desirable insect species composition, influencing stream carrying capacity, reducing effects of predation on young fish and determining spawning site preference. Frequent flow alterations that influence velocity would have a disruptive effect on community stability. Depth maintains pool quality, allows passage critical for anadromous fish, and supplies wetted area for spawning and food-producing riffles.

Rearing refers to all requirements for successfully completing the life history stages from hatching to spawning age. Rearing flows are those that will maintain the habitat, including food production, necessary for the sustenance of the fish species present. Adequate flows and suitable water quality **must be** available for food production, **instream** microhabitat, cover and maintenance of the riparian habitat.

As flows increase, more gravel is covered and becomes suitable for spawning. As flows continue to increase, velocities in some areas become too high for spawning, thus cancelling out the benefit of increases in **usable** spawning area near the edges of a stream. Water depth and velocity are important for successful spawning and maximum egg survival.

Intragravel rates of flow, exchange of flowing stream and gravel water, and dissolved oxygen levels are known to be of importance during the incubation period. The presence of a dam effectively traps recruitment **bedload** while allowing the downstream movement of existing sand and gravel below the dam. Under conditions of low velocity, permeability may be decreased as a result of fines settling from the slower water.

Idaho Water Law

Like all other western states, Idaho generally follows the “prior appropriation doctrine” in the allocation and use of water (Brendecke and Mann 1991). Under this system, a senior water right holder is entitled to have his right filled completely, before any junior right is entitled to divert (i.e. “**first** in time, first in right”) (Brendecke and Mann 1991).

From early statehood, governing statute has provided that “the right to the use of the waters of rivers, streams, lakes, springs, and of subterranean waters, may be acquired by appropriation” (Idaho Code 42- 103) (Rassier 1992). An appropriative water right in Idaho is defined by date of priority, amount of water, season of use, purpose of use, point of diversion, and place of use (Idaho Code 42- 14 11) (Rassier 1992).

A waterright is a real property right and may be sold, donated, mortgaged, deeded, leased, or otherwise treated like real estate (Brendecke and Mann 1991). The owner of a water right is authorized by statute (Idaho Code 42-222) to seek administrative approval for a change in the point of diversion, period of use, place of use, or nature of use of the water right. The primary requirements for approval of a change to a water right are: 1) that other water rights are not injured, 2) that the change does not constitute an enlargement in use of the original right; and 3) the change must be consistent with the conservation of water resources within Idaho and must be in the local public interest (Rassier 1992).

In the 1960’s, the Idaho Water Resource Board (IWRB) was established and empowered to “formulate and implement a state water plan for optimum development of water resources in the public interest”. The first State Water Plan (Plan) was adopted in 1976. The most recent Plan was adopted by the IWRB (IWRB 1992), but the Legislature took no action on the Plan. Since the Legislature neither amended nor rejected the Plan it is in effect (Sherman, IDWR, pers. comm. 1992).

In 1978, the Idaho Legislature enacted the “Minimum Streamflow” statute (Idaho Code 42- 150 1 to 42- 1505), which expressly recognized

that **instream** flows for “fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, transportation and navigation values, and water quality” were beneficial uses (Idaho Code 42- 1501) (Meyer 1992).

The statute provides that the IWRB may apply to the Idaho Department of Water Resources (IDWR) for a permit and license establishing a minimum streamflow or lake level (Idaho Code 42- 1503). The statute specifies that the approved amount must be found to be the “minimum flow or lake level and not the ideal or most desirable flow or lake level (Idaho Code 42- 1503) (Meyer 1992).

Typically, the minimum flow will be set at or even below what is required for a healthy and diverse aquatic habitat (Meyer 1992). As with other water rights, the application for **instream** flow must seek to appropriate only “unappropriated” waters.

Swan Falls Agreement

The 1984 Swan Falls Agreement (Agreement) arose out of a controversy over subordination of water rights. Swan Falls Dam was originally built in 190 1 to provide electricity for Silver City. Salmon runs were effectively blocked from 157 miles of the Snake River. Idaho Power Company purchased the Swan Falls facility and began operations in 1916. It was initially assumed that Idaho Power’s water right of 8,400 cubic feet per second (cfs) was subordinate **to later** diversions by upstream water users. Idaho Power, in failing to defend its water right, lost some of its flows to upstream irrigation. The impact on electric rates as a result of this action has not been quantified. It likely resulted in higher electric rates.

In 1977, ratepayers filed a complaint with the Public Utilities Commission charging Idaho Power with failing to protect its water right. In turn, Idaho Power filed suit against the State and upstream water users for illegally diverting water resources reserved for the company. In 1982, the Idaho Supreme Court ruled on the question of subordination only. The questions surrounding the forfeiture of the unused portion of Idaho

Power's claimed right were remanded to a lower court (Sherman, IDWR, pers. **comm.** 1992). The 1984 Agreement was a compromise to avoid the costs associated with the determination of Idaho Power's water right by the court. The 1984 Agreement provides that Idaho Power's claimed water right of 8,400 cfs at the Swan Falls Dam may be reduced to either 3,900 cfs during the irrigation season or 5,600 cfs during the winter. The claimed water right of 8,400 cfs is deemed appropriated, and the amount above the minimum flows of 3,900 cfs and 5,600 cfs up to the 8,400 cfs is held in trust by the State, but is allocated for specific consumptive uses under specific conditions (Sherman, IDWR, pers. **comm.** 1992). As a result of the Agreement, Public Law 100-216 was passed in 1987, mandating studies to determine the effect of **instream** flows on fish and wildlife resources in the Snake River (Anglin 1992).

Snake River Adjudication

The Swan Falls Agreement also called for an adjudication process covering the entire Snake River Basin. This process is expected to determine approximately 135,000 claims to water rights throughout the entire Snake River Basin (Rassier 1992)

Holders of all rights, including both ground and surface water rights are obliged to submit claims. The court will specify amounts and priorities of water rights based on recommendations from the IDWR. It is premature to estimate the impact of the process on claimed rights. The adjudication process will determine the allocation and distribution of water in the Snake River Basin (Sherman, IDWR, pers. **comm.** 1992).

Water Rental Flow Augmentation Simulation

The IDWR Snake River hydrologic model (Robertson et al. 1991) was used to provide one estimate of the future impacts of annual water rental releases on reservoir levels and **instream** flows. The model was developed with Snake River hydrologic data from 1928 to 1989. The model imposes present water management such as diversions, reservoir storage changes, reservoir evaporation, irrigation return flows, and flood control constraints onto the historic flow record. Model predictions are based on the assumption that the previous 62 years of hydrologic data adequately represent the future of Snake River flows.

Two operational scenarios were compared, including baseline, which imposes present Snake River management operations onto historic flow data, and the water rental flow augmentation simulation, which imposes flow augmentation releases onto baseline conditions.

A number of assumptions were made in order to run the water rental flow augmentation simulation, including:

1. Water releases followed the general direction of the Power Council's Phase II Amendments.
2. Water releases were not made in years when the April-July runoff forecast at Clarkston (Lower Granite) was greater than 29 MAF, including 1943, 1971, 1974, and 1984.
3. All water released for salmon flow augmentation came **from** rental pools and/or uncontracted storage.
4. Depending on availability, up to 337 **KAF** was provided annually from the Snake River system above Milner and 90 **KAF** was provided from the Payette River system (70 KAF from Cascade and 20 KAF from Deadwood).

Although the Phase II Amendments only call for up to half of the 337 KAF to come from the Water Rental Pilot Project, 337 **KAF** was used as an upper limit in order to provide some estimate of the impact of the entire flow augmentation program.

5. In order to estimate annual water availability from the upper Snake Rental Pool, an index of seasonal supply was correlated with annual rental pool inputs. The index is the sum of storage in Jackson Lake, Palisades Reservoir and American Falls Reservoir on April 30 plus the May through July forecast for runoff at Heise. The index was correlated with rental pool input data from 1984- 1991.

The "Last to Fill" rule has been in effect since 1980. It became a written rule when controversy developed because the reservoirs did not fill in 1987. Since the "Last to Fill" rule was adopted in 1988, it is believed to have affected (reduced) rental pool inputs from 1989 to 1991. The equation used to define water availability in the upper Snake Rental Pool was:

$$y = .827x - 4348$$

where y is the estimated water available (**KAF**) for use below Milner and x is the sum of the end of April storage (**KAF**) in Jackson Lake, Palisades, and American Falls plus the May through July forecast of runoff at Heise.

When $x < 5.26$ MAF, the equation indicates that there would not be any water available in the rental pool for use below Milner. This condition occurred in 1 ¹/₆₂ water years in the 1928- 1989 period.

6. In 1991 Idaho Power Company purchased 99 KAF for salmon flow augmentation. This left approximately 100 **KAF** used by or reserved for irrigation. With larger index values in 1989 and 1990 a 100 KAF reservation for irrigation was also assumed for those years. These points **define** a relationship between seasonal water supply and water that would be available for use below Milner through normal operation of the rental pool.

7. Water was released past Milner at a maximum rate of 1,847 cfs during July, August, and September. Lesser rates were released in some years. This water came from a combination of American Falls, Palisades, and Jackson Lake.

8. **Water was released from October through March** from Cascade and Deadwood Reservoir at a constant rate of 194 **cfs** and 53 cfs, respectively.

9. The water rental flow augmentation simulation would require exchange **to Payette** Rental Pool rules, which only allow rental pool water to be used through March 1 each year unless an extension is granted by the rental pool committee.

10. Existing operational minimum pools (except Deadwood and Cascade) were included in the baseline study and water rental flow augmentation simulation. The Milner minimum flow of 200 cfs required by FERC was included in the flow augmentation simulation.

Operational minimum pools (inactive plus dead storage) that were included in the baseline study and water rental flow augmentation simulation were the following: Palisades (201 **KAF**), Ririe (10 **KAF**), Anderson Ranch (70 **KAF**), and **Lucky** Peak (28.7 KAF).

The water rental flow augmentation simulation and accompanying assumptions represents only one of many possible flow augmentation **scenarios** in the Snake River Basin. The simulation does not represent all of the recommended release dates for resident fish and wildlife. The model needs additional modification and flexibility in order to more accurately reflect existing flow requirements throughout the Snake River Basin and recommended winter releases of flow augmentation water in the upper Snake.

Water Availability

Idaho Water Rental Pools

Background

A water rental pool has been in existence in the upper Snake River area since the 1930's, but there were no clear legal authorities in the Idaho statutes for operating such pools (Carlson, Water-master, Water District 01, pers. comm. 1992). The concept of "water banking" originated in the Idaho State Water Plan, adopted by the state of Idaho in 1976. In 1979 the water banking policy was implemented through the enactment of Idaho Code, Section 42-1761.

The legislation enabling water banking activities provides for the Idaho Water Resources Board (IWRB) to appoint local operating committees to manage storage rentals. The water banking activities managed by the local committees are referred to as rental pools. Each local committee adopts necessary rules to facilitate storage rental procedures. The water-master has administrative responsibility for operating the rental pool.

Rental pools provide a legal alternative to the permanent acquisition of water by making "stored water supplies available for a specified period of time for a particular beneficial use to water users who need additional water" (Idaho Code, Section 42-1765). Water conservation has provided part of the incentive for water banking in Idaho as irrigators have become concerned that unused storage water might be considered as abandoned (Brendecke and Mann, 1991). Three rental pools have been established in Idaho: the upper Snake Rental Pool in Water District 01, the Boise Rental Pool in Water District 63, and the Payette Rental Pool in Water District 65.

Operating Guidelines

Water District 01

Idaho's first rental pool was established in Water District 01. In 1979 the IWRB appointed the Committee of Nine as the local committee to operate the upper Snake Rental Pool under the state's water banking statutes. The rules, or "procedures", for operating the pool are adopted

by the Committee of Nine each year and must be approved by the water users within the district as well as the IWRB.

The primary purpose of the upper Snake Rental Pool is to benefit the agricultural water users within Water District 01 and meet the irrigation requirements of irrigation water users before other uses are considered (Idaho Code, Section 42-1765). Rule 3.8 specifies that only stored water and not reservoir space can be exchanged through the rental pools. A user who controls storage space can rent that space but is paid only for water accrued in that space. The holder of a water right does not own the water but merely has the right to use it, provided the user can apply it to the beneficial use for which it is appropriated.

Storage space is typically leased to the rental pool between June 1 and July 1. The yield of the leased storage space is based on a percentage of reservoir refill minus evaporation. The rental pool procedures encourage early committal of space to the rental pool.

The **first** priority in renting water is given to those irrigators owning storage space in USBR reservoirs above Milner Dam with rights that date prior to 1979. The second priority is given to other irrigators in the district for irrigation use above Milner. The last priority in renting water from the rental pool is given to other beneficial uses in the order in which their requests are received.

Each year **the** Committee of Nine sets the price at which storage water is rented from the rental pool. In 1991, the price for rented water for use above Milner was **\$2.95/acre-foot (AF)**, including administrative costs and a surcharge to the IWRB (Table 1). The price of water rented for use below Milner was **\$5.90/AF** in 1991/92. Two dollars plus a portion of the surcharge and any accrued interest is returned to the renter if the reservoirs fill in the following year. In the case that the reservoirs do not fill in the succeeding year, the person leasing storage to the rental pool is entitled to receive a payment from the \$2.00 and accrued interest in proportion to the storage lost (Idaho Code, Section 42-1765).

Table 1. Water rental costs (\$/acre-foot).

	cost to Purchase	Return to <u>Lessor</u>	Rental Pool Administrative Cost	Return to <u>IWRB</u>
Water District 01 (Above Milner) ¹	2.95	2.00	.75	.20
Water District 01 (Below Milner) ²	5.905	2.00	1.50	.40
Water District 63 (Boise) ³	6.50	2.256	.32	.65
Water District 65 (Payette) ⁴	2.70	2.00	.50	.20

¹ Lyle Swank, Deputy Water-master, Water District 01, pers. **comm.**, 4-15-92.

² John Dooley, Project Superintendent, Minidoka Project, pers. **comm.**, 7-1-92.

³ Lee **Sisco**, Watermaster, Water District 63, pers. **comm.**, 6-8-92.

⁴ Helen Bivins, Water-master, Water District 65, pers. **comm.**, 7-1-92.

⁵ Two years of water rental fees are paid in advance in case “Last to Fill” rule is invoked.

⁶ A surcharge of \$3.28 is an Operation and Maintenance assessment for Lucky Peak.

Water District 63

The general purpose of the Boise Rental Pool is to assure that “stored water is maintained and **first** made available for irrigation use” (Idaho Code, Section **42-1765**). The Boise Rental Pool Rules and Regulations are much the same as those for Water District 01, although some differences do occur.

The irrigation year extends from November 1 to October 31. Irrigators (lessors) assigning space to the rental pool before July 1 share proportionally in the proceeds from rentals attributable to that space. Rule 6.4 states that lessors assigning space after July 1 shall receive proceeds on a “first come” basis, whereby the first lessor to assign space shall be the **first** paid.

Prior to June 1, the first priority in renting stored water from the rental pool is given to those irrigators owning contracted space in the district reservoirs. After June 1 and until July 15 priority extends to all other irrigation water users within the district. After July 15, priority is given to all other users within the district who desire to rent water for any beneficial purpose

(Idaho Code, Section 42-1765). Rented water must be used by March 1 of the following year unless an extension is granted by the local committee,

The rental price of stored water in the Boise Rental Pool is **\$6.50/AF** which includes the administrative fee and 10 percent surcharge paid to IWRB (Table 1).

Water District 65

The Payette Rental Pool Rules and Regulations are similar to those approved for Water District 63. One primary difference is that the Payette Rental Pool Procedures include a “Last to Fill” rule. This rule provides that stored water utilized for downstream uses, such as salmon flow augmentation, will be the last storage space to be filled the subsequent year. The price of stored water rented from the rental pool is **\$2.70/AF** (Table 1).

Rental Pool Restrictions

The potential to purchase water from Idaho rentalpoolsforthepurposeofflow augmentation

is restricted by the rental pool rules and regulations. However, the procedures do provide a mechanism to rent water for nonagricultural uses below Milner Dam. Any water rented from the upper Snake Rental Pool for nonagricultural uses that is not used by March 15 of the following year is returned to the lessor(s) as carryover storage. For example, a water user cannot rent water from the rental pool on July 7 and carry it over through the winter to be used the following May.

The “Last to Fill” rule was instituted in 1988 in the upper Snake Rental Pool (and in 1992 in the Payette Rental Pool). Since the “Last to Fill” rule was instituted, there has been a disincentive for water users to lease storage water to the upper Snake Rental Pool for use below Milner Dam. The effects of the recent rule change on the Payette system are unknown at this time.

Rule 3.6 of the rental pool procedures states “the space of storage water leased to the rental pool that is rented for uses below Milner shall be the last space to fill in the ensuing year” (Idaho Code, Section 42-1765). The “Last to Fill” rule may be necessary to prevent senior right holders from being injured when the reservoir system does not fill (Sherman, IDWR, pers. comm. 1992). By making space holders whose water is rented for use outside the district the last space to fill, there can be no such impact on senior water rights (Sherman, IDWR, pers. comm. 1992).

IDWR policy allows an irrigator to have water rights for both natural and stored water in the full amount of his needs. The stored water in this case represents insurance water and is not needed by the irrigator in most years (Sherman, IDWR, pers. comm. 1992). While much of the water made available to the upper Snake Rental Pool by irrigators has gone unused, it is not necessarily considered available for salmon flow augmentation. Rental pool procedures allow individual water users to designate if water leased to the pool can be rented for use below Milner. The unused water in the rental pool is carried over and contributes to refill the following year.

Currently, irrigators must also specify whether water rented from rental pools will be used for irrigation or hydropower. It has not yet been determined if water for flow augmentation outside the state is a beneficial use according to Idaho Law. Water rental releases in 1991 proceeded without formally changing the place

and nature of use for which the water right was approved. In a September 5, 1991 letter to various state and federal agencies, the Director of IDWR stated he

“could not ignore the provisions of state law and allow rentals for (salmon flow augmentation) to continue beyond (1991) without more formal proceedings. “...the use of water stored in Bureau of Reclamation (USBR) and Idaho Power Company (IPC) reservoirs for fish flow enhancement purposes (water budget) is not authorized by the Idaho water rights held by the USBR or IPC.”

“If water from Idaho reservoirs is proposed to be used in the future for flow augmentation purposes..., then the holder of the water rights for such reservoirs (USBR and IPC) needs to file applications for transfer with (IDWR) pursuant to 42-222, Idaho Code, to change the place and nature of use of the water rights involved.”

The USBR filed an application with IDWR in November, 1991 for an interim modification of 427,000 AF of storage water rights for Reclamation reservoirs in the Boise, Payette, and upper Snake River basins (Keys 1991). The Idaho Legislature provided the authority for interim use of the water for salmon flow augmentation so the USBR’s application was withdrawn. A contributing factor to the withdrawal was the number of protests filed concerning the application. The Farm Bureau, Idaho Water Users Association, Idaho Cattleman’s Association and most entities having contracts with the USBR protested. Most frequently cited were concerns about impacts on existing contracts, use out of state, and impacts on public interest (Sherman, IDWR, pers. comm. 1992).

In April, 1992 the Idaho Legislature passed House Bill 796, which amended section 42-1763 of the Idaho Code to provide different factors the Director of IDWR shall consider before approving a rental of water for use outside of Idaho. In addition, Chapter 17, Title 42 of the Idaho Code was amended by the addition of a new section 42-1763A, to provide interim authority for storage water from reservoirs within Idaho to be rented through the rental pool operated by the IWRB to augment flows in and out of Idaho for salmon migration provided such flows are used for power production purposes within the state.

Historic Use

Water District 01

The upper Snake Rental Pool is the largest and most active rental pool in Idaho. Since 1979, an average of 352,899 AF of space has been leased (consigned) to the rental pool, and an average of 192,000 AF has gone unused (Table 2). The upper Snake Rental Pool contained as much as 895,642 AF in 1986 and as little as 4,668 AF in 1992 (Sherman, IDWR, pers. comm. 1992). Of the total 1579,063 AF consigned to the rental pool since the drought began in 1987, 45.6 percent (730,152 AF) has not been rented.

While some of the water is purchased by irrigators in need of more water, the largest purchaser of water has been Idaho Power (Table 2). When an acre-foot of stored water is released, it has the potential to generate 1,264 kilowatt hours of electricity as it passes through Idaho Power's downstream turbines (Whittlesey et al. 1986).

Water District 63

The Boise Rental Pool in Water District 63 was formed in 1988. In the first year, 26,518 AF of storage space was bought and transferred (Sisco 1988). With near normal runoff in 1989,

the rental pool received and sold only 16 1 AF of space (Sisco 1989); All of the 11,122 AF consigned to the rental pool in 1990 was purchased by the **Boise Project** Board of Control for the New York Canal Company (Sisco, Watermaster, Boise Project, pers. comm. 1992). Storage holders were very conservative about placing water in the rental pool in 1991 as only 2,765 AF was sold through the pool. Several thousand more could have been marketed had it been available (Sisco 1991). As of July 9, 1992 all of the 1,227 AF of storage water consigned to the rental pool had been rented. Water users in the Boise district are somewhat cautious with storage water to insure some carryover going into the next water year.

Water District 65

The Payette Rental Pool, in Water District 65, was recently established in 1990. Records for water year 1990 indicate Idaho Power purchased all of the 61,175 AF of space offered to the rental pool (Gregg, USBR, pers. comm. 1992). Of the total 104,525 AF leased to the Payette rental pool in 1991, **2,000** AF was rented by **Letha** Irrigation Company, and the remaining 102,525 AF was purchased by Idaho Power Company for salmon flow augmentation (Gregg, USBR, pers. comm. 1992).

Table 2. Water District 01 rental pool activity (acre-feet).

<u>Year</u>	<u>Total Consignment</u>	<u>Total Used</u>	<u>Total Used by Idaho Power</u>	<u>Irrigators</u>	<u>Total Used by Total Unused</u>
1979	88,870	73,960	50,000	23,960	14,910
1980	72,190	14,575	0	14,575	57,615
1981	170,107	149,039	125,000	24,039	21,068
1982	290,426	203,515	200,000	3,515	86,911
1983	540,606	353,084	350,000	3,084	187,522
1984	806,400	277,433	275,000	2,433	528,967
1985	497,302	362,169	350,000	12,169	135,133
1986	895,642	159,735	150,000	9,735	735,1907
1987	365,006	192,506	150,000	42,506	172,500
1988	236,050	186,181	50,000	136,181	49,869
1989	450,319	115,736	150,000	15,736	334,583
1990	295,000	168,800	63,000	105,800	126,200
1991	228,00	181,000	99,000*	82,000	47,000
1992	<u>4,688</u>	<u>4,688</u>	<u>0</u>	4,688	<u>0</u>
Average	352,899	174,459	154,769	34,316	192,169

* Purchased for salmon flow augmentation

1991/92 Water Rental Releases for Salmon Flow Augmentation

Water District 01

Idaho Power acts as the purchasing agent of salmon flow augmentation water for the Bonneville Power Administration (BPA). Idaho Power Company purchased 99,000 AF of water from the upper Snake Rental Pool in 1991/92 for salmon flow augmentation on the lower Snake and Columbia Rivers. A total of 50,000 AF was released past Milner Dam from July 13 through August 17, 1991 (36 days) for salmon flow augmentation (Figure 2). Flows in the middle Snake River increased from 200 cfs to 600 cfs for 19 days in July, and were held at about 800 cfs for 17 days in August. Another 49,000 AF was released in the winter of 1992. Salmon flow augmentation occurred at a rate of 450 cfs/day from December 22, 1991 through February 12, 1992 (53 days) (Figure 2).

As of July 3, 1992, only 4,100 AF had been leased to the upper Snake Rental Pool, while requests for irrigation reached 150,000 AF (Corless, USBR, pers. comm. 1992). Severe drought conditions continue to persist in Southwestern Idaho for the sixth year. It is unknown whether a higher rental price could encourage irrigators to lease water to the rental pool for salmon flow augmentation in 1992 (Corless, USBR, pers. comm. 1992). The Committee of Nine is considering a broad range of water rental changes/options for 1993 salmon flow augmentation which include pricing adjustments and rule changes (Corless, USBR, pers. comm. 1992).

Water District 63

No water was rented for salmon flow augmentation from the Boise Rental Pool in 1991. It is unlikely any water will be available in 1992 for salmon flow augmentation. All of the storage water consigned to the pool since its inception has been rented by irrigators.

Water District 65

Of the 102,525 AF purchased by Idaho Power in 1991, 50,000 AF was released at a rate of approximately 950 cfs/day from Cascade

Reservoir from July 11 through August 6, 1991 for salmon flow augmentation (Figure 3). An additional 50,000 AF of flow augmentation water was released from Cascade Reservoir from January 7 through February 4, 1992 (Figure 3). None of the releases for salmon flow augmentation came from Deadwood Reservoir (Ames, USBR, pers. comm. 1992).

The IWRB adopted certain emergency amendments to the Water District 65 Rental Pool Rules and Regulations on June 12, 1992 which include the following:

1. The USBR will place 35,000 AF of Cascade-Deadwood storage water in the rental pool for emergency irrigation needs (15,000 AF from Cascade Reservoir + 20,000 AF from Deadwood Reservoir).
2. The USBR will place 90,000 AF of Cascade-Deadwood storage water in the rental pool for salmon flow augmentation purposes under the following conditions:
  - a. The water is for calendar year 1992 only.
  - b. This water is not subject to any fees or payments except the \$0.50/AF administrative fee which is payable to the rental pool.
3. Cascade Reservoir will, under no circumstances, be drawn down below the 300,000 AF minimum pool, and Deadwood Reservoir will, under no circumstances, be drawn down below the 40,000 AF level. (Note: this is an emergency reservoir level for 1992 calendar year only.)

As of June 30, 1992, no water had been consigned to the Payette Rental Pool by irrigators. It is expected that a total of 90,000 AF will be released to backfill Brownlee Reservoir beginning between November 15 and December 1 and ending in mid-February. A slow, continuous release from Cascade will provide seasonally stable, higher flows in the North Fork of the Payette River.

Uncontracted Storage

Water District 63

A total of 166,200 AF of uncontracted storage space is held in Lucky Peak Reservoir. Water

Snake River at Milner
Water Year 1991

Snake River at Milner
Water Year 1992

Figure 2. Water rental releases below Milner Dam, 1991|92. Water Rental Pilot Project / 20

NORTH FORK OF THE PAYETTE RIVER NR BANKS

WATER YEAR 1991

NORTH FORK OF PAYETTE NR BANKS

WATER YEAR 1992

Figure 3. Water rental releases below Cascade Dam, 1991-92

space is held in Lucky Peak Reservoir. Water accruing to 13,900 AF of space is used for a flood control and would never be contracted. An additional 152,300 AF of space is used for streamflow maintenance by the USBR (102,300 AF) and IDFG (50,000 AF) (Table 3).

Water District 65

Cascade Reservoir contains the largest single block of uncontracted storage space in the entire study area. A total of 389,500 AF of space is currently uncontracted (Table 3). The State is negotiating the purchase of 300,000 AF of uncontracted space with the USBR in order to sustain the continued maintenance of the existing conservation pool of 300,000 AF operated by the USBR. A total of 19,900 AF of the uncontracted space in Cascade Reservoir has been designated to be contracted for irrigation and municipal users (Williams 1992). An additional 69,600 AF of uncontracted space is the amount of space potentially available on an annual basis for salmon flow augmentation if the reservoir fills.

Deadwood Reservoir contains a total of 105,400 AF of uncontracted storage space (Table 3). The State is negotiating the purchase of 80,000 AF of uncontracted space to continue the maintenance of the existing conservation pool and a 50 cfs **instream** flow in the Deadwood River. The remaining 25,400 AF of uncontracted space is the amount of space potentially available on an annual basis for salmon flow augmentation if the reservoir fills.

Shoshone-Bannock Tribal Water

Previously uncontracted storage supplies in **Ririe** (80,500 AF) and Palisades (18,980 AF) were committed to a group of irrigators impacted by the **Fort Hall** Indian Water Rights Agreement. Irrigators and canal companies impacted by the agreement formed a company called Mitigation Inc.

Federal contract storage rights for water that accrues to 46,931 AF in American Falls and 83,900 AF in Palisades are held by the U.S. for the benefit of the Shoshone-Bannock Tribes. Water accruing to the Tribal space in American Falls may be rented for use below Milner Dam. Water that accrues to Tribal storage space in Palisades may not be released for use past Milner at this time.

Table 3. Uncontracted storage supplies in upper Snake, Payette, and Boise River reservoirs (acre-feet).

Cascade

Proposed sale
to state for
minimum pool 300,000

Reserved for
irrigation and
municipal users 19,900

Unreserved and
uncontracted 69,600

Total 389,500

Deadwood

Proposed sale to
state for minimum
Pool 80,000

Unreserved and
uncontracted 25,400

Total 105,400

Lucky Peak

Flood control
surcharge 13,900

Reserved by IDFG
for streamflow
maintenance 50,000

Administered by
USBR for
streamflow
maintenance 102,300

Total 166,200

**TOTAL
UNCONTRACTED
SPACE 741,100**

Upper Snake River System

Description of the Study Area

The upper Snake River Basin includes that portion of the Snake River above Milner Dam. (Figure 4). The basin covers an area of about 36,000 square miles with 80 percent in Idaho, 15 percent in Wyoming, 4 percent in Nevada, and 1 percent in Utah (USBR 1990).

The upper Snake River is heavily regulated by 24 reservoirs with a total active storage capacity of more than 5 MAF. A series of USBR storage dams including Jackson Lake in Wyoming and Palisades, Island Park, Ririe, and American Falls reservoirs in Idaho contain the majority of active storage (Table 4). The system is operated by the USBR to provide storage space for flood control and water for irrigation and **instream** flows.

Total annual flows in the upper Snake system average 4.5 MAF in the South Fork Snake, 1.5 MAF in the Henrys Fork, 4.3 MAF in the Snake River near Shelley, and 2.4 MAF in the Snake River near Milner. Reduced flows at the Milner gauge are the result of extensive irrigation diversions.

The top 500 feet of the Snake River Plain aquifer has an estimated storage capacity of 200 to 300 MAF (Holland and Platts 1991). Seepage from irrigation provides an estimated 60 percent

of total aquifer recharge, while irrigation pumping totals about 20 percent of total aquifer discharge (USBR 1990).

Irrigated agriculture is a major part of the economy in the upper Snake River Basin. In 1990, it was estimated that 1.43 million acres were under irrigation above Milner (Morse, IDWR, pers. comm. 1992). About 8.85 MAF of water is diverted annually from the Snake River. **Of this**, about 3.56 MAF is consumptively used i.e., evapotranspiration from lands irrigated by both surface and ground water. The remaining 5.29 MAF is combined aquifer recharge and return to the river (Morse, IDWR, pers. comm. 1992).

Since the mid 1940's, irrigation development from ground water pumping has been extensive. Two to three MAF of ground water is pumped for irrigation in Idaho annually. Most of the pumping (1.6 MAF in 1980) is from the Snake River Plain Aquifer (USBR 1990).

Water use for recreation, fish and wildlife, and water quality control is mostly incidental to water uses with established water rights (USBR 1990). Because the upper Snake River Basin contains a rich and diverse fish and wildlife resource, **and is** a popular recreational destination for a number of people, conflicts over the use of water sometimes arise.

Table 4. Primary storage reservoirs in the upper Snake River (storage in acre-feet).

<u>Reservoir</u>	<i>Active</i>	<i>Inactive</i>	<i>Dead</i>	<i>Total</i>
Jackson Lake	847,000	0	0 ¹	847,000
Palisades	1,200,000	157,000	44,000	1,401,000
Island Park	127,265	381	0	127,646
Ririe	80,500	6,000	4,000	90,500
American Falls	1,672,590	0	0	1,672,590

¹ Dam was constructed on the outlet of a natural lake so the old lake still provides a minimum **pool**.

Figure 4. Upper Snake River Basin

The irrigation season in the upper Snake is generally from April 1 to October 31. During this period, releases from dams are increased to meet irrigation diversion demands. Flows in the upper portion of the system (i.e. South Fork Snake and Henrys Fork), above major diversions, are substantial during this time. Flows below Milner Dam often drop to near zero during the summer, as the entire Snake River is diverted at this point into irrigation canals.

The reservoir storage season is from October 1 until there is no more water available for storage. The storage season has ended as early as April 1 and as late as July 24. The availability of storage for each reservoir is determined by the water right priority system. Depending on forecasted runoff as predicted on the first of each month, the USBR attempts to have all reservoirs full by a target date of April 1 (Dooley, USBR, pers. comm. 1992). Any storage after April 1 and before October 1 is water that is excess to natural flow priority needs. Large evacuations of storage are caused primarily because of forecasted runoff and the need to make space available for that runoff within the USBR's flood control criteria. The term "adverse storage" is used to mean stored water that would or could be used to meet a natural flow right. (Dooley, USBR, pers. comm. 1992).

Jackson Lake, Palisades, and Ririe are the only USBR facilities that have specific flood control operational criteria (USBR 1990). American Falls is operated for flood control on an incidental basis. Excluding Lake Walcott (directly below American Falls) American Falls is the easiest reservoir in the upper Snake to fill, because of being the lowest in the system and because of the prolific discharge of natural springs immediately upstream. American Falls fills nearly every year.

Flood control rule curves are based upon regulating the flow past Heise on the South Fork Snake River to 20,000 cfs or less. Jackson Lake is drawn down by October 1 to provide 200,000 AF of flood control storage space (USBR 1990). This space is maintained until March 1. Jackson Lake provides 25 percent of the flood control requirement at Heise. Palisades provides the other 75 percent, through joint use of 1.2 MAF of active space for flood control purposes from October 1 to July 1 each year (USBR 1990).

During operation of the upper Snake reservoir system, the District 01 watermaster credits water being stored to the proper reservoir right even when the storage is actually taking place in a different reservoir. Water accrued to American Falls Reservoir storage space can be physically stored in upstream reservoirs such as Palisades, Island Park, etc. Winter flows in the South Fork Snake and Henrys Fork are influenced by the amount of storage space available in American Falls.

Upper Snake River Basin study reservoirs and stream reaches include Palisades Reservoir and above (including Jackson Lake), the South Fork Snake River from Palisades to the confluence with the Henrys Fork, Island Park Reservoir, the Henrys Fork Snake River from Island Park Reservoir to the confluence with the South Fork Snake River, the confluence down to American Falls Reservoir, Ririe Reservoir and Willow Creek, American Falls Reservoir, and the Snake River from American Falls Reservoir to Milner (Figure 4).

Palisades Reservoir and Jackson Lake

Palisades Reservoir and Jackson Lake are operated as a coordinated system for flood control, power production and irrigation storage. Palisades was constructed in 1957 and Jackson Lake in 1908. Jackson went through major reconstruction in the mid 1980's. Palisades and Jackson Lake have total storage capacities of 1,401,000 AF and 847,000 AF respectively. All of the storage in Jackson Lake is active, as is 1.2 MAF of the storage in Palisades. Although Jackson Lake contains no dead storage on paper, it is never drawn down below the surface of the existing lake that the dam was constructed over. Palisades also maintains 44,000 AF of dead pool and 157,000 AF of inactive storage for power head (Table 4). Palisades has maintained an average monthly volume of close to 1 MAF during the period from 1972-1990. However, in a series of dry years, the reservoir will be drawn down close to the operational minimum pool of 201,000 AF (Figure 5).

South Fork Snake River: Palisades to Henrys Fork Confluence

The South Fork Snake River extends 63 miles from Palisades Dam to the confluence with the Henrys Fork. The river flows through a mountain valley in the upper end, a rugged

PALISADES RESERVOIR

END OF DAY CONTENT

Palisades Reservoir

Minimum Daily Contents

1972-1991

Figure 5. Palisades Reservoir summary hydrograph and minimum daily contents.

canyon in the middle stretch and a broad, open flood plain in the lower stretch (USBLM and USFS 1991). The river flows through the most extensive and highest quality cottonwood riparian forest in Idaho (USFWS 1980). Palisades Reservoir storage has reduced the magnitude of spring runoff at Heise (Figure 6) and has also led to lower minimum winter flows in the South Fork. During dry years, winter flows have dropped to 750 cfs or less at the Irwin gage directly below Palisades Dam (Figure 7).

Island Park Reservoir

Island Park Reservoir has an active storage capacity of 127,265 AF and an inactive storage of 381 AF. Allocated irrigation storage in Island Park actually goes one foot above overflow. After flood season or when the threat of floods has passed, Island Park is filled to 135,205 AF (Dooley, USBR, pers. comm. 1992). As Figure 8 shows, the maximum storage often occurs in mid to late May. The “adverse storage” (stored water that would be used to meet a natural flow right) in Island Park is released after November 15.

During the period from 1977 to 1982, the reservoir was drawn down to levels between 0 and 12,000 AF during the fall/winter period (Figure 8). During the late summer of a low water year, water users along the Henrys Fork may divert available natural flows, which actually belong to users below the mouth of the Henrys Fork because of earlier priority dates (IWRB 1991).

Stored water to replace the Snake River natural flow is then released from American Falls, Jackson, Palisades, or other reservoirs. The volumes released are charged against Island Park reservoir for accounting purposes. Thus, a portion of Island Park Reservoir storage may actually belong to downriver water users (IWRB 1991).

Under an agreement with Utah Power and Light (UP&L) and the City of Idaho Falls, Island Park can store any inflow above irrigation demand during September and October. This “adverse storage” can then be released downstream during the winter to UP&L and City of Idaho Falls hydroelectric projects.

Henrys Fork Snake River: Island Park to Confluence

The Henrys Fork is a fourth order stream with an average depth of 2.5 feet and an average width of 300 feet (USFWS 1991a.). Important tributaries include the Buffalo, Warm, Fall, and Teton rivers. A small USBR reservoir is located in Wyoming on a tributary to Fall River. Grassy Lake has a storage capacity of 15,182 AF. The Henrys Fork flows through Harriman State Park and over the scenic Upper and Lower Mesa Falls. The river is heavily impacted by Island Park Reservoir releases. Spring runoff is now spread over two peak periods in the summer while minimum winter flows below Island Park are much reduced from natural conditions (Figure 9). Water releases from Island Park were reduced to 85-100 cfs during drought conditions in the winter of 1988-89 (USFWS 1991a.) (Figure 10).

Snake River: Henrys Fork confluence to American Falls Reservoir

The Snake River from the Henrys Fork confluence to American Falls Reservoir covers about 100 miles and encompasses a variety of habitat types (IDFG 1991). Extreme flow fluctuations in this region of the Snake occur as the result of irrigation diversions. During April 1992, the Snake River near Blackfoot was reduced to near zero flow, due to irrigation diversions.

American Falls Reservoir

American Falls Reservoir was constructed in 1927 and reconstructed in 1978. The reservoir covers 56,000 surface acres and has an active storage of 1,672,590 AF. American Falls has no inactive storage or dead pool. The entire capacity is contracted to water users (USBR 1990). It is operated to fill the storage capacity each year and is only operated for flood control purposes if water supplies are forecast to be above historical averages (USBR 1990). Numerous springs arise on the Fort Hall Indian Reservation, immediately upstream of American Falls Reservoir. Other springs arise in the Aberdeen-Springfield area and in the reservoir itself (Dooley, USBR, pers. comm. 1992). The springs produce over 2 MAF of water annually, adding to the ease of filling the reservoir each year (IDFG 1991).

SNAKE RIVER NR HEISE SUMMARY HYDROGRAPH

Figure 6. Heise natural flow and summary hydrograph. Water Rental Pilot Project / 30

Figure 7. Irwin minimum daily flows.

ISLAND PARK RESERVOIR

END OF DAY CONTENTS

Island Park Reservoir

Minimum Daily Contents

1972-1991

Proposed Min. Pool

Annual Min. Pool

Figure 8. Island Park Reservoir sununary hydrograph and minimum daily contents.

Figure 9. Henry's Fork natural flow and summary hydrograph.

Henry's Fork Flows Near Island Park

Minimum Daily Flows

1972-1991

Minimum Flow Rec. Annual Min. Flow

Figure 10. Henry's Fork minimum daily flows.

Refill begins in late September and continues through winter and spring runoff. Irrigation use of the water sometimes starts in April, but depending on precipitation, may not begin until May. During recent low water years (1987-89), drawdowns were considerably higher than the long-term average (Heimer and Howser 1990) (Figure 11).

Snake River: American Falls Reservoir to Milner Dam

This stretch of the Snake River includes the 11,850 - acre Lake Walcott. Flows during the irrigation season average 10,000 to 15,000 cfs, while flows in the winter storage period average about 5,000 cfs. Flows are regulated by releases from American Falls and Minidoka Dam (Lake Walcott). Winter flows below **American Falls** at the Neeley gauge have dropped to 300 cfs or less during a recent series of drought years (Figure 12).

Ririe Reservoir

Ririe Dam was constructed to provide local flood control protection on Willow Creek. Ririe has a total storage capacity of 100,500 AF, including 80,500 **AF of** active storage, 6,000 AF of inactive storage, and 4,000 AF of dead storage (USBR 1990). The total storage also includes 10,000 AF of exclusive flood control space which can only accumulate water until the threat of downstream flooding has passed (USBR 1990). The recent Fort Hall Indian Water Rights Agreement of 1991 committed **all** of the active storage in Ririe to Mitigation Inc., a group of water users and canal companies adversely affected by the agreement. This 80,500 AF of storage had previously been uncontracted.

Ririe is kept as full as possible in the summer for maximum recreational pool (USBR 1990). Each fall, the pool is reduced to **32,000-35,000** AF for flood control (Figure 13). Ririe Reservoir has poor refill potential in many years, as runoff in the Willow Creek drainage has not totaled 80,000 AF since 1986 (Elle, IDFG, **pers. comm.** 1992).

Fish Issues and Concerns

Palisades Reservoir and Jackson Lake

Jackson Lake provides important habitat for lake trout and is a popular recreational facility.

Lake levels need to be held stable during four months in the fall to maintain spawning habitat for lake trout. Under current operations, the lake is drawn down before spawning begins and no further drafting occurs after October 1. This maintenance of a winter minimum pool prevents lake trout redds from being exposed (USFWS 1991).

In the past 20 years, winter releases from Jackson Lake have often reduced the river to levels that limited the survival of native Snake River cutthroat trout and other organisms (Annear 1987). **Annear** (1987) recommended a **minimum instream** flow of 400 cfs or natural inflow (whichever is less) from October 1 to March 31, below Jackson Dam. This flow corresponds to releases of about 280 cfs from the dam. Using different methods that addressed maintenance of side channel habitat and bank cover for trout, **Annear** (1989) recommended reservoir releases of 700 cfs between October 1 and March 31, in order to maintain flows of 1000 cfs in 2 1.4 miles of the river. The state of Wyoming owns rights to 33,000 AF of water in Palisades Reservoir. The USBR has allowed this water to be shifted to Jackson Lake to maintain lake levels or be released for minimum flows below Jackson Lake in the winter.

Palisades Reservoir provides a popular fishery for bank, boat, and ice fishermen (IDFG 1991). The primary fishery is the fine-spotted Snakerivercutthroat, of which 85 percent caught are hatchery fish. Other fishery resources include brown trout, lake trout, and kokanee (IDFG 1991). In 1980, the reservoir provided over 43,000 angler-days of fishing.

No studies have been conducted to establish a **minimum pool** in Palisades Reservoir. Palisades has an operational minimum pool of 20 1,000 AF for power head. Increased outmigrations of fish occur at levels below 500,000 AF (Elle, IDFG, **pers. comm.** in USFWS 1991). Most of the fish are cutthroat trout, which then take up residence **in the South Fork Snake River. Large fluctuations** in water levels (up to 80 feet) may affect open water species such as lake trout and kokanee (IDFG 1991).

South Fork Snake River: Palisades to Henrys Fork Confluence

The South Fork is a popular recreation area and provides an important fishery for cutthroat

AMERICAN FALLS RESERVOIR

END OF MONTH CONTENT

American Falls Reservoir

Minimum Daily Contents
1972-1991

Proposed Min. Pool Annual Min. Pool

Figure 11. American Falls Reservoir summary hydrograph and minimum daily contents.

SNAKE RIVER AT NEELEY

SUMMARY HYDROGRAPH

Snake River Flows At Neeley

Minimum Daily Flows
1972-1991

Minimum Flow Rec. Annual Min. Flow

Figure 12. Neeley summary hydrograph and minimum daily flows.

Ririe Reservoir

Minimum Daily Contents

1979-1 991

Proposed Min. Pool Annual Min. Pool

Figure 13. Ririe Reservoir minimum daily contents.

trout and brown trout (Griswold 1991). Mountain whitefish are the most abundant game fish in the **South Fork and are caught incidentally** by anglers seeking cutthroat and brown trout (Griswold 1991). Winter flows in the South Fork are the result of releases from Palisades and the amount of storage space available in American Falls Reservoir. Winter flows have averaged 2,300 cfs but have dipped as low as 750 cfs in recent dry years (Griswold 1991) (Figure 7).

Cochnauer and Buettner (1978) recommended a minimum **instream** flow on the South Fork of 1,084 cfs, based on the wetted perimeter **instream** model. USBR and the upper Snake water users currently recognize a **minimum** flow of 550 cfs (Griswold 1991). Recent work by the Idaho Department of Fish and Game (IDFG) has shown that subyearling cutthroat and brown trout are most abundant in side channels during the winter and are closely associated with cover (Schrader and Griswold, unpubl. rept. 1992).

Habitat decreases with decreases in discharge during the winter but not at a constant rate (Figure 14). The greatest rate of decrease for juvenile brown and cutthroat trout and whitefish winter habitat occurred between 1,540 and 1,240 cfs (Figure 14).

Flood control releases in the spring can be a problem for **fish** in the South Fork. Large discharges, followed by rapid reductions, can strand fish in side channels. Flows below 4,000 cfs in the spring can be detrimental to fish in the South Fork, particularly when following higher flows (Elle, IDFG, pers. comm. 1992).

Island Park Reservoir

Island Park Reservoir provides an important regional fishery for rainbow and kokanee, with catch rate goals of 0.6 fish /hour (IDFG 1991). The fishery is primarily hatchery driven. Island Park is very productive and supports a large,

Figure 14. Relationship of available habitat with discharge in the South Fork Snake River during the winter.

increasing fishing effort. Drawdowns below 40,000 AF flush significant numbers of fish out of the reservoir (Elle, IDFG, pers. comm. 1992). Drawdowns of this magnitude occur in some drought years (Figure 8) and can have a profound effect on the reservoir fishery. The fishery has not come back around since the large drawdowns in 1987 and 1988. Chubs and suckers are a problem in Island Park Reservoir presently (Elle, IDFG, pers. comm. 1992).

Henry's Fork Snake River: Island Park to Confluence

The Henry's Fork drainage provides one of the most important rainbow trout fisheries in the state (IDFG 1991). The upper part of the river from Island Park Reservoir to St. Anthony attracts people from all over the nation in pursuit of wild rainbow trout (IDFG 1991). Over 175,000 angler hours are spent annually in the stretch of the Henry's Fork from St. Anthony to Big Springs

(IDFG 1991). The lower part of the river, from St. Anthony to the confluence, is impacted from irrigation diversions and low flows, which limit salmonid populations (IDFG 1991).

Since 1980, the state of Idaho has held an instream water right of 300 cfs for fish on the Henry's Fork below Buffalo River. The state's instream flow right is junior to the storage right held by the USBR for Island Park (Dooley, USBR, pers. comm. 1992). The Buffalo River is spring fed and flows are arelatively constant 200 cfs during normal years (USFWS 1991). Depending on water year, discharge from Island Park should be at least 100 cfs to meet the minimum flow, which is in effect from November through April. Minimum flow has been as low as 100 cfs in October to maximize the "adverse storage" in Island Park (Dooley, USBR, pers. comm. 1992).

Snake River: Henrys Fork Confluence to American Falls Reservoir

This stretch of the Snake River has been impacted by hydroelectric development, irrigation diversions, and the Teton Dam failure. Water quality is of concern because of irrigation flow returns. The river supports rainbow, cutthroat, and brown trout fisheries (IDFG 1991). Most of the fisheries is hatchery supported. Because trout habitat has undergone many changes in this stretch of the river, including increased water temperature, IDFG began introducing smallmouth bass to portions of the river in 1990.

Cochnauer (1978) recommended year-round minimum flows of 1,550 cfs between the confluence and the Blackfoot River and 1,325 cfs between the Blackfoot River and American Falls Reservoir.

American Falls Reservoir

Hatchery rainbow trout comprise the major fishery in American Falls Reservoir. Fish are planted in mid April and grow quickly (Heimer 1984). About 40 percent are taken by anglers annually (Heimer 1984). Yellow perch are also present in the reservoir and do well in good water years (Trent, IDFG, pers. **comm.** 1992). The reservoir contains a dense population of suckers, chubs, and carp (IDFG 1991).

Major annual fluctuations in American Falls are the result of storage releases to satisfy irrigation demands (Heimer and Howser 1990). In drought years, the reservoir is essentially drained. Drawdowns may be particularly detrimental to yellow perch populations, which rely on shoreline cover (Heimer and Howser 1990). When American Falls Reservoir is nearly empty, the river cuts through the sediment built up in the reservoir and transports it to the river below, harming downstream fisheries (Trent, IDFG, pers. **comm.** 1992). Scully (IDFG pers. **comm.** 1992) recommended a minimum pool of at least **250,000 AF** in American Falls.

Many planted rainbow emigrate through American Falls Dam during storage releases, as the water in reservoir becomes too warm and lacks sufficient oxygen (IDFG 1991). Heimer (1984) found that 42 percent of harvested hatchery rainbow were taken by anglers in the Snake River below the dam.

Snake River: American Falls Dam to Milner Dam

The free-flowing reach of the Snake River below American Falls is classified as a Class I rainbow trout **stream** (IDFG 1991). An estimated 58,000 hours of fishing occurs in this area, with rainbow trout harvest estimated at 22,000 fish (IDFG 1991). Many trout reach five to ten pounds (IDFG 1991). Many of the fish come from American Falls plants.

Mid-summer reservoir releases result in high temperatures and low oxygen in the **tailrace** (IDFG 1991). As part of their American Falls FERC license, Idaho Power adds air to the discharge of American Falls if dissolved oxygen levels fall below 5.5 ppm (Randolph pers. **comm.** 1992). Storage of water in American Falls often creates critical low flows in this stretch during the winter. In 1968, the USFWS recommended a minimum flow of 300 cfs (USFWS 1991). The release below American Falls has always been **300 cfs** or greater since 1979 (Dooley, USBR, pers. **comm.** 1992). It is the **USBR's** policy to not go below that flow of 300 cfs (Dooley, USBR, pers. **comm.** 1992). Scully (IDFG, pers. **comm.** 1992) recommends a minimum flow of at least 600 cfs during winter months.

Cochnauer (1978) recommended year-round minimum flows of 2,200 cfs (October-March) and 4,400 cfs (April-September) in the Snake River between American Falls Dam and Minidoka Dam. These flows were estimated to be adequate for the spawning and rearing of game fish, and the maintenance of fish populations in the river. Ideal or **bankfull** flows in this stretch would be 7,000 cfs (Cochnauer 1978).

Ririe Reservoir

Ririe Reservoir is located only 20 miles from Idaho Falls and supports over 80,000 angler hours with a 1989 catch rate of 0.75 trout/hour (IDFG 1991). The primary fishery is composed of hatchery rainbow trout and kokanee salmon. Smallmouth bass were introduced from 1984 to 1986, and should continue to expand in the future (IDFG 1991). Yellow perch were illegally introduced prior to 1989 and are presently increasing.

Ririe is drawn down to 35,000 AF by November 1 annually to provide for winter flood

control storage (IDFG 1991). Drafting does not begin until after Labor Day. After November 1, the lower 20 miles of Willow Creek are dewatered, to prevent ice buildup and floods near Idaho Falls (IDFG 1991). If icing problems could be solved by the USBR, a minimum winter flow of 15 cfs through Willow Creek would benefit the fishery (Elle, IDFG, pers. comm. 1992).

The commitment of 80,500 AF of previously uncontracted storage to Mitigation Inc., under terms of the Fort Hall Indian Water Rights Agreement of 1991, will likely adversely affect fishing and recreation in general at Ririe. The reservoir may now be drawn down in the summer to meet irrigation demands.

Wildlife Issues and Concerns

Most of the streamflow or reservoir related wildlife issues and concerns in the upper Snake River system include effects on bald eagle summer and winter habitat, Canada goose nesting and broodrearing habitat, other waterfowl nesting and brood rearing habitat, aquatic fur-bearer habitat, and maintenance of wetlands and riparian areas. The entire upper Snake River is regionally important as a wintering area for the federally listed endangered bald eagle. Riparian areas, which are important for a large diversity of wildlife, have been seriously degraded in much of the upper Snake from livestock grazing and hydroelectric development.

South Fork Snake River: Palisades to Henrys Fork Confluence

The South Fork of the Snake River supports Idaho's most unique riparian ecosystem, containing the largest continuous stand of cottonwoods in the state (IDFG 1991). This habitat supports a wide diversity of wildlife. Recent vegetation inventories suggest that there is an insufficient amount of young cottonwoods to replace the existing mature cottonwood stands (USBLM and USFS 1991). The number of young trees being established on gravel bars and disturbed areas is insufficient because Palisades Dam has reduced the amount of streambed sediments and major stream channel shifting and deposition, which are needed for establishment (USBLM and USFS 1991). Merigliano (unpubl. rept. 1991) is currently examining the relationship between flows and

cottonwood establishment in the South Fork corridor.

The South Fork provides habitat for nine nesting pairs of eagles and up to 100 wintering birds (IDFG 1991). Low winter flows that are detrimental to fish populations in the South Fork negatively impact bald eagles.

Approximately 260 islands exist between Palisades and the confluence with the Henrys Fork. Canada goose nesting success is dependent on the magnitude and timing of spring water releases from Palisades. Parker (1973) indicated that flows of less than 8,000 cfs expose island nesting geese to severe predation and human disturbance. Merrill and Bizeau (1972) suggested that flows be maintained below 16,000 cfs to reduce the flooding of islands after nest establishment. Cochnauer and White (1975) recommended flows between 8,000 cfs and 16,000 cfs from March through May, to protect nesting geese and other waterfowl. Naderman (IDFG, pers. comm. 1992) suggested that flows could be dropped below 8,000 cfs after April 1 (as the majority of nests would be established by this time), but not lower than 4,000 cfs. Large flood control releases from Palisades would be least detrimental to geese if they occurred in early March or after June 1 (Naderman, IDFG, pers. comm. 1992).

Henrys Fork Snake River: Island Park to Confluence

The Henrys Fork is the major wintering area for the Rocky Mountain population of trumpeter swans. The swans are dependent on releases from Island Park Dam to keep feeding areas ice-free and aquatic food accessible (USFWS 1991a.). A recent study by the USFWS indicates that 500 cfs is the absolute minimum to prevent desiccation of aquatic vegetation above freezing temperatures. Once freezing weather occurs, 500 cfs will not likely prevent ice formation and flushing flows will be needed. Constant higher flows are recommended during severe weather to prevent a high flush frequency, which could be detrimental to the fishery. A flow of 700 cfs is considered optimum, but in autumn of low flow years, 400 cfs would be adequate to insure winter flushing flows (USFWS 1991a).

The Henrys Fork provides excellent waterfowl nesting habitat and an important wintering area for geese. Several islands located

within Harriman State Park are utilized extensively by geese during the nesting season. Cochnauer (1978) recommended a maximum flow of 1,350 cfs through Harriman State Park during waterfowl nesting season.

American Falls Reservoir

American Falls Reservoir supports the largest density of migrating shorebirds in Idaho (Trost, Idaho State Univ., pers. **comm.** 1992). An estimated total of **30-50,000** shorebirds, representing over 30 species, forage on the open **mudflats** around the reservoir between July and September. Any change in American Falls reservoir operations that led to increased water levels and decreased **mudflats** would be detrimental to shorebird numbers (Trost, Idaho State Univ., pers. **comm.** 1992).

Snake River: American Falls Reservoir to Milner Dam

The Minidoka National Wildlife Refuge is located **around Lake** Walcott on the Snake River between American Falls Dam and Milner Dam. This stretch of the river is important for nesting Canada geese and other waterfowl. Cochnauer (1975) recommended maximum flows of **25,000** cfs from March to May between American Falls Dam and Minidoka Dam. Maximum and minimum flows of 16,000 cfs and 3,600 cfs were recommended during the waterfowl nesting period from Minidoka Dam to **Milner Dam** (Cochnauer 1975).

Recreation Issues and Concerns

The Snake River between Jackson Lake and Palisades is rated as a blue ribbon or class I fishery by the Wyoming Game and Fish Department (**Annear** 1987). The river, which flows through the Grand Teton National Park, receives approximately 250,000 days of use by recreationists annually (**Annear** 1987). **The most** sought after fishery on the river is the native Snake River cutthroat trout.

The seasonal salmon fly hatch draws heavy fishing attention to both the South Fork and Henrys Fork of the Snake River (USBLM and USFS 1991). Fishermen come from many states and abroad to fish the famous rivers. For about a two-week period during the peak of the fly hatch, rafts, drift boats, canoes, and power boats cover the river. Because of its scenic beauty and

abundant natural resources, the Snake River is a boom to southeastern Idaho's economy (USBLM and USFS 1991). Fishing and boating recreation is estimated at **143,900 Visitor Use Days (VUD's)** annually (USBLM and USFS 1991). Fishing and other associated recreation uses on the river provide employment for about 284 people and total income of approximately **\$5,692,000** per year within the local economy (USBLM and USFS 1991).

Island Park Reservoir is one of the ten most frequently fished waters in Idaho, according to a 1987 angler opinion survey (Reid 1989). Palisades, Ririe, and American Falls Reservoirs are all listed in the top ten of the most frequently fished waters in eastern Idaho (Reid 1989).

Severe drawdowns can reduce angler catch rates, impact aesthetics, and limit access to reservoirs. Boat ramps become inoperable at certain reservoir elevations (Table 5) at which the improved portion of the ramp is not in the water.

The Henrys Fork contains at least three Class II to Class IV whitewater runs (Appendix D). All three require flows of 1,000 to 2,000 cfs.

Potential Water Rental Impacts/Benefits

The majority of rental pool water will be stored in **American Falls**, Palisades, and Jackson Lake. Other possible sources in some years include Island Park and Ririe reservoirs. Movement of rented water from the upper Snake River system will reduce annual reservoir minimum pools in some years, through the decrease in carryover. Reduced pools can lead to increased fish emigration at American Falls, Palisades, and Island Park. Reduced pools and increased fluctuations will reduce total habitat available to fish populations and productivity in all reservoirs. Releases from Jackson Lake above inflow during the fall will dewater lake trout redds. Additional reservoir drawdowns will affect angler success and access, impact reservoir aesthetics, and have large impacts on many other recreational activities.

Indirect impacts of reservoir drawdowns on land-based recreational facilities include isolation of campgrounds and parking areas, decreased aesthetic quality, and inoperable water systems

Table 5. Elevations and reservoir volumes at which boat ramps in upper Snake River reservoirs become inoperable (Jansen Lute, USBR, pers. **comm.** 1992).

<u>Island Park Reservoir.</u>	<u>Elevation (feet msl)</u>	<u>Volume (acre-feet)</u>
Boat Ramp		
Buttermilk Campground	6286.7	42,685
McCrea Bridge Campground	6293.8	72,880
Mill Creek Campground	6296.5	88,656
Ponds	6284.5	36,175
West End Campground	6294.7	77,885
 <u>Jackson Lake</u>		
Boat Ramp		
Coulter Bay Marina	6754.3	490,390
Leeks Marina	6735.7	100,900
Signal Mountain Lodge	6737.7	138,200
 <u>Palisades Reservoir</u>		
Boat Ramp		
Blow Out	5552.8	380,949
Calamity	5560.2	449,392
 <u>Ririe Reservoir</u>		
Boat Ramp		
Blacktail Park	5075	33,500
Juniper	5030	28,031

to service facilities (Jansen Lute, USBR, pers. **comm.**, 1992) (Table 5).

Most streamflow problems in the upper Snake system occur between October and March. In past winters, flows have reached critical low levels below Jackson, Palisades, American Falls and **Island Park**. **Critical low** flows have **generally** been related to drought conditions and low carryover conditions.

Between the months of October and March, river flows at most locations are directly related to reservoir carryover. Reservoir releases are inversely proportional to the risk of not refilling the reservoir.

During the March to October period, storage is released to maintain flows at certain locations. Without upstream storage, the normal exercise of irrigation water rights would completely deplete river flows since all of the normal flow

of the Snake river, above Blackfoot, was fully appropriated by the year 1900. An effort is now made to release sufficient stored water to maintain at least 1 **000 cfs** at Blackfoot. If irrigators increase diversions unexpectedly at critical times, flows at Blackfoot can **quickly** fall below 1000 cfs. In 1992, flows at Blackfoot dropped to 0 cfs for two days.

In addition, low flows have been a problem in the stretch of the Snake River near Blackfoot during the irrigation season. This stretch is below several significant irrigation diversions and was totally dewatered during April 1992. Similar low flow conditions have occurred in previous years, when diversion operations are not in synchronization with releases from Palisades and Island Park.

Rented water has the potential to increase summer flows and benefit fish, wildlife, water quality, and recreation in the Snake River below

Milner. Release of rented water also has the potential to increase winter flows and benefit fish and wildlife in the South Fork Snake, Henrys Fork, and main Snake above Milner.

At the present, fry overwinter survival appears to be one of the major limiting factors to trout populations on both the South Fork and Henrys Fork (USBLM and USFS 1991). Storage of flow augmentation water in the upper Snake reservoirs and properly timed releases could give the USBR more operational flexibility to meet and exceed minimum flows in more years than without flow augmentation. In particular, juvenile fine-spotted cutthroat trout, brown trout, and whitefish can be benefitted by increased winter flows in some years below both Jackson Lake and Palisades, rainbow trout and trumpeter swans can be benefitted by increased fall and winter flows below Island Park, and rainbow trout can be benefitted by increased winter flows below American Falls Reservoir. Wintering bald eagles will be benefitted by increased winter flows throughout the upper Snake River system.

Increases in streamflows from releases of rented water during one part of the year will result in corresponding decreases in streamflows during another part of the year, or the following year. In order to adequately protect streams and reservoirs, close coordination of annual flow augmentation plans must take place.

The years when additional flows would be the most beneficial to both anadromous fish below Brownlee are the years when runoff and carryover are low and there is little or no water available in the bank. Changes in price incentives, increased conservation of irrigation water, or decreased irrigated acres may reduce this condition in the future.

Results from Flow Augmentation Simulation

Reservoir volumes in Island Park and Ririe Reservoir were not affected by the flow augmentation simulation. The flow augmentation simulation resulted in decreased average monthly reservoir levels at Palisades in all months (Figure 15). Flow augmentation resulted in increased average summer flows in the South Fork Snake River at Irwin, but decreased average winter flows (Figure 15). Years where minimum flows were less than 1,550 cfs at the Irwin gauge increased from 19/62 water years under baseline conditions to 24/62 water years under the flow augmentation simulation. Based on work by

Schrader (unpubl. rept. 1992) (Figure 14), the flow augmentation simulation would result in a serious reduction of winter habitat for juvenile cutthroat and brown trout and whitefish.

The flow augmentation simulation resulted in decreased average monthly reservoir levels in American Falls Reservoir in all months (Figure 16). Under baseline conditions, the reservoir level was dropped below the suggested minimum pool of 250,000 AF in 10/62 water years versus 15/62 water years under the flow augmentation simulation (Appendix A).

Flow augmentation resulted in increased average summer flows in the Snake River below American Falls (near Neeley), but decreased average winter flows (Figure 16). Winter flows of less than 600 cfs occurred in 21/62 water years under baseline conditions versus 26/62 water years under the flow augmentation simulation (Appendix A).

The flow augmentation simulation resulted in increased irrigation shortages in 4/62 water years, all drought years in the 1930's.

Recommendations for Protection and Enhancement of Resident Fish and Wildlife

American Falls Reservoir is the last major storage project on the Snake River before Brownlee Reservoir. Winter flows in the upper Snake are directly related to the amount of storage available in American Falls. There is frequently little extra space available because American Falls usually fills easily due to inflow from the prolific springs directly upstream. However, Dooley (USBR, pers. comm. 1992) notes that the reservoir has not filled in the last four years. The USBR prefers not to spill extra water over American Falls until runoff forecasts are solidified in early spring. Without extra space available in American Falls, the USBR is reluctant to provide more flows in the upper Snake system. The USBR is obligated by spaceholder contracts to store as much water as it can within runoff/flood forecast obligations and criteria @ooley, USBR, pers. comm. 1992).

In order to provide summer flow enhancement below Milner, provide extra storage space in American Falls, and provide winter flow enhancements in the upper Snake, the

Palisades Reservoir

Study Comparison

Mean Monthly Contents (1928-1989)

South Fork Snake River Flows Near Irwin

Study Comparison

Mean Monthly Flow (1928-1989)

Figure 15. Study comparison of Palisades Reservoir contents and South Fork Snake River flows near Irwin.

American Falls Reservoir

Study Comparison
Mean Monthly Contents (1928-1989)

Snake River Flows near Neeley

Study Comparison
Mean Monthly Flow (1928-1989)

Figure 16. Study comparison of American Falls Reservoir contents and Snake River flows near Neeley.

following recommendations apply to water rental flow augmentation releases, to the extent operationally possible:

1. Release adequate water from the upper Snake to maintain inflow equal to or greater than outflow at **Brownlee** Reservoir after June 10, to protect smallmouth bass and crappie nesting efforts.

2. In years when runoff forecasts and carryover indicate that South Fork Snake (**1,550 cfs**), **Henrys Fork (500 cfs)**, and Snake River below American Falls (600 cfs) flows will be met throughout the winter;

- a. Release the remaining upper Snake River rental water evenly from American Falls from July 1 through September 30 to refill **Brownlee**. This will provide higher summer flows and better quality fish and wildlife habitat conditions below Milner and improved water quality conditions in the middle Snake River.

- b. Release Ririe rental water evenly in September to backfill or pass through American Falls Reservoir. This will protect summer boating and fishing in Ririe.

- c. Release Palisades, Jackson Lake, and Island Park rental water evenly from July 1 through September 30 to backfill or pass through American Falls Reservoir. This will provide fish and wildlife and water quality benefits below Milner and other stretches of the Snake River.

3. In years when runoff forecasts and carryover indicate that South Fork Snake (**1,500 cfs**), **Henrys Fork (500 cfs)**, and Snake River below American Falls (600 cfs) flows will not be met throughout the winter,

- a. Release the American Falls flow augmentation contribution to the water **rental flow augmentation program evenly** from American Falls from July 1 through September 30 to backfill **Brownlee**. This will provide some benefits to fish and wildlife and water quality below Milner, and provide some protection of fishing and boating activities at **Brownlee**.

- b. Release Ririe flow augmentation water evenly in September and pass through **American Falls** Reservoir to refill **Brownlee** Reservoir. This will protect boating and fishing in Ririe and provide some September refill of **Brownlee**.

- c. Release Jackson, Palisades, and Island Park flow augmentation water evenly from October 1 to March 31 and pass through American Falls Reservoir to refill **Brownlee** Reservoir. This will benefit trumpeter swans in the Henrys Fork, juvenile cutthroat and brown trout and whitefish in the South Fork, and rainbow trout below American Falls Reservoir. Releases from the upper Snake delayed until this time would impact boating, fishing, and other recreational activities at **Brownlee**.

4. Meet minimum flows in the South Fork Snake, Henrys Fork, and main Snake below American Falls.

5. To the extent possible, maintain minimum pools of 20 1,000 AF in Palisades, 40,000 AF in Island Park, 35,000 AF in Ririe, and 250,000 AF in American Falls. This will help protect resident fish and wildlife habitat and reduce emmigration of fish at low pools.

6. Conduct additional analysis of reservoir minimum pool recommendations and analysis in the upper Snake, to ensure that resident fish and wildlife, water quality, and recreation are adequately protected.

7. Coordinate development of annual flow augmentation plan with the Snake River Anadromous Fish Water Management Office, which includes resident fish and wildlife conditions and constraints. Because all recommended reservoir minimum pools and streamflows cannot be operationally met every year, development of an annual flow augmentation plan that addresses priorities and tradeoffs between reservoir volumes and **instream** flows is important.

Middle Snake River

Milner Dam to Brownlee Reservoir

Description of Study Area

The middle Snake River study area consists of an upper and lower reach. The upper reach extends from Milner Dam to C.J. Strike Reservoir (Figure 17). The lower reach extends from C.J. Strike Reservoir to **Brownlee** Reservoir (Figure 18). The middle Snake River flows through the upper zones of the Snake River Plain Aquifer (Holland and Platts 1991). River flows below Milner Dam are controlled by Water District 01 and the USBR to meet storage and irrigation diversion rights upstream from Milner Dam. Major acreages below Milner also dictate water releases from as high as Jackson Lake. Aquaculture facilities in the middle Snake River area produce 90 percent of the commercially processed trout in the United States — 25 million pounds (Palmer 1991).

Diversions above the Milner gage irrigate approximately 1.9 million acres (Harenberg et al. 1990). From April through September river flow below Milner has often been zero due to upstream diversions for irrigation. November through March is characterized by relatively constant flows primarily influenced by ground water inflow from northside springs (Figure 19).

The IWRB stated that zero flow at Milner Dam is not a target or goal to be achieved, and may not necessarily be desirable (IWRB 1992). It is rather, a recognition of the current condition in which zero flow passes Milner Dam during certain periods of time. The State should seek to acquire water whenever it becomes available in order to mitigate the impacts of low flow below the dam (IWRB 1992). In 1988, Milner Dam underwent Federal Energy Regulatory Commission (**FERC**) review. As part of its licensing permit, Idaho Power is required to pass a year-round flow of **200** cfs below Milner, when water is available.

Most of the outflow from the Snake River Plain Aquifer occurs between Milner Dam and King Hill. Holland and Platts (1991) report an

estimated 200 to 300 MAF of water is stored in the top 500 feet of the aquifer. Groundwater discharge from the Thousand Springs area along the north wall of the Snake River Canyon increased steadily from 4,300 cfs in 1910 to about 6,800 cfs in the mid-1950's, when it began to decrease.

Discharge from the Springs in 1991 was almost 5,600 cfs, or about equal to the discharge in 1927 (Hughes 1992). Hughes (1992) reported that results from a 1980 U.S. Geological Survey (USGS) analysis of the hydrologic budget of the Snake River Plain aquifer indicate that the aquifer outflows are declining as a result of withdrawals and decreasing recharge from surface water irrigation. The difference between aquifer recharge and discharge in 1980 was an estimated 410,000 AF.

Irrigation return flows from **Twin Falls** Canal Company on the south and the Northside Canal Company lands on the north contribute significant flow directly into the river and its tributaries. Between Milner and Kimberly the river gains an average of 250 cfs. Spring flows and surface returns continue to add to the flow throughout the reach, producing summer flows of 8,000 cfs at King Hill (Brockway and Robison 1992).

Fish Issues and Concerns

The Snake River fishery between Milner Dam and **Brownlee** Reservoir is comprised of white sturgeon, rainbow trout, cutthroat trout, mountain whitefish, smallmouth bass, largemouth bass, channel catfish, crappie, and bluegill. Trout habitat, with the exception of spawning areas, is good throughout most of the free-flowing reaches between Milner and C.J. Strike Reservoir (IDFG 1991). Trophy size trout are caught in areas below Milner and Upper Salmon Falls Dam. A high quality fishery exists between Milner and King Hill where the river is recharged.

Numerous major hydropower facilities, which would seriously jeopardize the existing trout and sturgeon fisheries, have been proposed between Milner Dam and C.J. Strike Reservoir (IDFG 1991). The Snake River has the greatest potential for increasing angler opportunity of

Snake River Drainage

Milner to C.J. Strike Reservoir

17. Snake River drainage: Milner to C.J. Strike Reservoir.

Figure 18. Snake River drainage:
C.J. Strike Reservoir to
Brownlee Reservoir.

any major water in the southern portion of Idaho. Lack of flows, especially during the irrigation season, apparently deteriorating water quality, and loss of spawning areas appear to be the factors most significantly affecting fish populations in the Snake River (IDFG 1991).

Water quality of spring flows continues to decline as a result of commercial fish farm development and irrigation returns. Vinyard Creek, an aquifer spring entering the Snake River, is the major spawning area for cutthroat trout and rainbow/cutthroat hybrid trout (IDFG 1991). Many of the minor tributary streams entering the Snake River also contain good trout habitat and support populations of wild trout, primarily rainbow. Hydropower facilities proposed on tributary streams would also have impacts on trout fisheries by reducing access for spawning trout and reduced streamflows (IDFG 1991). IDFG (1991) has reported that all minor tributaries to the middle Snake River and impoundments below C.J. Strike Reservoir support populations of the native **redband** subspecies of rainbow trout. This subspecies is given management priority by IDFG to protect wild stocks from overharvest and habitat degradation (IDFG 1991).

White sturgeon historically inhabited the Snake River from Shoshone Falls downstream to the confluence of the Columbia River (Platts and Pratt 1991). **Hydroelectric dams have blocked** upstream passage of white sturgeon. Cochnauer (1983) reported white sturgeon were present between Bliss and C.J. Strike Dams, above Bliss Dam and between C.J. Strike Reservoir and Swan Falls Dam. The reach between Swan Falls and Bernard's Ferry is one of the three remaining areas in the Snake River where sturgeon reproduction is apparent. Additional impoundments in these river reaches will reduce or eliminate these remnant sturgeon populations (IWRB 1986).

The best available information on minimum requirements for maintaining viable populations of white sturgeon in the Snake River below Swan Falls suggests that sturgeon will be heavily impacted and could be extirpated if **instream** flows decline as provided for in the Swan Falls Agreement.

White sturgeon is designated a sensitive species by both the U.S. Bureau of Land Management (USBLM) and the U.S. Forest Service (**USFS**) (Moseley and Groves 1992).

IDFG considers the white sturgeon a priority species of special concern (Moseley and Groves 1992).

Platts and Pratt (1991) concluded that recruitment is low due, in part, to limited availability of spawning and rearing habitat in a 30-mile reach between Auger Falls and Upper **Salmon Falls**. The reach contains poor spawning conditions to initiate apopulation, spawning and rearing areas in poor condition, and what appears to be a low food supply for large mature sturgeon (Platts and Pratt 1991). Platts and Pratt (1991) also report that the limited boulder substrates in this reach of the Middle Snake River could provide some cover for eggs that settle to the bottom, and that the common mud substrate of the Middle Snake could be less suitable for incubation. Cochanauer (1983) reported that reduced recruitment is probably a result of low spawner numbers and the apparent low frequency of spawning.

Sturgeon spawn in swift water, over large substrate, and in waters at least two to three meters in depth. Sturgeon typically spawn from February through June at temperatures of **10-17°C** (Platts and Pratt 1991). Eggs are broadcast in fast flowing water and drift to sand and silt substrates where oxygen levels can be limiting.

Sturgeon fry feed on aquatic insect larvae and, after one year, begin to diversify their diet to include invertebrates, crustaceans and fish. Storage impoundments have blocked recruitment of incoming gravels, and eliminated anadromous fish runs which also provided sturgeon with an important food source. Suitable habitat for **molluscs** and crayfish, an important food source for sturgeon, has declined.

Sturgeon depend on deep pools for cover and cooler temperatures. Platts and Pratt (1991) have documented that in the flowing river habitat of the Snake River, many small sturgeon used deep, sand bottom pools. Apperson et al. (1990) report sturgeon use of waters up to 12 meters deep when fish were moving in the river system, and use of deeper waters when fish were sedentary. While sedentary in the river, sturgeon used water 12 - 27 meters deep (Apperson et al. 1990 in Platts and Pratt 1991). Macrophyte decomposition and hatchery solids contribute to stagnation of deep holes under low flow conditions. Many pools between Auger Falls and Upper Salmon Falls stratify in the summer (Platts and Pratt 1991). The bottom of these

stratified pools are probably not able to sustain sturgeon because they lack oxygen and have pH values in excess of 10 (Platts and Pratt 1991). Unless small sturgeon can escape the typical poor water quality during the summer, they are unlikely to survive in deep pool habitats of the Middle Snake River (Platts and Pratt 1991).

Platts and Pratt (1991) conclude the following, "present sturgeon population levels will return to previous natural levels only by returning the river to natural conditions. Present populations can only be increased by increasing river flows during certain periods and reducing incoming nutrients, toxicants, and sediments."

Catch-and-release sturgeon regulations are maintained to improve populations and sturgeon fishing opportunity between Lower Salmon Falls Dam and **Shoshone Falls** (Partridge, **IDFG**, pers. comm. 1992).

The 1976 State Water Plan (Plan) set the minimum flow near Murphy at 3,300 cfs, but there was no biological basis for this flow amount. A flow of 3,300 cfs was considered less than adequate for fish, wildlife and recreation at and below Swan Falls, and acknowledged as such in the Plan itself.

The Murphy minimum streamflow was raised to 3,900 cfs from April through October and 5,600 cfs from November through March as a

result of the **Swan Falls Agreement** (Agreement). **Neither the Plan's 3,300 cfs nor the Agreement's 3,900 cfs** is considered adequate by fish and wildlife proponents.

Since the **1950's**, there has been a general downward trend in the annual flow of the Snake River near Murphy (IWRB 1986). Causes of the declining flow include the large pumped diversions from the river between **Hagerman** and the Murphy gage and diminishing discharge from Thousand Springs which results from increased use of ground water on the Snake River plain. Higher values occurring in 1983, 1984, and 1986 are the result of flow past Milner during the summer (**IWRB** 1986). Average streamflows at the Murphy gage since 1972 have remained above 5,000 cfs during the summer months (Figure 19). In 1992, however, summer flows at the Murphy gage have been below average (Figure 20).

The USFWS is currently conducting a study pursuant to Public Law 100-216 to examine the impacts of several proposed hydrographs including Swan Falls Agreement flows on resident fish habitat. Flow recommendations will be derived for each month based on species priority, lifestage priority, and geographical priority (Anglin 1992). Several recommendations for minimum streamflows have been made by **IDFG** for the Snake River below Milner Dam (Table 6).

Table 6. Recommended minimum streamflows for the middle Snake River between Milner Dam and **Brownlee** Reservoir Cochnauer and Mabbott 198 1).

Reach	Flow (cfs)	Time Period	Purpose
Milner to Buhl	2,190	Year-round	Fisheries
Buhl to King Hill	4,520	Year-round	Fisheries
King Hill to C.J. Strike	4,344	Year-round	Fisheries
C.J. Strike to Swan Falls	5,000	Year-round	Fisheries
Swan Falls to Bernards Ferry	5,100	Year-round	Fisheries, Waterfowl
Bernards Ferry to Boise River	5,100	Year-round	Fisheries
Boise River to Payette River	5,650	Year-round	Fisheries, Waterfowl
Payette River to Brownlee	5,850	Year-round	Fisheries

SNAKE RIVER AT MILNER

SUMMARY HYDROGRAPH

SNAKE RIVER NR MURPHY

SUMMARY HYDROGRAPH

Figure 19. Milner and Murphy summary hydrographs.

Snake River

1992

Figure 20. Snake River 1992: Weiser and Murphy (IDWR, 1992).

At Weiser, the minimum flow of 4,750 cfs was not met for two days in 1977 as a result of large diversions from the Snake River and very low outflows from the Boise and Payette basins. The 1977 event demonstrated the potential for these events to occur at the same time in **severely dry years, and with continuing increases in Snake River diversions**, the resulting low flow may be significantly less next time (IWRB 1986). Flows at the Weiser gage fell below 4,750 cfs twice in June 1992 (Figure 20).

The 1992 State Water Plan points out that the minimum flows established for the Snake River at the Murphy and Weiser gauging stations are management and permitting constraints; they further insure that the state will be able to assure an adequate hydropower resource base and better protect other values recognized by the state, such as fish propagation, recreation, and aesthetic interests, all of which would be adversely impacted by an inadequate streamflow (IWRB 1992).

The middle Snake River between Milner Dam and Ring Hill has been listed as water quality limited by the Idaho Division of Environmental Quality (IDEQ) and as a state interimpounded reach by the IWRB (Brockway and Robison 1992). This reach is impacted by return flows from irrigated agriculture, runoff from Confined Animal Feeding Operations, hatchery effluent, hydroelectric development and point source discharge (IDEQ 1991).

Point sources along the river are primarily from aquaculture activities. There are approximately 18 commercial and governmental aquaculture facilities and two sewage treatment plants that discharge directly into the river between Milner and King Hill (Brockway and Robison 1992). Five impoundments in this reach modify the water quality and the ability of the river to assimilate nutrient loading. Under the low flow summer conditions, these factors appear to significantly degrade the water quality. Brockway and Robison (1992) collected and

analyzed water quality data and nutrient loads from 13 **instream** sample sites between Milner and King Hill from June, 1990 through July, 1991. The data suggest that water temperature, total phosphate concentration, and nitrate+nitrite N concentration exceed the maximum concentration recommended by the Environmental Protection Agency (EPA) for the protection of various designated beneficial uses in this reach including **salmonid** spawning, cold water biota, and primary and secondary contact recreation,

Large macrophyte beds are common below Milner Dam. Hill (1991) concluded that hatchery effluents and agricultural return flows in the area above Boulder Rapids and below Crystal Springs exert considerable influence on macrophyte growth. Higher spring and summer flows are needed to scour the substrate, prevent sediment accumulation, and dislodge macrophytes. During the summer, when flows are low and water temperatures are high, the plants remove DO faster than it can be replaced by turbulence and mixing (Hill 1991). The result is a substantial loss of fish habitat. Recent information suggests that an average discharge of approximately 5,987 cfs could decrease the number of macrophytes (Hill, 1991).

Poor water quality, high temperature, and high nutrient loads limit salmonid fish production between Auger Falls and Upper Salmon Falls (Hill 1991). Hill (1991) reported that egg to fry survival of salmonids is low because redds become embedded with sediment. Water temperatures in the middle Snake between Auger Falls and Upper **Salmon** Falls are often **>20°C** in the summer because there is no river flow and no **canopy cover** (Hill 1991). **High** water temperature lowers fish resistance to disease, the ability to compete for resources, and reduces metabolism and feeding activity (Hill 1991). Summer habitat and limiting conditions determine the residual population of fish that will over-winter, and thus be available in the fishery the following spring (Hill 1991).

A water quality model was recently developed by the EPA. It is being utilized in an ecological risk analysis of the Snake River to estimate the likelihood of deleterious alterations in the riverine **abiotic** and biotic systems (IDEQ 1991). Water quality data collected by Brockway and Robison (1992) are utilized in the EPA model and define baseline conditions.

The EPA water quality model was used to simulate the effects of renting water for salmon flow augmentation on the middle Snake River. Two flow augmentation scenarios were modeled, including the movement of 50,000 AF from July through September and the movement of 427,000 AF from July through September. These two scenarios were selected to represent a range of flow augmentation possibilities from the upper Snake River.

The amount of water rented from Water District 01 from July 14 to August 19, 1991 was 50,000 **AF**. A total of 427,000 AF represented not only the total amount of water specified in the Power Council's Phase III Amendments for flow, velocity and temperature improvements downstream, but was also the maximum quantity of water specified in the **USBR's** November 1991 transfer application to allow stored water to be leased from existing rental pools for salmon flow augmentation. Water quality conditions were modeled for the baseline study and both flow augmentation scenarios between Rock Creek and Mud Creek, river mile 607 to 594 (Table 7).

Based on the results of the water quality model, increased flows of up to 427,000 AF from July through September had little effect on mean daily dissolved oxygen (DO) levels or water temperature (Table 7). The model does not take into account the likely reduction of macrophytes and resulting decrease in DO concentration with higher flow volumes. The water quality model assumes an initial DO concentration of 8.07 **mg/l** under baseline conditions based on historic mean daily flows. The model does not take into consideration diurnal fluctuations or depressed DO levels in deeper pools.

Biological oxygen demand (BOD) and ammonia (NH₃) decreased from July to September in the 427,000 AF scenario (Table 7). Sediment loads decline as the irrigation season **draws** to a close, and with increased flow volumes the solutions become more diluted. Phosphorus is the limiting factor for plant growth. Major sources of phosphorus entering the system may include aquaculture effluent and irrigation return flows. Algae and phosphorus levels fluctuate together for all scenarios throughout the summer months. Total phosphorus decreased from July to September as flows increased (Table 7).

Table 7. Middle Snake water quality output generated by EPA modeling effort.

Water Quality Parameter	50			A: 50			September		
	Baseline	KAF	427 KAF	Baseline	KAF	427 KAF	Baseline	50 KAF	427 KAF
DO (mg/l)	8.07	8.00	8.30	8.30	8.30	8.30	8.40	8.80	8.50
BOD (mg/l)	1.82	1.90	2.20	1.10	0.85	1.00	1.60	1.70	1.60
Alage (ug/l)	4.57	1.17	0.93	3.30	1.35	2.86	1.44	0.52	1.16
NH3-N (mg/l)	0.11	0.10	0.57	0.13	0.06	0.12	0.08	0.04	0.07
NO ₂ + NO ₃ (mg/l)	1.48	1.47	1.41	1.77	1.82	0.81	1.92	2.00	1.98
Phos(ug/l)	91.06	87.48	72.05	95.42	87.81	92.88	65.26	52.05	61.73
Temp °C	19.87	19.72	18.32	18.25	17.66	18.14	16.68	16.06	16.57
Flow at Headwaters (cfs) RM 619	407	687	2,798	407	687	2,798	407	687	2,798
Groundwater Return Flow (cfs)	750	750	750	832	832	832	844	844	844
Flow Gain in Reach (cfs)	1,329	1,329	1,329	1,469	1,469	1,469	1,602	1,602	1,602

In the short term increased flows in the middle Snake probably would not result in increased DO concentration because macrophytes would not be eliminated completely. However, in the long term, higher flow volumes would improve water quality conditions in the middle Snake River. Macrophytes would be dislodged, DO levels would likely increase, and BOD would decrease.

Wildlife Issues and Concerns

Riparian habitat and numerous islands between **Milner Dam** and **Brownlee Reservoir** provide important wintering areas for resident and migrating waterfowl, particularly Canada goose and mallard.

The Snake River Birds of Prey Area encompasses 482,640 acres of **USBLM**-administered public land along an approximately **80-mile** reach of the middle Snake River. The area supports one of the world's densest concentrations of nesting birds of prey.

IDFG manages several Wildlife Management Areas (WMA's) along the middle Snake. Primary objectives of **WMA's** include upland game birds, such as ring-necked pheasant and Hungarian partridge, raptors, mule deer, and a variety of mammals, including muskrat and badger. The **Hagerman** WMA borders the river opposite Shoshone Falls. The number of successful breeding pairs of Canada geese increased from 7 in 1969 to 18 in 1985. During the same time period, the number of goslings increased from 31 to 90. The **15-** year average Canada goose and duck population estimates in the WMA from **1970 to 1984 were 925 and 293,767, respectively** (IDFG 1986).

The islands in the Deer Flat National Wildlife Refuge (Refuge) below **Swan Falls** are important waterfowl nesting areas. Waterfowl depend on the maintenance of island integrity in order to be productive and protected from mainland predators. Pursuant to Public Law 100-216, the USFWS was federally authorized to conduct a study to determine the river flows necessary to

protect and enhance migratory bird use of the islands in the Refuge. Preliminary data indicate that as flow volume increases, the number of islands that are adequately protected also increases (Table 8) (Zoellick 1992). Island isolation is measured as a function of water velocity and the distances a predator would have to swim and wade to cross the river to an island (USFWS, unpubl. rpt. 1992).

The **122-mile** reach between Milner and C.J. Strike Reservoir contains 30 kinds of native molluscs (Bowler and Frest 1992). South of the Snake River between Bruneau and Grand View, ground water levels in 1990 declined about 0.5 foot, jeopardizing the future of the endangered Bruneau Snail which inhabits a natural warm spring called Indian Bathtub (Harenberg et al. 1990).

Five molluscs in the middle Snake River have been proposed for listing under the Endangered Species Act by the USFWS (Appendix C). The population of these **taxa** is decreasing and unstable, as it is more subject to flow fluctuation and stress (Frest 1992). None of these molluscs can successfully compete under current conditions in the middle Snake (Frest 1992). Most of the endemic molluscs of the middle Snake are adapted to clear, cold water river conditions. The **taxa** all require stable water levels and substrate.

None of the five species live in areas subject to high temperature. Most are found in areas directly influenced by underwater springs. Falter (1992) concluded that it is unlikely that additional populations of any of these **taxa** will be found in the Snake River from C.J. Strike Reservoir upstream to Idaho Falls except in areas locally influenced **by spring** flows. These **taxa** are generally not **found in waters** deeper than six feet in depth because of rapidly deteriorating water quality in this reach.

Conditions adverse to productive molluscan habitat and those that contribute to a declining population include increased water withdrawals for irrigation and aquaculture, increases in fine sediments and organic suspended solids, increased filamentous algae and macrophyte growth, increased dissolved nitrogen gas and nitrogen compounds, and decreased dissolved oxygen and aeration (Falter 1992).

Recreation Issues and Concerns

The middle Snake River offers a variety of recreational activities including fishing, hunting, camping, boating, rafting, sightseeing and birdwatching. Limited access and inadequate public overnight camping areas and boat ramps make some areas of the river difficult to explore.

Some of the biggest whitewater in Idaho is frequently found in areas downstream from Milner Dam. The reach immediately below Milner Dam for 1.6 miles is a continuous Class V rapid. The reach between the hydro generators and Star Falls has Class II-III rapids between **12,000-15,000** cfs (Appendix D). The reach between Murtaugh Bridge and Twin Falls Reservoir is 13 miles long. At 900 cfs this reach has Class III rapids, at 1,000-8,000 cfs it has Class III-IV rapids, and at **8,000-17,000** cfs it has Class IV rapids (Appendix D).

Potential Water Rental Impacts/Benefits

Higher flows below Milner from July 1 through September 30 would improve water quality conditions by decreasing algae and phosphorus concentrations. Macrophyte beds may decrease, thus **mating** an increase in fish habitat and slowing oxygen depletion.

Table 8. Flow velocity and island isolation in the Deer Flat National Wildlife Refuge (USFWS, unpubl. rept. 1992).

<u>Velocity</u>	<u>Island Isolation</u>
< 9,000 cfs	Depradation rates on islands increase
9,000 cfs	Islands have a critical level of isolation
>12,000 cfs	Most islands are adequately protected

Deep pools are flushed with higher water velocities benefiting sturgeon and salmonids that use these pools for cover and cooler water. Increased summer flows would scour the substrate and aid in preventing sediment accumulation. Sediments from redds would be removed and eggs would receive more oxygen. Seasonally stable water levels would increase **salmonid** spawning and rearing habitat by preventing the dewatering of side channels which are important to sustaining a naturally reproducing fishery.

Higher, stable flows may benefit mollusc survival. Decreases in nitrogen compounds, such as ammonia, sedimentation and filamentous algae will likely improve mollusc habitat.

Increased **streamflows** through the Deer Flat National Wildlife Refuge would affect island isolation and waterfowl protection from mainland predators.

Recreational benefits as a result of higher flow volumes during the summer months would include increased boating opportunities, higher quality aesthetic resources, and increased fishing opportunities due to a healthier, more productive fishery.

Results from Flow Augmentation Simulation

The flow augmentation simulation indicates that in **4/62** (6%) years, flow augmentation from the upper Snake River is not needed because runoff at Lower Granite Dam exceeds 29 **MAF**. Therefore, the flow increment in 1943, 1971, 1974, and 1984 at the Kimberly gage was set to zero.

In **1 1/62** (18%) water years, flow augmentation did not occur because of an estimated shortage of rental water available for use below Milner (Appendix A). It must be noted, however, that while the model simulation attempted to represent water availability in the upper Snake Rental Pool, actual water rental releases in amounts less than 100,000 AF may occur for salmon flow augmentation. 1991 was one of the driest years on record in southern Idaho, yet 99,000 AF was rented and released below Milner for salmon flow augmentation (Figure 2).

Varying amounts up to a maximum of 337,000 AF were released from storage above Milner for flow augmentation in **47/62** (76%) water years in the July to September period (Appendix A). The release was made as an increment (maximum flow increase of 1,847 cfs) above baseline flows at Milner. In order to make increased summer flows possible, flows are decreased from October through April. The largest decrease in average monthly flows for the **62-** year period of record at the Milner gage occurred in October (Figure 21). Flows at the Murphy gage decreased during the winter, which made higher summer flows possible (Figure 2 1).

Data from the flow studies were analyzed to determine if the year-round minimum flow recommendation of 2,190 cfs to maintain fish habitat is met from July through September. Results from the baseline study indicate that 2,190 cfs is met in only **6/62** (10%) water years (Appendix A). By releasing 337,000 AF (1,847 cfs for 92 days) for **salmon** flow augmentation from July through September, flows are at least 2,190 cfs in **45/62** (73%) water years (Appendix A).

Recommendations for Protection and Enhancement of Resident Fish and Wildlife

1. Release the majority of water from upstream storage reservoirs for salmon flow augmentation from July 1 through September 30, holding back a portion to be released from October 1 through March 31 (see upper Snake recommendations).

Figure 21. Study comparison of Snake River flows at Milner and Murphy.

Payette River System

North Fork Payette

Description of Study Area

The Payette River basin lies in southwestern Idaho and comprises about 3,240 square miles (Figure 22). The average annual runoff from the Payette River basin is 2.4 MAF (Gregg, USBR, pers. comm. 1992). A dry water year is considered to be 80 percent of the average annual runoff. The North and South Forks of the Payette River are the principle tributaries, draining 950 and 1,200 square miles, respectively (IDFG 1991).

Cascade Reservoir

Cascade Reservoir has a surface area of about 28,300 acres at full pool and a total storage capacity of 703,200 AF (Williams 1992). Approximately 389,500 AF is **currently** uncontracted (Table 9). The reservoir is relatively

shallow with an average depth of 26.5 feet and a maximum depth of about 70 feet at the dam. The outlet capacity of Cascade Dam is 2,500 cfs (Gregg, USBR, pers. comm. 1992). Water is used for irrigation of lands in the Payette Division of the Boise Project and for power production at Black Canyon powerplant.

Water releases from Cascade Reservoir usually begin with the advent of spring runoff, but the **bulk of** water is released during the irrigation season from June through October. The daily reservoir contents from 1957 to 1991 have ranged from a minimum of 153,000 AF in January 1967 to a maximum of 721,100 AF in June 1974, while the average monthly contents have remained above 400,000 AF (Figure 23). As of June 30, 1992, Cascade Reservoir contained 500,963 AF, the lowest end of month contents in June since 1977 (Bivins, Watermaster, Payette Division, pers. comm. 1992).

Table 9. Reservoir space allocation in Cascade and Deadwood Reservoir (Gregg, USBR, pers. comm. 1992). Rounded to nearest 10 AF.

<u>Space Allocation</u>	<u>Cascade</u>	<u>Deadwood</u>	<u>Total</u>
Contracted Space:			
Irrigation	313,700	56,600	370,300
Committed Space:			
Designated for Irrigation and Municipal & Industrial Contracts	19,900	0	19,900
Conservation Pool:			
Space reserved for water quality, resident fish and wildlife, recreation, flood control	300,000 (includes 50 KAF of inactive space)	80,000 (includes 100 AF of inactive space and 30 KAF reserved for streamflow maintenance)	380,000
Uncontracted Space:			
Reserved for salmon flow augmentation	69,600	25,400	95,000
Total Space	703,200	162,000	865,200

Payette River Drainage

Figure 22. Payette River drainage.

CASCADE RESERVOIR

END OF MONTH CONTENT

Cascade Reservoir

Minimum Daily Contents

1971-1991

Proposed Min. Pool Historical Min. Pool

Figure 23. Cascade Reservoir **summary** hydrograph and minimum daily contents.

Approximately 69,600 AF of uncontracted storage space is being considered by the USBR for salmon flow augmentation. The authors of this report will use 70,000 AF in discussing Cascade Reservoir releases for salmon flow augmentation.

Cascade Dam to Banks

The North Fork of the Payette River between Cascade Reservoir and Banks consists of the upper reach, extending from Cascade Dam to Smiths Ferry, and the lower reach from Smiths Ferry to Banks. Streamflows in the North Fork are regulated by Cascade Dam and supplemented by Big Creek and Clear Creek.

Average monthly flows in the North Fork Payette before the creation of Payette Lake and Cascade Reservoir were much higher after spring runoff than post-dam flows. Flows on June 1 now average about 2,000 cfs compared to an estimated natural flow of 3,800 cfs (Figure 24). Even more dramatic are the flow differences that have occurred on the North Fork Payette in early late fall. The natural flow on October 1 is an estimated 400 cfs while flows since 1948 have averaged about 1,500 cfs (Figure 24).

Fish Issues and Concerns

Cascade Reservoir

Cascade Reservoir is the secondmost heavily fished water in Idaho. **Over 400,000** angler hours were expended on the reservoir in 1987 to harvest 530,000 yellow perch, **60,000 rainbow** trout and 25,000 **coho** salmon (Van Vooren, IDFG 1992). Yellow perch are the most abundant game fish present with rainbow trout, **coho** salmon, smallmouth bass, channel catfish, and black crappie making up the rest of **the reservoir fishery**. A complete listing of fish, wildlife, and **nongame** species is found in the Cascade Resource Management Plan (Howard et al. 1990).

Water quality conditions are a primary concern in Cascade Reservoir. **Of** particular importance is the direct link between water quality capable of supporting a healthy fishery and the role of that fishery as a major prey base for resident bald eagles. The reservoir is a water quality limited segment which means that water quality does not meet applicable standards (**Entranco** 1991). Bacterial contamination, algal blooms, and winter and summer fish kills have been noted to occur in the reservoir.

Water quality conditions appear to be deteriorating, although information regarding phosphorus loading is limited. As nutrient loads, such as phosphorus, continue to increase, the frequency of algal blooms will also likely increase. Extremes in dissolved oxygen levels are magnified by heavy algae growth. The addition of organic matter or inorganic nutrients could create additional problems for the resident fishery.

The nutrients entering the reservoir originate from several point and nonpoint sources including wastewater treatment plants, grazing, irrigated croplands, and increased recreational development. Zimmer (1983) estimated an annual watershed phosphorus load in Cascade Reservoir of 27,835 kg. **The IDEQ in conjunction** with Valley County Soil Conservation District and **Entranco** Engineers, Inc., published a Water Quality Management Plan in 1991 to describe current water quality conditions in the reservoir. Results from this study indicate an estimated annual watershed phosphorus load of 37,954 kg., a 36 percent increase over 1983 conditions.

Valbois, the planned year-round resort village near Cascade Reservoir, would likely have a detrimental impact on the total phosphorus load by introducing secondary effluent directly into the watershed. Water quality with existing development is already a fisheries concern. Adding the impacts of Valbois to an already eutrophic system might be significant enough to push the reservoir beyond the threshold limit for nutrient loading. Valbois would likely increase angling pressure and contribute to a decline in the quality of angling experience, which is dependent on the size and number of fish caught as well as the number of other recreationists encountered.

IDFG personnel conducted a study in 1982 of reservoir storage effects on fishery habitat, particularly overwinter habitat. Results from that study indicate a threat of serious oxygen limitation for fish exists in Cascade Reservoir during the winter period of ice cover and stagnation. Reininger et al. (1982) concluded that a significant winterkill risk of greater than ten percent exists when pool volumes are less than 300,000 AF from mid-December through March 31. Conversely, a wintertime minimum pool of 300,000 AF would decrease the winter-kill risk to less than ten percent (Reininger et al. 1982).

N. FORK PAYETTE RIVER NR BANKS

SUMMARY HYDROGRAPH

Figure 24. North Fork Payette natural flow and summary hydrograph.

In 1985, the USBR administratively set aside 250,000 AF of uncontracted storage space and 50,000 AF of inactive storage space as a **year-round** minimum pool of 300,000 AF to protect the reservoir fishery and recreational use. Minimum daily contents of Cascade Reservoir have remained above 300,000 AF since 1981 (Figure 23). IDFG recommended 300,000 AF in 1982 ~~only as a winter time~~ minimum conservation pool and was never intended as a year-round minimum. Nutrient concentrations have increased since the 1982 recommendation. **Because water quality conditions** have apparently deteriorated with average reservoir contents above 400,000 AF (Figure 23), a minimum pool of 300,000 AF may no longer be sufficient to protect the reservoir fishery from the risk of a winter fish kill.

IDFG manages the reservoir to maintain catch rates for **8-** inch perch or larger at 1.0-2.0 fish/hour and for trout at 0.5 fish/hour. Management also includes increasing annual trout stocking using catchable and fall subcatchable rainbow trout (IDFG 1991).

Cascade Dam to Banks

The Cabarton Bridge to Smiths Ferry reach is a high quality fishery which produces large, wild rainbow trout. It is one of a few streams in southwestern Idaho that offers anglers the chance to catch large, wild trout with high frequency. This section of the North Fork provides good rearing and adult holding habitat for wild rainbow trout because it provides good cover, and has a low gradient with a few long pools and sandy/gravel substrate. Other **fish** species present include **coho** salmon, yellow perch, brown trout, whitefish, and bullhead.

The existing water quality is marginal for cold water biota and **salmonid** spawning in the **North Fork** of the Payette River between Cascade Dam and Smiths Ferry (IDEQ 1988). **Tributaries** flowing into this reach are affected by agriculture, forest practices, and road construction activities. Pollutants and other problems contributing to a deterioration in water quality conditions include nutrients, sediment, organic solids, thermal modification and flow alteration.

The USBR is required to release at least 200 cfs year-round from Cascade Reservoir to satisfy water rights owned by Idaho Power Company. In December 1991, the IDWR approved an application for an **instream** flow of 294 cfs from October 13 through March 15 on the North Fork between Cabarton Bridge and Smiths Ferry. This amount was added to an existing minimum streamflow of 106 cfs for a new minimum flow **requirement of 400 cfs. In addition, a flow of** 100 cfs was added to an existing minimum streamflow of 500 cfs for a new minimum flow requirement of 600 cfs from March 16 through June 17 for the same reach. These minimum streamflows are for the purposes of fish spawning and egg incubation (Table 10).

IDFG manages this section of the river for wild trout, seeking to maintain a catch rate of 0.5 fish/hour (IDFG 1991).

The reach **from** Smiths Ferry to Banks maintains a significant population of rainbow trout, and provides angling opportunity for fishermen, particularly after irrigation releases from Cascade are reduced in the fall and winter. Other fish species present include whitefish and **coho** salmon. This section of the North Fork has been altered by highway and railroad construction and is highly turbulent, providing only marginal habitat for salmonids.

Table 10. Approved minimum streamflows for fish spawning and egg incubation in the North Fork Payette.

<u>Reach</u>	<u>Flow</u>	<u>Time Period</u>	<u>Purpose</u>
Cabarton to Smiths Ferry	400 cfs	Oct 13 - Mar 15	Fisheries
	600 cfs	Mar 16 - June 17	Fisheries
Smiths Ferry to Banks	400 cfs	Sept 2 - Apr 30	Fisheries

A minimum streamflow of 400 cfs has been legislatively approved for the Smiths Ferry to Banks reach of the North Fork from September 2 through April 30 for purposes of fishery maintenance, spawning, and egg incubation (Table 10).

Wildlife Issues and Concerns

Cascade Reservoir

Cascade Reservoir is an important nesting and resting area for shorebirds, waterfowl, raptors and passerine birds. Over twenty-two species of waterfowl use the area on a seasonal basis (Williams 1992). Canada geese and mallards are year-round residents of the reservoir. Nesting platforms have been erected around Cascade Reservoir to provide safe nesting sites for many species of waterfowl. The number of osprey has risen substantially since the development of the reservoir and subsequent fishery. Results from a survey conducted in 1989 indicate that the reservoir supports 69 pairs of nesting osprey, with the highest concentration occurring near the northern end. According to the 1991 Cascade Reservoir Bald Eagle Management Plan (Plan), the osprey population has doubled in the last decade in the area surrounding Cascade Reservoir.

Cascade Reservoir is an important site for bald eagle recovery. There are eight bald eagle nests located at or near the reservoir, six of which have been found to contain incubating adults (Lobdell 1991). Bald eagle nesting territories in the Cascade Reservoir area represent seven percent of the state's breeding bald eagles and nearly 70 percent of the southwestern region's breeding population (Lobdell 1991). An increase in fish habitat and enhancement of the reservoir fishery may result from higher reservoir volume and benefit bald eagles and osprey by providing an increased source of food.

Cascade Dam to Banks

Waterfowl are particularly dependent on the islands in the North Fork of the Payette River and the presence of wetlands for nesting and rearing success. Higher than normal flows may flood key nesting areas while low flows adversely impact island integrity as islands are exposed to predation. Cochnauer and Hoyt (IDFG 1979) recommend waterfowl nesting flows in this reach of 700 cfs from March through May. These

flows are slightly higher than the existing streamflow water right for fisheries maintenance.

Recreation Issues and Concerns

Cascade Reservoir

Cascade Reservoir plays an important role in meeting the demand for a variety of water-based recreational activities for a large geographic region that includes the Treasure Valley area. There are several recreation facilities planned for development around the reservoir to accommodate increasing seasonal recreation needs. There are about 4,000 homes within close proximity to the reservoir (Brendecke and Mann 1991). Dispersed recreation on and adjacent to Cascade Reservoir is increasing and has the potential to displace bald eagles from nest sites during periods of incubation and brood rearing. Summer recreation activities pose a threat of increasing disturbance in the most important bald eagle foraging areas and may scare away potential prey.

The Valbois Resort Master Development Plan will include plans for a boating marina and other water-related summer activity facilities along the shores of Cascade Reservoir. Resort facilities will include alpine and cross-country skiing, tennis, golf, and fishing. Increased crowding at boat ramps, reservoir facilities and access roads will alter the quality of the recreation experience at Cascade Reservoir. Valbois will bring an increase in human activity that could render an area unsuitable for bald eagle nesting.

Reservoir drawdowns affect boat ramp operations and accessibility of land-based recreational facilities including parking areas, campgrounds, and service areas (Table 11).

Cascade Dam to Banks

The IWRB adopted the Payette River Plan in 1991, which designates both the upper and lower reach of the North Fork of the Payette River as Recreational Rivers. The reach from Rainbow Bridge to Banks is eligible for future study as a potential Wild and Scenic River (IWRB 1991). The Cabarton to Smiths Ferry reach is used extensively by both novice and commercial whitewater boaters. Optimum streamflow for boating in this reach is 1,500-3,000 cfs (Table 12). An instream flow of 1,400 cfs was legislatively approved in the Cabarton to Smiths Ferry reach

Table 11. Elevations and reservoir volumes at which boat ramps at Cascade Reservoir become inoperable (Jansen Lute, USBR, pers. comm. 1992).

<u>Boat Ramp</u>	<u>Elevation (feet msl)</u>	<u>Volume (acre-feet)</u>
Cabarton	4805	233,500
Campbell Creek	4818	465,400
City of Cascade	4805	233,500
City of Donnelly	4818	465,400
French Creek	4825	626,000
Poison Creek	4808	280,060
Rainbow Creek	4817	444,780
Sugarloaf	4810	313,500

Table 12. Optimum streamflows for boating (IWRB 1990).

	<u>Optimum Flow (cfs)</u>	<u>Craft</u>
<u>North Fork</u>		
Cabarton - Smiths Ferry	1,500 - 3,000	raft, kayak
Smiths Ferry - Banks	1,500 - 2,500	kayak, cataraft
<u>South Fork</u>		
Deadwood River - Garden Valley	1,000 - 2,5000	raft, kayak
<u>Main Stem</u>		
Garden Valley - Banks	> 2,500	jet boat
Banks - Horseshoe Bend	1,000 - 2,500	raft, kayak
	1,500 - 5,000	raft, kayak
	> 3,000	jet boat
Horseshoe Bend - Black Canyon	> 3,000	jet boat

Table 13. Approved minimum streamflows for recreation and aesthetics in the North Fork Payette.

<u>Reach</u>	<u>Flow (cfs)</u>	<u>Time Period</u>
Cabarton - Smiths Ferry	1,400	June 18 - Oct 12
Smiths Ferry - Banks	1,800	May 1 - June 30
	1,300	July 1 - Aug 1
	1,800	Aug 1 - Sept 1

from June 18 through October 12 for recreation and aesthetic purposes (Table 13).

The Smiths Ferry to Banks reach is a **16-mile** highly technical Class V section of whitewater (Appendix D). The preferred streamflow by boaters in this river section is **1,500- 2,500 cfs** (Table 12). Recreational flows approved in the Smiths Ferry to Banks reach include 1,800 cfs from May 1 through June 30 and August 1 through September 1, and 1,300 cfs from July 1 through August 1 (Table 13).

Potential Water Rental Benefits/Impacts

Cascade Reservoir

A slow, continuous release of all or a portion of the 70,000 AF of uncontracted storage space from October 1 through March 31 to refill **Brownlee** Reservoir as a result of salmon flow augmentation may make it possible to forego some flood control releases depending on the water year, and emigration of **coho** salmon would not occur.

Emphasis should be placed on a slow, continuous release from the reservoir. Water rented in 1991 was released in the summer of 1991 and winter 1992 by the USBR. During each period, 50,000 AF of water was spread out over a period of only 28 days (Figure 3). Average water rental releases from Cascade were approximately **950 cfs/day**. Such flow regimes are not beneficial to fish and wildlife that depend on adequate, seasonally stable flows for forage and cover.

Slow, even releases from October 1 through March 31 may or may not negatively affect **reservoir water quality**. If **water quality** conditions continue to deteriorate, to which the Valbois Resort would contribute, and the wintertime minimum pool recommendation remains **300,000 AF**, releases to refill **Brownlee** Reservoir could significantly affect reservoir water quality and trigger a major **fish** kill under ice cover. In the long term, it is assumed that Cascade Reservoir water quality will improve as state water quality measures are implemented as planned.

In dry years, when releases for salmon are more likely, release of all or a portion of the 70,000 **AF** of uncontracted storage would impact

carryover storage. Water released in the winter could draw the reservoir down to biologically dangerous levels going into the irrigation season. A lower pool volume in the summer could cause irrigation shortages which may require severe emergency reservoir drawdowns. However, in normal years, carryover storage would probably not be significantly affected by water rental releases during the winter.

Because the 300,000 AF minimum pool was an administratively determined level and is not under contract, the USBR is not legally required to operationally respect this level. This administrative constraint could come into play in a particularly dry year when irrigation needs, salmon recovery and bald eagle protection necessitate a firm commitment to safeguarding resident fish and wildlife habitat in Cascade Reservoir.

Waterfowl and shorebird brood rearing habitat and survival would be negatively affected by a spring release. Inadequate cover and forage habitat for waterfowl would result from greater reservoir drawdowns in the spring.

Yellow perch spawn from April 15 to May 15. Reininger et al. (IDFG 1982) recommended no **drawdown** during this period. A lowering of the water level at this time could result in the exposure and desiccation of eggs deposited along shoreline areas causing greater fluctuations in year-class strength (Reininger et al. 1982). Spring releases for salmon flow augmentation are not possible under the current rental pool rules. Water rented for purposes other than irrigation is not available until July 15 and must be used by March 1 of the following year.

A summer release would be the most detrimental to the reservoir fishery. Stratification is heaviest from July to mid- September. Fish are crowded into the thermocline where the oxygen supply is greater and water is cooler (Anderson, IDFG, pers. **comm.** 1992). Any summer release from the reservoir would reduce suitable fish habitat by forcing the fish into the epilimnion where temperature and oxygen levels exceed thresholds for **salmonid** survival. Reservoir mixing does not occur until the **end of** September when air temperature begins to fall, water density changes and cooler water begins to settle. Releases from Cascade to refill **Brownlee** would be the least detrimental to the reservoir fishery after stagnation when nutrient mixing has begun.

North Fork Payette

A slow, continuous release in the winter would provide higher flows in the North Fork of the Payette River and improve fish habitat. Low winter flows do not provide deep water needed by rainbow trout seeking cover **from ice** scouring. Flow peaking displaces fish, whereas fish have a better **opportunity** to seek shelter when flows are gradually increased and remain fairly stable. Stable water levels also protect beaver lodges from predators and provide concealment for beavers when **traveling** to and from food gathering areas (Allen 1983). Goose nests on the North Fork would be less susceptible to predation in the beginning of the nesting season as higher flows would maintain island integrity.

A winter release strategy does not benefit whitewater recreationists. Recreation benefits from summer drawdowns would likely be minimal as a major portion of reservoir storage is already released for irrigation.

Results from Flow Augmentation Simulation

Cascade Reservoir

One of the assumptions of the flow augmentation simulation is that water for salmon flow augmentation will not be required from the Payette basin in years when the April to July runoff forecast at Lower Granite Dam exceeds 29 MAF. As a result, the flow augmentation study does not include flow increments in 1943, 1971, 1974, and 1984.

A total of 70,000 AF, a flow increment of 194 **cfs/day**, was released from Cascade Reservoir over a period of six complete months (October 1 through March 31) for the entire **62**-year period of record. Although rental pool rule 7.7 specifies water must be used by the renter no later than March **1**, water rental releases to refill **Brownlee** were simulated to coincide with **IDFG's** recommendations to release water from Cascade Reservoir through March 3 1.

October through March releases from Cascade the flow augmentation program would have the most impact on Cascade Reservoir levels in dry years when refill capability is significantly altered by the lack of runoff and reduced carryover storage.

Under baseline conditions, the proposed minimum pool of 300,000 AF is not met in **5/62**

(8%) water years (Appendix B). The most frequent month in which the minimum pool is not met is March. In the flow augmentation study, the proposed minimum pool is not met in **16/62** (26%) water years (Appendix B).

Model simulation results from the flow augmentation study indicate reservoir contents would become depleted during the winter compared to baseline conditions (Figure 25). Reservoir contents in March would likely suffer the single greatest monthly impact as a result of winter releases for **Brownlee** refill. Average monthly contents in March fall from an average of 439,700 AF to 363,300 AF for the 62-year period of record.

Long periods of drought, such as the 1930's and **post-** 1987, dramatically illustrate the impacts to reservoir contents from releases to refill **Brownlee** (Appendix B). Releases for salmon would occur immediately after the irrigation season, thus lengthening the period during which water is drawn out of the reservoir. Consequently, lower reservoir levels are experienced much earlier in the year and for an extended period of time. North Fork Payette

River flows in the Cabarton reach of the North Fork Payette increase in the flow augmentation study by an average of 180 cfs over the baseline study during the **October-March** period (Appendix B).

Data from the flow studies were analyzed to determine if the minimum flow right of 400 cfs is met from October through March. Results from the baseline study indicate that 400 cfs is met in only **6/62** (7%) water years. (Appendix **B**). **By releasing 70,000 AF of water from October** through March to refill Brownlee, flows are at least 400 cfs in **61/62** (98%) water years (Appendix B).

Increased winter flows in the North Fork, as a result of releases from Cascade would shift the hydrograph and decrease average flows in April by 563 cfs for the 62-year period of record (Figure 25). The minimum flow right of 600 cfs during the spring would be met in **53/62** (85%) water years in the baseline study and in **51/62** (82%) years in the flow augmentation study (Appendix B).

Decreased spring flows may adversely affect island integrity and waterfowl nesting and rearing success. The recommended streamflow of

Cascade Reservoir

Study Comparison
Monthly Average (1928-1989)

North Fork Payette at Banks

Study Comparison
Monthly Average (1928-1989)

Figure 25. Study comparison of Cascade Reservoir contents and North Fork Payette River flows near Banks.

700 cfs for waterfowl during the March-May period was met in **21/62** (34%) water years in the baseline study and in **32/62** (52%) water years in the flow augmentation study (Appendix B).

Recommendations for Protection and Enhancement of Resident Fish and Wildlife

1. Continue to operate Cascade Reservoir at no less than 300,000 AF during the winter to protect resident fish habitat until further studies are conducted to reflect current water quality conditions and to determine an adequate year-round minimum pool level.
2. Reduce the amount of point and **non-point** source pollution entering Cascade Reservoir to decrease the amount of phosphorus loading and improve reservoir water quality conditions.
3. Consult with appropriate agencies on an annual basis to discuss water releases from Cascade Reservoir.

Any releases of water from Cascade Reservoir for salmon flow augmentation or other purposes should be reviewed on an annual basis by the IDFG, USBR, **IDEQ**, USFWS, and NMFS to determine whether release of the additional 70,000 AF of uncontracted storage would be detrimental to bald eagle recovery objectives, reservoir water quality, or until it can be shown that water quality conditions have improved.

4. Release water from Cascade Reservoir from October 1 through March 31 to protect and enhance fish spawning and waterfowl nesting habitat in the Payette River and backfill **Brownlee** Reservoir.

If release of some portion of the 70,000 AF of uncontracted storage is approved for flow augmentation and/or water is rented from the rental pool, the preferred water release strategy from Cascade Reservoir is a slow, continuous release during the fall and winter. Rental pool rules and regulations would have to be amended or local committee approvals would have to be secured to allow for any releases past March 1.

South Fork Payette

Description of Study Area

Deadwood Reservoir

Deadwood Dam was built in 1930. The reservoir has a surface area of 3,000 acres and a total storage capacity of 161,900 AF. Approximately 105,000 AF is currently uncontracted (Appendix B). Water is used to augment flow in the Payette River for the Black Canyon powerplant and, since 1956, as a supplemental irrigation supply for Emmett Irrigation District and other users.

The reservoir normally fills in June during spring runoff and is drawn down to its lowest level in early October as a result of irrigation releases. The minimum daily reservoir contents from 1971 to 1991 range from 27,250 AF in 1977 to 73,200 AF in 1981 (Figure 26).

Approximately 25,000 AF of uncontracted storage space is being considered by the USBR to refill **Brownlee** as a result of salmon flow augmentation. However, this number has been rounded to 20,000 AF by the USBR. The authors of this report will use 20,000 AF in discussing Deadwood Reservoir releases for the salmon flow augmentation program and recognize that potentially more water is available.

Deadwood River

The Deadwood River extends about 24 miles from the dam to the South Fork of the Payette and flows through a steep-sided, rocky, forested canyon. Streamflows are regulated by releases from Deadwood Dam and fluctuate widely. Average monthly flow in the river below the dam ranges from zero in the winter months to 800 cfs from June through August. These flows are dramatically different from the estimated average monthly flows in the river before Deadwood Dam was built. The current hydrograph has shifted **from** the natural flow hydrograph so that average flows are now higher during the latter part of the summer months (Figure 27).

Deadwood Reservoir

Minimum Daily Contents
1971-1991

Figure 26. Deadwood Reservoir minimum daily contents.

DEADWOOD RIVER BL RESERVOIR

SUMMARY HYDROGRAPH

NATURAL FLOW OF DEADWOOD RIVER AT DEADWOOD RESERVOIR (MONTHLY AVERAGES)

Figure 27. Deadwood River natural flow and summary hydrograph.

South Fork Payette

The South Fork of the Payette River extends from the headwaters in the Sawtooth Wilderness Area to the Middle Fork Payette confluence. Deadwood storage and releases have altered stream flows on the South Fork below the confluence of the Deadwood River to meet downstream power and irrigation demands.

Fish Issues and Concerns

Deadwood Reservoir

Deadwood Reservoir supports a popular fishery for kokanee. Cutthroat trout supports a secondary fishery, and landlocked Atlantic salmon were introduced in 1990. Other fish species present include rainbow trout, bull trout, rainbow/cutthroat hybrid trout, and mountain whitefish. In the past, kokanee spawning potential exceeded reservoir carrying capacity. Spawning runs have recently been controlled to limit kokanee densities, maintain desirable growth rates, and provide a mean harvest size of 12 inches or greater.

Water quality in Deadwood Reservoir is generally good. Low benthos productivity is caused by the exposure of large areas of mud flats during the productive summer months (Williams 1992). Little or no spawning habitat for salmonids exists in the reservoir. Logging activities and natural erosion have caused extensive sediment deposition in nearby streams, thus degrading some spawning and rearing habitat.

In 1985, an interim minimum pool of 50,000 AF was administratively established in Deadwood Reservoir by the USBR to protect resident fish and wildlife pending development of a more comprehensive study to determine an adequate minimum pool level. Minimum daily contents of the reservoir have remained above 50,000 AF since 1981 with the exception of 1988 and 1989 (Figure 26). An additional 30,000 AF of uncontracted storage space has been set aside to maintain a 50 cfs wintertime minimum streamflow in the Deadwood River.

A proper sized conservation pool would yield long-term environmental and economic benefits. Wolflin and Ray (1985) suggested that environmental benefits would include improved winter water quality conditions, increased and improved plankton and insect habitats and

populations, and improved growth of salmonids. The establishment of an adequate conservation pool would cause a significant increase in fishing. Average annual use would be about 10,600 angler-days, an increase from an estimated average annual use of 4,500 angler-days (Wolflin and Ray 1985).

IDFG manages the kokanee population by controlling spawning and utilizing Atlantic salmon as a predator for excess kokanee (IDFG 1991).

Deadwood River

Deadwood River below Deadwood Dam supports coldwater fish populations of rainbow trout, bull trout, and mountain whitefish. Trout are the most sought after fish by anglers. Spawning conditions for rainbow trout are excellent, rearing conditions are good, but food production is poor. Angler use on the river is estimated at 3,000 angler-days per year (Wolflin and Ray 1985).

Water quality in this section of the Deadwood River is considered good, although logging, road maintenance, and livestock activities have caused erosion and siltation. Tributaries contribute a significant portion of fines, and the river's nutrient fertility is relatively low due to the infertile soils within the drainage (Wolflin and Ray 1985).

The USBR has reserved 30,000 AF of uncontracted storage in Deadwood Reservoir to provide for better flow conditions in Deadwood River during the winter. In the past, the outlet valves at Deadwood Dam have remained closed during the winter because they incur too much wear at releases below 300 cfs. In 1990, the **USBR replaced** two of the dam's outlet valves to provide a wintertime minimum streamflow of 50 cfs. However, icing conditions have made it difficult to release water through the gates, and an underwater bypass pipe is being considered as a substitute (Ames, USBR, pers. comm. 1992).

Average flows in the Deadwood River peaked in May before the construction of Deadwood Dam, but since the dam was built average flows are lower and peak in late August (Figure 27). A year-round **instream** flow of 125 cfs in the Deadwood River has been recommended for the purpose of maintaining trout rearing and spawning habitat (Pruitt and Nadeau). This is a minimum flow and is not considered an ideal or most desirable flow. A higher flow in the river

is necessary not only to provide good spawning and rearing habitat for salmonids, but also to alleviate the existing adverse conditions that affect the productivity of the aquatic environment. Trout need a relatively stable water flow and a silt-free rocky substrate for optimal spawning and rearing conditions. Optimal feeding occurs in areas with low water velocity, a plentiful food supply and escape cover nearby. During winter, rainbow trout tend to move into deeper water or find sufficient cover to avoid damage from ice scouring.

LDFG will seek to maintain the population of wild trout and improve access areas (IDFG 1991).

South Fork Payette

The South Fork is characterized by rubble/gravel riffles, long deep pools and boulder/rubble runs. Game fish populations include rainbow trout, cutthroat trout, bull trout, and mountain whitefish. The IDFG lists the bull trout, native to the drainage, as a species of special concern. State species of special concern are those for which population viability is a concern. The bull trout is the only native char of Idaho. The bull trout is one of the most sensitive salmonids to habitat degradation and sedimentation, and is considered threatened in all areas of its current range (IDFG 1991). The South Fork of the Payette River and its tributaries are impacted by forest practice, highway construction, and rangeland.

There is an established minimum streamflow on the South Fork Payette of 337 cfs from the confluence of the Deadwood River to the confluence of the Middle Fork of the Payette from January 1 to April 14 and September 1 to December 31 for the purpose of maintaining fish and aquatic habitat (Table 14).

The IDFG will seek **put-and-take** trout management of the South Fork of the Payette River. (IDFG 1991).

Wildlife Issues and Concerns

Deadwood Reservoir and Deadwood River

Deadwood Reservoir is surrounded by evergreen forest dominated by lodgepole pine. Wetland habitats also occur adjacent to the tributaries and Deadwood River above the reservoir.

Fluctuations in water levels associated with water rental releases would have the most impact on waterfowl, bald eagles and aquatic furbearers such as beaver, river otter, and mink. Beavers require a permanent supply of water and prefer seasonably stable water levels (Allen 1983).

Recreation Issues and Concerns

Deadwood Reservoir

Recreational uses at Deadwood Reservoir include camping, boating, fishing and hunting. During 1984, there were 10,000 recreational visits to the reservoir and a total of 220,000 recreation visitor hours. Recreational facilities include four campgrounds with a total of 28 campsites (Martin and Albin-Stone 1986). The Cozy Cove boat ramp was recently completed in September, 1992 (Waugh, Lowman Ranger District, pers. comm. 1992).

Deadwood River

The lower ten miles of the Deadwood River below Deadwood Dam are steep and swift. Most kayakers float this section from May through July when irrigation flows are released. The

Table 14. Approved minimum streamflows in the South Fork Payette River.

<u>Reach</u>	<u>Flow (cfs)</u>	<u>Time Period</u>	<u>Purpose</u>
Deadwood River - Middle Fork	337	Jan 1 - Apr 14	Fisheries
	1,100	Apr 15 - Aug 31 Recreation	Fisheries,
	337	Sept 1 - Dec 31	Fisheries

upper 14 miles of the Deadwood River, from the dam to Julie Creek, provide a Class IV to V run at **900-2,000** cfs depending on irrigation releases (Lucachick, IDPR, pers. **comm.** 1992) (Appendix D).

South Fork Payette

The South Fork of the Payette from Deadwood River to the confluence of the Middle Fork of the Payette has been designated a Recreational River pursuant to Idaho Code **42-1734a(6)** (IWRB 1991). **This reach is also eligible** for future study as a potential Wild and Scenic River (IWRB 1991).

The Oxbow reach of the South Fork of the Payette River is a Class IV whitewater reach when flows reach 2,000 cfs (Appendix D). This stretch of river is used extensively during the summer months for recreation. Optimal stream flow preferred by kayakers, and canoeists is 1,000-2,500 cfs, however, streamflows below 1,100 cfs are too low to float a standard commercial or private raft (Table 12). Sixty percent of the commercial outfitters' revenues are derived from trips which include the Oxbow reach (IWRB 1991). Reduction of flows to **non-**passable levels would prevent two and three day trips, which are the best source of revenue for the commercial outfitters.

An established minimum streamflow of 1,100 cfs from Deadwood River to the Middle Fork of the Payette April 15 to August 31 provides a recreational boating flow during the high use season (Table 14).

Potential Water Rental Benefits/ Impacts

Deadwood Reservoir

The release of up to 50,000 **AF** of water (30,000 AF for a wintertime streamflow in the Deadwood River, plus 20,000 AF for the flow augmentation program) from Deadwood Reservoir would not affect the minimum conservation pool of 50,000 AF. However, the reservoir would have to fill in order to release any water for flow **augmentaion**. Carryover storage would be negatively impacted especially in dry year when salmon flow augmentation would be most needed.

Because the 50,000 AF minimum pool was an administratively determined level and is not

a legal water right, the USBR is not legally required to meet this level. This administrative constraint could come into play in a particularly dry year when irrigation needs, salmon recovery and bald eagle protection necessitate a firm commitment to safeguarding resident fish and wildlife habitat in Deadwood Reservoir.

Deadwood River

The combined effect of releasing 30,000 AF from Deadwood Reservoir for a winter flow target **and 20,000** AF to refill **Brownlee** Reservoir as a result of salmon flow augmentation would improve **instream** flows in the Deadwood River and likely meet the recommended year-round **instream** flow of at least 125 cfs.

A slow, continuous winter release strategy from Deadwood Reservoir would increase the availability of rearing and winter carryover habitat downstream and enable the river to support more fish. Wolflin and Ray (1985) reported that an improved winter flow regime would increase productivity by protecting the habitat of aquatic insects and other invertebrate organisms throughout the winter. Thus, the increased abundance of aquatic organisms available as a source of food for fish would improve fish growth rates, their size, and the number of healthy fish which can be supported in the river. An increase in the trout population would result (Wolflin and Ray 1985). Increased, stable streamflows during the winter also benefit the Deadwood River fishery by providing deeper water for adult rainbow trout to avoid damage from ice scouring.

Results from Flow Augmentation Simulation

Deadwood Reservoir

The flow augmentation simulation affected Deadwood Reservoir similar to Cascade Reservoir. Water designated for salmon flow augmentation was not released in **4/62** years because runoff at Lower Granite Dam exceeded 29 MAF. If water is released from Deadwood to refill **Brownlee** as a result of the flow augmentation program, reservoir contents would be drawn down earlier and for longer periods of time during periods of drought or in years following low runoff forecasts.

The **required** wintertime target flow of 50 cfs in the **Deadwood** River (requiring 30,000 AF of storage) was not included in the baseline study.

Therefore, the flow augmentation study has more dramatic effects **on Deadwood Reservoir contents** than the baseline study.

Under baseline conditions, the proposed minimum pool of 50,000 AF is not met in **8/62** (13%) water years (Appendix B). July through February reservoir contents are low in dry years and in years when runoff and carryover storage are low, such as **1931, 1977**, and post-1987.

The flow augmentation study reflects only the release of 20,000 AF for flow augmentation and does not include the release of 30,000 AF for an **instream** flow of 50 cfs. The release of 20,000 AF lowers the reservoir contents below 50,000 AF in **14/62** (23%) water years (Appendix B). The reservoir remains low for several more months before it begins to store spring runoff. In consecutive years of low runoff and reduced carryover storage, the effects of releases to refill **Brownlee** on Deadwood Reservoir contents become more pronounced. Results from the study comparison indicate releases from Deadwood for salmon flow augmentation would decrease the Deadwood Reservoir contents every month (Figure 28).

Deadwood River

Releases for salmon flow augmentation reduces spring and summer flows when compared with baseline conditions (Figure 28). The average monthly discharge from Deadwood Dam from October through March increases from 2 cfs (due primarily from leakage) in the baseline study to 53 cfs in the salmon flow augmentation study (Appendix B). Model results from the flow augmentation study indicate that in order to release water in the winter from Deadwood Reservoir, **streamflows** during the summer would be reduced by as much as 137 cfs in June from the baseline study (Appendix B).

Recommendations for Protection and Enhancement of Resident Fish and Wildlife

1. Continue to operate **Deadwood Reservoir** at no less than 50,000 AF year-round to protect fish spawning and rearing habitat until further studies are conducted to determine a more adequate minimum pool level.

2. Meet or exceed a wintertime streamflow of 50 cfs to protect and enhance spawning habitat in the Deadwood River.

Operate Deadwood Reservoir to provide an **instream** flow of 50 cfs from October 1 through March 31 in Deadwood River. Ordinarily, this involves maintaining 30,000 AF of additional storage in the reservoir going into October.

3. Consult with appropriate agencies on an annual basis to discuss water releases from Deadwood Reservoir.

Any releases of water from Deadwood Reservoir to refill **Brownlee** should be reviewed on an annual basis by the IDFG, USBR, USFWS, IDEQ and NMFS to determine whether such release will be detrimental to the health of the reservoir.

4. Release water **from Deadwood** Reservoir from October 1 through March 31 to increase winter streamflows in the Deadwood River and backfill **Brownlee** Reservoir.

If release of some portion of the 20,000 AF of additional **uncontracted** storage is approved for salmon flow augmentation and/or rented from the rental pool, the preferred water release strategy from the reservoir is a slow, continuous release during the fall and winter. Such action would meet the previously recommended year-round **instream** flow of 125 cfs on the lower Deadwood River.

Main Stem Payette

Description of Study Area

The main stem of the Payette River consists of the upper reach, which extends from the **Middle Fork Payette** confluence to Black Canyon Reservoir, and the lower reach from Black Canyon Dam to the mouth at the Snake River confluence. Flows in the main stem are influenced by releases from Cascade and Deadwood Reservoir and irrigation diversions. Horseshoe Bend has a channel capacity constraint of 12,000 cfs.

Deadwood Reservoir

Study Comparison
Monthly Average (1928-1 989)

Deadwood River

Study Comparison
Monthly Average (1928-1 989)

Figure 28. Study comparison of Deadwood Reservoir contents and Deadwood River flows.

Middle Fork to Black Canyon

Streamflows in the upper reach are low in the winter and high from April through July. Average monthly flows for the period of 1949- 1991 peak at about 8,500 cfs in June at Horseshoe Bend as a result of irrigation and flood control releases.

Black Canyon to Snake River

Flows below Black Canyon Reservoir are low during the irrigation season due to large irrigation diversions. Black Canyon Reservoir provides little storage and has no significant control on flows downstream.

Fish Issues and Concerns

Middle Fork to Black Canyon

The reach from the Middle Fork Payette to Black Canyon Reservoir is relatively unpolluted and supports a quality fishery for trout and mountain whitefish. Game fish populations include rainbow trout, brown trout, mountain whitefish, smallmouth bass, and channel catfish. IDFG manages the upper section of the Payette to maintain a native fishery (IDFG 1991).

There is an established minimum streamflow of 407 cfs from January 1 to April 14 and September 1 to December 31 from the Middle Fork confluence to Banks to maintain fish and aquatic habitat.

Black Canyon to Snake River

The river does not support cold water biota or salmonid spawning below **Black Canyon Dam**. The lower reach is characterized by shallow riffles, island complexes and long, deep runs. Mountain whitefish are the most abundant game fish in this section of the river. **Other** fish species include smallmouth bass, largemouth bass, channel catfish, black crappie, bluegill, pumpkinseed, yellow perch, rainbow trout, and brown trout.

IDEQ has characterized water quality in the Payette River near Payette as poor due to excessive temperature, sediment, nutrients, bacteria, and metals. Significant stream flow fluctuation as a result of irrigation diversion, upstream storage, sand and silt deposition, and poor water quality has contributed to the degradation of fisheries habitat.

The lower reach is managed as a **put-and-take** fishery of catchable rainbow trout and steelhead (IDFG 1991).

Wildlife Issues and Concerns

Middle Fork to Black Canyon

Riparian habitat and emergent wetland vegetation along the main stem of the Payette River provides good nesting and rearing opportunities for Canada geese, and provides critical winter habitat and escape cover for upland game birds such as ring-necked pheasant and California quail. Bald eagles, osprey, aquatic furbearers, and prairie falcons also frequent the area. In 1989, the Horseshoe Bend reach of the Payette River was protected for bald eagles under the Northwest Power Planning Council's Protected Rivers Program. The Horseshoe Bend hydropower project was proposed before the protected status designation. A change in flows as a result of the project may affect eagle populations through impacts to the fishery in this reach.

Black Canyon to Snake River

The lower section of the Payette River has been designated as critical waterfowl nesting habitat. Goose nesting and rearing success is affected by large or sudden fluctuations in streamflow during incubation. Low water renders the low relief islands as part of the mainland resulting in increased predation and harassment by livestock and human activity. In contrast, high flows severely reduce nesting habitat by flooding low profile islands.

Recreation Issues and Concerns

The main stem Payette from the confluence of the Middle and South Forks to Banks has been designated a Recreational River (IWRB 1991). The main stem of the Payette River above Black Canyon Reservoir is a popular reach for jet boaters. The Western Whitewater Association sponsors an annual three-day jet boat whitewater race in May. Estimates are that jet boat recreational usage in this river section is greater than 500 user days per year (IWRB 1990). Jet boaters prefer stream flows greater than 3,000 cfs. Kayaks, rafts, drift-boats and canoes are also used in this reach at optimal flows of 1,500-5,000 cfs (Table 12). The main stem Payette River is heavily used for primary contact recreation, i.e., swimming and sunning at

numerous locations along the river, from Banks down to and including Black Canyon Reservoir (Lucachick, IDPR, pers. comm. 1992).

Potential Water Rental Benefits/Impacts

Higher, stable streamflows in the main stem of the Payette River **will** result from water rental releases from Cascade **and Deadwood Reservoir** during the winter for the flow augmentation program. Stable flows during the winter would increase aquatic insect production, decrease egg mortality and increase fish spawning and rearing habitat in the lower reach of the Payette River.

An increase in fish habitat during the winter will benefit not only the fishery but also wintering bald eagles and other resident and migrating waterfowl. Higher spring flows would improve waterfowl brood rearing habitat. Island isolation would be maintained, providing waterfowl with better protection from-predators.

Gravel dams constructed in the main river channel between Black Canyon Dam and the Payettebridge **would be damaged** by **streamflows** greaterthan 1,500 cfsduringtheirirrigation season. **At 2,000 cfs, the dams are destroyed** and irrigators are affected (Bivins, Water-master, Payette Division, pers. comm. 1992).

Results from Flow Augmentation Simulation

The recommended waterfowl nesting flow of 2,005 cfs below Black Canyon Dam during March-May period was met in **33/62** (53%) water years in the baseline study (Appendix B). Results from the flow augmentation study indicate 2,005 cfs is met in **45/62** (73%) water years (Appendix B).

Streamflows at the Emmett gage would remain about the same during the fall and increase during the winter (Figure 29).

Figure 29. Study comparison of Payette River flows near **Emmett**.

***Recommendations for Protection
and Enhancement of Resident
Fish and Wildlife***

1. Meet or exceed a year-round streamflow of 794 cfs from Banks to Black Canyon to maintain trout, bass, catfish, and mountain whitefish habitat.

2. Meet or exceed a year-round minimum streamflow of 1,165 cfs from **Letha** Bridge to the mouth for maintenance of trout, bass and catfish habitat.

3. **Meet or exceed an instream flow of 2,005** cfs below Black Canyon Dam to maintain waterfowl nesting habitat during the nesting period of February 15 through May 31.

A discharge of 10,000 cfs should not be exceeded during the nesting season so that islands are not flooded. It is important to maintain a relatively stable water level during this period. If flows exceed 10,000 cfs, releases should occur early in the nesting season from February 15 to April 1. Flows should not exceed 10,000 cfs until after May 15 (Cochner, 1979).

Table 15. Recommended streamflows in the main stem Payette River (Cochner and Hoyt 1979).

<u>Reach</u>	<u>Flow (cfs)</u>	<u>T i m e</u>	<u>Purpose</u>
Banks - Black Canyon	794	Year-round	Fisheries
Black Canyon - Letha Bridge	1,165	Year-round	Fisheries
Black Canyon - Snake River	< 10,000 2,005 10,000	Feb 15 - Apr 1 Apr 1 - May 15 May 15 - May 31	Waterfowl

Boise River System

South Fork Boise

Description of Study Area

The Boise River basin comprises 2,680 square miles (Gregg, USBR, pers. comm. 1992). The headwaters of the Boise River originate in the Sawtooth Mountains (Figure 30). The average annual runoff for the basin is 2 MAP (Gregg, USBR, pers. comm. 1992). The drainage flows in a westerly direction for 200 miles before it empties into the Snake River near Parma. Principle tributaries to the Boise River include Mores Creek and the North and Middle Forks of the Boise River.

Anderson Ranch Reservoir

Anderson Ranch Reservoir was completed in 1950 and has a total storage capacity of **493,200 AF (Table 16)**. At full pool, the reservoir has a surface area of 4,740 acres. Nearly all of the 423,200 AF of active storage space is contracted

for purposes of irrigation, municipal and industrial use, and hydropower. Winter releases from the reservoir are dictated by flood control rule curves and power peaking operations.

Irrigation releases usually begin in April and continue through September. Average monthly reservoir contents from 1951- 1991 have been at least 280,000 AF (Figure 31). Minimum daily reservoir contents have remained well above 100,000 AF since 1966 (Figure 31).

Anderson Ranch Dam to Arrowrock Reservoir

The South Fork Boise River below Anderson Ranch Dam extends for 29 miles into a deep, rocky canyon. Minimum flows have historically remained below 1,000 cfs since 1951 and peak during the irrigation season in July. Winter flows fluctuate between zero and 2,500 cfs, while the average is **500-600** cfs from November through March (Figure 32).

Table 16. Reservoir storage in Anderson Ranch, Arrowrock and Lucky Peak Reservoir (USBR 1990) (Storage in acre- feet).

	<u>Anderson Ranch</u>	<u>Arrowrock</u>	<u>Lucky Peak</u>
Date Completed	1950	1915	1954
Total Storage	493,200	286,600	307,100
Active Storage	423,200	286,000	278,300
Uncontracted	4,200	0	166,200s
Reserved	4,200¹	286,000	50,000
Contracted	419,000		112,100
Inactive Storage	41,000²	0	28,800
Dead Storage	29,000	0	0

¹ Reserved for Municipal and Industrial Use.

² Proposed Minimum Pool.

³ Of this amount, 50,000 AF is reserved for IDFG. The remaining 116,150 AF is for flood control (13,900 AF) and **instream** flow maintenance (102,300 AF).

Boise River Drainage

Figure 30. Boise River drainage.

ANDERSON RANCH RESERVOIR

END OF MONTH CONTENT

Anderson Ranch Reservoir

Minimum Daily Contents

1965-1991

Proposed Min. Pool Historical Min. Pool

Figure 31. Anderson Ranch Reservoir summary hydrograph and minimum daily contents.

S. FORK BOISE R. BL ANDERSON RANCH RES.

SUMMARY HYDROGRAPH

Figure 32. South Fork Boise River **summary** hydrograph.

Fish Issues and Concerns

Anderson Ranch Reservoir

Anderson Ranch Reservoir is one of the more popular kokanee fisheries in southern Idaho. Kokanee populations have fluctuated significantly from 1983 through 1989 due to a combination of extreme high and low water conditions in the drainage and the over stocking of fall chinook salmon (Partridge, IDFG, pers. comm. 1992). Anglers harvested an estimated 34,000 kokanee in 1985 (IDFG 1991). Smallmouth bass occupy the warmer waters of the reservoir while rainbow trout and kokanee dominate the cold, mid-water fishery. Other common species found in the reservoir include bull trout, mountain whitefish, fall chinook salmon, and yellow perch. Water quality in Anderson Ranch Reservoir is generally considered good (IDEQ 1988).

IDFG manages the reservoir with an emphasis on kokanee salmon. Fall chinook

salmon are used to crop excess kokanee and to provide a trophy fishery (IDFG 1991). Chinook salmon releases will be reduced in the future to help stabilize the kokanee fishery (Partridge, IDFG, pers. comm. 1992). IDFG is also seeking to improve trout fishing in the reservoir through a hatchery program and public awareness, and maintain catch rates of 0.4 trout/hour (IDFG 1991).

Anderson Ranch Dam to Arrowrock Reservoir

The South Fork Boise River was the first designated quality trout stream segment in southwestern Idaho. It provides quality angling experience, both in aesthetics and high catch rates (IDFG 1991). Wild rainbow trout, bull trout and mountain whitefish make up the majority of the fish caught. In 1988, anglers caught an estimated 18,400 rainbow trout and released 99 percent (IDFG 1991).

During periods of high runoff, some South Fork tributaries degrade main river spawning bars by the addition of heavy loads of fine sand and silt from disturbed watersheds. Because of the limited spawning gravels in the main channel of the South Fork, the tributaries are important spawning areas. Tributaries to the South Fork Boise River are affected by rangeland activities, forest practice activities, including road building or maintenance, and dredge mining. The South Fork has nonirrigated crop production and rangeland activities, but there are no pollutants or impacts to the beneficial uses (IDEQ 1988). Stream resource maintenance flows of 300 cfs from September 16 through March 31 and 600 cfs from April 1 through September 15 have generally been maintained in the South Fork by the USBR since 1980.

IDFG manages the trophy rainbow trout fishery in the South Fork with limit, size and tackle restrictions. IDFG works with the USFS to restrict boating at lower flows above **Danskin** Bridge and to preserve a low density angling experience below **Danskin** Bridge (IDFG 1991).

Wildlife Issues and Concerns

Anderson Ranch Reservoir

Anderson Ranch Reservoir provides an important resting area for migrating waterfowl, although ice conditions reduce the reservoir's resting value during winter. Many upland game bird species frequent the wetlands at the upper end of the reservoir. At least 19 species of raptors including bald eagle and osprey use the reservoir (Martin and Ablin-Stone 1986). As many as fifty bald eagles have been observed passing through the area in the winter. Three active bald eagle nests are located near the reservoir (Partridge, IDFG, pers. comm. 1992). Bald eagles generally feed on kokanee during spawning season in September and October when the fish are more vulnerable to predation. Ten pairs of osprey nest just to the north of the reservoir (Martin and Ablin-Stone 1986).

Many other wildlife species are dependent on the reservoir including mule deer, elk, and aquatic **fur-bearing** mammals such as beaver, muskrat, and river otter.

Anderson Ranch Dam to Arrowrock Reservoir

Lewis (1980) documents a complete list of fish, wildlife, and **nongame** species in the area between Anderson Ranch and Arrowrock Reservoirs. Bald eagles use the river directly downstream from Anderson Ranch Reservoir during the fall and winter for foraging and roosting. Martin and Ablin-Stone (1986) reported that in 1985, one pair was observed nesting in a ponderosa pine about one mile below the dam. Wintering bald eagle habitat below the reservoir has been improved by increasing the fishery in that section of the river (Martin and Ablin-Stone 1986).

The river corridor supports both resident and wintering mule deer, limited numbers of elk, and a wide variety of bird species including great blue heron, sandhill crane, numerous shorebirds, upland game birds, and waterfowl. **Nongame** birds nest along the river, and many more rest and feed there during migration. The South Fork riparian habitat and fishery provide food for river otter, beaver, mink, and other fur-bearer species.

Recreation Issues and Concerns

Anderson Ranch Reservoir

Recreational use of Anderson Ranch Reservoir includes fishing, hunting, camping, water skiing, sailboarding, jet skiing, and boating. Recreation facilities include several boat docks, boat launching ramps, campsites, picnic tables, and sanitation facilities. Most of the people that **use the reservoir are from Boise, Mountain Home, Magic Valley, and Wood River Valley**. Recreational use is projected to increase as the population in Ada and Canyon counties continues to increase. The USBR predicts a recreation demand of about 110,000 recreation-days for fishing at Anderson Ranch Reservoir in the year 2000 (USBR 1982).

Reservoir drawdowns affect boat ramp operations and accessibility of land-based recreational facilities including parking areas, campgrounds, and service areas (Table 17).

Table 17. Elevations and reservoir volumes at which boat ramps at Anderson Ranch Reservoir become inoperable (Jansen Lute, USBR, pers. comm. 1992).

<u>Boat Ramp</u>	<u>Elevation feet msl</u>	<u>Volume (acre-feet)</u>
Castle Creek	4111	194,047
Curlew Creek	4102	172,092
Deer Creek	4157	333,550
Elk Creek (high water)	4157	333,550
Elk Creek (low water)	4078	123,929
Fall Creek (high water)	4171	385,884
Fall Creek (low water)	4130	245,690
Pine	4150	309,079

Anderson Ranch Dam to Arrowrock Reservoir

The South Fork Boise River is used extensively by anglers and white water boating enthusiasts. Flow levels during the summer months are usually 600 cfs which are considered inadequate for rafting and kayaking. Driftboaters **prefer streamflows of 800- 900 cfs from Anderson Ranch Dam to Danskin Bridge**. The river section between **Danskin Bridge** and Neal Bridge contains Class **III rapids** when flows are between **600-1,800 cfs** (Appendix D). Preferred streamflows for whitewater rafting and kayaking in this reach are at least 1,000-1,200 cfs (Trip, USFS, pers. comm. 1992).

Some streamside areas along the South Fork Boise River from Anderson Ranch Dam to **Danskin Bridge** are heavily disturbed by those who drive, park and camp along the river. Recreation demand for this river section is expected to grow to 56,000 recreation- days by **the year 2000** from 30,000 recreation-days per year in 1982 (**USBR 1982**). Increased damage to soils and vegetation is expected to occur in undeveloped areas due to uncontrolled access, dispersed recreation and overuse.

Potential Water Rental Impacts/Benefits

Anderson Ranch Reservoir

The continued maintenance of a year-round minimum pool of at least 70,000 AF in Anderson Ranch Reservoir would protect resident fish habitat within the reservoir.

South Fork Boise

The downstream fishery would benefit from water rental releases for salmon flow augmentation particularly during the winter months when flows in the South Fork are low. Continuing to maintain stable flows of at least 300 cfs during the winter would increase aquatic insect production, decrease egg mortality and **provide suitable fish spawning and rearing habitat** in the South Fork Boise River. An increase in fish habitat during the winter would benefit not only the fishery but also wintering bald eagles and other resident and migrating waterfowl.

Recommendations for Protection and Enhancement of Resident Fish and Wildlife

1. Continue to operate Anderson Ranch Reservoir at no less than 70,000 AF to increase resident fish habitat.
2. Continue to maintain wintertime streamflows in the South fork Boise River to protect and enhance spawning habitat in the South Fork Boise River.

Instream flows of at least 300 cfs from September 16 through March 31 and at least 600 cfs from April 1 through September 15 should continue to be maintained in the South Fork Boise River.

Main Stem Boise

Description of Study Area

Arrowrock Reservoir

Arrowrock Reservoir has a surface area of **3,100 acres and a total storage capacity of 286,600 AF**. All of the storage in the reservoir is contracted for irrigation use (Table 16). Because there is no conservation pool, the reservoir has a history of being drained by late October as a result of downstream irrigation demands. The North, South, and Middle Forks of the Boise River provide most of the inflow to Arrowrock Reservoir. Releases from Arrowrock Dam provide nearly all the inflow to Lucky Peak Reservoir.

Minimum daily contents of Arrowrock Reservoir since 1966 have fallen far below 28,700 AF in most years (Figure 33). Reservoir contents have fluctuated from near zero to 280,000 AF (Figure 33).

Lucky Peak Reservoir

Mores Creek is the principle tributary to Lucky Peak Reservoir. The reservoir is operated in conjunction with Arrowrock and Anderson Ranch Reservoirs to meet irrigation, flood control, power production, recreation, and **instream** flow needs. Lucky Peak has a total storage capacity of 307,100 AF, of which 112,100 AF is

contracted storage space (Table 16). The total surface area of the reservoir is 2,750 acres. Reservoir contents range from a minimum of 30,000 AF to a maximum of 300,000 AF, while the average monthly contents fluctuate from 80,000 AF in the winter to 280,000 AF in the summer (Figure 34). The minimum daily contents of Lucky Peak Reservoir have remained above 30,000 **AF** since 1966 (Figure 34).

Lucky Peak Dam to Star

The main stem of the Boise River extends 64 miles from Lucky Peak Dam to its mouth at **Parma**. **Much** of the channel has been altered and is no longer in a natural condition. The upper **25**-mile reach flows through the Boise metropolitan area from Lucky Peak Dam to Star.

The historical discharge from Lucky Peak since 1956 ranges from a low of zero in the winter months to a high of over 13,000 cfs after spring runoff (Figure 35). The natural flow of the Boise River before upstream impoundments was considerably higher than under present conditions. Minimum flows during the winter months may have fluctuated from 50 to 160 cfs, while flood flows were considerably higher, peaking at nearly 17,000 cfs (Figure 35).

Star to Mouth

The lower reach of the Boise River, from Star to the mouth, is significantly affected by numerous irrigation diversions and agricultural irrigation return flows. In 1990, irrigation diversions between **Glenwood** Bridge and **Parma** were between 1,200 and 1,700 cfs per day from mid-April to mid-September (Harenberg et al. 1990). Streamflows at **Parma** for the same year ranged from a low of 77 cfs in April to a high of 1,730 cfs in May.

Fish Issues and Concerns

Arrowrock Reservoir

Arrowrock Reservoir contains a variety of fish species including **smallmouth** bass, yellow perch, rainbow trout, bull trout, and mountain whitefish. IDFG stocks Arrowrock Reservoir annually with rainbow trout fingerlings. Fishing use on the reservoir in 1984 was estimated at 8,000 angler-days per year (Wolflin and Ray 1984). Drawdowns and low winter reservoir levels prevent development of the fish food

ARROWROCK RESERVOIR

END OF MONTH CONTENT

Arrowrock Reservoir

Minimum Daily Contents
1966-1991

Proposed Min. Pool Historical Min. Pool

Figure 33. Arrowrock Reservoir **summary** hydrograph and minimum daily contents.

LUCKY PEAK RESERVOIR

END OF MONTH CONTENT

Lucky Peak Reservoir

Minimum Daily Contents
1966-1991

Figure 34. Lucky Peak Reservoir sununary hydrograph and minimum daily contents.

BOISE RIVER NR BOISE

LUCKY PEAK RELEASE

Figure 35. Boise River natural flow and summary hydrograph.

base, limit spawning conditions for warmwater fish, expose nests and kill the eggs, reduce the sport fishery carrying capacity, and force fish to migrate into Lucky Peak Reservoir (Wolflin and Ray 1984).

A minimum pool of 28,700 AF has been recommended for Arrowrock Reservoir to increase fish habitat and winter carryover of rainbow trout (Wolflin and Ray 1984). Minimum daily reservoir contents are highest during the winter months as the irrigation season approaches.

Lucky Peak Reservoir

Lucky Peak Reservoir provides good habitat for coldwater fish species. Smallmouth bass, yellow perch, rainbow trout, bull trout, kokanee, mountain whitefish, and many **nongame** species make up the Lucky Peak Reservoir fishery. Rainbow trout and kokanee are the most sought after species by many anglers. IDFG annually stocks 15,000 **to 30,000 catchable rainbow** trout, and many more are restocked when Arrowrock Reservoir is drawndown during irrigation season. Spawning conditions for warmwater fish are better in Lucky Peak than Arrowrock because water levels are generally maintained at a constant level throughout the summer (Wolflin and Ray 1984).

IDFG will continue to stock catchable rainbow trout and improve the kokanee salmon fishery by managing spawning escapement at Mores Creek (IDFG 1991).

Lucky Peak Dam to Star

The upper reach of the Boise River supports several coldwater fish species. Mountain whitefish is the most abundant game fish present, and hatchery reared rainbow trout, wild rainbow trout, and brown trout comprise the remaining fishery (IDFG 1991). Rainbow trout require good water quality and temperatures below **70°F**. Spawning occurs at temperatures between 36 and **47°F**. Trout require small gravels for spawning that are relatively free of fine sediments such as sand and silt (Raleigh et al. 1986). The Boise River is comprised of a combination of pools and riffles, and the channel substrate is composed of larger cobble-sized materials.

Sedimentation has rendered suitable spawning gravels unusable and limited trout reproduction. **Significant benthic** production does

not occur in this reach because habitat quality has been degraded by channel disturbances, such as levee construction, riprapping, stream channel alteration, diversion dams, road and bridge construction, farming activities, and home development (Wolflin and Ray 1984).

In a water quality assessment published in 1988, IDEQ reported that most beneficial uses in this river section are "potentially at risk" (IDEQ 1988). Water quality problems are made worse under low flow conditions by industrial discharges and sewage treatment plants that discharge treatment effluent directly into the Boise River. Low fall and winter flows reduce habitat quality for fish and aquatic organisms, thus limiting the winter carryover and growth of game fish.

Under current operations, there is 166,200 AF of uncontracted storage space in Lucky Peak Reservoir (Table 16). IDFG has reserved 50,000 AF for winter streamflow maintenance in the Boise River. The remaining 116,200 AF is for flood control and **instream** flow maintenance. The USBR contributes to a wintertime **instream** flow of 150 cfs by releasing 80 cfs from uncontracted storage. IDFG uses its existing space to provide an additional 70 cfs. However, there is no guarantee that either the IDFG or USBR streamflow maintenance space will accrue sufficient water to supply desired minimum streamflows. If adequate water supplies are not available to fill IDFG's reservoir space, the recommended flow of 150 cfs would not be met, and release of 80 cfs would be provided when water is available. A release of 225 cfs from Lucky Peak has been recommended during October **and November** for brown trout spawning (Pruitt and Nadeau 1978).

These recommended streamflows are not the ideal or most desirable flows in the Boise River. The ideal flows for a healthy, productive fishery would be bank full discharge. High flushing flows are necessary to move silt and sand from suitable spawning gravels and increase aquatic insect production. The Boise River is **currently** operated so as not to exceed a flow of 6,500 cfs as measured at the USGS gage near the **Glenwood Street Bridge**. Major flooding generally occurs when flows at the bridge exceed 10,000 cfs (Jarvis 1985).

Because of the last six years of severe drought conditions in the Boise River basin, there has been no lengthy flood control operations. **Sisco**

(1991) predicts that if the basin returns to a normal water cycle (2 MAF of runoff per year), there will be flooding. There seems to be some reduced carrying capacity in the Boise River and should the US Army Corps of Engineers (USACE) go back to making flood control releases, the Eagle Island area may not carry the flows (Sisco 1991).

The management direction of IDFG is to stock the reach from Lucky Peak Dam to Barber Dam with predatory trout, bull trout, brown trout, and rainbow trout (IDFG 1991). The reach from Barber Dam to Eagle Island is stocked seasonally with brown trout fingerlings and adult steelhead. IDFG manages this reach for a high density of anglers. Both channels around Eagle Island are managed for high catch rates of 3 fish/hour for large fish and stocked with large trout (IDFG 1991).

Star to Mouth

The lower reach of the Boise River supports a fair fishery for warmwater fish species, but is poor habitat for coldwater fish species (Wolflin and Ray 1984). The fishery is comprised of rainbow trout, mountain whitefish, blackcrappie, largemouth bass, and smallmouth bass. Nongame fish make up the majority of the fish biomass. Habitat quality is low due to frequent channel disturbances, intensive agricultural use adjacent to the river, irrigation diversions, poor quality irrigation return flows, low streamflows, and sedimentation.

The management direction of IDFG is to stock brown trout fingerlings and catchable rainbow trout in this reach, and improve water quality and habitat conditions by working with state and federal regulatory agencies (IDFG 1991).

Wildlife Issues and Concerns

Arrowrock Reservoir

Because of its close proximity to Lucky Peak Reservoir, many of the wildlife issues and concerns associated with Arrowrock Reservoir are similar to those for Lucky Peak.

Lucky Peak Reservoir

Land adjacent to Lucky Peak Reservoir is critical mule deer winter range. This deer herd is one of the most important in Idaho in terms of

hunter activity and harvest. As many as 6,000 deer annually have been taken from this general area. **Raccoons**, mink, waterfowl, raptors, and many **nongame** wildlife species are found in the Lucky Peak Reservoir area.

Lucky Peak Dam to Star

The quality and quantity of the riparian habitats critical to waterfowl, aquatic furbearers, bald eagles, mule deer, and many other game and **nongame** species is of particular concern in the upper reach of the Boise River. At least 23 species of waterfowl are present between Lucky Peak Dam and Star. Muskrat, beaver, river otter, and mink use the river and associated riparian habitat within 100 meters of the water (Martin and Ablin-Stone 1986).

Mule deer winter in the area directly below Lucky Peak Dam. The area around Barber Park is unique in that it is a relatively isolated and undisturbed riparian area close to the city center. The primary value of this 1.8 miles of river is as a wildlife sanctuary (Wolflin and Ray 1984).

The area from Lucky Peak Dam to the city of Boise provides the requirements of open water, suitable perch and roost sites, and adequate prey for wintering bald eagles. A total of 385 bald eagle observations were recorded during a census conducted in the winter of 1988-89 (Spahr 1990). Spahr (1990) concluded that adults accounted for 60 percent of the observations, while immature eagles accounted for 40 percent.

Fish that are flushed out of Lucky Peak provide a food source for bald eagles. Bald eagles select pools over runs, riffles and pocket water when foraging in the river. Flow level may have a significant effect on bald eagle foraging success. Of the physical factors affecting the suitability of river habitat for eagle foraging, the amount of shallow water with no surface turbulence is most strongly correlated with eagle activity, and is the one factor most affected by increased flows (BioSystems 1985).

Haywood and Ohmart (1986) suggest there is a strong relationship between aquatic habitat and bald eagle productivity. The dependence of bald eagles on benthic-feeding fish relates nest site selection to physical characteristics of the stream bottom. A productive river bottom is essential to nest site establishment and continued productivity of bald eagles (Haywood and Ohmart 1986). Star to Mouth

A combination of return irrigation flows and several slight depressions in the Deer Flat National Wildlife Refuge at the eastern end of Lake Lowell provides seasonally flooded grassland for a variety of wildlife species including upland game birds, shorebirds, waterfowl and small mammals (Wolflin and Ray 1984).

Recreation Issues and Concerns

Arrowrock Reservoir

Arrowrock Reservoir provides users with recreational opportunities for boating, water skiing, fishing, swimming, and camping. Reservoir drawdowns affect boat ramp operations and accessibility of land-based recreational facilities including parking areas, campgrounds, and service areas (Table 18).

Lucky Peak Reservoir

Lucky Peak Reservoir is a popular recreational resource, especially during the summer months when reservoir levels are highest. Boat launching ramps, boat docks, swimming access, and sanitation facilities are provided. Numerous recreational opportunities are available including boating, water skiing, fishing, and other water related activities. There are over one hundred reservoir camp sites accessible by boat (Lucachick, IDPR, pers. **comm.** 1992). Spring Shores, an IDPR facility, has camping and picnicking facilities as well as a marina. Reservoir drawdowns affect boat ramp operations and accessibility of land-based recreational facilities including parking areas, campgrounds, and service areas (Table 19).

Table 18. Elevations and reservoir volumes at which boat ramps at Arrowrock Reservoir become inoperable (Jansen Lute, USBR, pers. **comm.** 1992).

<u>Boat Ramp</u>	<u>Elevation (feet msl)</u>	<u>Volume (acre-feet)</u>
Arrowrock	3184	240,100
Cinch Creek	3118	113,200

Table 19. Elevations and reservoir volumes at which boat ramps at Lucky Peak Reservoir become inoperable (Jansen Lute, USBR, pers. **comm.** 1992).

<u>Boat Ramp</u>	<u>Elevation feet msl</u>	<u>Volume (acre-feet)</u>
Barclay Bay	3040	253,573
Macks Creek	3045	266,416
#1 Spring Shores	2940	64,604
#2 Spring Shores	3040	253,573
Turner Gulch	2915	37,382
Robie Creek	3050	279,598

Lucky Peak Dam to Star

The Boise River provides many recreational opportunities for outdoor enthusiasts. The river and its adjoining Greenbelt is used for fishing, floating, wildlife viewing, walking, jogging, biking, and aesthetic enjoyment. The Boise River and Greenbelt have played a significant role in making Boise a premier place to reside and in attracting new businesses to the area (Findorff and Reichmuth 199 1).

The first annual Boise River Festival took place in 1991 on the Boise River from Barber Park to the city center. The three- day event was attended by approximately 3 10,000 people and brought \$5 million in revenue to Boise. The 1992 Festival has been expanded and revenue is projected to be \$5-10 million (Campbell, Boise River Festival, pers. comm. 1992).

Potential Water Rental Benefits/Impacts

The USBR manages 102,300 AF of storage space in Lucky Peak Reservoir to contribute toward maintenance of a minimum streamflow of 150 cfs in the Boise River. The USBR has considered the option of using some of this space for salmon flow augmentation (USBR 1990). The use of this storage space for purposes other than wintertime **instream** flow maintenance in the Boise River would jeopardize the resident fisheries, recreation, and reservoir pool elevations in the entire Boise Project.

Winter flows of 150 cfs in the Boise River would not likely occur if the streamflow maintenance space in Lucky Peak Reservoir is used for the flow augmentation program. The results would be detrimental to both the fishery and water quality. Low flow conditions displace fish, limit winter carryover, and reduce spawning habitat. Loss of sufficient cover and deeper water to protect fish from ice scouring would result from lower winter flows. Incubating eggs would be deprived of oxygen and even frozen if the river freezes.

Higher winter flows in the Boise River would increase fish food production and fish growth by protecting benthic invertebrates. More fish would be carried over through the winter resulting in larger populations of rainbow trout, brown trout and whitefish.

Increased flows in October and November would provide brown trout spawning habitat, while winter flows would then permit successful rearing. A greater abundance of pool habitat in the winter would benefit trout in the Boise River. An increase in fish size and population will result in an increase in angler- days per year and improve angler success in the summer.

Higher winter flows and the resulting improvement in the Boise River fishery and benthic community may have an effect on bald eagle foraging success. An increase in the winter fish population would provide a consistent prey base for aquatic furbearing mammals.

Recommendations for Protection and Enhancement of Resident Fish and Wildlife

1. Meet or exceed a year-round minimum pool of 28,700 AF in Arrowrock Reservoir to increase fish habitat and winter carryover of rainbow trout.
2. Maintain a wintertime streamflow of in **the Boise** River to protect fish spawning habitat.

Operate Lucky Peak Reservoir so as to provide **instream** flows in the Boise River of at least 225 cfs from October 1 through November 31 and at least 150 cfs from December 1 through March 3 1. Rental pool rules and regulations would have to be amended to allow for any releases past March 1.

3. Release water rented from the Boise **Rental Pool** on a slow, continuous basis from October 1 through March 3 1 to increase fish habitat and backfill **Brownlee** Reservoir.

If water is made available in the Boise Rental Pool for the purpose of salmon flow augmentation, releases should be made during the fall and winter to provide increased **streamflows** in the Boise River. However, in dry years when salmon flow augmentation would be needed most, it is unlikely that water would be available in the rental pool.

Description of Study Area

Brownlee Reservoir

Brownlee Reservoir is the uppermost of Idaho Power Company's (IPC's) three Hells Canyon hydroelectric projects. **Brownlee** is the largest of the three projects (including Oxbow and Hells Canyon) and stores 1.4 MAF of water at full pool (2077 ft. msl). 444,700 AF is inactive storage used primarily for power head. **Brownlee** covers 14,621 acres at full pool.

The Hells Canyon complex is the source of 62 percent of IPC's hydropower production (NMFS 1992). Historically **Brownlee** has been operated to refill by July 1 (IPC 1991). Since 1966, mean date of refill (2072 ft. msl or greater) has been June 7 (Randolph et al. 1991). Early June refill helps IPC meet its summer power demands (NMFS 1992). IPC **tries** to operate **Brownlee** to remain within nine feet of full

throughout the summer to maintain recreational opportunities and resident fish habitat (NMFS 1992) (Figure 36). IPC also operates **Brownlee** to provide year-round FERC license minimum flows of 5,000 cfs below Hells Canyon Dam (IPC 1991).

Brownlee is the last major storage project on the Snake River before the lower Snake complex. Although not a part of the Pacific Northwest Coordination Agreement, **Brownlee** operations are taken into account during Northwest Power Pool coordination (NMFS 1992). **Brownlee** has historically been a part of spring Water Budget releases into the lower Snake River.

The Phase II Amendments to the Columbia River Basin Fish and Wildlife Program (NPPC 1991) **include** the following requirements from **Brownlee**, in years when the April through July runoff forecast at Lower Granite is less than 29 MAF:

Figure 36. Brownlee Reservoir summary hydrograph.

1. Pass 190,000 AF of flow augmentation water from the Snake River Basin, for spring migrants from April 15 to June 15.

2. Draft **Brownlee** during May to a minimum elevation of 2069 ft. which will provide a maximum of 110,000 AF for spring migrants whenever sufficient inflows are forecast so that resident fish, fall chinook, and **Brownlee** refill by July 1 will not be significantly affected. Shift **Brownlee** flood control storage space to other Columbia River Basin projects. 3. Modify operation of the Hells Canyon complex to provide coordinated fall and spring flows below Hells Canyon Dam to maintain fall chinook spawning, incubation, and emergence.

Evaluate options by the end of 1992 for providing more water for fish flows from Brownlee, including substantially improved ability to shape water from the Snake River Basin for spring and summer migrants.

4. During July, draft **Brownlee** to a minimum elevation of 2067 ft. to provide up to 137,000 AF for fall chinook migrants. Refill this space in August with flow augmentation water from the Snake River Basin. The amount of water drafted from **Brownlee** in July is contingent on flow augmentation water availability in the Snake River Basin.

5. During September, draft 100,000 AF from **Brownlee** to reduce Snake River water temperatures for adult fish passage. In addition, pass 100,000 AF of flow augmentation water from the Snake River Basin.

IPC has proposed an interim fall chinook recovery plan and study to protect fall chinook spawning between Hells Canyon Dam and the mouth of the Salmon River (IPC 1991). The operational goal of the plan is to establish fall chinook spawning flows in November that can be maintained until the fry emerge from the gravel the following spring. Flows would be dropped in November during the establishment of redds. Flows could be increased again the rest of the winter, as long as they did not drop below November levels and dry out redds. In median water years, large October drafts would be necessary in order to drop November flows during redd establishment (IPC 1991).

Implementation of the interim fall chinook recovery plan requires a shift of **Brownlee** flood control requirements to another facility in the Columbia River Basin (IPC 1991). With this shift, **Brownlee** could refill by April 15 and then pass inflow (in lieu of "shaping") for spring migrant water budget requirements (IPC 1991). By holding **Brownlee** at full pool, 400,000 AF of inflow in average water years could be passed downstream (Randolph, 1992). The USACE waived flood control requirements at **Brownlee** in 1992 (NMFS 1992).

Fish Issues and Concerns

The CBFWA (1990) identified the following resident fish concerns related to **Brownlee** operations.

"A 1989 Idaho Department of Fish and Game and Oregon Department of Fish and Wildlife survey documented that Brownlee Reservoir supports the single most heavily utilized resident sport fishery in Idaho and one of the most heavily used in Oregon. Idaho and Oregon anglers expended 850,000 hours of fishing and harvested 32 million resident fish. Smallmouth bass and crappie, two shallow-shoreline nest-spawning species, were the preferred target species for 28 and 41 percent of the anglers respectively. These two species comprised 94 percent of the harvest."

"The reproductive success of both species in reservoirs has been shown to be correlated to water level regimes during spawning, incubation and early rearing, with that of smallmouth being the most critical. Spawning periods of the two species overlap and operations recommended for smallmouth would benefit crappie as well."

"The initiation of spawning by smallmouth is controlled by three factors: photoperiod, water temperature, and water level. Photoperiod and water temperatures may be conducive to spawning anytime after early May at Brownlee. Falling water levels will inhibit nest building and spawning. Spawning may be delayed by falling water levels as late as early June with no adverse impact on egg viability. Spawning will occur with stabilized water levels, and is especially triggered by any rise in water level during the May to early June period when photoperiod and water temperatures are conducive."

Most nests are built in one to three feet of water. Eggs incubate for approximately ten days and sac fry remain in interstitial spaces at the nest for another three to five days. During incubation, male smallmouth "guard" the eggs from predation. Any drop in water level during this period will cause the male to abandon the nest, and any cumulative drop of a foot or more during the two weeks following spawning will dewater eggs or sac fry.

"Consequently, to avoid impacts on smallmouth (and crappie) recruitment, reservoir levels may decline continuously during May, but no declines should occur after any stabilization or increase in water levels which occur in May.

"Brownlee also provides an important resident rainbow trout fishery supported by hatchery plants. Loss of marked trout from the reservoir during drawdown has been documented. The duration and magnitude of drawdown is felt to have a major influence on the loss of trout and the reservoir fishery. That relationship is not well enough defined at this time, however, to recommend drawdown rates, duration or magnitudes that would minimize impacts to the resident trout fishery."

IPC initiated research in the spring of 1991 to describe nesting characteristics and behavior of smallmouth bass and crappie in relationship to fluctuating water levels in **Brownlee** (Brown and Chandler 1986 in IPC 1991). Preliminary results indicated that both smallmouth bass and crappie nest elevations were affected by water level fluctuations. Nests were established at higher elevations as the reservoir filled (Brown and Chandler 1991 in IPC 1991).

Wildlife Issues and Concerns

Brownlee Reservoir provides habitat for a growing number of wintering bald eagles, which depend primarily on fish as a prey base. In addition, some waterfowl nesting and brood rearing occurs in the upper end of Brownlee.

Recreation Issues and Concerns

Brownlee Reservoir provides recreation opportunities for boating, fishing, water skiing, camping, swimming and picnicking. **Brownlee** provides more angler hours of fishing than any other reservoir in Idaho. **Brownlee** has 8 boat ramps to provide for fishing and other access. Ramp access to the reservoir is heavily impacted if the pool is drawn down past 2048 ft. (Table 20).

Table 20. Elevations at which boat ramps at **Brownlee** Reservoir become inoperable.

<u>Boat Ramp</u>	<u>Elevation (feet msl)</u>
Farewell Bend	2048.5
Spring Recreation Site	2026
Hewitt 1	2072
Hewitt 2	2048.5
Woodhead 1	2030
Woodhead 2	2073
Steck Park (old)	2066.5

Potential Water Rental Benefits/Impacts

Smallmouth bass and crappie are the most important fishery in Brownlee. Both spawn when water temperatures are between 55 and 65°F., which occurs in **Brownlee** between May 12 and June 27 (Randolph et al. 1991). The key protective measure in **Brownlee** is to stabilize or raise reservoir levels continuously after June 10. Additional releases from **Brownlee** Reservoir for salmon flow augmentation may impact the emigration of rainbow trout through the dam, although the relationship is not well known.

Lower reservoir levels during the summer will reduce available habitat for fish and impact reservoir aesthetics and access for anglers and campers. Increased releases from **Brownlee** in the spring may lead to lower summer flows in the Snake River below the Hells Canyon complex, leading to increased water temperatures and decreased water quality (Randolph et al. 1991). Increased water temperatures could negatively impact fall chinook while lower summer flows may also impact motorized water craft recreation below Hells Canyon Dam (Randolph pers. commun. 1992).

Recommendations for Protection and Enhancement of Resident Fish and Wildlife

Rental pool rules do not allow the release of any water for non-irrigation purposes until July 1. Because uncontracted storage is put into the rental pool prior to use for anadromous fish, it falls under the July 1 constraint also. This rule would need to be changed in order to begin refilling **Brownlee** before July 1. In order to protect and/or enhance resident fish and wildlife in the upper Snake and Payette river systems, backfill of **Brownlee** is recommended, from July 1 to March 31.

Most of the backfill should occur from the July 1 to September 30 period with water from the upper Snake River. If necessary, upper Snake water should be used to ensure that **Brownlee** inflows meet or exceed outflows after June 10. From October 1 to March 31, backfill would be provided by releases from the Payette system and releases of any water held back from the upper Snake for wintertime **instream** flow purposes.

A backfill which is spread out will reduce available power head at Brownlee. Increased flows into **Brownlee** during the summer from Snake River water rental could improve water temperatures and dissolved oxygen (DO) conditions at the headwaters of **Brownlee** and benefit sturgeon and other fish (IPC 1991).

Dworshak Reservoir and the Lower Clearwater River

Description of Study Area

Dworshak Reservoir

Dworshak Reservoir is **located** on the North Fork Clearwater River and is 53.6 miles long. (Figure 1) The reservoir has a surface area of 16,970 acres at full pool and 9,050 acres at minimum pool. Full pool storage volume equals **3,453,000** AF of water. Two MAP of active storage space is available for flood control, power production, navigation, and anadromous fish flow improvement.

Dworshak dam was completed in 1971 and is located **1.9 miles upstream from the confluence** with the main Clearwater River. The dam rises 717 feet above the North Fork Clearwater and is equipped with selector gates at various levels to provide temperature control of the water discharged from the reservoir. The reservoir has historically been drawn down in the winter to provide storage for spring flood waters. Refill occurs during the spring and summer, with full pool attained in early July for the recreational season. The **50-year** average runoff into Dworshak Reservoir is 2.75 MAF.

Water Budget requirements have altered Dworshak releases. To make water available for the juvenile spring chinook salmon outmigration in April, less water is released into the Columbia River system during the winter. Salmon flow augmentation is achieved operationally by shifting a portion of Dworshak flood control storage to other Columbia River Basin projects.

Lower Clearwater River

The lower Clearwater River flows 36.5 miles from the confluence with the North Fork Clearwater to the slackwater of Lower Granite pool (Figure 1). This stretch of river and the lower 15 percent of Dworshak Reservoir are within **the Nez Perce** Indian Reservation.

Flows in the lower Clearwater are greatly **influenced by releases from Dworshak Reservoir**. Dworshak releases can fluctuate dramatically in a short period of time. Releases have dropped from 25,000 cfs to 1,000 cfs in less than 24

hours. The maximum river fluctuation attributable to Dworshak operations is one foot per hour at the Peck gauge, located 3 miles downstream of the North Fork Clearwater confluence (Kronemann and Lawrence 1988).

Average monthly flows, seasonal peak flows, and flood frequency and magnitude in the lower Clearwater River have been changed as a result of the construction of Dworshak Dam. Since the dam was built, average spring peak flows have been delayed one month, from May to June, and reduced from 51,600 cfs to 40,300 cfs (Hansen and Martin 1989).

Dworshak releases have increased winter water temperatures and decreased summer water temperatures in the lower Clearwater River (**USACE** 1975). Stanton (1977) found a decrease of two to three degrees Celsius in summer water temperatures and an increase of one to three degrees Celsius in the winter water temperatures at the Peck gauging station. Prior to Dworshak, most of **the** lower Clearwater was ice-covered during the winter. The post-Dworshak temperature change has led to open water in the lower Clearwater the entire winter.

Flow Augmentation

The Power Council Phase II Amendments (NPPC 1991) to the Columbia River Basin Fish and Wildlife Program place heavy reliance upon releases from Dworshak Reservoir for anadromous fish flow augmentation. The Phase II Amendments (NPPC 1991) contain the following Dworshak water release recommendations for spring migrants and returning adult fall chinook. Flow augmentation **from** Dworshak is not required if the runoff forecast at Lower Granite Reservoir is greater than 29 MAP.

Spring Migrants

1. Shift flood control storage space from Dworshak to other Columbia River Basin projects, **from** January to April 30.
2. Operate Dworshak as close as possible to its upper rule curve by April 15 of each year.

3. Provide 900 KAF from Dworshak and any water gained from the flood control shift when the April forecast for the April-July runoff at Lower Granite is **<16 MAF**. This water is in addition to any minimum flow release requirements from Dworshak (2,000 cfs). When the runoff forecast is between 16 and 29 MAF, Dworshak will provide all available water, including water gained from flood control shift, while maintaining a 70 percent confidence of refill by July 31.

4. Limit Dworshak's outflow to 25,000 cfs during the migration period.

5. Dworshak may temporarily be used to respond to emergency capacity needs, until arrangements can be made to continue filling toward the upper rule curve.

Fall Chinook

1. Continue to release cool water from Dworshak during August and September to reduce lower Snake River water temperatures for adult fall chinook salmon and steelhead, and evaluate the effectiveness of releases on temperature reduction at Ice Harbor Dam and adult fall chinook passage.

2. If Dworshak reservoir is full or nearly full by the end of July, draft the reservoir up to 20 feet in August as needed for the temperature control evaluation. Immediately after Labor Day, release up to 200 KAF of additional cool water from Dworshak, as needed for the temperature control evaluation.

On January 9, 1992, the USACE, BPA, and the USBR submitted the 1992 Columbia River Flow Options Biological Assessment to NMFS. The Biological Assessment examined actions proposed to increase velocities in Snake and Columbia River reservoirs during 1992 operations only. Measures to provide additional flow augmentation during the 1992 juvenile Snake River fall chinook migration period were agreed upon by the USACE and BPA during consultations with NMFS. The resulting Flow Amendment superseded Dworshak release requirements under both the Power Council's Phase II Amendments and the Biological Assessment. Additional 1992 Dworshak operational requirements from the Biological Assessment and Flow Amendment include:

1. The end of Dworshak spring release period was extended from May 31 to June 15.

2. When runoff forecasts are greater than 16 MAF at Lower Granite, 900,000 AF will be provided with the following conditions (a) when natural flows at Lower Granite Dam exceed 100,000 cfs, the volume of releases from Dworshak will be reduced equal to the amount by which flows at Lower Granite Dam exceed 100,000 cfs and (b) additional water above **900,000 AF** will be released when refill probability is excess of 70 percent.

3. An additional 400,000 AF will be **released from Dworshak and the upper** Snake during the June 16 - August 30 juvenile and adult migration period.

4. If adequate water is not available for both juvenile fall chinook requirements and the temperature control experiment, water that would have been used in August for the temperature control experiment will be released earlier to benefit juvenile fall chinook migration.

Fish Issues and Concerns

Dworshak Reservoir

The gates on Dworshak dam were closed in 1971, blocking salmon and steelhead from the North Fork Clearwater River. Dworshak Reservoir provides an important, popular reservoir fishery for smallmouth bass, stocked rainbow trout, and kokanee (Maiolie et al., unpubl. rept. 1991). Recent annual angler harvest includes 161,175 kokanee, **12,370 rainbow** trout, and 12,370 smallmouth bass.

Early and late spawning kokanee were introduced to the reservoir in 1972. Early Dworshak Reservoir studies documented an abundant population of smallmouth bass which fed on **redside** shiners (Pettit et al. 1975; Ball and Pettit 1974; Horton 198 1). Later studies showed reduced populations of smallmouth bass and **redside** shiners, but increased abundance of kokanee. Falter (1982) documented a decline in reservoir productivity during the late 1970's.

The Nez Perce Tribe and IDFG recently **completed a four year (1987-1991) joint fisheries** research effort. IDFG examined kokanee population dynamics. The Nez Perce Tribe examined the rainbow trout stocking program and the status of the reservoir's smallmouth bass population.

Late spawning kokanee, which are primarily shoreline spawners, are gone from the reservoir, probably due to water level fluctuations and reduced water temperatures during the late October and November spawning season (Maiolie et al., unpubl. rept. 1991 and Bowler pers. **comm.** 1992). Early spawning kokanee, which spawn in tributaries during September and early October, support about 90 percent of **the fishing pressure on the reservoir. The kokanee** harvest has declined from 206,000 fish in 1988 (1.5 fish/hr.) to 95,000 fish in 1990 (0.5 fish/hr.) (Maiolie et al. unpubl. rept. 1991). Angler satisfaction has also declined, primarily because of the low catch rates.

Dworshak kokanee have lower annual survival rates than kokanee populations in other reservoirs. Losses of **kokanee through Dworshak** dam (entrainment) appear to have a significant impact on survival rates. Results from the 1987-1991 **IDFG/Nez** Perce study indicate that as many as 83,000 to 235,000 kokanee of a single age group were lost annually, impacting both catch rates and fishing effort (Maiolie et al., unpubl. rept. 1991).

The number of kokanee in tributary spawner counts and the reservoir was negatively correlated with increased mean annual discharge from Dworshak Dam. Entrainment losses were low when discharge was below 7,500 cfs.

Smallmouth bass and **redside** shiners are shallow shoreline spawners in Dworshak reservoir and can be impacted by fluctuating water levels during periods of spawning, incubation, and early rearing. The initiation of spawning by smallmouth bass is controlled by photoperiod, water temperature, and water level. Photoperiod and water temperatures may be conducive to spawning **by mid May in Dworshak.**

Falling water levels can inhibit and delay nest building and spawning as late as early June, with no impact on egg viability. Spawning will occur when falling water levels stabilize, and is especially triggered by any rise in water levels

during the May to early June period (CBFWA, 1990). Rapid increases in water levels during June can cause temperature depressions and lead to abandonment of nests and affect egg development and survival (Statler 1992).

Redside shiners, an initial important prey species of smallmouth bass and trout, require vegetation to spawn. Water level fluctuations, combined with steep-sided and unstable banks, have precluded the establishment of rooted littoral vegetation. No **redside** shiners were captured in 1988 gill net sampling (Statler 1990). **The redside** shiner decline is partially a function of heavy predation.

Dworshak Reservoir thermally stratifies annually. Reduced reservoir levels result in losses of productivity that can impact populations of kokanee, smallmouth bass, bull trout and cutthroat trout. Lower levels may also impact kokanee access to spawning tributaries (Statler, Nez Perce Tribe, pers. **comm.** 1992).

Drawdowns affect angler access **to Dworshak** Reservoir. Six sites around Dworshak provide improved boat launching facilities and only one (Big Eddy) provides access at minimum pool (1445 ft. msl). Most of the other sites are only operational down to **1530-** 1540 ft. msl. Reduced reservoir levels due to Snake River flow augmentation requirements could impact angler access in May.

Lower Clearwater River

The lower Clearwater supported a substantial smallmouth bass fishery and a minimal trout fishery before Dworshak Dam was constructed. Since Dworshak, smallmouth populations have been significantly reduced in the lower Clearwater, primarily because cooler water temperatures during the summer have interrupted spawning activities (Pettit 1976). Resident trout populations have increased because reduced summer water temperatures have increased trout and aquatic insect survival (Pettit 1976).

The lower Clearwater River supports a substantial sport fishery for steelhead returning to the hatchery near the confluence of the North Fork and main Clearwater River. Under an **agreement with IDFG, the USACE releases** 1,300 cfs plus inflow from Dworshak Dam from October 1 to November 15. The purpose of the agreement is to benefit steelhead anglers.

Simulation modeling was recently conducted to describe fish habitat characteristics of the lower Clearwater River. Habitat availability for adult chinook holding and spawning was modeled for river discharges between 3,000 and 50,000 cfs. The same assessment was also made for rearing juvenile chinook and rainbow/steelhead (Arnsberg et al. 1992). Weighted useable area (WUA) and habitat area (HA) values for chinook salmon and rainbow/steelhead trout fry and juveniles were highest at relatively low flows (3,000 cfs). WUA and HA values were also highest at the same low flows (3,000 cfs) for spawning chinook salmon (Arnsberg et al. 1992). High velocities dominate the lower Clearwater at higher discharges. WUA and HA values for chinooksalmon and steelheadtrout adult holding habitat were highest at moderate discharges (16,000 cfs) (Arnsberg et al. 1992).

IDFG recommends minimum winter flows of 5,000-6,000 cfs to provide optimum fishing opportunity for steelhead in the lower Clearwater. Flows of 5,000 to 6,000 cfs allows good boat access up and down the river and keeps the river ice free.

Wildlife Issues and Concerns

Dworshak Reservoir

Extreme drawdowns at Dworshak Reservoir preclude the establishment of riparian vegetation. The reservoir provides minimal habitat for breeding waterfowl. The reservoir supports a large population of breeding osprey and a small number of wintering bald eagles on the lower, unfrozen portion of the reservoir.

In the winter, solid ice frequently forms on upper Dworshak Reservoir and extends as far as Dent Bridge (Hansen and Martin 1989). In exceptionally cold winters, the entire reservoir freezes over. Reservoir operations resulting in lower water levels in the winter often expose and weaken ice along the reservoir edges. The blocks of ice left on steep hillsides can create a barrier to big game movements (Meske 1975).

Lower Clear-water River

The lower Clear-water River system contains several large islands, providing excellent nesting and brood rearing habitat for Canada geese and some ducks. Goose nesting platforms have been

placed on most islands and have alleviated most nest flooding problems.

Since the construction of Dworshak Reservoir, flood frequency and magnitude along the lower Clearwater River has been reduced. Because of reduced scouring, riparian vegetation has increased in areas around islands and near the shoreline, which were previously cobble/gravel (Hansen and Martin 1989).

Bald eagles congregate below Dworshak Dam in the winter to feed on discharged kokanee and other fish. In recent winters, eagles have been observed along the entire length of the lower Clearwater River (Kronemann and Lawrence 1988).

Aquatic furbearers, including river otter and beaver, are fairly abundant along the lower Clearwater River. The Nez Perce Tribe is examining habitat requirements of the river otter along the lower Clearwater in order to design effective mitigation for river otter losses from the construction of Dworshak Dam.

Critical Discharge Periods/Concerns

Dworshak Reservoir and Lower Clear-water River

1. Dworshak releases after June 1 cause decreased pool levels, dewater smallmouth bass nests, and decrease smallmouth bass productivity and harvest.
2. Dworshak releases above 7,500 cfs lead to increased entrainment losses of kokanee and reduce kokanee survival and harvest.
3. Dworshak releases in April and May could impact angler access to the reservoir if reservoir levels drop below 1530'- 1540' msl.
4. Fluctuating reservoir levels will continue to reduce and destroy the benthic community, preclude the establishment of aquatic vegetation, and reduce overall volume and productivity of the reservoir.
5. Dworshak releases of 1,300 cfs, plus inflow from October 1 to November 15, will provide optimum flows for steelhead anglers, during that period.

6. Flows of 5,000 to 6,000 cfs from November 15 through March will provide optimum steelhead fishing opportunity in the lower Clearwater River.

7. Because of the tendency of kokanee to **outmigrate during the spring, increased spring** discharges will probably aggravate kokanee entrainment losses.

Summary

Use of Idaho water to augment flows for anadromous fish is a very complex issue. Differences of opinion exist on the relationship between flow, travel time and anadromous fish survival and benefits. An obvious concern exists **in Idaho over the possible impacts of anadromous fish flow releases on resident fish and wildlife resources in the state.**

This report attempts to summarize all important resident fish and wildlife issues, concerns, and habitat conditions in the Snake River system, predict potential impacts to those resources from the implementation of the water rental flow augmentation program, and provide management recommendations for resident fish and wildlife protection and enhancement.

Implementation of the water rental flow augmentation program for anadromous fish provides a mixed opportunity for resident fish and wildlife in Idaho. Increased reservoir drawdowns can have severe adverse effects on resident fish and wildlife, while increased seasonal **instream** flows can show positive benefits. Water releases driven by political or economic motives can seriously impact resident fish and wildlife in both reservoirs and streams.

Most rented water will come from a combination of the Payette River system (Cascade and Deadwood Reservoirs) and the upper Snake River system (American Falls, Palisades, and Jackson Lake). Smaller amounts may occasionally come from additional reservoirs in the upper Snake system (Island Park and Ririe Reservoirs) and the Boise River system (Lucky Peak, Arrowrock, and Anderson Ranch Reservoirs). These reservoirs and **Brownlee** Reservoir all provide significant fisheries to the citizens of Idaho. Any serious impacts to these fisheries from the flow augmentation program are unacceptable.

The Snake River system, including the Payette and Boise Rivers, is driven by irrigation operations. Storage season for irrigation water occurs during the winter, often resulting in critically low flow conditions in river stretches below many reservoirs. A similar flow problem occurs below Milner dam in the summer, when the entire Snake River is often diverted for

irrigation. Low instream flows result in reductions in fish and wildlife habitat and water quality.

Recommendations for the release of flow augmentation water are designed to protect reservoir fisheries through the identification of minimum pools and enhance **instream** flows in both the winter and summer in the Snake River system. Recommendations can be summarized as the following:

1. Stabilize or increase **Brownlee** Reservoir water levels after June 10 each year.
2. Maintain identified minimum pools in reservoirs.
3. Release flow augmentation water from the Payette River system (Cascade and Deadwood Reservoirs) from October 1 to March 31.
4. Release the majority of flow augmentation water **from** the upper Snake reservoirs from July through September. Hold back enough water to ensure adequate winter flows below Jackson Lake, Palisades Reservoir, Island Park Reservoir, and **American Falls** Reservoir. Release held back water from October to March. If necessary, use a portion of upper Snake water early to stabilize or increase **Brownlee** Reservoir water levels after June 10.
5. Release flow augmentation water from the Boise River system (Anderson Ranch, Arrowrock, and **Lucky Peak Reservoirs**) from October 1 through March 31.
6. Develop annual flow augmentation plans that include resident fish and wildlife concerns and constraints. Plans should be closely coordinated between agencies and entities. Because all recommended minimum reservoir pools and **instream** flows can't be met every year, plans should include coordinated priorities and tradeoffs between reservoir pools and **instream** flows.

Potential fish, wildlife, and recreation impacts from the release of rented water for flow augmentation have been listed in different

reservoirs and stream stretches in the Snake River basin. The relationship between recommendations for the release of rented water and possible impacts to fish and wildlife are summarized in Table 2 1.

Increased flows from releases of rented water during one part of the year will result in a reduction in flows during another part of the year, or the following year. As an example, increased flows to enhance winter fish habitat can lead to reduced periods of bank full discharge the following spring. The release recommendations are broad in nature and should be better defined by an interagency team of biologists on an annual basis to ensure seasonal balance in flows.

During a succession of dry years, flow augmentation releases will cumulatively reduce carryover and affect reservoir levels, **instream** flows, and irrigation water supply. An inherent problem with the water rental flow augmentation program is that in the dry years when water is needed the most for flow augmentation, the least is available in the rental pools.

Based on a correlation between seasonal water supply in the upper Snake (carryover + runoff projection) and recent inputs to the upper Snake Rental Pool, it was estimated that in 1 **1/62** water years no water would be available through the rental pool for flow augmentation. This prediction included estimates on the long term effect of the “Last to Fill” rule on inputs to the rental pool.

Rental pool rules such as “Last to Fill” and “priority of use by irrigators” affect the amount and dependability of using rental pool water for flow augmentation. The “Last to Fill” rule in particular can affect future water supplies of a contributing water user for a number of years, if a drought persists. However, both provisions are necessary under current Idaho law (42-1763). Additional price incentives may reduce reluctance of water users to put water in the pool and mitigate for potential impacts caused by the “**Last to Fill**” rule. A modification of cutoff dates on the use of rented water would **also** increase effectiveness of using rented water for salmon flow augmentation.

The flow augmentation simulation did not release water in 1 **1/62** years in the upper Snake because of the predicted shortage in rental pool. Impacts on irrigation, reservoir minimum pools,

and **instream** flows in the upper Snake would have been more severe if 337,000 AF had been released in those years.

Impacts of the flow augmentation simulation were more severe in the Payette system, where 90,000 AF was released in all but four high runoff years (>29 MAF). Cascade **Reser-**voidropped below the minimum pool of 300,000 AF in **16/62** water years under the flow augmentation simulation versus only **5/62** water years under existing baseline conditions. Deadwood Reservoir dropped below the minimum pool of 50,000 AF in **14/62** water years under flow augmentation as compared to **8/62** water years under baseline.

Water quality conditions in the middle Snake River below Milner were compared under flow augmentation scenarios including 427,000 AF and 50,000 AF. Increased summer flows in the middle Snake would likely improve water quality conditions under either scenario.

Recommendations for protection of resident fish and wildlife include a slower and steadier backfill of **Brownlee** Reservoir than called for in the Power Council’s Phase II Amendments. This could cause a reduction in annual power production at **Brownlee** Reservoir because of a reduction in power head. This reduction may be partially offset by a shift toward winter power production at upstream hydroelectric projects during periods of increased winter flows.

Increased irrigation efficiency, corresponding conservation of water, and changes in price incentives should lead to increased water supplies and operational flexibility in the Snake River. When drawdowns of the four lower Snake River reservoirs begin, 840,000 AF of water will be needed for annual refill from a combination of Dworshak and **Brownlee** Reservoirs. The incorporation of resident fish and wildlife protection, enhancement, and monitoring measures into the future movement of flow augmentation and/or refill water can provide a win/win situation for all involved parties in the Snake River system.

Table 21. Summary of water rental minimum pool and water rental release recommendations, including potential impacts to resident fish, wildlife, and related recreation.

RECOMMENDATIONS BY SECTION	POTENTIAL IMPACTS TO RESIDENT FISH AND WILDLIFE
<i>JPPER SNAKE</i>	<i>UPPER SNAKE</i>
1. Release adequate water from the upper Snake reservoirs to ensure inflow is equal to or greater than outflow at Brownlee after June 10. 2. If water supply forecasts indicate that winter flows in the South Fork Snake (1,500 cfs), Henrys Fork below Island Park (500 cfs) and Snake River below American Falls (600 cfs) will be met, release upper Snake water rental contribution evenly from July 1 to September 30. Release Ririe water in September. 3. If water supply forecasts indicate that winter flows in the South Fork (1,500 cfs), Henrys Fork (500 cfs), and Snake River below American Falls (600 cfs) won't be met: a. Release American Falls water from July 1 to September 30. b. Releases Ririe water in September. c. Release Jackson, Palisades, and Island Park water evenly from October 1 to March 3 1, pass through American Falls to backfill Brownlee. 4. Maintain minimum pools of at least 20 1,000 AF in Palisades, 40,000 AF in Island Park, 35,000 AF in Ririe, and 250,000 AF in American Falls.	1. Stabilized or increasing water levels in Brownlee after June 10 will protect small mouth bass and crappie spawning in Brownlee. Some reduction in upper Snake River reservoir volumes will result. 2. Will decrease reservoir volumes in American Falls, Palisades, Jackson, and possibly Ririe and Island Park. Some impact to fisheries and recreation will result. Will provide increased flows and fish and wildlife habitat below Milner. Will enhance water quality in the middle Snake. Will be early summer reduced water levels in Brownlee, causing some impacts to fisheries and recreational opportunities. Backfill of Brownlee will be complete by end of September. 3. Will decrease upper Snake reservoir volumes, with potential impacts to fisheries and recreational opportunities. Summer releases will provide some enhancement to fish, wildlife, and water quality below Milner. Winter releases will benefit juvenile fish in South Fork, trumpeter swans in Henrys Fork and rainbow trout in Snake River below American Falls. Delayed backfill of Brownlee will be detrimental to fishing and boating activities. 4. Observance of annual minimum pools will help protect resident fish, wildlife, and recreational opportunities in upper Snake. Additional analysis of minimum pool recommendations is needed.

Table 21 . . , Continued

RECOMMENDATIONS BY SECTION	POTENTIAL IMPACTS TO RESIDENT FISH AND WILDLIFE
<i>‘AYETTE RIVER SYSTEM</i>	<i>PAYETTE RIVER SYSTEM</i>
1. Maintain a minimum pool of at least 300,000 AF in Cascade Reservoir. 2. Conduct an annual interagency review before the release of any portion of the additional 70,000 AF of uncontracted storage from Cascade. 3. Release rented water from Cascade from October 1 through March 31. 4. Maintain a minimum pool of at least 50,000 AF in Deadwood Reservoir. 5. Meet or exceed winter flows of 50 cfs in the Deadwood River. 6. Release rented water from Deadwood Reservoir from October 1 through March 31. 7. Meet or exceed a year-round flow of 794 cfs from Banks to Black Canyon. 8. Meet or exceed a year-round flow of 1165 cfs from Letha Bridge to the Snake River confluence. 9. Meet or exceed flows of 2005 cfs below Black Canyon Dam from February 15 through May 31.	1 & 2. Maintenance of a minimum pool of at least 300,000 AF in Cascade is considered the absolute minimum to protect fish, wildlife, and recreation. With continued declines in water quality, a minimum pool of greater than 300,000 AF may be required. Releases of rented water could be very detrimental to resident fish populations, bald eagles, and recreational opportunities at Cascade. 3. Even winter releases will provide additional flows in the North Fork Payette and enhance fish habitat. Winter releases will result in delayed backfill of Brownlee, impacting recreational opportunities. 4. Maintenance of a minimum pool of at least 50,000 AF in Deadwood should protect resident fish and wildlife. 5 & 6. Even winter releases from Deadwood will enhance winter fish habitat in the Deadwood River. Winter releases will result in delayed backfill of Brownlee, impacting recreational opportunities. 7 & 8. Flows maintain trout, bass, catfish, and mountain whitefish habitat. 9. Flows maintain waterfowl nesting habitat during the nesting period of February 15 through May 31.

Table 21 . . . Continued

RECOMMENDATIONS BY SECTION	POTENTIAL IMPACTS TO RESIDENT FISH AND WILDLIFE
<i>BOISE RIVER SYSTEM</i>	<i>BOISE RIVER SYSTEM</i>
1. Maintain a minimum pool of at least 70,000 AF in Anderson Ranch. 2. Maintain South Fork Boise River flows of at least 300 cfs from September 16 through March 31 and at least 600 cfs from April 1 through September 15. 3. Maintain a minimum pool of at least 28,700 AF in Arrowrock Reservoir. 4. Maintain winter flows in the Boise River below Lucky Peak of at least 225 cfs from October 1 through November 31 and at least 150 cfs from December 1 to March 31. 5. Release rented water evenly from October 1 through March 31.	1. Minimum pool of at least 70,000 AF in Anderson Ranch should protect fish, wildlife, and recreation. Any release of rented water that reduced Anderson Ranch volumes below 70,000 AF would be particularly detrimental to resident fish and recreational opportunities. 2. Maintenance of flows in South Fork will protect trophy rainbow trout fishery and winter population of bald eagles. 3. Maintenance of a minimum pool of at least 28,700 AF in Arrowrock will increase fish habitat and winter carryover of rainbow trout. 4. Maintenance or enhancement of winter flows in the Boise River below Lucky Peak will benefit fish populations and bald eagles. Delayed backfill of Brownlee would be detrimental to recreational opportunities.

Phase II Water Rental Goals and Objectives

Project Goal:

Refine Snake River hydrologic modeling efforts based on continuing new information on water availability and habitat/discharge relationships. Develop a monitoring plan to coordinate assessments of water releases on resident fish and wildlife resources and programs. Quantify benefits/impacts to resident fish and wildlife as a result of water rental releases for the improvement of anadromous fish migration.

Objective 1:

Refine water rental flow augmentation simulation to define water availability and frequency of occurrence.

Objective 2 :

Calibrate models to incorporate resident fish and wildlife issues and concerns, and develop an annual flow augmentation plan to be approved by the Snake River Anadromous Fish Water Management Office (**NPPC 1991 Phase II, Sec. III.4B.2(7)**).

Objective 3:

Relate expected changes in lacustrine habitat conditions to impacts/benefits to resident fish and wildlife resources.

Objective 4:

Apply the **Instream** Flow Incremental Methodology (IFIM) Time Series Library (TSLIB) to hydrologic model outputs (modified hydrographs) and annualize changes in fish and wildlife habitat under different water rental flow augmentation strategies.

Objective 5:

Compare alternative water rental flow augmentation strategies by applying the TSLIB to modified hydrographs. The amount of available resident fish and wildlife habitat will be assessed to select the best augmentation alternative for a specific species.

Objective 6:

Refine timing and amount of flow augmentation simulation for the **EPA/DEQ** water quality modeling effort in the middle Snake River.

Objective 7:

Develop monitoring plan to evaluate resident fish and wildlife impacts as a result of water rental releases for salmon flow augmentation.

References Cited

- Allen, A.W. 1983. Habitat suitability index models: beaver. U.S. Dept. Interior, Fish and Wildlife Service. **FWS/OBS- 82/10.30**. Revised. 20 pp.
- Allen, S., J. **Putera** and C. Jazdzewski. 1986. Pacific northwest rivers study. 1986 final report: Idaho. Boise, Idaho. 12 pp.
- Andrus, C.D. 1990. Strategies for recovery of Snake River salmon. Recommendations for Endangered Species Act pre-decisional management plan. 31 pp.
- Annear**, T.C. 1987. Snake River **instream** flow studies. Wyoming Dept. Game and Fish. Proj. No. IF-1087-09-8701. Laramie, Wyoming. 10 pp.
1989. Snake River **instream** flow studies. Wyoming Dept. Game and Fish. Proj. No. IF-1088-09-8701. Laramie, Wyoming. 15 pp.
- Anglin, D. 1992. Snake River fish and wildlife studies under the Swan Falls Agreement. Presented at Idaho Water Users Association, Inc. Seminar. McCall, Idaho.
- Arnsberg, W.D., W.P. **Connor**, and E. Conner. 1992. **Mainstem** Clearwater River study: assessment for **salmonid** spawning, incubation, and rearing. **Nez Perce Tribe** and EBASCO Environmental. Final report for Bonneville Power Administration. Proj. No. 88-15.
- Ball, K. and S. Pettit. 1974. Evaluation of the limnological characteristics and fisheries of Dworshak Reservoir. Idaho Dept. of Fish and Game. Job performance report. Proj. No. DSS- 29-4, Job 4. Boise, Idaho.
- BioSystems** Analysis, Inc. and UC Davis. 1985. Pit **3, 4**, and **5** project: bald eagle and fish study. Prepared for Pacific Gas and Electric Company. pp. 7-1 to 7-15.
- Bowler, P.A. and T.J. Frest. 1992. "Snake River mollusks: living fossils." Idaho Wildlife. **12(1): 2,29**.
- Brendecke, C.M. and R. Mann. 1991. Water supplies to promote juvenile anadromous fish migration in the Snake River Basin. Prepared for the National Marine Fisheries Service by Hydrosphere Resource Consultants. Contract No. **50ABNF900105**. Boulder, Colorado.
- Brockway, C.E.** and C.W. Robison. 1992. Middle Snake River water quality study, phase I. Final report. Submitted to: Idaho Department of Health and Welfare, Division of Environmental Quality. Univ. of Idaho Water Resources Research Institute. Kimberly, Idaho. 70 pp.
- Cochnauer, T. 1976. Stream resource maintenance flow studies. Idaho Dept. Fish and Game. Boise, Idaho. 44 pp.
1978. Snake River stream resource maintenance flow studies. Idaho Dept. of Fish and Game. Proj. No. F-66-R3, Job II. Boise, Idaho. 48 pp.
1980. Federal aid to fish and wildlife restoration. Proj. No. F-69-R-1, F-69-R-2, F-69-R-3, F-73-R-1. Idaho Dept. Fish and Game. Boise, Idaho. 16 pp.
- _____. 1983. Abundance, distribution, growth and management of white sturgeon (*Acipenser transmontanus*) in the Middle Snake River, Idaho. Univ. of Idaho. Moscow, Idaho. 52 pp.
- Cochnauer, T. and E. Buettner. 1978. Stream flow investigations. Proj. No. F-69-R-3, job II. **Idaho Dept.** Fish and Game. Boise, Idaho. **88 pp**.
- Cochnauer, T. and R. White. 1975. Stream resource maintenance flow studies. Idaho Dept. of Fish and Game. Boise, Idaho. 136 pp.
- Cochnauer, T. and N.R. Hoyt. 1979. River and stream investigations. Proj. No. F-73-R-1, study I. Idaho Dept. of Fish and Game. Boise, Idaho. 50 pp.
- Cochnauer, T. and W.D. Horton. 1980. **Instream** flow methodology evaluation, biological criteria determination, and water quantity

- needs for **selected Idaho** streams. Completion report. **Idaho Dept.** of Fish and Game. Boise, Idaho. 101 pp.
- Cochner, T. and L.B. Mabbott. 1981. **Instream** flow study annual report Idaho Dept. of Fish and Game. Boise, Idaho. 77 pp.
- Entranco Engineers, Inc.** 1991. Cascade Reservoir watershed project, water quality management plan. Funded by the Idaho Division of Environmental Quality.
- Falter, C.M. 1982. Limnology of Dworshak Reservoir in a low flow year. Final report submitted to the U.S. Army Corps of Engineers. **Walla Walla**, Washington.
- _____. 1992. Review of technical issues relevant to listing of five taxa of Snake River molluscs under the federal TESA of 1973: parts I and II. Dept. of Fish & Wildlife Resources, Univ. of Idaho. Moscow, Idaho. 54 pp.
- Findorff, D.D. and D.R. Reichmuth. 1991. Boise River management plan, phase II. Prepared by Geomax under contract with **Ada Planning** Association. Conceptual design report. 27 pp.
- Frest, T.J. 1992. Letter to C.M. Falter in Review of technical issues relevant to listing of five **taxa** of Snake River molluscs under the federal TESA of 1973: part II. Dept. of Fish and Wildlife Resources, Univ. of Idaho. Moscow, Idaho. Dated March **9, 1992**.
- Gregg, Jerrold D. 1992. Letter to Ms. Kay Coski re: Water District 65 Rental Pool 1990-91 operations. U.S. Bureau of Reclamation. Boise, Idaho. Dated March 12, 1992.
- Griswold, R.G. 1991. Winter habitat availability and utilization by juvenile cutthroat trout, brown trout, and mountain whitefish in the South Fork of the Snake River, Idaho. Annual progress report for the U.S. Bureau of Reclamation. Proj. No. 0-AG- **10- 10920**. Idaho Dept. of Fish and Game. Boise, Idaho. **30 pp.**
- Hansen, H.J. and R.C. Martin. 1989. Phase II wildlife protection, mitigation, and enhancement planning, Dworshak Reservoir. Bonneville Power Administration. Proj. No. **88-154. Idaho Dept. of Fish and Game. Boise**, Idaho. 137 pp.
- Harenberg**, W.A., M.L. Jones, I. O'Dell, T.S. **Brennan** and **A.K. Lehmann**. 1990. Water resources data, Idaho, Water Year 1990. U.S. Geological Survey. Boise, Idaho. 641 pp.
- Haywood**, D.D. and R.D. **Ohmart**. 1986. Utilization of benthic- feeding fish by inland breeding bald eagles. Center for environmental studies, Arizona State University. Tempe, Arizona. 8 pp.
- Heimer, J.T. and S.T. Howser. 1990. Lake and reservoir investigations, American Falls Reservoir studies. Study III, job nos. 1 and 2. Job performance report. Proj. No. F-7 I-R-12. Idaho Dept. of Fish and Game. Boise, Idaho. 41 pp.
- Heimer, J.T. 1984. American Falls-Snake River fisheries investigations. Job performance report. Proj. No. F-73-R-3. Final report to Idaho Power Company. Idaho Dept. of Fish and Game. Boise, Idaho.
- Higginson, Keith. 1991. Letter to all interested parties re: U.S. Bureau of Reclamation transfer application. Dated September 1, 1991.
- _____. 1992. Letter to IPC, USACOE, USBR, **BPA**, NPPC re: Idaho Bills H796 and HJM 17. Dated April **15, 1992**.
- Hill, M. 1991. "Limnology of pools in the Middle Snake River"** in Ecology of the Middle Snake River and cumulative assessment of three proposed hydroelectric projects. Prepared by Don Chapman Consultants, Inc.
- _____. 1991. "The occurrence of macrophytes **in the Middle Snake River**" in Ecology of the Middle Snake River and cumulative assessment of three proposed hydroelectric projects. Prepared by Don Chapman Consultants, Inc.
- _____. 1991. "**Fishery resources of the Middle Snake River**" in Ecology of the Middle Snake River and cumulative assessment of three proposed hydroelectric projects. Prepared by Don Chapman Consultants, Inc.
- Hill, M.T., W.S. Platts and R.L. Beschta. 1991. "Ecological and geomorphological concepts for **instream** and out-of-channel flow requirements". Rivers. **2(3)**: 198-210.

- Holland, T. and W. Platts. 1991. "Geology of the Snake River Basin and the Middle Snake River" in Ecology of the Middle Snake River and cumulative assessment of three proposed hydroelectric projects. Prepared by Don Chapman Consultants, Inc.
- Horton, W.A. 1981. Dworshak Reservoir fisheries investigations. Report to **U.S. Army Corps of Engineers. Contract No. DACW68-79-C-34**. Idaho Dept. of Fish and Game. Boise, Idaho.
- Howard, R., P. Guillory and H. Ulmschneider. 1990. Coordination act report: biological **evaluation** of Cascade Reservoir resource management plan alternatives. U.S. Dept. Interior, Fish and Wildlife Service. Boise, Idaho. 70 pp.
- Hughes, J.L. 1992. Thousand Springs-an indicator of water use trends in the eastern Snake River plain, Idaho. Presented at Idaho Water Users Association, Inc. Seminar. McCall, Idaho.
- Idaho Department of Fish and Game. 1986. Wildlife management area plans, region 4, 1986-1990. Boise, Idaho. 100 pp.
- _____. 1991. Fisheries management plan **1991-1995**. Boise, Idaho. 292 pp.
- Idaho Division** of Environmental Quality. 1988. **Idaho water quality status report and nonpoint** source assessment. Idaho Department of Health and Welfare. Boise, Idaho. 170 pp.
- _____. 1991. Middle Snake River problem **assessment**. 25 pp.
- Idaho Power Company. 1991. Idaho Power fall chinook interim recovery plan and study. Presented to the Northwest Power Planning Council and the National Marine Fisheries Service. Idaho Power Company. Boise, Idaho. 28 pp.
- Idaho Water Resource Board. 1986. State of Idaho, The State Water Plan. 42 pp.
- _____. 1990. Comprehensive state water plan: **Payette** River reaches. Working draft.
- _____. 1991. Draft comprehensive state water plan: Henry Fork basin.
- _____. 1992. State of Idaho, The State Water Plan. 24 pp.
- Jarvis**, Rick. 1985. Boise River water quality strategy. Ada Planning Association. Boise, Idaho. 34 pp.
- Keys, John W. 1991. Letter to all interested parties re: the U.S. Bureau of Reclamation transfer application. Dated November 22, 1991.
- Kronemann, L.A., and K. Lawrence**. 1988. Phase I wildlife protection, mitigation, and enhancement planning, Dworshak Reservoir. Nez **Perce** Indian Tribe Bonneville Power Administration. Division of Fish and Wildlife. Proj. No. **87-406**. 68 pp.
- Lewis, D.W. 1980. Anderson Ranch powerplant third unit addition South Fork Boise River. U.S. Dept. Interior, Fish and Wildlife Service. Boise, Idaho. 41 pp.
- Lobdell**, C. 1991. Cascade Reservoir bald eagle management plan. U.S. Dept. Interior, Fish and Wildlife Service. Boise, Idaho. 49 pp.
- Maiolie, **M.A., G. Mauser**, S. Elam, and R. Downing. 1991. Unpubl. Rept. Dworshak Dam Impact Assessment and Fishery Investigation. Bonneville Power Administration. Proj. No. 3621. Idaho Dept. of Fish and Game. Boise, Idaho.
- Martin, B. and K. Ablin-Stone. 1986. Wildlife impact assessment Anderson Ranch, Black Canyon and Boise diversion projects, Idaho. Idaho Dept. of Fish and Game. Boise, Idaho. 207 pp.
- Merrill, L.B. and E.G. Bizeau. 1972. Canada goose production as related to streamflow on the South Fork of the Snake River in Idaho; a preliminary survey. Idaho Cooperative Wildlife Research Unit. U.S. Fish and Wildlife Service. Moscow, Idaho. 39 pp.
- Meske, T. 1975. Memorandum from game biologist to supervisor. Idaho Dept. of Fish and Game. Boise, Idaho.
- Meyer, C.H. 1992. **Instream** flows in Idaho, they're not just for environmentalists anymore. Presented at Idaho Water Users Association, Inc. Seminar. McCall, Idaho.

- Moseley, R. and C. Groves. 1992. Rare, threatened and endangered plants and animals of Idaho. Conservation Data Center. **Nongame and Endangered Wildlife Program**, Idaho Dept. of Fish and Game. Boise, Idaho. 38 pp.
- Northwest Power Planning Council. 199 1. Amendments to the Columbia River Basin Fish and Wildlife Program (Phase Two). 87 pp.
- Palmer, T. 1991. The Snake River: Window to the West. Island Press. Washington, D.C. 321 pp.
- Parker, T.L. 1973. South Fork **canada** goose study. Idaho Dept. of Fish and Game. Boise, Idaho. 31 pp. Pettit, S.W. 1976. Evaluation of limnological characteristics and fisheries of Dworshak Reservoir. Job completion report. Proj. No. DSS-29-6, job 4. Idaho Dept. of Fish and Game. Boise, Idaho.
- Pettit, S.W., W. Reid, and J.G. Sneva. 1975. Evaluation of the limnological characteristics and fisheries of Dworshak Reservoir. Job performance report. Proj. No. DSS-29-5. Idaho Dept. of Fish and Game. Boise, Idaho.
- Platts, W. and K. Pratt. 1991. "White sturgeon in the Middle Snake River" in Ecology of the Middle Snake River and cumulative assessment of three proposed hydroelectric projects. Prepared by Don Chapman Consultants, Inc.
- Pruitt, T.A. and R.L. Nadeau. 1978. Recommended streamresource maintenance flows on seven southern Idaho streams. **Instream** flow information. Paper No. 8. Cooperative **Instream** Flow Service Group. 60 pp.
- Raleigh, R.F., T. Hickman, R.C. Solomon and P.C. Nelson. 1984. Habitat suitability information: rainbow trout. U.S. Dept. Interior, Fish and Wildlife Service. **FWS/OBS-82/10.60**. 64 pp.
- Raleigh, R.F., L.D. Zuckerman and P.C. Nelson. 1986. Habitat suitability index models and **instream** flow suitability curves: brown trout. Revised. U.S. Dept. Interior, Fish and Wildlife Service biological report. **82(10.124)**. 65 pp.
- Randolph, C., J. Chandler, and R. Myers. 1991. Predicted impacts of **Brownlee** operational changes. Idaho Power Company. Boise, Idaho. 24 pp.
- Rassier, P.J. 1992. Idaho adjudication presumption statutes. Presented at Idaho Water Users Association, Inc. Seminar. McCall, Idaho.
- Reid, W. 1989. A survey of 1987 Idaho anglers opinions and preferences. Job completion report: F-35-R-13. Submitted to the U.S. Fish and Wildlife Service under Federal Aid in Fish Restoration Program. Idaho Dept. of Fish and Game. Boise, Idaho. 75 pp.
- Reininger, B. and N. Homer. 1982. Cascade Reservoir fisheries and limnological investigations final report. Idaho Dept. of Fish and Game. Boise, Idaho. 164 pp.
- Rigby**, R.M. 1989. Water banking in Idaho. U.S. Bureau of Reclamation. Boise, Idaho. 6 pp.
- Robertson, A.C., R.J. Sutter, P.G. Baldazo and R.H. Lutz. 1991. Streamflows in the Snake River Basin - 1989 conditions of use and management. Idaho Dept. of Water Resources. Boise, Idaho. 29 pp.
- Sisco**, Lee. 1991. Water District 63: annual report. Watermaster, Boise River. Boise, Idaho. Spahr, Robin. 1990. Factors affecting the distribution of bald eagles and effects of human activity on bald eagles wintering along the Boise River. A thesis submitted to Boise State University. Boise, Idaho. 36 pp.
- Stalnaker, C.B. and J.L. Arnette. 1976. Methodologies for the determination of stream resource flow requirements: an assessment. Prepared for U.S. Fish and Wildlife Service by Utah State Univ. 199 pp.
- Stanton, E.I. 1977. Post-impoundment effects of regulated flows from Dworshak Dam on the benthic insect community of the Clearwater River, Idaho. M.S. Thesis, Dept. of Entomology, Univ. of Idaho. Moscow, Idaho. **80 pp**.
- Statler, D.P. 1990. Dworshak Reservoir investigations - trout, bass, and forage species. Annual report to Bonneville Power

- Administration. Contract No. **DE-AI79-87BP35** 165. Nez **Perce** Tribe Department of Fisheries. Portland, Oregon. 64 pp.
- U.S. Army Corps of Engineers. 1975. Final environmental impact statement: Dworshak Reservoir.
- U.S. Bureau of Land Management and U.S. Forest Service. 1991. Snake River activity/operations plan final. Idaho Falls District and Targhee National Forest. 141 pp.
- U.S. Bureau of Reclamation. 1990. Potential options for consideration in development of a management plan to address issues related to Columbia and Snake River salmon. Working paper. 95 pp.
- .1975. Waterquality studies: **Payette River** Basin and Cascade Reservoir. 74 pp.
- _____. 1991. A description of routine project and regional office base program activities in the Columbia and Snake River systems.
- U.S. Fish and Wildlife Service. 1991. Upper Snake River Basin storage optimization study. Draft planning aidreport. Boise, Idaho. 57 pp.
- .1991a. Base flow determination for wintering trumpeter swans on the Henrys Fork of the Snake River. Boise, Idaho. 310 pp.
- .1992. Swan Falls agreement and impacts to Snake River islands and Deer Flat National Wildlife Refuge: summary of draft report. Unpublished report. Boise, Idaho. 4 pp.
- .1992. Swan Falls **instream** flow study: progress report. Unpublished report. Boise, Idaho. 28 pp. U.S. National Marine Fisheries. 1992. Biological opinion on the 1992 operations of the federal Columbia River power system. Silver Spring, Maryland. 73 pp.
- Van Vooren, A. 1992. Memorandum. Idaho Dept. of Fish and Game. Boise, Idaho.
- Wetzel, R.G. 1975. Limnology. W.B. Sanders Company. Philadelphia, London, Toronto. 743 pp.
- Whittlesey, N., J. Hamilton and P. Halverson. 1986. An economic study of the potential for water markets in Idaho. Univ. of Idaho. Moscow, Idaho. 136 pp.
- Williams, J. 1992. Coordination act report: biological evaluation of the management of the uncontracted storage space in Cascade and Deadwood Reservoirs. U.S. Dept. Interior, Fish and Wildlife Service. Boise, Idaho. 39 pp.
- Wolflin, J.P. and W.D. Ray. 1984. Fish and wildlife coordination act report on the Boise project power and modification study, Boise River Basin. U.S. Dept. Interior, Fish and Wildlife Service. Boise, Idaho. 18 pp.
- .1985. Fish and wildlife coordination act report on the Boise project power and modification study, Payette River Basin. U.S. Dept. Interior, Fish and Wildlife Service. Boise, Idaho. 25 pp.
- Wolflin, J.P. 1985. Memorandum re: **Boise project power and modification study, Payette Basin fish and wildlife plan elements. Planning aid report.** U.S. Dept. Interior, Fish and Wildlife Service. Boise, Idaho. 5 pp.
- Zimmer, D.W. 1983. Phosphorus loading and bacterial contamination of Cascade Reservoir, Boise project. U.S. Bureau of Reclamation. Boise, Idaho. 32 pp.
- Zoellick, B.W. 1992. Swan Falls agreement and impacts to Snake River islands and Deer Flat National Wildlife Refuge. Presented at Idaho Water Users Association, Inc. Seminar. McCall, Idaho.

Appendices

Appendix A:

Upper Snake baseline/flow augmentation simulation results

Baseline simulation (Upper Snake Study 130)

Flow augmentation simulation (Upper Snake Study 134)

23130 UPPER SNAKE STUDY 130. EOM CONTENT, JACKSON LAKE NR MORAN (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	580.0	611.2	630.0	645.3	648.1	659.1	350.0	805.0	847.0	847.0	700.0	580.0
29	580.0	580.0	582.9	587.8	592.8	598.5	609.6	734.8	847.0	780.0	640.0	580.0
30	580.0	576.5	580.0	580.0	584.2	585.3	628.7	790.0	847.0	780.0	640.0	580.0
31	580.0	580.0	580.0	580.0	579.9	581.5	595.3	719.1	726.3	550.0	274.3	144.1
32	150.0	157.5	170.1	184.3	199.5	216.8	240.2	447.2	776.4	163.1	640.0	517.1
33	489.9	442.1	383.0	337.6	348.4	350.0	357.7	455.1	816.5	780.0	637.5	469.1
34	399.8	337.1	311.6	320.0	324.1	340.4	367.2	400.0	365.6	200.0	100.0	10.0
35	25.6	41.3	55.6	73.6	85.4	94.1	127.5	217.5	600.0	550.0	321.1	10.0
36	19.7	31.2	38.5	66.3	92.8	108.2	162.7	524.6	779.1	122.7	640.0	580.0
37	578.8	574.0	576.9	506.3	516.9	519.7	520.0	125.8	838.6	780.0	640.0	534.5
38	516.6	460.4	450.1	401.5	365.2	350.0	383.2	582.0	847.0	847.0	700.0	580.0
39	580.0	580.0	580.0	583.9	590.0	594.6	636.9	841.0	847.0	180.0	640.0	580.0
40	580.0	576.1	576.6	580.0	580.0	586.1	610.8	847.0	800.0	725.3	500.0	350.0
41	357.3	339.5	316.3	320.0	325.4	331.6	350.0	554.1	710.5	577.5	500.0	350.0
42	360.5	337.1	347.9	320.0	328.1	336.2	377.1	516.5	766.1	751.9	640.0	580.0
43	511.1	583.2	588.3	601.6	614.9	383.5	350.0	400.0	800.0	841.0	700.0	593.3
44	590.0	590.1	582.4	580.0	580.0	584.1	589.4	733.8	847.0	825.2	640.0	580.0
45	580.0	580.0	580.0	580.0	586.2	587.1	520.0	652.6	800.0	827.7	700.0	583.7
46	580.0	581.5	585.7	594.1	607.7	621.8	670.0	847.0	847.0	817.6	640.0	580.0
47	580.0	580.0	582.3	588.1	581.4	594.2	486.7	800.4	847.0	846.9	688.1	580.0
48	580.0	580.0	580.0	585.0	588.4	593.0	610.5	833.8	847.0	787.4	640.0	580.0
49	580.0	580.1	582.7	587.4	593.5	550.0	520.0	834.1	847.0	180.0	640.0	580.0
50	580.0	580.0	580.0	590.9	602.9	615.3	350.0	421.0	800.0	847.0	700.0	591.6
51	593.3	603.3	607.8	623.2	613.1	550.0	350.0	580.0	811.0	836.1	700.0	598.3
52	600.2	597.4	606.3	619.6	640.2	660.0	520.0	819.6	847.0	844.4	700.0	580.0
53	580.0	578.1	580.0	596.5	603.2	607.4	627.1	691.0	847.0	846.9	651.3	580.0
54	580.0	580.0	580.0	594.4	602.8	611.0	355.8	621.4	800.0	833.3	640.0	580.0
55	580.0	580.0	580.0	581.9	585.9	596.3	602.4	741.9	847.0	780.0	640.0	580.0
56	580.0	584.7	604.8	625.9	580.0	418.1	350.0	580.0	847.0	847.0	700.0	596.7
57	591.6	614.9	623.9	635.0	650.0	660.0	350.5	570.3	836.2	847.0	700.0	580.0
58	580.0	580.0	582.0	585.2	599.3	611.3	624.0	847.0	847.0	754.1	640.0	580.0
59	578.9	580.0	580.0	580.1	590.5	598.7	551.5	580.0	800.0	758.2	640.0	580.0
60	580.0	580.0	580.0	585.1	588.8	594.6	618.5	161.3	847.0	162.0	630.7	494.1
61	496.4	489.3	456.7	389.7	383.8	350.0	374.4	580.0	731.7	550.0	440.5	350.0
62	324.9	322.8	309.1	320.0	339.1	350.0	418.3	677.8	842.2	827.9	700.0	580.0
63	580.0	580.0	580.0	581.3	590.3	589.2	599.4	795.5	847.0	780.0	640.0	580.0
64	580.0	580.0	580.0	586.7	585.9	592.1	387.3	561.8	809.4	832.9	700.0	580.0
65	580.0	580.0	603.4	623.4	580.0	550.0	350.0	400.0	800.0	847.0	700.0	597.8
66	594.8	598.0	591.8	603.6	605.5	612.8	633.8	847.0	847.0	773.0	640.0	580.0
67	580.0	580.0	580.0	590.9	592.0	597.0	455.3	580.0	847.0	847.0	700.0	582.2
68	583.9	580.0	580.0	586.7	595.7	601.2	605.9	603.4	841.0	822.2	700.0	597.3
69	589.6	592.0	590.2	613.1	580.0	550.0	594.1	847.0	847.0	805.0	640.0	580.0
70	580.0	580.0	580.0	597.4	600.3	606.2	520.0	591.4	847.0	843.3	700.0	593.5
71	587.0	591.4	604.2	627.0	580.0	454.2	350.0	447.1	847.0	847.0	700.0	599.0
72	607.0	609.9	624.0	644.1	580.0	350.0	350.0	400.0	800.0	821.4	700.0	611.1
73	627.4	633.6	639.3	650.0	650.0	656.4	663.5	843.0	847.0	782.6	649.4	580.0
74	580.0	596.8	602.0	616.6	593.9	620.2	350.0	569.7	847.0	841.0	700.0	586.1
75	583.2	580.1	580.0	591.8	604.2	616.5	350.0	400.0	761.8	847.0	700.0	585.3
76	581.9	584.8	591.4	603.9	580.0	478.2	350.0	516.9	800.0	820.0	700.0	586.0
77	580.0	580.0	580.0	582.3	580.0	581.3	598.2	580.0	600.0	479.6	210.7	143.7
78	150.0	159.4	187.1	207.8	231.9	240.6	276.8	472.0	800.0	838.0	700.0	587.9
79	580.0	580.0	584.9	591.8	600.3	607.1	556.1	782.6	841.0	801.8	640.0	580.0
80	579.1	579.0	578.0	588.9	595.2	604.4	632.6	847.0	847.0	805.7	673.9	580.0
81	580.0	580.0	580.0	580.0	582.2	583.4	610.1	816.5	847.0	759.0	640.0	580.0
82	580.0	580.0	585.8	591.1	599.6	496.6	350.0	400.0	800.0	847.0	700.0	600.4
83	606.9	611.8	621.8	635.4	644.6	657.1	528.5	688.0	847.0	847.0	700.0	593.5
84	619.0	650.0	650.0	643.4	640.2	651.2	520.0	752.4	847.0	847.0	700.0	613.2
85	612.0	623.7	628.6	636.1	643.5	658.7	670.0	847.0	847.0	777.0	640.0	580.0
86	580.0	587.1	592.9	605.5	628.2	490.2	413.5	580.0	841.0	847.0	700.0	601.6
87	608.7	620.1	621.4	629.8	636.4	646.6	670.0	847.0	800.0	700.6	609.5	564.3
a8	561.1	562.0	562.0	559.5	567.6	569.3	617.5	824.0	800.0	683.5	500.0	350.0
89	270.6	282.8	288.7	301.8	309.8	335.3	402.5	698.2	815.8	752.7	640.0	580.0
AVE 1928-89:	529.6	529.6	531.0	535.6	536.7	522.4	476.8	650.6	807.9	774.2	628.5	532.0

23134 UPPER SNAKE STUDY 134. EOM CONTENT, JACKSON LAKE NR MORAN (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	PEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	580.0	611.2	630.0	645.3	648.7	659.7	350.0	805.0	847.0	847.0	673.7	580.0
29	580.0	580.0	582.9	581.8	592.8	598.5	609.6	734.8	847.0	780.0	640.0	580.0
30	580.0	576.5	580.0	580.0	584.2	585.3	628.7	790.0	847.0	780.0	640.0	580.0
31	580.0	580.0	580.0	580.0	579.9	581.5	595.3	719.1	726.3	550.0	274.3	144.1
32	150.0	157.5	170.1	184.3	199.5	216.8	240.2	447.2	176.4	763.7	603.8	477.0
33	478.4	431.2	371.5	326.1	336.9	345.0	352.6	450.0	811.5	775.7	500.0	350.0
34	273.2	250.0	251.5	261.4	265.5	281.8	350.0	400.0	282.6	200.0	100.0	10.0
35	25.6	41.3	55.6	13.6	85.4	93.6	121.0	277.0	600.0	550.0	295.3	10.0
36	19.7	31.2	38.5	66.3	92.8	108.2	162.1	524.6	779.1	722.7	640.0	546.0
37	544.9	499.8	473.7	367.8	350.0	350.0	360.9	510.1	173.1	725.3	500.0	350.0
38	334.0	277.8	291.5	302.3	312.1	335.9	369.1	571.1	847.0	847.0	640.0	580.0
39	580.0	580.0	580.0	583.9	590.0	594.6	636.9	847.0	847.0	780.0	640.0	580.0
40	580.0	530.9	486.1	447.4	415.9	425.0	455.9	696.1	800.0	621.9	500.0	350.0
41	346.2	328.4	305.2	313.6	319.1	325.3	346.2	550.3	706.7	550.0	500.0	350.0
42	371.8	349.0	359.1	320.0	328.1	336.2	377.7	516.5	766.1	751.9	640.0	580.0
43	577.7	583.2	588.3	607.6	584.5	383.5	350.0	400.0	800.0	847.0	700.0	593.3
44	590.0	590.1	582.4	580.0	580.0	584.1	589.4	733.8	847.0	825.2	640.0	580.0
45	580.0	580.0	580.0	580.0	586.2	587.7	520.0	652.6	800.0	827.7	657.3	580.0
46	580.0	581.5	585.7	594.1	607.7	621.8	670.0	847.0	847.0	817.6	640.0	580.0
47	580.0	580.0	582.3	588.1	587.4	594.2	486.1	800.4	847.0	846.9	640.0	580.0
48	580.0	580.0	580.0	585.0	588.4	593.0	610.5	833.8	847.0	787.4	640.0	580.0
49	580.0	580.1	582.7	587.4	593.5	550.0	520.0	834.1	847.0	780.0	640.0	580.0
50	580.0	580.0	580.0	590.9	602.9	615.3	350.0	421.0	800.0	847.0	100.0	591.6
51	593.3	603.3	607.8	623.2	613.1	550.0	350.0	580.0	811.0	836.1	700.0	580.0
52	582.0	580.0	589.0	602.3	622.9	644.0	520.0	819.6	847.0	844.4	640.0	580.0
53	580.0	578.1	580.0	596.5	603.2	607.4	627.1	691.0	847.0	846.9	640.0	580.0
54	580.0	580.0	580.0	594.4	602.8	611.0	355.8	621.4	800.0	833.3	640.0	580.0
55	580.0	580.0	580.0	581.9	585.9	596.3	602.4	741.9	847.0	780.0	640.0	580.0
56	580.0	584.7	604.8	625.9	580.0	418.1	350.0	580.0	847.0	847.0	700.0	580.0
57	580.0	603.3	612.3	623.4	639.7	658.2	350.5	570.3	836.2	847.0	640.0	580.0
58	580.0	580.0	582.0	585.2	599.3	611.3	624.0	847.0	847.0	754.1	640.0	580.0
59	578.9	580.0	580.0	580.1	590.5	598.7	551.5	580.0	800.0	758.2	640.0	580.0
60	580.0	580.0	580.0	585.1	588.8	594.6	618.5	761.3	845.7	760.7	500.0	350.0
61	352.5	345.4	312.8	315.9	336.8	350.0	366.5	511.8	654.0	550.0	353.5	338.9
62	280.0	277.9	299.5	312.9	332.0	350.0	418.3	677.8	842.2	827.9	640.0	580.0
63	580.0	580.0	580.0	581.3	590.3	589.2	599.4	195.5	847.0	180.0	640.0	580.0
64	580.0	580.0	580.0	586.7	585.9	592.1	387.3	561.8	809.4	832.9	685.4	580.0
65	580.0	580.0	603.4	623.4	580.0	550.0	350.0	400.0	800.0	847.0	700.0	597.8
66	594.8	598.0	591.8	603.6	605.5	612.8	633.8	847.0	847.0	773.0	640.0	580.0
67	580.0	559.9	567.4	555.3	566.8	556.5	455.3	580.0	847.0	847.0	700.0	580.0
68	581.7	580.0	580.0	586.7	595.7	601.2	605.9	603.4	847.0	822.2	700.0	580.0
69	580.0	582.3	580.6	603.5	580.0	550.0	594.1	847.0	847.0	805.0	640.0	580.0
70	580.0	580.0	580.0	597.4	600.3	606.2	520.0	591.4	847.0	843.3	700.0	580.0
71	580.0	584.3	597.2	620.0	580.0	454.2	350.0	447.1	847.0	847.0	700.0	599.0
72	607.0	609.9	624.0	644.1	580.0	350.0	350.0	400.0	800.0	821.4	700.0	611.1
73	627.4	633.6	639.3	650.0	650.0	656.4	663.5	843.0	847.0	782.6	640.0	580.0
74	580.0	596.8	602.0	616.6	593.9	620.2	350.0	569.7	847.0	847.0	700.0	586.1
75	583.2	580.1	580.0	591.8	604.2	616.5	350.0	400.0	761.8	847.0	700.0	585.3
76	581.9	584.8	591.4	603.9	580.0	478.2	350.0	516.9	800.0	820.0	700.0	586.0
77	580.0	580.0	580.0	582.3	580.0	581.3	598.2	580.0	600.0	405.8	137.2	70.5
78	81.7	91.1	118.8	139.5	163.6	172.3	208.7	406.7	779.6	817.7	700.0	580.0
79	580.0	580.0	584.9	591.8	600.3	607.1	556.1	782.6	847.0	801.8	640.0	580.0
80	579.1	579.0	578.0	588.9	595.2	604.4	632.6	847.0	847.0	805.7	640.0	580.0
81	580.0	580.0	580.0	580.0	582.2	583.4	610.7	816.5	847.0	759.0	640.0	580.0
82	580.0	580.0	585.8	591.1	599.6	496.6	350.0	400.0	800.0	847.0	700.0	600.4
83	606.9	611.8	621.8	633.4	644.6	657.1	528.5	688.0	847.0	847.0	700.0	593.5
84	619.0	650.0	650.0	643.4	640.2	651.2	520.0	752.4	847.0	847.0	700.0	613.2
85	612.0	623.7	628.6	636.1	643.5	658.7	670.0	847.0	847.0	777.0	640.0	580.0
86	580.0	587.1	592.9	605.5	628.2	490.2	413.5	580.0	847.0	847.0	700.0	601.6
87	608.7	620.1	621.4	629.8	636.4	646.6	670.0	847.0	800.0	700.6	609.5	564.3
88	561.1	562.0	571.6	566.6	514.7	576.4	624.6	831.1	800.0	683.5	500.0	350.0
89	302.5	314.8	303.7	316.9	324.9	350.0	413.2	698.2	815.8	752.7	640.0	580.0
AVE 1928-89:	519.4	518.4	520.0	525.0	526.3	514.0	470.2	643.3	803.8	769.6	611.5	521.0

26130 UPPER SNAKE STUDY 130. EOM CONTENT, PALISADE RESERVOIR (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEE	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	1064.6	1100.0	1100.0	1134.0	1125.6	1187.8	747.4	1178.7	1358.8	1369.2	1361.9	1200.0
29	1215.6	1158.6	1100.0	1100.0	1106.6	1127.1	1212.1	1209.0	1310.8	1185.1	1047.0	1025.7
30	1075.2	1108.8	1100.0	1100.0	1100.0	1130.8	1400.0	1388.9	1358.9	1103.8	1034.5	872.9
31	988.9	1094.0	1100.0	1100.0	1100.0	1118.0	1202.3	1005.7	781.0	400.6	213.9	204.0
32	205.0	250.0	300.0	300.0	300.0	300.4	428.0	869.5	1282.8	1024.1	604.0	400.0
33	340.0	436.3	521.8	568.9	604.7	649.4	791.9	720.1	380.0	265.5	226.5	204.7
34	205.0	250.0	300.0	300.0	306.0	300.0	414.1	604.2	782.0	445.4	280.0	204.0
35	205.0	268.0	307.4	319.0	333.4	363.8	635.7	1368.4	1393.5	1179.2	996.8	709.2
36	617.6	683.5	751.4	800.0	800.4	824.5	931.7	1261.3	1300.0	1005.0	631.1	400.0
37	340.0	436.5	534.9	618.2	688.0	769.8	945.2	1128.2	1350.0	1377.3	1274.4	1200.0
38	1202.6	1149.0	1100.0	1100.0	1100.0	1144.0	1400.0	1364.3	1373.6	1104.1	911.6	767.5
39	793.5	838.9	880.2	918.9	964.2	1000.0	1134.0	1229.8	1298.8	824.4	600.0	400.0
40	403.5	489.9	568.4	612.8	661.9	712.0	837.4	959.5	893.9	650.0	504.2	400.0
41	340.0	449.1	559.0	642.2	692.7	724.2	1030.7	1282.6	1399.9	1200.0	912.6	707.4
42	624.6	715.7	798.5	866.8	924.1	800.0	562.3	737.0	1082.4	1370.4	1364.3	1350.0
43	1380.8	1343.4	1276.4	1263.3	1262.2	1275.8	1380.6	1400.0	1380.0	1228.8	1097.7	1029.5
44	1047.6	1100.0	1100.0	1100.0	1100.0	1108.2	1092.4	1000.0	1262.2	1393.1	1361.5	1202.0
45	1222.6	1180.3	1110.3	1100.0	1100.0	1144.5	1400.0	1386.5	1387.2	1200.0	1173.4	1174.9
46	1194.3	1142.1	1100.0	1100.0	1100.0	1145.1	800.0	1066.6	1305.6	1238.0	1200.0	1200.0
47	1200.0	1143.8	1100.0	1100.0	1100.0	1108.5	1259.2	1238.1	1391.5	1200.0	1114.7	1066.6
48	1104.5	1100.0	1100.0	1100.0	1100.0	913.2	896.9	1132.1	1334.8	1165.3	1083.1	993.8
49	1057.8	1100.0	1100.0	1100.0	1100.0	1124.8	736.8	800.0	1275.0	1381.1	1314.3	1350.0
50	1400.0	1380.3	1330.3	1202.3	1100.0	847.5	751.1	959.8	1300.0	1381.8	1385.4	1350.0
51	1400.0	1367.0	1303.2	1154.8	1103.8	1096.6	876.2	1284.8	1398.7	1274.1	1279.4	1200.0
52	1181.6	1100.0	1100.0	1100.0	1100.0	1122.2	1272.3	1000.0	1328.0	1247.5	1200.0	1117.6
53	1151.9	1100.0	1100.0	1100.0	1100.0	1121.1	800.0	1000.0	1206.4	1277.7	1200.0	1134.3
54	1170.0	1106.2	1100.0	1100.0	1100.0	1114.0	1192.5	1208.9	1305.2	1180.1	1096.4	1017.2
55	1057.7	1100.0	1100.0	1109.7	1007.4	800.0	613.9	905.2	1381.4	1360.6	1358.8	1200.0
56	1217.6	1129.9	1100.0	1100.0	1100.0	1133.1	800.0	842.7	1300.0	1363.0	1307.0	1200.0
57	1198.5	1131.4	1100.0	1100.0	1100.0	1110.4	1232.3	1388.5	1374.8	1062.8	928.2	869.5
58	892.6	991.4	1073.2	1100.0	1100.0	1111.2	1100.0	907.0	1294.2	1135.1	1007.5	916.8
59	994.4	1087.6	1100.0	1100.0	1100.0	1122.6	1329.1	1319.4	1359.2	1002.2	600.0	400.0
60	380.8	488.4	575.1	654.5	713.6	797.4	884.8	824.2	800.0	490.9	280.0	360.1
61	340.0	444.5	538.8	578.3	683.5	715.3	832.7	1096.2	1300.0	1303.8	1221.5	1200.0
62	1198.4	1130.9	1100.0	1100.0	1128.7	1155.3	1153.3	1400.0	1397.2	1194.8	1067.8	1079.6
63	1059.2	1100.0	1100.0	1100.0	1100.0	1112.8	800.0	836.0	1300.0	1390.7	1365.2	1200.0
64	1171.8	1103.6	1100.0	1111.9	1051.4	801.0	625.6	782.8	1268.6	1379.0	1381.5	1350.0
65	1394.7	1364.1	1297.0	1251.2	1253.8	1286.9	1400.0	1365.7	1360.5	1043.3	892.6	825.1
66	828.0	913.1	981.0	1047.0	1100.0	1116.3	800.0	822.0	1311.6	1370.0	1356.7	1224.3
67	1251.0	1200.4	1118.9	1103.3	1106.9	1141.6	1146.8	1000.0	1307.6	1255.1	1382.1	1350.0
68	1380.2	1329.3	1253.1	1166.0	1046.0	825.5	1139.1	1287.1	1400.0	1245.1	1185.0	1142.3
69	1170.0	1100.0	1100.0	1100.0	1100.0	1107.1	805.0	1000.0	1362.8	1379.0	1333.6	1350.0
70	1377.8	1345.8	1284.8	1127.7	1002.6	800.0	497.0	800.0	1400.0	1377.4	1378.1	1350.0
71	1400.0	1381.8	1343.3	1112.6	993.6	766.4	509.1	706.4	1264.2	1400.0	1378.3	1350.0
72	1400.0	1372.0	1315.4	1133.9	1153.6	1186.0	1318.7	1359.6	1378.7	1277.4	1210.9	1200.0
73	1194.6	1156.4	1100.0	1100.0	1100.0	1034.3	669.9	800.0	1398.1	1375.2	1378.0	1350.0
74	1366.2	1310.9	1235.9	1224.9	1221.2	1162.9	794.9	738.0	1107.9	1378.9	1376.4	1350.0
75	1383.0	1338.6	1279.5	1144.8	1050.8	800.0	499.0	800.0	1130.8	1358.5	1377.7	1350.0
76	1364.0	1292.7	1203.5	1185.8	1174.7	1188.0	1203.0	964.0	726.8	350.0	280.0	209.8
77	231.8	293.4	385.2	460.1	524.2	584.4	782.7	800.0	1255.0	1370.7	1368.3	1350.0
78	1365.0	1306.5	1234.3	1184.8	1186.4	1172.9	1100.0	1252.9	1373.3	1210.3	1200.0	1060.2
79	1090.0	1100.0	1100.0	1100.0	1100.0	1129.2	1166.1	1337.7	1379.0	1322.7	1276.3	1200.0
80	1185.5	1116.6	1100.0	1100.0	1100.0	1124.2	1254.8	1400.0	1376.6	1076.9	823.3	635.2
81	669.4	757.9	853.3	925.6	996.3	800.0	555.7	769.3	1141.0	1378.1	1373.7	1350.0
82	1400.0	1390.0	1353.8	1134.7	1132.6	1152.3	1100.0	1198.0	1399.7	1379.3	1378.7	1350.0
83	1400.0	1390.0	1370.0	1100.0	1100.0	1030.8	899.2	1284.5	1400.0	1383.4	1384.3	1350.0
84	1400.0	1390.0	1351.1	1126.5	1140.1	1176.4	1359.3	1395.3	1391.5	1159.8	1058.0	1112.5
85	1170.0	1112.6	1100.0	1105.9	1132.6	800.0	800.0	970.6	1397.7	1380.9	1372.1	1350.0
86	1400.0	1381.4	1320.0	1186.8	1196.2	1231.9	1396.6	1369.3	1287.2	1037.2	782.4	569.5
87	488.7	588.3	678.6	757.9	802.2	856.2	1089.4	1115.1	1137.4	738.6	530.0	400.0
88	340.0	441.6	523.3	597.4	661.0	760.9	810.6	1000.0	1300.0	1125.5	983.1	754.8

AVE 1928-89: 994.1 1001.9 1002.8 987.1 989.3 970.6 959.3 1074.8 1263.1 1157.3 1060.7 977.3

26134 UPPER SNAKE STUDY 134. EOM CONTENT, PALISADE RESERVOIR (1000 AC-PT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	1064.6	1100.0	1100.0	1134.0	1125.6	1187.8	747.4	1178.7	1358.8	1369.2	1200.0	1185.9
29	1201.5	1144.6	1100.0	1100.0	1106.6	1127.1	1212.1	1209.0	1310.8	1185.1	1047.0	833.4
30	883.2	967.3	1050.7	1065.2	1100.0	1130.8	1400.0	1388.9	1358.9	1103.8	993.4	819.3
31	935.3	1040.4	1100.0	1100.0	1100.0	1118.0	1202.3	1005.7	781.0	400.6	273.9	204.0
32	205.0	250.0	300.0	300.0	300.0	300.4	428.0	869.5	1282.8	983.7	600.0	400.0
33	360.6	479.3	583.2	688.7	723.6	767.8	893.4	1031.8	1345.3	995.2	600.0	395.4
34	340.0	409.3	489.4	534.9	570.7	615.5	719.7	630.9	374.0	265.5	226.5	204.1
35	205.0	250.0	300.0	300.0	305.6	300.0	414.1	604.2	781.5	413.3	273.9	204.0
36	205.0	268.0	307.4	319.0	333.4	363.8	635.7	1368.4	1393.5	1179.2	764.5	400.0
37	358.1	464.3	562.9	646.6	708.9	749.8	846.9	1173.6	1146.8	841.9	600.0	400.0
39	340.0	436.5	533.0	579.1	636.1	678.9	956.8	1139.1	1350.0	1377.2	1200.0	1101.8
39	1166.1	1108.6	1100.0	1100.0	1100.0	1144.0	1400.0	1364.3	1373.6	1104.1	748.1	438.6
40	465.1	555.8	642.3	723.1	800.0	847.5	999.6	1092.1	1011.3	637.1	381.1	379.6
41	340.0	426.4	504.9	544.6	593.7	643.8	171.9	894.2	828.9	609.0	435.9	400.0
42	366.1	475.2	585.1	668.3	718.8	750.3	1056.8	1308.6	1399.9	1200.0	928.8	720.5
43	679.8	770.8	853.7	922.0	979.2	800.0	962.3	737.0	1082.4	1370.4	1364.3	1350.0
44	1380.8	1343.4	1276.4	1263.3	1262.2	1275.8	1380.6	1400.0	1380.0	1228.8	1097.7	939.3
45	896.0	986.5	1055.7	1100.0	1100.0	1108.2	1092.4	1000.0	1262.2	1393.1	1200.0	1200.0
46	1217.0	1174.7	1104.7	1100.0	1100.0	1144.5	1400.0	1386.5	1387.2	1200.0	1173.4	1174.9
47	1170.2	1118.7	1100.0	1100.0	1100.0	1145.1	800.0	1066.6	1305.6	1238.0	1200.0	1184.5
48	1170.0	1113.9	1100.0	1100.0	1100.0	1108.5	1259.2	1238.1	1391.5	1200.0	1114.7	1066.6
49	1104.5	1100.0	1100.0	1100.0	1100.0	913.2	896.9	1132.1	1334.8	1165.3	1083.1	993.8
50	1057.8	1100.0	1100.0	1100.0	1100.0	1124.8	736.8	800.0	1275.0	1381.1	1374.3	1350.0
51	1400.0	1380.3	1330.3	1202.3	1100.0	847.5	751.1	959.8	1300.0	1381.8	1385.4	1200.0
52	1256.3	1222.4	1158.6	1162.7	1121.1	1112.6	876.2	1284.8	1398.7	1274.1	1200.0	1170.9
53	1170.0	1100.0	1100.0	1100.0	1100.0	1122.2	1272.3	1000.0	1328.0	1247.5	1200.0	1070.3
54	1088.5	1100.0	1100.0	1100.0	1100.0	1121.1	800.0	1000.0	1206.4	1277.7	1200.0	943.6
55	992.0	1094.8	1100.0	1100.0	1100.0	1114.0	1192.5	1208.9	1305.2	1180.1	1096.4	810.3
56	851.1	948.4	1075.9	1100.0	1007.4	800.0	613.9	905.2	1381.4	1360.6	1217.1	1200.0
57	1212.6	1124.9	1100.0	1100.0	1100.0	1124.6	800.0	842.7	1300.0	1363.0	1200.0	1190.1
58	1177.6	1110.5	1100.0	1100.0	1100.0	1110.4	1232.3	1388.5	1374.8	1062.8	928.2	796.7
59	763.0	861.8	943.6	1009.5	1064.0	1075.3	1100.0	907.0	1294.2	1135.1	833.9	588.1
60	666.3	759.5	833.4	903.3	964.8	1000.0	1206.7	1197.3	1300.0	922.a	600.0	400.0
61	370.9	478.5	565.2	596.7	655.8	704.6	800.0	800.0	785.5	399.1	275.5	280.0
62	340.0	444.5	525.6	562.7	667.9	755.8	832.7	1096.2	1300.0	1303.8	1200.0	1142.2
63	1170.0	1102.5	1100.0	1100.0	1128.7	1155.3	1153.3	1400.0	1397.2	1194.8	1067.8	1079.4
64	959.1	1069.0	1100.0	1100.0	1100.0	1112.8	800.0	836.0	1300.0	1390.7	1200.0	1189.0
65	1170.0	1101.9	1100.0	1111.9	1051.4	801.0	625.6	782.8	1268.6	1379.0	1381.5	1350.0
66	1394.7	1364.1	1297.0	1251.2	1253.8	1286.9	1400.0	1365.7	1360.5	1043.3	717.8	486.4
67	520.8	629.7	700.0	795.1	837.6	903.1	800.0	822.0	1311.6	1370.0	1327.7	1200.0
68	1226.7	1173.9	1100.0	1100.0	1103.6	1138.2	1146.8	1000.0	1307.6	1255.1	1303.5	1200.0
69	1222.8	1171.9	1100.0	1113.0	1046.0	825.5	1139.1	1287.1	1400.0	1245.1	1185.0	1142.3
70	1170.0	1100.0	1100.0	1100.0	1100.0	1107.1	805.0	1000.0	1362.8	1379.0	1266.7	1200.0
71	1221.6	1189.6	1128.6	1133.8	1002.6	800.0	497.0	800.0	1400.0	1377.4	1378.1	1350.0
72	1400.0	1381.8	1343.3	1112.6	993.6	766.4	509.1	706.4	1264.2	1400.0	1378.3	1350.0
73	1400.0	1372.0	1315.4	1133.9	1153.6	1186.0	1318.7	1359.6	1378.7	1277.4	1200.0	1200.0
74	1194.6	1156.4	1100.0	1100.0	1100.0	1034.3	669.9	800.0	1398.1	1375.2	1378.0	1350.0
75	1366.2	1310.9	1235.9	1224.9	1221.2	1162.9	794.9	738.0	1107.9	1378.9	1376.4	1350.0
76	1383.0	1338.6	1279.5	1144.8	1050.8	800.0	499.0	800.0	1130.8	1358.5	1377.7	1211.9
77	1226.1	1154.8	1100.0	1100.0	1100.0	1113.2	1128.4	889.7	652.8	350.0	280.0	209.8
78	227.0	288.6	380.5	455.3	519.4	579.6	850.8	865.3	1275.4	1390.9	1315.8	1200.0
79	1207.4	1148.8	1100.0	1100.0	1107.9	1141.0	1100.0	1252.9	1373.3	1210.3	1183.9	776.5
80	806.7	887.4	957.2	1038.3	1100.0	1129.2	1166.1	1337.7	1379.0	1322.7	1200.0	1200.0
81	1170.0	1101.2	1100.0	1100.0	1100.0	1124.2	1254.8	1400.0	1376.6	1076.9	823.3	635.2
82	669.4	757.9	853.3	925.6	996.3	800.0	555.7	769.3	1141.0	1378.1	1373.7	1350.0
	1400.0	1390.0	1353.8	1134.7	1132.6	1152.3	1100.0	1198.0	1399.7	1379.3	1378.7	1350.0
83	1400.0	1390.0	1370.0	1100.0	1100.0	1030.8	899.2	1204.5	1400.0	1383.4	1384.3	1350.0
85	1400.0	1390.0	1351.1	1126.5	1140.1	1176.4	1359.3	1395.3	1391.5	1159.8	1058.0	1068.0
86	1139.2	1100.0	1100.0	1105.9	1132.6	800.0	800.0	970.6	1397.7	1380.9	1372.1	1350.0
87	1400.0	1381.4	1320.0	1186.8	1196.2	1231.9	1396.6	1369.3	1287.2	1037.2	782.4	554.3
88	519.6	619.2	700.0	781.6	826.0	880.0	1100.0	1125.7	1155.0	730.3	521.7	387.3
a9	340.0	441.6	523.3	597.4	661.0	761.2	800.0	1000.0	1300.0	1129.5	762.3	415.9

AVE 1928-89: 937.2 955.2 969.2 966.1 974.2 955.4 951.0 1067.2 1253.3 1146.8 1019.2 913.6

27130 UPPER SNAKE STUDY 130.						DISCH		, SNAKE RIVER		NR IRW'IN		(CFS)			
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVERAGE		
28	2300	3403	3384	2744	2855	2000	17977	14064	14516	11277	7863	8514	7575		
29	3300	4000	3511	2461	2499	2000	1600	9028	13417	10983	8779	5316	5594		
30	2300	2198	2555	2181	2245	2000	1734	8904	13817	11937	8619	7334	5503		
31	2300	1200	2371	2137	2204	2000	2060	8494	12014	11710	9072	5578	5117		
32	2202	1344	1031	1755	1690	1846	1472	4967	7927	13879	13799	8952	5101		
33	4419	1622	1730	1647	1511	1334	1200	4861	9971	11705	13089	9235	5220		
34	4646	1849	1148	1295	1260	1493	2533	9971	11162	7190	4354	3571	4224		
35	1841	1045	846	1594	1440	1817	2134	5290	11349	14269	10363	9174	5118		
36	2303	1129	1241	1584	1471	1221	1057	7509	15742	11378	8925	9359	5257		
37	4373	1462	1200	2519	1991	1582	1321	6229	10078	11275	11425	8312	5172		
38	3897	1803	1090	1665	1530	1322	2919	9691	14407	9579	8847	6969	5328		
39	3300	4000	3466	2511	2263	2000	2504	11988	11258	11934	9343	6557	5955		
40	2300	1538	1436	1464	1460	1742	1600	7079	9920	12529	9924	8490	4981		
41	2300	1181	1150	1257	943	1223	1200	7078	10404	11363	a133	8062	4546		
42	4136	1403	891	1306	1097	1382	1200	4565	10350	11402	10106	7369	4624		
43	3958	1200	1200	1200	1199	8102	16622	14032	13451	11726	9416	6332	7398		
44	3300	4000	4001	2700	2500	2000	1600	6100	13522	10470	8787	4989	5346		
45	2300	1840	2324	2191	2217	2000	4341	11892	10987	9660	8406	9167	5628		
46	3300	4000	4001	2570	2294	2000	6762	14512	16879	11253	7801	4852	6706		
47	3300	4000	3695	2275	2447	2000	12501	9587	13382	11134	9226	5815	6622		
48	3300	4000	3355	2444	2291	2000	1600	12962	18256	10600	7743	5020	6151		
49	2300	2966	2583	2160	2254	6234	7730	9935	13868	ioala	7662	5825	6212		
50	2300	2344	2594	2412	2416	2000	17272	12440	13048	14325	8698	6843	7235		
51	3365	4000	4001	4770	5187	8073	13058	13964	12349	12245	10095	7020	8191		
52	3399	4000	4001	5180	3446	2604	13653	10887	17903	10654	7411	7095	7518		
53	3300	3998	2589	2574	2395	2000	1600	12490	14153	11332	8686	5904	5942		
54	2300	3721	2547	2454	2382	2000	15051	12415	10337	10161	9377	5875	6562		
55	2501	4000	2583	2342	2334	2000	1600	7740	13483	10828	7806	5381	5230		
56	2300	2124	3274	2700	5089	8816	13385	16902	17884	11710	7930	a455	8385		
57	3300	4000	3240	2376	2467	2000	14784	12123	12202	11698	8182	7601	7006		
58	3300	4000	3352	2394	2319	2000	1600	13090	14185	11903	7317	4914	5890		
59	2300	1200	1200	1834	2182	2000	5470	12739	11290	11309	8241	5880	J492		
60	2300	1200	2200	2337	2269	2000	1600	8444	12259	12601	12028	8675	5684		
61	3225	1012	1301	1839	1183	1449	1800	8937	11468	12045	8304	3415	4696		
62	4080	1079	1273	1431	700	802	7492	9859	13626	10472	8458	5746	5440		
63	3300	4000	2958	2157	2499	2000	3366	6276	18313	12036	7954	4754	5808		
64	3316	2361	2402	2275	2185	2000	12587	11022	11352	11298	7401	8075	6366		
65	3300	4000	3358	2700	4626	6966	13416	13178	13970	14133	9325	7248	8028		
66	3300	4000	4001	3420	2499	2000	2586	12669	13140	11875	7837	5319	6081		
67	2805	1200	1200	1200	1302	2000	11221	10498	12982	12667	7642	7952	6070		
68	3300	4000	4001	2700	2500	2000	3600	13194	12873	10963	5912	6853	6011		
69	3300	4000	4001	4329	5546	6504	1600	13235	12266	10516	7764	5252	6542		
70	2779	3695	2485	2376	2213	2000	9441	9603	14911	10742	8076	5625	6170		
71	3300	4000	4001	5339	5897	8136	12518	16104	19375	17958	9792	7352	9496		
72	3853	4000	4001	6692	6253	11789	10789	16302	15856	9852	8846	7174	8797		
73	3737	4000	4001	5808	2499	2000	1600	10342	14175	9114	6923	5141	5800		
74	3300	4000	3744	2622	3101	3851	17684	13928	20657	14037	7982	6164	8426		
75	3300	4000	4001	2700	2578	3310	13575	9914	12374	14526	8857	6485	7151		
76	3300	4000	4001	4798	4631	1252	12698	16034	13401	9101	7675	6517	7880		
77	3300	4000	4001	2700	2499	2000	2652	9094	10740	11285	7977	4433	5413		
78	1800	973	699	759	753	1283	3292	13739	13414	13577	8670	6774	5510		
79	3300	4000	4001	3264	2614	2758	6818	10449	13632	10576	6873	6247	6225		
80	2300	2390	2334	2519	2448	2000	4227	12456	17721	11474	7188	6848	6171		
81	3300	4000	3018	2387	2242	2000	1600	6221	16306	12354	9107	6665	5781		
82	2300	1200	1200	1304	1199	7629	11591	16115	15133	16398	10163	7478	7682		
83	4154	4064	4001	6739	2931	2788	8019	11410	20825	15870	9512	7320	8158		
84	3898	4657	4435	7897	3223	4110	10330	10127	21590	14409	9073	7352	8440		
85	3726	4015	4001	6707	2499	2000	4682	14892	13061	11139	7574	3744	6538		
86	2521	4000	2916	2700	2499	12970	12367	14378	24899	13516	9133	7194	9109		
87	3353	4000	4001	4902	2499	2000	3526	10106	10569	10729	8981	7206	6014		
88	3968	800	878	917	1200	1218	1200	9410	12145	12393	9018	6976	5039		
89	4640	800	699	701	724	812	5833	9433	11080	12680	8411	a399	5376		
MEAN	3135	2871	2689	2757	2447	3120	6530	10821	13833	11848	8676	6679	6300		

27134 UPPER SNAKE STUDY 134. DISCH., SNAKE R NR IRWIN, IDAHO (CFS)													AVERAGE
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
28	2300	3403	3384	2744	2855	2000	17917	14064	14516	11277	10922	5594	7602
29	3300	4000	3282	2461	2499	2000	1600	9028	13417	10983	8779	8549	5840
30	2300	1200	1200	1943	1619	2000	1734	8904	13817	11937	9288	7547	5312
31	2300	1200	1499	2137	2204	2000	2060	8494	12014	11710	9072	5578	5043
32	2202	1344	1031	1755	1690	1846	1472	4967	7927	14536	13801	8951	5162
33	3619	1622	1730	1647	1511	1334	1200	4861	9971	12430	14747	9008	5336
34	4695	1649	787	1295	1260	1493	2482	9971	11162	5752	4354	3571	4055
35	1841	1045	846	1594	1446	1820	2134	5290	11349	14782	10363	8638	5118
36	2303	1129	1241	1584	1471	1221	1057	7509	15742	11378	12703	11231	5735
37	3573	1462	1173	2519	1390	1351	1321	6229	9675	11215	10677	8546	4958
38	3869	1803	730	1306	931	1322	1200	9651	14407	9579	11031	6366	5210
39	2300	4000	2874	2511	2263	2000	2504	11988	11258	11934	12001	9344	6275
40	2300	1538	1436	1464	1460	1501	1200	7079	9920	12602	8774	5163	4566
41	3183	1181	1150	1257	943	1223	1113	7078	10404	11363	8133	6917	4520
42	3529	1403	891	1488	1097	1382	1200	4565	10786	11402	9842	7421	4606
43	3274	1200	1200	1200	1748	8506	16622	14032	13451	11726	9416	6332	7417
44	3300	4000	4001	2700	2500	2000	1600	6100	13522	10470	8787	6505	5477
45	3301	1200	1200	1470	2217	2000	4341	11892	10987	9660	11727	5836	5512
46	3300	4000	4001	2479	2294	2000	6762	14512	16879	11253	7801	4852	6696
47	3690	4000	3305	2275	2447	2000	12501	9587	13382	11134	10008	5270	6644
48	3536	4000	2869	2444	2291	2000	1600	12962	18256	10600	7743	5020	6135
49	2300	2966	2583	2160	2254	6234	7730	9935	13868	10818	7662	5825	6212
50	2300	2344	2594	2412	2416	2000	17272	12440	13048	14325	8698	6843	7235
51	3365	4000	4001	4770	5187	8073	13058	13964	12349	12245	10095	9848	8424
52	3300	4000	4001	2700	3281	2604	13653	10887	17903	10654	9677	5247	7335
53	3015	3805	2589	2574	2395	2000	1600	12490	14153	11332	8872	6509	5967
54	2563	2655	2547	2454	2382	2000	15051	12415	10337	10161	9377	9080	6760
55	2300	1200	2397	2342	2334	2000	1600	7740	13483	10828	7806	8860	5253
56	2300	1200	1200	2466	4920	8816	13385	16902	17884	11710	10234	6357	8136
57	3300	4000	3157	2376	2443	2000	14611	12123	12202	11698	10898	4968	6997
58	3479	4000	3012	2394	2319	2000	1600	13090	14185	11903	7317	6136	5977
59	3227	1200	1200	1200	1199	2000	4867	12739	11290	11309	11064	8493	5847
60	2300	1200	1200	1200	1200	1795	1600	8444	11231	12932	12848	8903	5438
61	3386	1012	1301	1480	700	1254	1800	8937	11468	12045	8304	3415	4626
62	3329	1079	914	1431	700	750	7164	9849	13626	10472	9784	5351	5394
63	2825	4000	2496	2157	2499	2000	3366	6276	18313	12036	7954	4759	5729
64	4939	1200	1898	2215	2185	2000	12587	11022	11352	11298	10326	5243	6387
65	3150	4000	3329	2700	4626	6966	13416	13178	13970	14133	9325	7248	8013
66	3300	4000	4001	3420	2499	2000	2586	12669	13140	11875	10680	8082	6549
67	2300	1138	1039	1103	1302	1449	6966	10498	12982	12667	8114	7910	5640
68	3300	4000	3876	2448	2500	2000	3543	13194	12873	10963	7190	8347	6212
69	3300	4000	3929	2700	4419	6504	1600	13235	12266	10516	7764	5252	6311
70	2779	3695	2485	2376	2213	2000	9441	9603	14911	10742	9164	7250	6396
71	3300	4000	4001	2700	5879	8136	12518	16104	19375	17958	9792	7352	9270
72	3853	4000	4001	6692	6253	11789	10789	16302	15856	9852	8846	7174	8813
73	3737	4000	4001	5808	2499	2000	1600	10342	14175	9114	7253	4800	5800
74	3300	4000	3744	2622	3101	3851	17684	13928	20657	14037	7982	6164	8426
75	3300	4000	4001	2700	2578	3310	13575	9914	12374	14526	8857	6485	7151
76	3300	4000	4001	4798	4631	8252	12698	16034	13401	9101	7675	8838	8082
77	3300	4000	3440	2413	2299	2000	2652	9094	10740	11285	7977	4433	5326
78	1800	973	699	759	753	1283	2067	13741	13414	13577	9524	8549	5628
79	3300	4000	3620	2459	2499	2000	6284	10449	13632	10576	7135	10745	6399
80	2301	1200	1200	1200	1375	2000	4227	12456	17721	11474	8982	5000	5787
81	3552	4000	2768	2387	2242	2000	1600	6221	16306	12354	9107	6665	5781
82	2300	1200	1200	1304	1199	7629	11591	16115	15133	16398	10163	7478	7602
83	4154	4064	4001	6739	2931	2788	8019	11410	20825	15870	9512	7320	8158
84	3898	4657	4435	7897	3223	4110	10330	10127	21590	14409	9073	7352	a440
85	3726	4015	4001	6707	2499	2000	4682	14892	13061	11139	7574	4490	6599
86	2300	3695	2709	2700	2499	12970	12367	14378	24099	13516	9133	7154	9048
87	3353	4000	4001	4902	2499	2000	3526	10106	10569	10729	8981	7462	6035
88	3220	800	878	917	1200	1218	1420	9410	12145	12812	9018	7052	5038
a9	3915	800	976	701	724	812	6085	9433	11080	12680	12002	10392	5828
MEAN	3101	2717	2412	2545	2339	3090	6385	10820	13817	11869	9382	6953	6312
MAX	4940.	4657.	4435.	7898.	6254.	12970.	17977.	16903.	24899.	17958.	14748.	11231.	9271.
MIN	1801.	800.	700.	701.	701.	750.	1058.	4566.	7928.	5753.	4354.	3415.	4055.

31130 UPPER SNAKE STUDY 130						DISCH. ,	SNAKE	RIVER	NEAR HEISE	(CFS)			
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JVN	JUL	AUG	SEP	AVERAGE
28	2770	3895	3854	3153	3225	2383	18595	15985	15468	12243	8258	8979	8237
29	3762	4442	3958	2836	2883	2379	2143	9955	14315	11838	9192	5784	6145
30	2758	2623	2960	2545	2623	2376	2371	9816	14668	12848	9042	7803	6055
31	2765	1633	2772	2500	2582	2374	2583	9288	12760	12391	9400	6008	5611
32	2653	1754	1410	2109	2051	2218	2007	6089	8801	14769	14222	9411	5655
33	4876	2052	2127	2018	1889	1708	1719	5679	10923	12549	13500	9705	5756
34	5100	2265	1534	1657	1637	1869	3127	10864	11836	7806	4645	3983	4712
35	2288	1444	1216	1945	1813	2186	2687	6185	12217	15161	10800	9626	5653
36	2755	1543	1621	1940	1834	1591	1674	9078	16698	12223	9320	9828	5858
37	4830	1886	1594	2880	2368	1953	1825	7314	10871	12082	11820	8767	5708
38	4350	2220	1485	2026	1909	1695	3543	10841	15387	10542	9259	7436	5910
39	3760	4433	3871	2882	2641	2379	3163	13061	12068	12765	9755	7013	6512
40	2753	1951	1821	1823	1825	2116	2138	7980	10688	13285	10312	8929	5494
41	2750	1591	1530	1613	1318	1597	1721	8021	11182	12142	8512	8520	5064
42	4593	1828	1293	1667	1473	1755	1842	5474	11186	12280	10516	7825	5169
43	4412	1622	1597	1566	1581	8485	17521	15270	14513	12976	9849	6808	8047
44	3767	4465	4422	3070	2868	2374	2117	6933	14419	11332	9202	5450	5885
45	2753	2265	2718	2552	2595	2373	4840	12887	11863	10677	8828	9638	6184
46	3762	4442	4411	2945	2683	2394	7621	15725	17814	12139	8208	5316	7309
47	3762	4435	4110	2640	2827	2319	13075	10904	14345	12071	9655	6290	7218
48	3758	4432	3758	2812	2656	2373	2166	14193	19264	11488	8154	5482	6732
49	2755	3393	2981	2521	2632	6616	a379	11157	14772	11698	8063	6294	6790
50	2879	2796	2950	2719	2800	2454	18086	13651	13844	14798	9247	7366	7810
51	3820	4477	4453	5170	5557	8385	13696	15131	12757	12754	10552	7420	8697
52	3807	4435	4406	5521	3729	2929	14369	12165	18782	11020	7779	7475	8035
53	3789	4489	2966	2905	2735	2314	2040	13315	14791	11661	9049	6369	6393
54	2718	4043	2866	2726	2627	2300	15545	13253	10171	10535	9600	6188	6942
55	2900	4295	2817	2552	2539	2251	1926	8507	14120	11103	8133	5746	5589
56	2610	2489	3619	2989	5283	9033	14268	18083	1a795	12285	8434	9065	8918
57	3760	4420	3713	2828	2870	2404	15301	13593	13483	12132	8763	8125	7625
58	3786	4385	3708	2773	2748	2409	2156	14430	14945	12419	7842	5401	6444
59	2744	1649	1586	2244	2611	2381	6021	13726	12256	11862	8621	6368	6027
60	2744	1612	2574	2669	2622	2444	2218	9150	12594	12879	12536	9026	6114
61	3767	1425	1709	2168	1613	1940	2299	9699	11954	12474	8626	3922	5165
62	4490	1457	1677	1821	1257	1197	8443	11064	14116	10799	8795	6294	5972
63	3757	4383	3358	2521	2870	2345	3753	7196	19432	12622	8576	5176	6341
64	3815	2754	2718	2570	2477	2267	13069	12471	12905	11937	7966	8919	7000
65	3976	4495	3822	3144	5121	7481	14493	14808	15247	14739	9849	7902	8767
66	3822	4453	4490	3786	2877	2420	3112	13510	13469	12175	8445	5988	6574
67	3235	1627	1595	1633	1748	2472	11565	11431	14118	13131	7943	8339	6584
68	3911	4484	4534	3147	2905	2394	4087	14364	14007	11444	6598	7268	6616
69	3768	4490	4516	4855	6055	6884	2580	14411	13175	10861	8195	5558	7128
70	3210	4104	2851	2792	2620	2431	9900	10833	16150	11213	a350	6068	6719
71	3619	4285	4306	5679	6295	8619	13562	18265	20986	18895	10589	8070	10281
72	4323	4598	4477	7109	6662	12285	11596	17982	17197	10246	9086	7720	9454
73	4259	4482	4391	6188	2816	2374	2121	10971	14740	9655	7501	5551	6277
74	3783	4517	4134	2976	3482	4315	18588	15764	21966	15182	8933	6860	9214
75	4267	4746	4629	3415	3198	3815	13866	10944	14597	15437	9737	7107	7996
76	3850	4529	4572	5313	5144	8789	13212	18268	14693	9587	8117	7052	8608
77	3931	4450	4346	2922	2955	2376	2820	9226	11098	11659	8190	4751	5749
78	2288	1526	1145	1174	1221	1732	4346	15383	14305	14105	9168	7174	6163
79	3617	4467	4384	3672	2910	3090	7319	11607	14619	10960	7276	6500	6712
80	2625	2724	2578	2745	2669	2087	4838	13430	18637	11983	7746	7324	6629
81	3832	4403	3311	2687	2631	2365	2079	7164	17447	12773	9586	7107	6296
82	2714	1590	1491	1592	1534	8159	12846	18267	16834	17341	11018	8152	8503
83	4728	4529	4461	7309	3475	3480	8893	13469	22728	17050	10364	7976	9064
04	4770	5457	5219	8511	3812	4533	11278	11869	22959	15030	9732	7949	9276
a5	4241	4448	4411	7157	2955	2462	5784	16387	13888	11631	7865	4178	7152
86	3097	4613	3406	3168	3056	13874	13964	16375	26630	14661	9703	7818	10052
87	4064	4529	4302	5251	2975	2404	4013	11017	11449	11199	9216	7193	6493
88	4181	1119	1212	1249	1495	1638	1919	10282	12836	13024	9428	7102	5486
69	4840	1186	1051	1085	1116	1247	6504	10584	11974	12913	9021	8866	5891
MEAN	3614	3316	3093	3136	2838	3522	7183	12012	14796	12508	9141	7150	6878

31134 UPPER SNAKE STUDY 134. DISCHARGE, SNAKE R NR HEISE (cfs)												SEP	AVERAGE
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JVL	AVG		
28	2770	3895	3854	3153	3225	2383	1a595	15985	15468	12243	11318	6060	8257
29	3762	4442	3729	2836	2883	2379	2143	9955	14315	11838	9192	9018	6391
30	2758	1625	1604	2308	1999	2378	2371	9816	14668	12848	9711	8016	5864
31	2765	1633	1900	2500	2582	2374	2583	9288	12760	12391	9400	6008	5537
32	2653	1754	1410	2109	2051	2218	2007	6089	8801	15426	14222	9409	5711
33	4076	2052	2127	2018	1889	1708	1719	5679	10923	13274	15161	9478	5872
34	5149	2065	1174	1657	1637	1869	3077	10864	11836	6369	4645	3983	4543
35	2288	1444	1216	1945	1819	2189	2687	6185	12217	15673	10800	9090	5653
36	2755	1543	1621	1940	1834	1591	1674	9078	16698	12223	13098	11700	6332
37	4030	1a86	1566	2880	1768	1722	1a25	7314	10468	12082	11072	9001	5495
36	4323	2220	1125	1667	1307	1695	1823	10800	15387	10542	11443	6833	5792
39	2760	4433	3277	2882	2641	2379	3163	13061	12068	12765	12414	9797	6831
40	2753	1951	1821	1823	1825	1875	1738	7980	10688	13359	9163	5601	5075
41	3633	1591	1530	1613	1318	1597	1633	8021	11182	12142	8512	7376	5038
42	3986	1828	1293	1849	1473	1755	1842	5474	11621	12280	10252	7878	5150
43	3728	1622	1597	1566	2128	8886	17521	15270	14513	12976	9849	6808	8064
44	3767	4465	4422	3070	2868	2374	2117	6933	14419	11332	9202	6964	6009
45	3755	1623	1594	1831	2595	2373	4840	12887	11863	10677	12149	6307	6068
46	3762	4442	4411	2854	2683	2394	7621	15725	17814	12139	8208	5316	7302
47	4152	4435	3719	2640	2827	2379	13075	10904	14345	12071	10438	5744	7240
48	3994	4432	3271	2812	2656	2373	2166	14193	19264	11488	8154	5482	6711
49	2755	3393	2981	2521	2632	6616	a379	11157	14772	11698	8063	6294	6790
50	2879	2796	2950	2719	2800	2454	18086	13651	13844	14798	9247	7366	7810
51	3820	4477	4453	5170	5557	8385	13696	15131	12757	12754	10552	10248	8929
52	3708	4435	4406	3041	3564	2929	14367	12165	18782	11020	10046	5626	7843
53	3505	4295	2966	2905	2735	2314	2040	13315	14797	11661	9234	6974	6418
54	2983	2978	2866	2726	2627	2300	15545	13253	10771	10535	9600	9392	7140
55	2698	1496	2631	2552	2539	2251	1926	8507	14120	11103	8133	9224	5612
56	2610	1565	1543	2755	5115	9033	14268	18083	1a795	12285	10739	6967	8656
57	3760	4420	3630	2828	2847	2404	15128	13593	13483	12132	11479	5492	7616
58	3965	4385	3368	2773	2748	2409	2156	14430	14945	12419	7842	6625	6530
59	3671	1649	1586	1608	1630	2381	5418	13726	12256	11862	11444	8981	6382
60	2744	1612	1514	1532	1552	2239	2218	9150	11565	13211	13355	9255	5866
61	3928	1425	1709	1808	1131	1745	2299	9699	11954	12474	8626	3922	5094
62	3739	1457	1317	1821	1257	1145	8115	11064	14116	10799	10121	5897	5926
63	3282	4383	2896	2521	2870	2345	3753	7196	19432	12622	8576	5179	6261
64	5438	1593	2213	2570	2477	2267	13069	12471	12905	11937	10890	6987	7015
65	3827	4495	3793	3144	5121	7481	14493	14800	15247	14739	9849	7902	8752
66	3822	4453	4490	3786	2877	2420	3112	13510	13469	12175	11288	8751	7042
67	2729	1565	1434	1535	1748	1921	7310	11431	14118	13131	8415	8297	6154
68	3911	4484	4411	2895	2905	2394	4030	14364	14007	11444	7876	8762	6811
69	3768	4490	4445	3225	4928	6884	2580	14411	13175	10861	8195	5558	6897
70	3210	4104	2851	2792	2620	2431	9900	10833	16150	11213	9446	7693	6945
71	3619	4285	4306	3040	6277	8619	13562	18265	20986	18895	10589	8070	10055
72	4323	4598	4477	7109	6662	12285	11596	17982	17197	10246	9086	7720	9454
73	4259	4482	4391	6188	2816	2374	2121	10971	14740	9655	7831	5210	6277
74	3783	4517	4134	2976	3482	4315	18588	15764	21966	15182	8933	6860	9214
75	4267	4746	4629	3415	3298	3815	13866	10944	14597	15437	9737	7107	7996
76	3850	4529	4572	5313	5144	8709	13212	18268	14693	9587	8117	9372	8799
77	3931	4450	3784	2636	2753	2376	2820	9226	11098	11659	8190	4751	5662
78	2288	1526	1145	1174	1221	1732	3121	15385	14305	14105	10021	8949	6281
79	3617	4467	3954	2867	2796	2332	6786	11607	14619	10960	7538	10999	6886
80	2627	1534	1443	1426	1596	2087	4838	13430	18637	11983	9540	5473	6240
81	4084	4403	3059	2687	2631	2365	2079	7164	17447	12773	9586	7107	6296
62	2714	1590	1491	1592	1534	8159	12846	18267	16834	17341	11018	8152	8503
83	4728	4529	4461	7309	3475	3480	8893	13469	22728	17050	10384	7976	9064
84	4770	5457	5219	8511	3812	4533	11278	11869	22959	15030	9732	7949	9276
a5	4241	4448	4411	7157	2955	2462	5784	16387	13888	11631	7865	4924	7213
86	2875	4309	3199	3168	3056	13874	13964	16375	26630	14661	9703	7818	9991
a7	4064	4529	4302	5251	2975	2404	4013	11017	11449	11199	9216	7445	6513
88	3433	1119	1212	1249	1495	1638	2139	10282	12836	13443	9428	7178	5483
a9	4115	1186	1327	1085	1116	1247	6756	10584	11974	12913	12612	10860	6342
MEAN	3580	3162	2876	2925	2730	3492	7038	12011	14780	12528	9847	7424	6887

59130 UPPER SNAKE STUDY 130. ROM CONTENT, AMERICAN FALLS RES (1000 AC-PT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JVN	JUL	AVG	SEP
28	600.0	908.2	1203.2	1241.9	1350.1	1503.0	1672.6	1672.6	1672.6	1279.3	837.8	772.2
29	897.9	1245.7	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1541.7	1045.7	616.9	385.1
30	538.5	850.0	1133.7	1260.0	1400.0	1630.0	1591.8	1486.3	1183.6	685.2	380.0	250.0
31	407.3	702.5	950.0	1226.6	1400.0	1630.0	1658.9	1381.9	1013.7	556.4	226.5	54.3
32	137.0	309.2	532.7	773.5	980.2	1245.3	1374.0	1153.4	807.6	520.0	380.0	250.0
33	400.0	678.8	950.0	1203.9	1400.0	1630.0	1672.6	1480.5	1026.2	553.2	380.0	250.0
34	400.0	652.4	949.5	1195.4	1400.0	1625.1	1597.8	1322.7	1018.7	535.4	154.1	33.8
35	100.2	264.6	464.0	686.5	878.3	1095.7	1207.6	980.1	582.9	250.0	30.9	20.4
36	105.0	346.5	598.3	851.4	1075.0	1309.3	1423.4	1228.6	1276.2	784.5	381.6	250.0
37	400.0	671.3	936.8	1196.4	1400.0	1630.0	1672.6	1411.9	1124.4	645.2	380.0	250.0
38	400.0	661.8	950.0	1212.2	1400.0	1558.5	1672.6	1672.6	1624.0	1225.4	800.0	549.3
39	697.9	1025.4	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1358.3	855.1	436.5	250.0
40	400.7	671.7	950.0	1220.1	1400.0	1630.0	1672.6	1368.7	947.9	520.0	208.6	250.0
41	427.6	705.1	950.0	1200.4	1400.0	1630.0	1672.6	1412.6	1059.3	583.2	230.2	172.9
42	400.0	690.3	950.0	1199.7	1400.0	1630.0	1672.6	1556.8	1192.8	729.6	380.0	250.0
43	400.0	722.9	950.0	1203.9	1319.7	1466.7	1672.6	1672.6	1672.6	1429.3	1109.2	855.0
44	963.7	1280.0	1270.0	1260.0	1400.0	1630.0	1672.6	1578.6	1634.6	1166.9	737.8	497.4
45	524.2	850.0	1090.8	1260.0	1400.0	1630.0	1672.6	1672.6	1618.2	1159.7	815.5	800.0
46	974.7	1280.0	1270.0	1260.0	1400.0	1559.1	1672.6	1672.6	1672.6	1202.0	806.8	647.9
47	845.6	1221.8	1270.0	1260.0	1400.0	1630.0	1672.6	1588.6	1578.4	1115.4	800.0	623.1
48	756.8	1103.6	1270.0	1260.0	1400.0	1553.0	1672.6	1672.6	1672.6	1214.5	820.9	610.7
49	737.3	1009.3	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1197.5	822.1	598.8
50	743.8	986.3	1263.9	1251.2	1352.0	1504.0	1672.6	1672.6	1672.6	1581.8	1283.5	1202.1
51	1290.0	1280.0	1270.0	1260.0	1374.1	1536.3	1672.6	1672.6	1486.6	1086.8	1051.7	881.6
52	1033.6	1280.0	1270.0	1234.9	1352.5	1511.0	1672.6	1672.6	1672.6	1232.3	844.2	724.7
53	783.9	1111.5	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1176.0	800.0	535.5
54	600.0	912.3	1205.1	1260.0	1400.0	1630.0	1672.6	1672.6	1370.6	924.3	651.7	386.9
55	520.1	850.0	1117.1	1260.0	1400.0	1630.0	1672.6	1659.5	1514.6	1056.0	646.9	380.7
56	485.5	850.0	1208.1	1252.6	1350.3	1505.2	1672.6	1672.6	1672.6	1249.8	884.1	800.0
57	952.3	1280.0	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1185.1	800.0	706.0
58	050.2	1190.6	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1615.3	1113.4	718.2	504.8
59	538.1	850.0	1094.5	1260.0	1400.0	1630.0	1672.6	1672.6	1347.9	862.5	426.1	250.0
60	478.8	808.2	1087.5	1260.0	1400.0	1630.0	1672.6	1410.3	1091.0	587.3	380.0	250.0
61	400.0	689.4	950.0	1208.9	1400.0	1630.0	1669.3	1426.9	1060.6	583.6	189.3	38.2
62	329.0	608.5	880.3	1126.5	1400.0	1630.0	1672.6	1672.6	1643.3	1163.4	800.0	531.4
63	601.9	864.1	1132.2	1260.0	1400.0	1630.0	1672.6	1629.2	1672.6	1171.9	759.3	539.4
64	527.0	850.0	1077.5	1260.0	1396.6	1537.8	1672.6	1672.6	1672.6	1271.1	833.8	735.9
65	767.3	1092.4	1270.0	1230.6	1359.7	1540.4	1672.6	1672.6	1672.6	1581.2	1400.0	1300.0
66	1290.0	1280.0	1270.0	1260.0	1400.0	1630.0	1672.6	1645.9	1375.0	862.9	435.1	250.0
67	400.0	690.3	950.0	1238.6	1400.0	1630.0	1672.6	1672.6	1672.6	1440.1	991.0	800.0
68	914.1	1231.7	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1177.8	947.1	884.7
69	935.4	1232.4	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1210.6	800.0	588.3
70	724.1	1045.3	1270.0	1260.0	1400.0	1550.5	1672.6	1672.6	1672.6	1380.2	959.2	879.6
71	965.5	1280.0	1270.0	1062.6	1226.4	1401.6	1636.4	1672.6	1672.6	1672.6	1400.0	1300.0
72	1290.0	1280.0	1270.0	1174.7	1319.0	1503.7	1672.6	1672.6	1672.6	1331.5	1152.6	1161.9
73	1290.0	1280.0	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1239.8	833.9	800.0
74	1054.0	1280.0	1270.0	1161.7	1299.1	1463.0	1672.6	1672.6	1672.6	1624.8	1400.0	1221.6
75	1290.0	1280.0	1270.0	1239.0	1352.2	1516.1	1672.6	1672.6	1672.6	1672.6	1400.0	1252.8
76	1290.0	1280.0	1270.0	1152.5	1300.7	1474.3	1672.6	1672.6	1672.6	1222.0	1030.8	995.5
77	1268.4	1280.0	1270.0	1260.0	1400.0	1630.0	1575.9	1364.6	1044.3	567.3	246.2	51.1
78	287.0	551.4	830.4	1073.0	1281.5	1529.8	1672.6	1672.6	1593.3	1320.1	945.8	872.6
79	939.4	1217.3	1270.0	1260.0	1400.0	1630.0	1672.6	1619.5	1499.2	979.5	593.9	304.0
80	409.4	711.1	957.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1175.8	800.0	748.0
81	767.4	1063.7	1270.0	1260.0	1400.0	1630.0	1672.6	1504.4	1672.6	1173.6	742.4	430.7
82	561.6	843.4	1013.5	1192.1	1311.0	1477.5	1672.6	1672.6	1672.6	1672.6	1400.0	1300.0
a3	1290.0	1280.0	1270.0	1144.0	1292.3	1451.3	1640.9	1672.6	1672.6	1672.6	1400.0	1230.6
84	1290.0	1280.0	1270.0	1089.1	1268.1	1409.5	1602.6	1672.6	1672.6	1672.6	1400.0	1295.2
85	1290.0	1280.0	1270.0	1260.0	1400.0	1611.0	1672.6	1672.6	1514.9	1024.0	646.0	533.7
86	667.5	972.5	1270.0	1062.6	1222.0	1382.8	1625.6	1672.6	1672.6	1500.4	1222.0	1215.2
a7	1290.0	1280.0	1270.0	1260.0	1400.0	1630.0	1586.5	1326.2	1055.9	747.8	425.5	250.0
88	400.0	750.3	950.0	1224.3	1400.0	1630.0	1670.1	1378.0	1000.7	520.0	159.9	48.6
89	234.0	511.1	772.7	993.2	1199.8	1496.6	1672.6	1604.4	1289.2	785.0	388.8	250.0
AVE 1928-89:	718.6	960.2	1119.7	1198.8	1352.6	1560.3	1647.5	1581.9	1461.2	1076.2	740.7	597.6

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JVN	JVL	AVG	SEP
28	618.7	926.9	1221.9	1241.9	1350.1	1503.0	1672.6	1672.6	1672.6	1165.7	800.0	453.2
29	640.4	988.2	1269.2	1260.0	1400.0	1630.0	1672.6	1672.6	1547.7	938.0	397.1	250.0
30	473.0	782.0	982.3	1251.3	1400.0	1630.0	1580.5	1464.6	1168.1	656.8	380.0	250.0
31	456.5	751.7	950.0	1226.6	1400.0	1630.0	1647.6	1366.3	1004.1	547.0	217.2	39.2
32	125.9	303.5	526.9	768.2	975.0	1237.0	1354.5	1123.6	766.6	520.0	380.0	250.0
33	400.0	678.8	950.0	1203.9	1400.0	1630.0	1672.6	1470.1	1021.8	520.0	375.9	161.4
34	364.8	605.3	880.3	1126.2	1343.6	1582.1	1547.9	1284.1	995.4	507.8	134.5	27.9
35	103.9	267.6	468.3	690.4	882.2	1096.6	1197.1	959.4	550.7	250.0	30.9	14.4
36	108.7	353.8	605.6	858.7	1082.3	1316.5	1419.3	1218.2	1268.8	663.6	380.0	250.0
37	400.0	671.3	935.1	1194.7	1395.0	1630.0	1672.6	1397.0	1005.3	557.4	210.2	51.8
38	237.5	505.3	782.5	1022.6	1232.2	1489.7	1605.7	1672.6	1629.9	1117.2	708.0	312.4
39	513.3	850.0	1136.5	1260.0	1400.0	1630.0	1672.6	1672.4	1364.0	747.2	380.0	250.0
40	449.9	720.9	950.0	1220.1	1400.0	1630.0	1672.6	1358.2	943.4	520.0	152.9	10.0
41	284.2	567.7	859.2	1109.6	1340.9	1586.1	1634.3	1374.5	1027.4	551.7	202.5	71.5
42	312.5	602.8	914.2	1175.2	1380.7	1630.0	1672.6	1546.3	1208.5	746.1	380.0	250.0
43	407.1	730.0	950.0	1203.9	1319.7	1466.7	1672.6	1672.6	1672.6	1429.3	1109.2	855.0
44	1025.1	1280.0	1270.0	1260.0	1400.0	1630.0	1672.6	1568.2	1630.2	1048.9	507.8	250.0
45	407.6	705.8	950.0	1254.2	1400.0	1630.0	1672.6	1672.6	1624.1	1052.1	800.0	478.5
46	714.8	1063.9	1270.0	1260.0	1400.0	1559.1	1672.6	1672.6	1672.6	1088.5	583.1	314.7
47	600.0	976.2	1270.0	1260.0	1400.0	1630.0	1672.6	1578.1	1574.0	997.5	620.1	300.7
48	563.2	910.0	1241.5	1260.0	1400.0	1553.0	1672.6	1672.6	1672.6	1100.9	595.2	277.4
49	533.4	850.0	1118.2	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1083.9	596.4	265.5
50	541.0	850.0	1127.5	1251.2	1352.0	1504.0	1672.6	1672.6	1672.6	1468.2	1057.4	867.9
51	1110.4	1280.0	1270.0	1260.0	1374.1	1536.3	1672.6	1672.6	1492.6	977.2	829.9	720.1
52	928.5	1280.0	1270.0	1234.9	1352.5	1511.0	1672.6	1672.6	1672.6	1118.7	757.8	419.2
53	575.1	891.2	1221.1	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1062.4	587.6	250.0
54	407.6	817.1	1109.9	1260.0	1400.0	1630.0	1672.6	1672.6	1376.6	816.6	431.8	250.0
55	438.1	754.8	1010.6	1260.0	1400.0	1630.0	1672.6	1649.0	1510.1	938.0	416.8	250.0
56	417.2	748.3	978.8	1252.6	1350.3	1505.2	1672.6	1672.6	1672.6	1136.2	800.0	484.0
57	689.1	1071.0	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1071.5	741.3	361.3
58	600.0	940.5	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1621.2	1005.8	498.4	250.0
59	407.6	721.7	966.2	1260.0	1400.0	1630.0	1672.6	1672.6	1353.8	754.8	380.0	250.0
60	527.9	850.0	1067.8	1260.0	1400.0	1630.0	1672.6	1399.8	1028.5	520.0	338.0	196.8
61	406.3	695.7	950.0	1186.8	1400.0	1630.0	1658.0	1405.2	1045.0	571.2	189.0	32.0
62	323.0	602.5	852.2	1098.3	1400.0	1630.0	1672.6	1672.6	1649.2	1049.9	655.9	257.5
63	412.9	835.7	1075.4	1260.0	1400.0	1630.0	1672.6	1618.7	1672.6	1073.2	563.2	250.0
64	406.6	701.4	950.0	1260.0	1396.6	1537.8	1672.6	1672.6	1672.6	1157.6	800.0	424.1
65	560.8	885.8	1255.9	1230.6	1359.7	1540.4	1672.6	1672.6	1672.6	1467.6	1173.9	965.5
66	1097.2	1280.0	1270.0	1260.0	1400.0	1630.0	1672.6	1635.5	1370.6	744.9	380.0	250.0
67	418.1	704.7	950.0	1232.6	1400.0	1630.0	1672.6	1672.6	1672.6	1326.6	800.0	500.3
68	675.8	993.4	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1064.3	800.0	717.9
69	831.0	1128.1	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1097.1	576.3	255.1
70	505.5	850.0	1131.9	1260.0	1400.0	1550.5	1672.6	1672.6	1672.6	1266.6	800.0	708.6
71	857.0	1191.1	1270.0	1062.6	1226.4	1401.6	1636.4	1672.6	1672.6	1672.6	1400.0	1300.0
72	1290.0	1280.0	1270.0	1174.7	1319.0	1503.7	1672.6	1672.6	1672.6	1217.9	926.5	828.0
73	1146.9	1280.0	1270.0	1260.0	1400.0	1630.0	1672.6	1672.6	1672.6	1126.2	630.4	468.4
74	748.9	1128.5	1270.0	1161.7	1299.1	1463.0	1672.6	1672.6	1672.6	1624.8	1400.0	1221.6
75	1290.0	1280.0	1270.0	1239.0	1352.2	1516.1	1672.6	1672.6	1672.6	1559.1	1173.7	918.1
76	1212.4	1280.0	1270.0	1152.5	1300.7	1474.3	1672.6	1672.6	1672.6	1108.4	805.1	800.0
77	1126.1	1280.0	1270.0	1260.0	1400.0	1630.0	1564.6	1342.9	1028.8	561.5	240.4	39.4
78	279.3	543.7	822.6	1065.2	1273.8	1519.0	1672.6	1672.6	1599.2	1212.4	800.0	723.8
79	852.9	1130.8	1270.0	1260.0	1400.0	1630.0	1672.6	1609.1	1494.8	861.5	380.0	250.0
80	405.0	635.9	941.2	1226.5	1400.0	1630.0	1672.6	1672.6	1672.6	1062.3	684.6	413.9
81	563.4	859.7	1154.1	1260.0	1400.0	1630.0	1672.6	1494.0	1672.6	1173.6	742.3	430.6
82	600.0	850.0	1020.1	1192.1	1311.0	1477.5	1672.6	1672.6	1672.6	1559.0	1173.7	965.3
83	1290.0	1280.0	1270.0	1144.0	1292.3	1451.3	1640.9	1672.6	1672.6	1559.0	1173.8	895.9
a4	1260.8	1280.0	1270.0	1089.1	1268.1	1409.5	1602.6	1672.6	1672.6	1672.6	1400.0	1295.2
85	1290.0	1280.0	1270.0	1260.0	1400.0	1611.0	1672.6	1672.6	1520.8	915.7	425.5	250.0
86	484.0	850.0	1173.3	1062.6	1222.0	1382.8	1625.6	1672.6	1672.6	1386.8	995.0	881.0
87	1188.3	1280.0	1270.0	1260.0	1400.0	1630.0	1575.2	1304.6	1040.4	732.4	410.4	250.0
88	403.1	753.5	950.0	1224.3	1400.0	1630.0	1671.9	1369.4	998.1	520.0	142.5	13.8
89	199.8	477.0	755.5	976.0	1182.6	1476.4	1672.6	1593.9	1284.8	667.1	380.0	250.0

AVE 1928-89: 621.1 885.7 1082.2 1190.7 1347.3 1557.3 1643.6 1575.6 1456.9 995.0 625.9 423.5

60130 UPPER SNAKE STUDY 130. DISCH., SNAKE R NEAR NEELEY (CFS)													AVERAGE
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
28	3902	3200	2500	5936	5287	4115	18630	16821	13856	12097	11106	8065	8798
29	4391	3200	6904	5554	3088	2835	5769	11714	10915	12152	10774	7541	7105
30	2879	1455	2500	3157	3983	2005	4784	7988	10807	12062	10405	7651	5817
31	2944	501	2017	600	2449	1673	4235	9800	10150	11557	9364	6139	5140
32	2361	691	299	208	402	631	2526	8481	9739	12147	10937	8635	4783
33	3449	501	447	600	610	891	3796	9036	11033	11950	10893	8438	5165
34	3368	501	400	600	832	1016	4106	8569	9431	11365	9410	4818	4563
35	2225	405	329	200	400	750	1793	8325	10404	11537	8987	6522	4350
36	1992	660	299	400	400	600	2070	10103	10745	11988	10709	7821	4846
37	3098	501	400	600	1140	1358	3874	9231	10144	12124	10796	7655	5104
38	2838	501	483	600	1594	2378	4413	11932	10614	11927	11235	8519	5614
39	3958	3200	3775	6310	3095	2449	6297	9738	10685	12375	10903	7841	6746
40	2586	501	751	600	1970	1438	3937	9486	11118	11981	10086	6599	5109
41	2384	501	1158	600	1170	1046	3981	9605	10218	11843	10008	6415	4937
42	2823	501	1241	600	695	1130	4385	8302	10631	12056	10940	7910	5129
43	3653	501	2051	1543	3389	10119	19084	15253	11441	12311	11467	8813	8324
44	4576	3848	8989	6291	3927	2600	5228	7889	9068	12046	10787	8223	6985
45	3695	677	2500	3516	4094	2023	7184	13497	10397	12150	11051	8411	6620
46	4258	3936	8862	6865	3585	4489	10530	15556	13017	12191	10973	6922	8470
47	3965	3200	7130	5947	4168	1971	15508	9530	9979	12314	11144	7677	7776
48	4534	3200	5674	6770	3924	3658	4621	15639	15851	12245	11005	7641	7930
49	3845	3200	2623	5627	3075	7390	11036	12321	10745	12433	11017	7730	7618
50	4116	3200	2500	6359	5124	4973	20876	13082	12140	12337	11147	8794	8723
51	5744	9782	9369	9255	8313	10166	16130	15450	10692	12459	10581	9221	10606
52	4406	5237	9086	9773	5838	5077	17261	15782	16268	12316	11342	8268	10070
53	4500	3200	5287	8055	4545	2379	4342	12567	12107	12591	11266	8414	7466
54	3810	3200	2500	5751	4127	2526	17472	10709	9766	11937	10867	8302	7586
55	3427	3077	2500	3693	3273	2046	5532	8358	10996	12038	10822	8309	6187
56	3235	862	2500	7042	6806	10630	15990	16361	13901	12352	10867	8640	9110
57	4021	4111	8304	6304	4622	2745	18057	17333	11313	12716	11145	8162	9092
58	3971	3200	7244	6871	4617	2449	5705	13502	10779	12290	10769	7529	7440
59	3602	536	2500	3539	4100	2324	8048	10309	10596	12072	10709	7216	6311
60	2183	501	2500	3832	4237	2775	6157	9543	10846	12014	10791	8154	6140
61	3043	501	820	600	1500	1143	3667	9020	10186	11573	9547	6006	4824
62	2644	501	400	600	2472	2106	12708	10839	10544	12627	11093	8519	6266
63	4279	3200	2500	3547	5414	1589	6657	8232	16915	12562	10685	7754	6938
64	3199	1186	2500	2709	2902	2731	14760	14250	14760	12884	11672	8468	7684
65	4215	3200	5658	8119	6457	7377	17768	16382	12853	12007	10491	10288	9578
66	6206	8177	8748	7878	4420	2700	5788	9491	10604	11978	10529	7739	7881
67	2752	501	1070	600	2433	1999	13451	11181	13760	12739	11835	9403	6819
68	4333	3200	7449	6523	4786	2392	5324	12586	12596	12602	10073	8314	7539
69	4231	3200	7385	9740	8328	7167	8115	14650	11149	12306	11153	7549	8765
70	4097	3200	3432	7232	4035	3401	10555	13453	16373	12004	11275	7771	8087
71	4476	3531	9021	13850	7935	10166	15972	25328	22213	16071	13139	11265	12781
72	8813	10729	9597	13043	9423	14190	13891	20578	19050	11682	10784	7808	12486
73	6274	9290	8979	10205	4498	3251	7181	12245	11460	11591	10608	7060	8585
74	3597	5781	9067	8728	4847	5725	20492	18153	22057	11807	10698	8549	10803
75	6419	9359	9237	7732	5717	5634	15209	15102	17551	12513	12430	9066	10512
76	7605	9549	9829	11615	7371	10303	15145	24803	17859	12080	10776	8176	12125
77	4050	8235	8920	7301	4952	2568	4761	8252	9621	11430	9332	6873	7208
78	1034	400	400	600	600	750	5391	17177	10275	12402	11682	8246	5785
79	4310	3200	6759	6966	4564	3046	10041	10158	11811	12464	10594	8021	7680
80	3336	501	2500	1631	4842	1660	6808	14058	16610	11848	11005	7714	6881
81	5329	3200	4185	6559	4118	1978	4117	8914	9890	11703	10909	8465	6637
82	2908	501	2500	1971	3511	8302	12362	22326	15851	13285	12152	9656	8811
83	8698	9319	9436	14388	5868	6387	10359	19501	24616	13633	12206	8892	11977
84	8140	10861	9942	16205	6107	7756	12796	19976	29043	12871	14489	9001	13131
85	8174	10866	9990	12560	5427	5004	12589	18799	12122	12524	11000	7161	10558
86	4204	3200	3124	10737	6054	16536	18066	20578	24095	11823	11409	8317	11536
87	7653	9811	9925	10273	5540	3750	6142	10056	10320	10878	10462	8147	8605
88	2495	501	1571	600	2109	1348	3936	9517	10621	11791	9945	6808	5124
89	2828	400	299	600	400	646	7310	10296	11787	12194	10421	8147	5470
MEAN	4131	3361	4540	5431	3960	3972	9431	13028	13016	12223	10914	8003	7689

60134 UPPRE SNAKE STUDY 134. DISCH., SNAKE RIVER NR NEELEY (CFS)													
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVERAGE
28	3597	3200	2500	6240	5287	4115	18630	16821	13856	13944	12952	9876	9274
29	3423	3200	2500	5539	3088	2835	5769	11714	10814	13999	12622	9387	7105
30	1760	501	2500	600	3200	2005	4914	8158	10707	12275	10618	7863	5442
31	2143	501	1945	600	2449	1673	4425	9872	10050	11557	9364	6238	5087
32	2301	600	299	200	400	680	2716	8652	9934	12147	10937	8633	4821
33	2649	501	447	600	610	891	3796	9207	10932	13144	12087	9631	5405
34	2570	501	400	600	600	800	4176	8135	9325	11440	9288	4600	4448
35	1992	405	299	200	400	800	1983	8496	10599	11535	8989	6085	4343
36	1838	600	299	400	400	600	2260	10207	10697	13833	12557	9668	5315
37	2298	501	400	600	600	1047	3874	9400	10043	12915	11402	8374	5152
38	2283	400	299	600	600	756	2669	10809	10515	13775	13082	10366	5548
39	2132	3043	2500	4139	3095	2449	6297	9743	10584	14222	12750	9687	6742
40	1786	501	1552	600	1970	1197	3536	9657	11019	11981	9911	6436	5038
41	1763	400	400	600	600	797	3803	9600	10118	11843	10008	6514	4732
42	2023	501	400	600	600	816	4385	8472	10530	12056	10940	7910	4962
43	2853	501	2166	1543	3936	10521	19084	15234	11441	12313	11467	8813	8341
44	3576	4882	8989	6291	3927	2600	5228	8098	8969	13892	12633	10070	7467
45	2596	501	1321	600	3990	2023	7184	13497	10297	13996	12898	10226	6610
46	3290	3200	5347	6772	3585	4489	10530	15556	13017	14038	12788	8801	8486
47	2965	3200	3344	5947	4168	1971	15508	9699	9880	14162	12959	9555	7790
48	2708	3200	2500	6308	3924	3658	4621	15639	15851	14090	12853	9488	7942
49	1773	2452	2500	3160	3075	7390	11036	12321	10745	14281	12864	9517	7626
50	2030	2082	2500	4142	5124	4973	20876	13082	12140	14185	12994	10641	8731
51	3258	6764	9369	9255	8313	10166	16130	15450	10592	14338	12427	11068	10607
52	3406	3470	9086	7292	5673	5077	17261	15782	16268	14162	13189	10115	10097
53	2674	3200	2500	7260	4545	2379	4342	12567	12107	14438	13080	10287	7472
54	2591	501	2500	4202	4127	2526	17472	10709	9666	13785	12713	10147	7586
55	2347	501	2500	1961	3273	2046	5532	8527	10897	13886	12669	10155	6209
56	2233	501	2500	3080	6638	10630	15990	16361	13903	14198	12715	10453	9125
57	3201	3200	4824	6304	4599	2745	11884	17333	11313	14564	12993	10009	9101
58	2971	3200	2835	6871	4617	2449	5705	13502	10680	14136	12617	9376	7438
59	2534	501	2500	818	3117	2324	7445	10309	10495	13918	12557	9063	6318
60	1382	623	2500	2373	3168	2570	6157	9714	10693	12438	11215	8579	5976
61	2243	501	920	600	619	950	3857	9189	10085	11524	9547	6107	4707
62	1893	501	400	600	1966	2054	12379	10839	10443	14569	12939	10366	6597
63	2452	501	2500	2623	5414	1589	6657	8402	16741	14167	12288	9359	6888
64	2104	501	1651	636	2902	2731	14760	14250	14760	14731	13318	10315	7743
65	2384	3200	2500	7889	6457	7317	17733	16382	12853	13855	12337	12135	9597
66	3928	4937	8748	7878	4420	2700	5788	9662	10505	13825	12376	9586	7893
67	1952	501	1143	600	2325	1447	9196	11181	13760	14586	13583	11216	6807
68	3365	3200	3449	6271	4786	2392	5268	12586	12596	14448	11921	10160	7569
69	3236	3200	5619	8110	7199	7167	8115	14650	11149	14154	12968	9428	8771
70	2267	2810	2500	4986	4035	3401	10555	13453	16373	13851	13123	9618	8095
71	3475	3200	7577	11210	7917	10166	15972	25328	22213	16071	13139	11265	12321
72	8813	10729	9597	13043	9423	14190	13891	20578	19050	13529	12630	9655	12975
73	3201	6885	8979	10205	4498	3251	7181	12245	11460	13438	12423	8907	8589
74	3201	3200	6604	8728	4847	5725	20492	18153	22057	11807	10698	8549	10348
75	6419	9359	9237	7132	5717	5634	15209	15102	17551	14359	14277	10913	10977
76	3453	8243	9829	11615	7371	10303	15145	24803	17859	13926	12622	10023	12149
77	3201	5843	8361	7013	4752	2568	4951	8423	9522	11430	9333	6973	6882
78	974	400	400	600	600	800	3986	17179	10176	14250	13172	10092	6096
79	3310	3200	4973	6161	4451	2288	9507	10329	11710	14312	12441	9868	7730
80	2535	501	400	600	3188	1660	6808	14058	16610	13694	12853	9561	6894
81	3498	3200	2500	4674	4118	1978	4117	9083	9715	11703	10909	8465	6178
82	2283	1034	2500	2018	3511	8302	12362	22326	15851	15133	13999	11505	9277
83	3280	9319	9436	14388	5868	6387	10359	19501	24616	15481	14051	10739	11982
84	3201	10371	9942	16205	6107	7756	12796	19976	29043	12871	14487	9001	12686
85	8174	10866	9990	12560	5427	5004	12589	18799	12023	14382	12846	9006	11016
86	2383	1870	2500	9163	6054	16536	18066	20578	24095	13671	13255	10164	11551
87	3902	8102	9925	10273	5540	3750	6332	10225	10221	10878	10462	8147	8167
88	1695	501	1621	600	2109	1348	4126	9688	10520	12168	10228	7184	5175
89	2103	400	299	600	400	694	1225	10465	11688	14040	12269	9994	5877
MEAN	2869	2821	3720	4741	3802	3906	9302	13070	12966	13522	12188	9290	7708
MAX	8814.	10867.	9991.	16205.	9423.	16537.	20876.	25329.	29043.	16072.	14488.	12136.	12976.
MIN	975.	400.	300.	201.	400.	601.	1984.	8059.	8969.	10879.	8989.	4600.	4343.

W-YR	65130 UPPER SNAKE STUDY 130.					DISCHARGE,		SNAKE RIVER NR		MILNER	(CFS)		AVERAGE
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AVG	SEP	
28	1304	3716	3074	6286	5388	3557	15873	7240	3941	1000	1000	1000	4422
29	2000	3924	7432	6440	3017	2672	4240	2295	301	1000	660	1000	2925
30	1000	2153	2966	3596	4503	1327	10	29	301	660	660	1000	1500
31	1000	593	2409	825	2487	820	10	29	301	660	241	101	782
32	260	260	764	499	501	150	10	29	5	660	660	1000	400
33	1000	655	1000	836	670	405	274	29	301	660	660	1000	625
34	1000	583	877	894	999	150	10	29	301	660	241	101	486
35	260	200	400	503	605	150	10	29	5	299	241	101	232
36	260	260	418	831	916	429	10	29	301	660	660	1000	479
37	1000	864	1021	891	1332	766	1670	29	301	660	660	1000	845
38	1000	743	1062	927	1721	1820	1659	3100	301	1000	1000	1000	1278
39	2000	3870	4370	6565	3236	2126	1575	197	301	1000	660	1000	2240
40	1000	714	1181	951	2253	901	748	29	301	660	241	760	802
41	1000	854	1760	968	1457	447	378	29	301	660	241	101	680
42	1000	1118	1969	763	801	626	886	29	301	660	660	1000	818
43	1000	810	2864	2009	3585	9673	15772	5986	1778	1000	1000	1800	3931
44	2000	4448	9426	6637	4019	1805	2845	29	301	1000	660	1000	2846
45	1000	1129	3069	3801	4289	1417	5074	5082	301	1000	1000	1800	2402
46	2000	4475	9480	7143	3743	3994	7401	6504	1949	1000	1000	1000	4149
47	2000	3885	8205	6333	4509	1449	11286	29	301	1000	1000	1000	3400
48	2000	3853	6195	7382	4329	3036	1502	6172	5294	1000	1000	1000	3564
49	2000	3642	3085	6066	3453	7252	7361	3635	452	1000	1000	1000	3330
50	2000	3867	3207	6949	5449	4508	17793	4440	2104	1000	1000	1800	4481
51	3481	10424	10062	9317	8985	9696	12184	7403	301	1000	1000	1800	6284
52	2000	5635	9587	9940	5852	4289	15100	6635	5593	1000	1000	1000	5621
53	2000	3590	5751	8472	4669	1857	783	4498	2880	1000	1000	1000	3124
54	1096	3675	3087	6164	4235	1833	13088	896	301	1000	660	1000	3061
55	1000	3734	2949	4012	3446	1459	3529	29	301	1000	660	1000	1912
56	1000	1296	3067	7375	7091	10184	11834	7234	3979	1000	1000	1800	4719
57	2000	4492	8906	6722	5085	2370	15849	9218	807	1000	1000	1000	4867
58	2000	3743	7706	7182	5015	2192	2717	3983	301	1000	660	1000	3122
59	1000	1044	2872	3937	4165	1542	3576	2031	301	1000	660	1000	1914
60	1000	450	2960	4097	4377	2022	2617	29	301	660	660	1000	1665
61	1000	951	1298	868	1777	579	10	29	301	660	241	101	645
62	1000	1084	888	792	2704	1514	8804	2337	301	1000	1000	1000	1852
63	2000	3805	3243	3986	5702	794	3976	29	7250	1000	660	1000	2750
64	1000	1760	3337	3097	3134	2462	12436	5450	4821	1000	1000	1000	3359
65	2000	4205	6764	8611	6302	6710	14436	7906	2633	1000	1177	3331	5408
66	3279	7794	9631	8395	4566	2246	1257	29	301	1000	660	1000	3345
67	1000	1210	1644	1020	2551	1060	9873	2433	3887	1000	1000	1800	2352
68	2000	4149	8219	7101	5151	1540	1239	3310	1607	1000	1000	1800	3171
69	2000	3813	8049	10218	8776	6614	4067	5162	760	1000	854	1000	4344
70	2000	3699	4196	8029	4545	2726	7547	5806	6114	1000	1000	1800	4026
71	2000	4047	9948	14923	8632	9651	13108	17517	12207	4563	2586	4264	8623
72	6471	11663	10436	13965	10038	14367	11811	12464	9638	1000	1000	1800	8710
73	4957	10350	10368	11607	5571	3436	5184	3841	1215	1000	1000	1247	4982
74	2000	6524	9756	9288	5267	5912	19333	9664	11290	1000	1158	1800	6899
75	3828	9685	9966	8073	5789	5292	13922	8741	8349	1685	2627	1800	6634
76	5152	9772	10511	12022	7661	10070	14274	16011	7401	1000	1000	1800	8057
77	2000	8379	9652	7579	4991	1226	10	29	301	660	241	101	2922
78	260	466	878	1003	753	150	3090	8945	301	1000	1000	1800	1647
79	2000	3927	7203	7234	4853	2659	6934	29	301	1000	660	1000	3137
80	1000	1000	2988	2168	4956	1046	2057	5879	7613	1000	1000	1000	2620
81	2000	3746	4846	6956	4136	1223	859	29	469	1000	660	1000	2236
82	1000	1612	3158	2387	3914	7881	11900	14848	5667	2230	1693	2822	4928
83	6917	10295	10273	15466	6651	6074	8376	12261	14231	3205	3284	1800	8244
84	6774	12419	11090	17585	6912	7717	12365	14743	21333	1384	4533	1800	9889
85	5575	11184	10231	12323	5508	4409	9992	8519	301	1000	660	1000	5903
86	2000	3795	3547	10963	6358	16240	14974	13017	14738	1000	1000	1800	7447
87	4752	8902	10015	10605	5704	2737	10	29	301	660	660	1000	3779
88	1000	1235	2148	960	2297	758	10	29	301	660	241	101	804
89	1000	1121	768	907	592	150	4243	29	301	660	660	1000	948
MEAN	1994	3827	5133	5862	4226	3454	6351	4294	2892	1031	947	1225	3428

65134 UPPER SNAKE STUDY 134. DISCHARGE, SNAKE R NR MILNER (CFS)													
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVERAGE
28	1000	3716	3074	6590	5388	3557	15873	7240	3941	2848	2848	2847	4901
29	1000	3924	3028	6427	3077	2672	4240	2295	200	2846	2506	2841	2922
30	200	869	2966	1039	3720	1327	200	200	200	873	873	1213	1125
31	200	593	2337	825	2487	820	200	200	200	660	241	200	737
32	200	200	789	493	499	200	200	200	200	660	660	1000	443
33	200	655	1000	836	670	405	274	200	200	1854	1854	2193	864
34	200	583	877	894	767	200	200	200	200	660	241	200	434
35	200	200	208	503	605	200	200	200	200	299	241	200	269
36	200	200	418	831	916	429	200	200	200	2506	2508	2847	958
37	200	864	1021	891	792	455	1670	200	200	1449	1449	1790	914
38	200	644	880	927	729	200	200	1864	200	2848	2848	2047	1205
39	200	3687	3095	4396	3236	2126	1515	200	200	2846	2508	2847	2237
40	200	714	1981	951	2253	660	348	200	200	660	241	760	760
41	200	600	1000	968	886	200	200	200	200	660	241	200	461
42	200	1118	1127	763	708	312	886	200	200	660	660	1000	651
43	200	810	2979	2009	4132	10075	15772	5967	1778	1000	1000	1800	3947
44	1000	5482	9426	6637	4019	1805	2845	200	200	2848	2506	2847	3328
45	200	642	1890	885	4185	1417	5074	5082	200	2846	2848	3647	2395
46	1000	3738	5964	7052	3743	3994	7401	6504	1949	2848	2846	2847	4162
41	1000	3885	3820	6333	4509	1449	11286	200	200	2848	2848	2841	3414
48	200	3827	3020	6918	4329	3036	1502	6172	5294	2846	2848	2847	3577
49	200	2613	2963	3597	3453	7252	7361	3635	452	2848	2846	2847	3338
50	200	2454	3207	4731	5449	4508	17793	4440	2104	2846	2846	3647	4490
51	1000	7408	10062	9317	8985	9696	12184	7403	200	2848	2848	3647	6283
52	1000	3869	9587	7460	5687	4289	15100	6635	5593	2846	2040	2847	5647
53	200	3563	2963	7676	4669	1857	783	4498	2880	2848	2848	2847	3130
54	200	640	3087	4617	4235	1833	13088	896	200	2848	2508	2847	3062
55	200	867	2949	2278	3446	1459	3529	200	200	2848	2508	2847	1933
56	200	726	3067	3412	6924	10184	11834	7234	3979	2846	2848	3647	4738
57	1140	3583	5424	6722	5061	2310	15676	9278	807	2848	2846	2847	4873
58	1000	3743	3297	7182	5015	2192	2717	3983	200	2846	2508	2847	3120
59	200	731	2872	1215	3182	1542	2973	2031	200	2846	2506	2847	1921
60	200	575	2960	2638	3310	1817	2617	200	200	1085	1085	1425	1506
61	200	951	1400	868	897	384	200	200	200	660	241	200	532
62	200	1084	888	792	2197	1462	8475	2337	200	2846	2846	2847	2170
63	200	1079	3243	3062	5702	794	3976	200	7075	2605	2265	2605	2699
64	200	770	2488	1025	3134	2462	12436	5450	4821	2846	2848	2847	3435
6	5	200	4173	3606	8382	6302	6710	14400	7906	2633	2846	3023	5427
66	1000	4554	9631	8395	4566	2246	1257	200	200	2848	2508	2847	3357
67	200	1210	1717	1020	2443	511	5618	2433	3887	2848	2848	3647	2351
68	1000	4149	4220	6848	5151	1540	1183	3310	1607	2846	2848	3647	3199
69	1000	3813	6282	8590	7649	6614	4067	5162	760	2846	2701	2847	4350
70	200	3277	3266	5783	4545	2726	7547	5806	6114	2848	2848	3647	4034
71	1000	3717	8502	12285	8614	9651	13108	17517	12207	4563	2586	4264	8163
72	6471	11663	10436	13965	10038	14367	11811	12464	9638	2846	2846	3647	9201
73	1882	7946	10368	11607	5571	3436	5184	3841	1215	2848	2846	3094	4909
74	1569	3943	7292	9288	5267	5912	19333	9664	11290	1000	1158	1800	6441
75	3828	9685	9966	8073	5789	5292	13922	8741	8349	3531	4474	3647	7099
76	1000	8468	10511	12022	7661	10070	14274	16011	7401	2846	2846	3647	8082
77	1151	5989	9093	7292	4790	1226	200	200	200	660	241	200	2596
78	200	466	878	1003	753	200	1684	8945	200	2846	2846	3647	1987
79	1000	3927	5417	6429	4739	1901	6399	200	200	2848	2508	2847	3187
80	200	1000	888	1135	3301	1046	2057	5879	7613	2846	2848	2847	2633
81	200	3714	3163	5069	4136	1223	859	200	296	1000	660	1000	1778
82	376	2144	3158	2495	3914	7881	11900	14848	5667	4077	3540	4669	5394
83	1499	10295	10273	15466	6651	6074	8376	12261	14231	5053	5129	3647	8250
84	1834	11928	11090	17585	6912	7717	12365	14743	21333	1384	4533	1800	9447
85	5575	11184	10231	12323	5508	4409	9992	8579	200	2848	2506	2847	6360
86	200	2443	2922	9390	6358	16240	14974	13017	14738	2848	2848	3647	7462
87	1000	7193	10015	10605	5704	2737	200	200	200	660	660	1000	3342
88	200	1235	2199	960	2297	758	200	200	200	1038	618	477	063
89	200	1099	768	907	592	200	4158	200	200	2506	2508	2847	1347
MEAN	770	3239	4311	5172	4068	3392	6228	4340	2843	2327	2242	2530	3450
MAX	6472.	11929.	11090.	17586.	10038.	16241.	19333.	17518.	21333.	5053.	5130.	5178.	9447.
MIN	201.	200.	209.	493.	499.	201.	200.	201.	200.	300.	241.	200.	270.

	CENTRAL SNAKE STUDY 89. DISCHARGE SNAKE RIVER NEAR MURPHY (CFS)												
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	CFS-MONTH
28	9323	10983	11065	14290	13284	11795	23697	13916	11164	7180	7863	9149	143709
29	10260	12620	14625	14065	10638	10662	12134	9907	7505	7102	7425	9192	126136
30	9432	10190	10608	10798	12477	8627	7233	7941	6692	6766	8032	9433	108228
31	9497	8516	10062	8404	9943	8175	6815	6614	6262	6507	6796	7977	95568
32	8338	8173	8391	7926	8024	8572	7889	8071	7535	6683	7253	9160	96015
33	9486	8962	8470	8458	8182	8056	7616	7655	6821	6463	7160	9135	96464
34	9580	8883	8809	8769	8606	7139	6538	6114	5944	6121	6329	7313	90145
35	8159	7869	7515	7464	7595	7241	7349	6649	6717	5946	6422	7527	86454
36	8162	8152	7765	8508	9098	8354	9510	7591	8369	6694	7616	9446	99265
37	9450	9000	8539	7973	8415	8087	9838	7118	6846	6543	7303	9377	98490
38	9635	9047	9195	8682	9315	10017	10621	13420	8508	8254	8030	9159	113884
39	11052	12645	12555	14083	10745	10718	9845	7482	6781	7270	7552	9367	120095
40	9574	8896	8940	8625	10091	8733	8190	7428	6517	6603	6983	9507	100085
41	9717	9234	9561	8591	9092	7682	7356	7030	7174	6826	7422	8734	98418
42	8996	9251	9673	8300	8128	8230	9236	7799	8142	6370	6845	8705	99683
43	9053	9515	10833	10725	11956	18876	28959	15557	10029	8468	7650	9806	151427
44	10405	12891	17205	14376	11652	9256	10939	7908	7868	6975	7176	8823	125474
45	9452	9594	10706	11441	12200	8858	12735	13231	7863	7398	7640	9949	121065
46	10146	12719	17359	15061	11227	12275	17369	14713	8451	6967	7690	9239	143217
47	10692	12061	15921	13582	12315	9019	18757	7056	7357	6979	7830	9246	130815
48	10390	11973	13929	14872	12014	10435	8556	13147	12365	7265	7479	9207	131632
49	10432	11719	10325	13412	10712	15327	16105	11815	7300	6795	7607	9335	130885
50	10533	12092	10686	14436	13078	12167	26117	12301	8949	8018	7752	9937	146067
51	11829	18942	18148	16757	18005	17525	23040	16269	7522	6826	8030	10058	172951
52	10980	14232	17587	17318	13490	11985	30584	19255	13723	8055	7825	9202	174237
53	10962	12262	13592	16955	12167	9216	9532	12275	11204	6992	7598	9243	131998
54	9759	11938	10776	13680	11895	8951	20452	6825	7329	6792	7054	9051	124502
55	9479	12034	10598	11327	10723	8414	10423	6997	6041	6678	6867	8792	108374
56	9328	9688	11376	15690	14771	17821	20656	15423	12506	6725	7603	10080	151665
57	10514	13133	16926	13919	13570	10193	24758	18364	9426	6861	7511	9473	154648
58	10836	12081	15390	14770	13098	9434	11092	14160	8021	6749	7396	9288	132313
59	9705	9449	10694	11652	11845	9042	10929	8917	6530	6562	7056	9540	111921
60	9393	8264	10693	11642	12292	10606	10356	6705	6414	6313	6867	8554	108100
61	9134	8940	8925	8081	9290	7781	6852	6075	5811	5617	6119	7744	90370
62	8969	9148	a440	7809	11188	8793	17159	10657	8011	6720	7276	8611	112779
63	10509	12079	10846	11117	14691	8264	11641	7106	16301	6710	6880	8932	125077
64	9279	9891	11042	10689	10637	9925	20457	12898	13084	6759	7110	8759	130530
65	10331	12203	16587	16461	14328	15166	24944	18382	12592	8273	8728	12347	170342
66	12382	16201	17671	16204	12066	10094	9363	6555	6231	6522	7142	9172	129604
67	9736	9212	9239	8559	10077	8481	16953	9305	13284	7292	7350	9969	119458
68	10871	12692	15923	14553	12698	8882	8321	9419	8297	6526	8822	9918	126924
69	10980	12666	15642	18296	16434	13937	17748	15856	9144	7236	7401	9459	154798
70	10993	12281	12002	16581	13138	10113	15449	14506	14293	7749	7780	10952	145838
71	10718	12323	17299	24384	16807	17110	24336	28629	21680	12023	9437	12580	207328
72	15165	19941	18247	22822	18449	26328	21444	21686	18071	8003	8222	10785	209163
73	14443	19462	18418	19631	13428	11484	13540	11693	7962	6904	7536	9688	154188
74	10401	14620	16364	16331	13253	15041	29403	19219	20010	7195	7694	9359	178889
75	12337	18063	17416	15724	13771	13325	21867	20202	18976	8720	9448	10056	179907
76	13852	17729	18452	19764	15499	17723	23862	24497	15217	6709	8328	10458	192090
77	10580	16499	17315	14724	12416	8477	7381	7053	6656	6320	6381	7712	121514
78	8006	8163	8720	8469	8240	8352	11016	16705	7599	7039	7253	10122	109684
79	9969	11903	14706	15193	13125	10403	15512	7770	7038	6556	6950	8688	127812
80	9559	9267	10676	10146	12455	8302	9626	13730	16393	7073	7350	9564	124143
81	10301	11503	12244	13898	11186	8043	7554	6262	7060	6408	6674	8705	109837
82	9165	9526	11028	9450	15424	15303	21464	25281	14950	9522	8326	11212	160652
83	15758	18631	18164	23155	14479	15958	18952	24100	24786	11056	10886	9819	205745
84	15425	21223	20369	26666	16035	16570	24143	29138	34404	9057	12338	10347	235715
85	14117	19892	18497	20356	13836	12148	20923	16367	7364	6715	6906	9676	166798
86	11138	12371	11345	18491	17828	27185	24516	21787	23547	7793	7725	10471	194198
87	13781	17642	17788	18530	13325	10128	7709	7154	6599	6618	6895	8594	134762
88	9183	9197	9761	8250	9634	8318	7415	6788	6371	6003	6054	7401	94373
89	8793	8847	8133	8033	0182	9256	12799	7050	6544	6408	7292	9014	100352
AVG	10491	12083	12900	13531	12138	11329	14961	12444	10454	7166	7580	9389	134465

CENTRAL SNAKE STUDY 93. DISCHARGE SNAKE RI VER NEAR MURPHY (CFS)													
U- YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
28	9019	10983	11065	14594	13284	11795	23697	13916	11164	9028	9709	10996	12413
29	9260	12620	10221	14052	10638	10662	12134	9907	7404	8948	9271	11039	10509
30	8632	8906	10608	8240	11694	8627	7423	8110	6591	6979	8245	9646	8622
31	8697	8516	9990	8404	9943	8175	7005	6784	6162	6507	6796	8078	7910
32	8277	8111	8416	7916	8022	8620	8079	8242	7730	6683	7253	9160	8040
33	8686	8962	8470	8458	8182	8056	7616	7825	6722	7657	8354	10328	8276
34	8780	8883	8809	8769	8375	7189	6727	6285	5843	6121	6331	7403	7455
35	8085	7858	7312	7456	7588	7289	7539	6820	6912	5946	6422	7611	7231
36	8090	8081	7754	8502	9091	8352	9700	7760	8270	8540	9461	11291	8733
37	8651	9000	8539	7973	7875	7775	9838	7287	6747	7333	8094	10167	8269
38	8835	8946	9013	8682	8323	8398	9163	12185	8409	10101	9878	11006	9421
39	9252	12464	11280	11912	10745	10718	9845	7487	6682	9117	9400	11214	10003
40	8773	8896	9740	8625	10091	8492	7790	7598	6418	6603	6985	9507	8285
41	8911	8980	8801	8591	8521	743s	7178	7199	7075	6826	7422	8834	7977
42	8196	9257	8832	8300	8035	7916	9236	7970	8043	6370	6845	8705	8136
43	8253	9515	10948	10725	12504	19279	28959	15537	10029	8468	7650	9806	12619
44	9404	13924	17205	14376	11652	9256	10939	8077	7769	8821	9024	10669	10924
45	8651	9106	9527	8525	12095	8858	12735	13231	7764	9246	9487	11795	10066
46	9146	11982	13845	14970	11227	12275	17369	14713	8451	8813	9538	11086	11954
47	9692	12061	11537	13582	12315	9019	18757	7225	7258	8826	9678	11093	10894
48	8590	11946	10755	14410	12014	10435	8556	13147	12365	9112	9326	11054	10970
49	8632	10691	10203	10943	10712	15327	16105	11815	7300	8642	9453	11182	10914
50	8734	10677	10686	12220	13078	12167	26117	12301	8949	9865	9600	11784	12150
51	9343	15924	18148	16757	18005	17525	23040	16269	7421	8673	9876	11905	14376
52	9980	12464	17587	14838	13324	11985	30584	19255	13723	9903	9673	11049	14511
53	9162	12235	10805	16160	12167	9216	9532	12275	11204	8839	9445	11088	11001
54	8863	8901	10776	12132	11895	8951	20452	6825	7230	8639	8902	10898	10343
55	8679	9167	10598	9595	10723	8414	10423	7168	5941	8525	8715	10639	9035
56	8528	9118	11376	11728	14602	17821	20656	15423	12506	8571	9450	11927	12621
57	9655	12222	13446	13919	13546	10193	24585	18364	9426	8709	9359	11320	12874
58	9835	12081	10982	14770	13098	9434	11092	14160	7920	8597	9244	11135	11017
59	8907	9136	10694	8930	10862	9042	10325	8917	6431	8410	8902	11387	9316
60	8595	8389	10693	10185	11224	10401	10356	6876	6314	6738	7292	8979	8827
61	8334	8940	9027	8081	8408	7586	7042	6246	5712	5617	6121	7843	7405
62	8168	9148	8440	7809	10680	8741	16831	10657	7910	8566	9123	10458	9688
63	8708	9352	10846	10193	14691	8264	11641	7276	16128	8315	8486	10537	10317
64	8479	8901	10193	8617	10637	9925	20457	12898	13084	8605	8957	10606	10923
65	8531	12171	13428	16232	14328	15166	24909	18382	12592	10121	10574	14194	14199
66	10104	12961	17671	16204	12066	10094	9363	6726	6132	8369	8990	11019	10808
67	8936	9212	9312	8559	9969	7929	12698	9305	13284	9140	9198	11816	9927
68	9871	12692	11924	14301	12698	8882	8265	9419	8297	8372	10668	11765	10589
69	9980	12666	13874	16666	15307	13937	17748	15856	9144	9083	9248	11306	12884
70	9193	11859	11070	14335	13138	10113	15449	14506	14293	9597	9627	12799	12141
71	9718	11993	15855	21745	16789	17110	24336	28629	21680	12023	9437	12580	16816
72	15165	19941	18247	22822	18449	26328	21444	21686	18071	9851	10068	12632	17887
73	11369	17057	18418	19631	13428	11484	13540	11693	7962	8751	9382	11535	12853
74	9970	12040	13900	16331	13253	15041	29403	19219	20010	7195	7694	9359	14425
75	12337	18063	17416	15724	13771	13325	21867	20202	18976	10566	11296	11903	15443
76	9700	16425	18452	19764	15499	17723	23862	24497	15217	8554	10174	12305	16007
77	9731	14109	16754	14438	12216	8477	7571	7224	6557	6322	6383	7813	9788
78	7946	8163	8720	8469	8240	8403	9610	16707	7498	8886	9099	11967	9488
79	8969	11903	12921	14387	13012	9645	14977	7939	6939	8403	8798	10535	10679
80	8759	9267	8577	9113	10800	8302	9626	13730	16393	8919	9198	11411	10324
81	8502	11471	10561	12013	11186	8043	7554	6432	6887	6409	6676	8705	8683
82	8541	10061	11028	9559	15424	15303	21464	25281	14950	11370	10172	13059	13827
83	10341	18631	18164	23155	14479	15958	18952	24100	24786	12902	12732	11666	17163
84	10486	20734	20369	26666	16035	16570	24143	29138	34404	9057	12338	10347	19173
85	14117	19892	18497	20356	13836	12148	20923	16367	7265	8561	8752	11523	14351
86	9339	11020	10720	16918	17828	27185	24516	21787	23547	9641	9570	12318	16168
87	10029	15934	17788	18530	13325	10128	7899	7324	6500	6618	6897	8596	10788
88	8383	9197	9811	8250	9634	8318	7605	6958	6270	6380	6433	7779	7911
89	7994	8825	8133	8033	8182	9307	12714	7220	6443	8254	9139	10861	8753
AVG	9266	11494	12077	12841	11980	11267	14838	12490	10405	8461	8876	10694	11203

CENTRAL SNAKE STUDY 89. CONTENTS BROWNLEE RESERVOIR

(1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
28	1375.0	1390.1	1340.0	1119.5	1060.1	920.1	1120.1	1420.1	1410.0	1380.0	1340.0	1320.0
29	1375.0	1390.1	1340.0	1100.0	1050.0	1220.1	1420.1	1358.0	1400.0	1380.0	1340.0	1320.0
30	1375.0	1278.7	1200.0	1030.0	1050.0	1098.1	1350.0	1350.0	1400.0	1334.8	1340.0	1320.0
31	1375.0	1250.0	1200.0	1030.0	1050.0	1110.6	1350.0	1300.4	1300.0	1282.3	1250.0	1318.5
32	1355.5	1250.0	1200.0	1030.0	1000.1	1220.1	1320.1	1420.1	1410.0	1380.0	1340.0	1320.0
33	1375.0	1278.1	1200.0	1030.0	1022.9	1087.7	1320.1	1373.4	1410.0	1380.0	1340.0	1320.0
34	1375.0	1260.9	1200.0	1030.0	1050.0	1050.6	1322.8	1300.0	1301.0	1293.1	1286.2	1320.0
35	1375.0	1250.0	1195.7	1030.0	1003.1	1050.0	1420.1	1350.0	1400.0	1328.4	1340.0	1320.0
36	1375.0	1250.0	1188.8	1030.0	1050.0	1120.1	1320.1	1420.1	1400.0	1380.0	1340.0	1320.0
37	1375.0	1250.0	1200.0	1030.0	1047.6	1083.8	1420.1	1350.0	1400.0	1329.2	1340.0	1320.0
38	1375.0	1307.0	1200.0	1030.0	1050.0	920.1	1120.1	1420.1	1410.0	1408.7	1340.0	1320.0
39	1375.0	1390.1	1259.1	1063.0	1050.0	1220.1	1420.1	1350.0	1400.0	1380.0	1340.0	1320.0
40	1375.0	1250.0	1200.0	1030.0	1050.0	1220.1	1420.1	1420.1	1400.0	1375.1	1340.0	1320.0
41	1375.0	1342.3	1200.0	1030.0	1050.0	1220.1	1420.1	1400.0	1400.0	1380.0	1340.0	1320.0
42	1375.0	1340.1	1264.6	1030.0	1050.0	1220.1	1320.1	1420.1	1410.0	1380.0	1340.0	1320.0
43	1375.0	1389.2	1340.0	1250.0	1060.1	920.1	920.1	1420.1	1410.0	1420.1	1340.0	1320.0
44	1375.0	1390.1	1340.0	1100.0	1050.0	1175.0	1420.1	1350.0	1400.0	1380.0	1340.0	1320.0
45	1375.0	1329.6	1200.0	1030.0	1060.1	1120.1	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
46	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
47	1375.0	1390.1	1340.0	1100.0	1060.1	1120.1	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
48	1375.0	1390.1	1340.0	1100.0	1050.0	1020.1	1120.1	1420.1	1410.0	1380.0	1340.0	1320.0
49	1375.0	1390.1	1200.0	1030.0	1050.0	1020.1	1220.1	1420.1	1400.0	1380.0	1340.0	1320.0
50	1375.0	1390.1	1200.0	1051.4	1050.0	920.1	1220.1	1420.1	1410.0	1420.1	1340.0	1320.0
51	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	1120.1	1420.1	1410.0	1380.0	1340.0	1320.0
52	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1420.1	1410.0	1409.3	1340.0	1320.0
53	1375.0	1390.1	1318.4	1242.3	1060.1	920.1	1120.1	1420.1	1410.0	1420.1	1340.0	1320.0
54	1375.0	1390.1	1200.0	1100.0	1060.1	1020.1	1220.1	1420.1	1400.0	1380.0	1340.0	1320.0
55	1375.0	1390.1	1200.0	1030.0	1050.0	1050.0	1420.1	1400.0	1400.0	1380.0	1340.0	1320.0
56	1375.0	1353.6	1340.0	1250.0	1060.1	920.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
57	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	920.1	1420.1	1410.0	1380.0	1340.0	1320.0
58	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
59	1375.0	1341.2	1200.0	1030.0	1050.0	1183.6	1420.1	1420.1	1400.0	1380.0	1340.0	1320.0
60	1375.0	1281.8	1200.0	1030.0	1050.0	1220.1	1320.1	1400.0	1400.0	1374.4	1340.0	1320.0
61	1375.0	1337.5	1200.0	1030.0	1050.0	1175.9	1393.4	1350.0	1400.0	1300.0	1283.1	1320.0
62	1375.0	1269.1	1200.0	1030.0	1050.0	1197.1	1320.1	1420.1	1400.0	1380.0	1340.0	1320.0
63	1375.0	1390.1	1340.0	1030.0	1060.1	1020.1	1120.1	1350.0	1410.0	1380.0	1340.0	1320.0
64	1375.0	1377.2	1200.0	1030.0	1050.0	920.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
65	1375.0	1390.1	1340.0	1250.0	1257.0	920.1	920.1	1420.1	1410.0	1420.1	1396.6	1320.0
66	1375.0	1390.1	1340.0	1100.0	1050.0	1260.0	1420.1	1350.0	1400.0	1360.0	1340.0	1320.0
67	1375.0	1282.4	1200.0	1030.0	1050.0	1099.4	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
68	1375.0	1390.1	1340.0	1100.0	1187.5	1260.0	1420.1	1350.0	1400.0	1370.5	1340.0	1320.0
69	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	1120.1	1420.1	1410.0	1360.0	1340.0	1320.0
70	1375.0	1390.1	1221.8	1250.0	1060.1	920.1	920.1	1420.1	1410.0	1415.7	1340.0	1320.0
71	1375.0	1390.1	1340.0	1250.0	1129.4	920.1	920.1	1220.1	1410.0	1420.1	1351.3	1320.0
72	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1420.1	1410.0	1380.0	1340.0	1320.0
73	1375.0	1390.1	1340.0	1245.7	1060.1	1220.1	1420.1	1420.1	1400.0	1380.0	1340.0	1320.0
74	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1240.1	1410.0	1420.1	1340.0	1320.0
75	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	920.1	1420.1	1410.0	1420.1	1387.0	1320.0
76	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1420.1	1410.0	1380.0	1340.0	1320.0
77	1375.0	1390.1	1340.0	1100.0	1050.0	1050.0	1150.0	1300.0	1300.7	1270.3	1250.0	1317.7
78	1375.0	1250.0	1200.0	1030.0	1050.0	920.1	1220.1	1420.1	1410.0	1385.9	1340.0	1320.0
79	1375.0	1390.1	1340.0	1100.0	1060.1	1220.1	1420.1	1400.0	1400.0	1353.6	1340.0	1320.0
80	1375.0	1264.9	1200.0	1030.0	1060.1	1120.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
81	1375.0	1390.1	1340.0	1100.0	1060.1	1120.1	1220.1	1350.0	1400.0	1380.0	1340.0	1320.0
a2	1375.0	1352.6	1340.0	1030.0	1230.2	920.1	920.1	1240.1	1410.0	1420.1	1340.0	1320.0
a3	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1200.1	1410.0	1420.1	1400.0	1320.0
a4	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1200.1	1410.0	1420.1	1400.0	1320.0
85	1375.0	1390.1	1340.0	1250.0	1060.1	1020.1	1320.1	1420.1	1400.0	1380.0	1340.0	1320.0
86	1375.0	1390.1	1232.9	1100.0	1261.0	920.1	920.1	1420.1	1410.0	1380.0	1340.0	1320.0
87	1375.0	1390.1	1340.0	1100.0	1050.0	1260.0	1408.4	1350.0	1400.0	1361.4	1340.0	1320.0
88	1375.0	1261.3	1200.0	1030.0	1050.0	1050.0	1274.8	1300.0	1399.8	1300.0	1250.0	1320.0
89	1375.0	1250.0	1200.0	1030.0	1042.8	1220.1	1420.1	1420.1	1400.0	1380.0	1340.0	1320.0
AVG	1374.7	1350.0	1274.5	1104.5	1065.2	1050.7	1196.0	1380.7	1400.7	1377.0	1337.7	1319.9

CENTRAL SNAKE STUDY 93. CONTENTS BROUNLEE RESERVOIR

(1000 AC-FT)

W- YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	1375.0	1390.1	1340.0	1153.6	1060.1	920.1	1120.1	1420.1	1410.0	1380.0	1340.0	1320.0
29	1375.0	1390.1	1200.0	1030.0	1050.0	1220.1	1420.1	1358.0	1400.0	1380.0	1340.0	1320.0
30	1375.0	1250.0	1200.0	1030.0	1050.0	1113.3	1350.0	1350.0	1400.0	1308.8	1340.0	1320.0
31	1375.0	1250.0	1200.0	1030.0	1050.0	1125.9	1350.0	1310.9	1300.0	1282.3	1250.0	1320.0
32	1368.6	1250.0	1200.0	1030.0	1014.3	1220.1	1320.1	1420.1	1410.0	1380.0	1340.0	1320.0
33	1375.0	1292.9	1200.0	1030.0	1036.7	1116.9	1320.1	1383.9	1410.0	1380.0	1340.0	1320.0
34	1375.0	1275.8	1200.0	1030.0	1050.0	1069.0	1350.0	1300.0	1300.0	1292.1	1269.1	1320.0
35	1375.0	1250.0	1198.5	1030.0	1016.5	1050.0	1420.1	1350.0	1400.0	1310.7	1337.4	1320.0
36	1375.0	1250.0	1200.0	1030.0	1050.0	1120.1	1320.1	1420.1	1400.0	1380.0	1340.0	1320.0
37	1375.0	1257.4	1200.0	1030.0	1031.4	1063.7	1420.1	1350.0	1400.0	1347.8	1340.0	1320.0
38	1375.0	1315.9	1208.0	1030.0	1050.0	920.1	1120.1	1420.1	1410.0	1420.1	1340.0	1320.0
39	1375.0	1390.1	1200.0	1030.0	1050.0	1220.1	1420.1	1350.0	1400.0	1380.0	1340.0	1320.0
40	1375.0	1262.0	1200.0	1030.0	1050.0	1220.1	1420.1	1420.1	1400.0	1375.1	1340.0	1320.0
41	1375.0	1342.1	1200.0	1030.0	1050.0	1220.1	1420.1	1400.0	1400.0	1380.0	1340.0	1320.0
42	1375.0	1362.9	1243.0	1030.0	1050.0	1220.1	1420.1	1420.1	1410.0	1380.0	1340.0	1320.0
43	1375.0	1389.2	1340.0	1250.0	1060.1	920.1	920.1	1420.1	1410.0	1420.1	1340.0	1320.0
44	1375.0	1390.1	1340.0	1100.0	1050.0	1190.3	1420.1	1350.0	1400.0	1380.0	1340.0	1320.0
45	1375.0	1315.4	1200.0	1030.0	1060.1	1120.1	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
46	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
47	1375.0	1390.1	1340.0	1100.0	1060.1	1120.1	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
48	1375.0	1390.1	1217.2	1100.0	1050.0	1020.1	1120.1	1420.1	1410.0	1380.0	1340.0	1320.0
49	1375.0	1390.1	1200.0	1030.0	1050.0	1020.1	1220.1	1420.1	1400.0	1380.0	1340.0	1320.0
50	1375.0	1390.1	1200.0	1030.0	1050.0	920.1	1220.1	1420.1	1410.0	1420.1	1340.0	1320.0
51	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	1120.1	1420.1	1410.0	1380.0	1340.0	1320.0
52	1375.0	1390.1	1340.0	1141.8	1060.1	920.1	920.1	1420.1	1410.0	1420.1	1340.0	1320.0
53	1375.0	1390.1	1200.0	1100.0	1060.1	920.1	1120.1	1420.1	1410.0	1420.1	1340.0	1320.0
54	1375.0	1326.0	1200.0	1031.2	1060.1	1020.1	1220.1	1420.1	1400.0	1380.0	1340.0	1320.0
55	1375.0	1300.4	1200.0	1030.0	1050.0	1050.0	1420.1	1400.0	1400.0	1380.0	1340.0	1320.0
56	1375.0	1334.6	1340.0	1250.0	1060.1	920.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
57	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	920.1	1420.1	1410.0	1380.0	1340.0	1320.0
58	1375.0	1390.1	1254.2	1100.0	1060.1	920.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
59	1375.0	1337.5	1200.0	1030.0	1050.0	1198.9	1420.1	1420.1	1400.0	1380.0	1340.0	1320.0
60	1375.0	1304.0	1200.0	1030.0	1050.0	1220.1	1320.1	1377.1	1400.0	1380.0	1340.0	1320.0
61	1375.0	1352.4	1200.0	1030.0	1050.0	1179.2	1408.1	1350.0	1400.0	1300.0	1283.2	1320.0
62	1375.0	1283.9	1200.0	1030.0	1050.0	1209.3	1320.1	1420.1	1400.0	1380.0	1340.0	1320.0
63	1375.0	1390.1	1340.0	1030.0	1060.1	1020.1	1120.1	1350.0	1410.0	1380.0	1340.0	1320.0
64	1375.0	1333.2	1200.0	1030.0	1050.0	920.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
65	1375.0	1390.1	1340.0	1250.0	1270.8	920.1	920.1	1420.1	1410.0	1420.1	1400.0	1320.0
66	1375.0	1390.1	1340.0	1100.0	1050.0	1260.0	1420.1	1350.0	1400.0	1380.0	1340.0	1320.0
67	1375.0	1297.3	1200.0	1030.0	1050.0	1080.8	1220.1	1420.1	1410.0	1380.0	1340.0	1320.0
68	1375.0	1390.1	1224.8	1057.4	1159.2	1260.0	1420.1	1350.0	1400.0	1380.0	1340.0	1320.0
69	1375.0	1390.1	1340.0	1227.7	1060.1	920.1	1120.1	1420.1	1410.0	1380.0	1340.0	1320.0
70	1375.0	1390.1	1200.0	1047.0	1060.1	920.1	920.1	1420.1	1410.0	1420.1	1354.5	1320.0
71	1375.0	1390.1	1340.0	1250.0	1128.4	920.1	920.1	1220.1	1410.0	1420.1	1351.3	1320.0
72	1375.0	1390.1	1340.0	1250.0	1071.3	920.1	920.1	1420.1	1410.0	1419.3	1349.9	1320.0
73	1375.0	1390.1	1340.0	1250.0	1060.1	1220.1	1420.1	1420.1	1400.0	1380.0	1340.0	1320.0
74	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1240.1	1410.0	1420.1	1340.0	1320.0
75	1375.0	1390.1	1340.0	1100.0	1060.1	920.1	920.1	1420.1	1410.0	1420.1	1400.0	1320.0
76	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1420.1	1410.0	1380.0	1400.0	1320.0
77	1375.0	1390.1	1340.0	1100.0	1050.0	1050.0	1150.0	1300.0	1300.0	1269.7	1250.0	1320.0
78	1375.0	1250.0	1200.0	1030.0	1050.0	920.1	1220.1	1420.1	1400.0	1420.1	1340.0	1320.0
79	1375.0	1390.1	1264.3	1056.8	1050.0	1220.1	1420.1	1400.0	1400.0	1380.0	1340.0	1320.0
80	1375.0	1279.7	1200.0	1030.0	1050.0	1120.1	1020.1	1420.1	1410.0	1380.0	1340.0	1320.0
81	1375.0	1390.1	1340.0	1100.0	1060.1	1120.1	1220.1	1350.0	1400.0	1380.0	1340.0	1320.0
82	1375.0	1390.1	1340.0	1037.2	1251.2	920.1	920.1	1240.1	1410.0	1420.1	1400.0	1320.0
83	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1200.1	1410.0	1420.1	1400.0	1320.0
84	1375.0	1390.1	1340.0	1250.0	1060.1	920.1	920.1	1200.1	1410.0	1420.1	1400.0	1320.0
85	1375.0	1390.1	1340.0	1250.0	1060.1	1020.1	1320.1	1420.1	1400.0	1380.0	1340.0	1320.0
86	1375.0	1390.1	1209.9	1100.0	1274.8	920.1	920.1	1420.1	1410.0	1412.8	1361.4	1320.0
87	1375.0	1390.1	1340.0	1100.0	1050.0	1260.0	1419.7	1350.0	1400.0	1361.4	1340.0	1320.0
88	1375.0	1276.1	1200.0	1030.0	1050.0	1050.0	1286.1	1311.8	1400.0	1300.0	1269.7	1320.0
89	1368.2	1252.6	1200.0	1030.0	1050.0	1220.1	1420.1	1420.1	1400.0	1380.0	1340.0	1320.0
AVG	1374.8	1349.1	1262.3	1096.3	1065.9	1052.1	1197.1	1380.9	1400.5	1379.7	1340.6	1320.0

Appendix B:

Payette baseline/flow augmentation simulation results

Baseline simulation (Central Snake Study 89)

Flow augmentation simulation (Central Snake Study 93)

CENTRAL SNAKE STUDY 89. CONTENTS CASCADE RESERVOIR

(1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
28	420.0	480.8	490.0	488.2	484.0	484.6	459.6	682.7	703.2	662.2	550.0	450.0
29	400.9	401.2	400.4	396.1	392.9	398.4	438.1	548.2	649.0	608.4	479.3	403.5
30	377.9	370.6	381.0	379.6	387.1	406.5	482.1	617.3	672.1	629.1	500.5	420.0
31	400.0	398.9	385.4	377.8	370.7	378.0	427.2	525.4	534.8	504.5	406.4	342.8
32	323.3	313.4	300.0	292.0	282.3	297.7	386.7	614.4	703.2	675.2	550.0	453.0
33	400.0	404.2	393.3	389.8	383.3	385.6	440.3	547.4	703.2	661.8	550.0	438.1
34	400.0	400.1	405.0	425.0	438.5	477.9	604.9	696.2	681.1	641.8	488.3	404.7
35	378.4	379.2	376.8	378.0	378.1	384.1	458.8	598.2	682.2	643.7	516.5	420.0
36	391.0	383.6	363.5	357.9	353.2	358.3	482.0	637.5	703.2	666.8	528.4	420.0
37	392.4	379.0	371.4	359.6	347.5	347.6	391.9	518.3	600.0	568.0	450.0	370.0
38	350.0	352.9	374.9	387.4	396.7	427.7	433.7	530.2	703.2	680.0	569.8	474.7
39	420.0	422.9	422.5	422.0	420.9	434.8	530.2	673.6	602.6	655.7	513.0	420.0
40	397.7	393.0	399.2	414.3	426.5	498.8	533.2	596.7	660.7	628.0	492.6	420.0
41	400.0	416.9	426.1	427.1	431.2	467.1	539.8	689.0	703.2	670.0	553.0	471.7
42	420.0	441.5	488.9	505.6	519.8	521.6	622.6	614.7	703.2	679.9	555.7	453.9
43	400.0	408.9	414.8	430.2	365.8	284.5	394.8	472.5	691.5	680.0	630.1	542.2
44	478.4	487.1	406.2	483.9	474.4	430.3	464.7	540.4	611.9	582.1	455.4	305.3
45	363.1	365.1	357.1	356.7	365.0	378.2	422.4	582.3	703.2	679.1	564.1	471.6
46	420.0	426.6	437.8	452.8	456.8	474.6	481.7	621.6	703.2	680.0	571.4	494.6
47	443.0	464.1	490.0	503.2	483.7	514.0	476.3	624.3	703.2	676.3	558.9	473.4
48	437.5	449.6	460.8	482.6	493.7	475.1	524.6	572.1	703.2	680.0	550.0	472.5
49	420.0	444.0	453.0	453.8	448.9	449.2	488.2	635.3	703.2	664.6	528.2	420.3
50	399.5	403.3	402.8	411.5	429.0	462.5	432.6	522.9	703.2	680.0	586.8	497.7
51	455.8	499.5	490.0	493.2	481.6	456.6	432.3	556.0	660.3	653.3	550.0	466.0
52	453.6	477.8	490.0	451.1	387.1	299.7	384.6	594.1	703.2	680.0	567.2	477.3
53	420.0	408.2	408.1	433.2	449.7	464.3	492.4	562.8	703.2	680.0	585.7	485.2
54	420.0	446.7	455.3	461.9	476.5	485.1	476.4	586.2	703.2	680.0	561.7	464.5
55	410.2	409.3	421.2	423.7	413.7	417.2	443.6	568.6	703.2	680.0	550.0	450.0
56	420.0	447.0	490.0	443.9	415.9	315.1	400.0	581.3	703.2	670.3	550.0	453.9
57	431.6	444.2	454.6	457.1	477.7	507.7	461.2	600.0	703.2	665.0	550.0	443.0
58	420.0	421.2	433.6	436.4	453.9	473.9	459.1	657.1	703.2	662.9	550.0	450.0
59	407.0	429.2	448.6	477.2	494.3	482.6	521.6	585.3	703.2	655.9	550.0	482.1
60	405.6	500.0	490.0	497.0	506.7	529.8	634.3	673.8	703.2	648.4	534.4	420.0
61	400.0	417.0	421.0	418.0	448.3	479.9	523.7	657.8	703.2	641.7	499.5	420.0
62	400.0	405.0	411.1	412.7	422.3	425.0	521.7	502.3	703.2	655.9	550.0	427.2
63	455.3	514.7	490.0	505.3	555.7	588.1	585.6	630.6	703.2	657.4	550.0	453.6
64	420.0	440.5	447.1	457.3	450.3	444.0	496.3	587.6	703.2	680.0	550.2	474.9
65	420.0	431.7	490.0	440.2	364.0	350.3	435.4	531.2	703.2	680.0	619.0	558.3
66	506.8	500.0	490.0	505.4	502.7	508.4	585.3	692.2	703.2	648.8	496.5	409.5
67	395.7	407.7	415.7	430.4	441.4	450.0	479.9	541.3	703.2	680.0	554.2	456.0
68	425.5	440.0	450.9	460.5	487.0	525.8	560.0	652.2	703.2	646.5	545.4	450.0
69	420.0	449.2	470.3	488.1	402.5	324.2	406.0	557.8	684.6	645.8	548.1	438.6
70	404.2	400.0	409.7	456.7	476.4	500.8	473.1	560.8	703.2	680.0	564.5	503.1
71	446.3	481.9	490.0	439.3	377.7	323.2	338.8	514.9	703.2	680.0	599.6	528.9
72	466.7	474.4	480.6	493.5	485.5	415.8	424.5	520.4	703.2	670.6	566.4	497.9
73	437.6	447.5	471.3	491.2	496.7	506.0	535.1	651.7	694.2	640.9	491.3	420.0
74	400.0	483.5	490.0	441.6	364.4	325.9	352.4	430.0	703.2	680.0	602.6	528.3
75	465.1	469.9	477.3	486.7	497.3	516.4	423.5	517.8	703.2	680.0	611.3	533.7
76	515.8	530.0	490.0	502.6	478.9	492.4	485.1	629.3	703.2	680.0	596.6	535.1
77	482.5	481.6	466.6	465.8	450.0	425.0	400.0	375.7	383.4	328.6	243.3	198.5
78	202.2	215.1	261.7	284.2	302.8	348.9	475.9	612.1	703.2	680.0	594.3	539.6
79	460.6	459.5	458.1	460.0	465.0	486.6	534.7	679.5	703.2	659.0	529.9	420.0
80	400.0	406.7	413.9	443.0	463.0	487.4	533.2	676.3	703.2	680.0	556.2	511.6
81	448.5	470.2	490.0	510.0	547.7	581.6	650.0	690.6	703.2	665.6	543.1	420.0
82	400.0	437.0	486.9	491.0	484.3	399.9	388.0	503.8	703.2	680.0	604.8	551.3
a3	532.0	530.0	490.0	480.5	474.8	458.9	403.0	551.5	703.2	680.0	612.3	547.7
a4	503.2	530.0	490.0	455.6	473.2	463.0	460.0	562.0	703.2	610.0	591.7	536.0
85	493.8	516.0	490.0	404.7	479.9	483.7	541.5	637.5	685.5	625.8	480.5	433.7
86	420.0	440.8	455.1	467.9	516.1	491.8	488.8	612.6	703.2	660.2	550.0	468.4
87	436.3	449.4	450.0	455.0	460.8	498.6	553.5	617.2	600.0	534.7	439.5	369.6
88	347.3	344.9	352.0	358.5	358.5	373.4	436.6	536.3	588.7	530.0	436.8	366.4
a9	350.0	364.9	365.4	372.1	374.8	418.9	509.3	590.5	662.7	627.7	501.3	420.0
AVG	419.6	432.4	437.7	440.5	438.5	439.7	477.8	509.3	683.0	649.2	537.6	453.7

CENTRAL SNAKE STUDY 93. CONTENTS CASCADE RESERVOIR												(1000 AC-FT)
W-YR	OCT	NOV	DEC	JAN	FEE	MAR	APR	MAY	JUN	JUL	AUC	SEP
28	408.0	457.3	454.6	440.8	425.5	414.1	479.6	682.7	703.2	662.2	550.0	450.0
29	389.0	377.8	365.0	348.8	334.8	328.4	368.1	478.2	600.0	559.4	450.0	373.8
30	336.3	317.4	316.0	302.7	299.4	306.8	382.4	517.6	595.0	552.0	450.0	377.5
31	345.5	332.9	307.4	287.9	270.0	265.5	314.7	412.8	402.5	361.8	263.7	200.1
32	168.6	147.2	121.9	102.0	81.0	84.5	173.6	441.1	634.2	606.2	515.2	420.0
33	355.1	347.7	324.9	309.5	292.2	282.6	337.3	444.3	703.2	661.8	550.0	438.1
34	388.1	376.6	369.5	377.6	380.3	407.7	534.7	626.1	606.4	567.1	450.0	370.0
35	331.7	321.0	306.7	295.9	285.3	279.4	354.1	493.5	600.0	561.5	450.0	370.0
36	329.0	310.1	278.1	260.5	244.7	237.8	361.5	620.9	703.2	666.8	528.4	420.0
37	380.4	355.5	336.0	312.3	289.4	277.6	321.9	448.3	533.5	513.8	445.0	370.0
38	338.1	329.4	339.4	340.1	338.6	357.6	455.6	552.2	703.2	680.0	569.8	474.7
39	408.1	399.5	387.1	374.7	362.8	364.8	460.2	603.6	609.6	582.7	450.0	370.0
40	335.7	319.5	313.7	316.9	317.9	378.3	508.7	608.1	672.1	639.4	503.9	420.0
41	388.0	393.4	390.7	379.8	373.1	397.0	469.7	643.8	703.2	670.0	553.0	471.7
42	408.1	418.0	453.5	458.3	461.7	451.6	552.9	631.6	703.2	679.9	555.7	453.9
43	400.0	408.9	414.8	430.2	365.8	284.5	394.8	472.5	691.5	680.0	630.1	542.2
44	466.5	463.7	450.8	436.6	415.9	359.9	394.3	470.0	564.1	534.3	450.0	379.9
45	345.8	336.2	316.3	303.9	301.5	302.8	347.0	506.9	686.;	662.0	550.0	450.0
46	386.5	381.5	380.8	383.9	377.1	382.9	502.2	621.6	703.2	680.0	571.4	494.6
47	431.1	440.6	454.6	456.0	425.7	444.0	496.1	624.3	703.2	676.3	558.9	473.4
48	425.5	426.1	425.5	435.3	435.2	404.8	479.5	585.8	703.2	680.0	550.0	472.5
49	408.1	420.6	417.6	406.5	390.8	379.2	506.0	638.5	703.2	664.6	528.2	420.3
50	387.6	379.9	367.4	364.1	370.9	392.4	452.5	542.8	703.2	680.0	586.8	497.7
51	443.9	476.0	454.5	445.8	423.4	386.5	452.2	556.8	668.3	653.3	550.0	466.0
52	441.7	454.4	454.6	403.8	328.6	229.3	357.4	563.8	703.2	680.0	567.2	477.3
53	408.1	384.7	372.6	385.9	391.6	394.2	475.9	582.7	703.2	680.0	585.7	485.2
54	408.1	423.3	419.9	414.6	418.4	415.0	496.2	586.2	703.2	680.0	561.7	464.5
55	398.3	385.8	385.8	376.3	355.5	347.1	373.5	498.5	663-L	652.5	550.0	427.3
56	385.4	400.8	431.9	373.8	334.7	222.0	350.8	564.3	703.2	670.3	550.0	453.9
57	419.7	420.8	419.3	409.9	419.7	437.8	481.1	600.0	703.2	665.0	550.0	443.0
58	408.1	397.8	398.2	389.1	395.8	403.9	478.9	657.1	703.2	662.9	550.0	450.0
59	395.0	405.7	413.1	429.8	436.1	412.6	487.6	602.9	703.2	655.9	550.0	482.1
60	473.6	476.5	454.6	450.5	448.3	459.4	563.9	693.7	703.2	648.4	534.4	420.0
61	388.0	393.5	385.5	370.6	390.1	409.8	453.6	607.4	703.2	641.7	499.5	420.0
62	388.1	381.5	375.7	365.3	364.1	354.9	465.3	600.7	703.2	655.9	550.0	427.2
63	443.3	491.2	454.6	458.0	497.6	518.1	570.8	630.6	703.2	657.4	550.0	453.6
64	408.1	417.1	411.7	410.0	391.9	373.6	425.9	559.0	703.2	680.0	550.2	474.9
65	408.1	408.3	454.6	392.9	305.9	280.2	439.4	531.2	703.2	680.0	619.0	558.3
66	494.9	476.5	454.6	458.2	444.7	438.4	515.3	648.7	695.0	640.6	488.2	401.3
67	375.5	376.0	372.1	374.9	375.1	371.8	420.4	561.2	703.2	680.0	554.2	456.0
68	413.6	416.5	415.5	413.2	428.6	455.4	489.5	606.8	703.2	646.5	545.4	450.0
69	408.0	425.7	434.9	440.8	344.4	254.2	384.5	557.8	684.6	645.8	548.1	438.6
70	392.2	376.5	374.3	409.4	418.3	430.8	474.9	580.8	703.2	680.0	564.5	503.1
71	446.3	481.9	490.0	439.3	377.7	323.2	338.8	514.9	703.2	680.0	599.6	528.9
72	454.8	450.9	453.2	446.2	427.1	345.4	410.0	528.2	703.2	670.6	566.4	497.9
73	425.6	424.0	435.9	443.8	438.7	435.9	465.0	581.6	624.2	570.8	450.0	389.6
74	383.2	466.7	490.0	459.9	382.7	344.1	352.4	430.0	703.2	680.0	602.6	528.3
75	453.1	446.4	441.8	439.4	439.1	446.4	443.3	537.6	703.2	680.0	611.3	533.7
76	503.9	506.6	454.6	455.3	420.5	422.0	505.1	629.3	703.2	680.0	596.6	535.1
77	470.6	458.1	431.1	418.4	391.8	354.9	358.3	334.0	314.4	259.6	174.3	129.5
78	121.3	122.7	157.3	167.9	175.7	209.9	336.9	511.2	703.2	680.0	594.3	539.6
79	448.7	436.0	422.7	412.7	406.9	416.5	464.6	609.4	654.4	610.2	481.1	387.8
80	355.9	351.1	346.4	363.6	372.4	384.9	483.6	676.3	703.2	680.0	556.2	511.6
81	436.6	446.7	454.6	462.7	489.6	511.6	580.8	690.6	703.2	665.6	543.1	420.0
82	388.1	413.5	451.4	443.6	426.1	329.8	392.5	508.3	703.2	680.0	604.8	551.3
83	520.1	506.6	454.7	433.2	416.8	388.9	422.8	551.5	703.2	680.0	612.3	547.7
84	503.2	530.0	490.0	455.6	473.2	463.0	460.0	562.0	703.2	680.0	591.7	536.0
85	481.9	492.5	454.6	437.4	421.8	413.7	500.3	646.2	694.2	634.5	497.1	442.4
86	416.8	426.1	428.4	429.3	466.7	430.6	508.7	612.6	703.2	660.2	550.0	468.4
87	424.4	425.9	414.6	407.7	402.7	428.6	483.5	553.3	550.0	498.2	400.7	330.8
88	296.5	282.6	277.8	272.4	261.3	264.2	327.4	427.1	479.5	429.9	322.7	252.3
89	224.0	227.4	215.9	210.6	202.6	234.8	325.2	482.4	589.2	534.3	450.0	393.9
AVG	397.1	399.1	393.5	385.4	373.3	363.3	434.9	562.0	665.1	631.2	524.74	411.7

CENTRAL SNAKE STUDY 89. DISCHARGE NF PAYETTE RIVER NR BANKS (CFS)												
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT CFS-MONT1
28	1064	484	1033	799	629	1503	2824	3013	2927	1125	2082	19391
29	1036	280	266	266	278	305	608	710	1032	1081	2461	9809
30	568	293	350	338	364	449	669	814	928	1041	2427	9865
31	597	269	389	258	352	345	610	506	270	800	1747	7303
3 2	438	340	459	382	389	384	1225	2386	3147	1153	2428	14566
33	1085	302	410	279	349	266	763	833	3365	1083	2189	12988
34	787	284	315	429	406	531	792	581	992	1020	2691	10350
35	565	289	259	289	298	283	889	752	980	1029	2399	9746
36	557	252	456	273	283	301	1338	3327	1457	1039	2481	13744
37	560	371	296	364	372	270	686	770	585	1046	2274	9085
38	439	291	388	339	346	544	3467	4229	2762	1641	2196	18624
39	1214	297	272	287	283	370	1005	861	861	1037	2629	10860
40	575	277	315	354	419	1028	2899	3281	966	1041	2475	15082
41	703	334	324	312	328	560	845	1405	2814	1241	2507	13055
42	1153	339	487	377	350	559	1158	3602	2018	1203	2511	15780
43	1094	349	424	590	1879	2190	3824	2857	1839	2556	1567	20898
44	1368	280	315	310	473	1043	645	674	931	1062	2491	10945
45	500	274	378	347	389	410	639	1193	2426	1211	2458	12078
46	1096	274	277	360	350	672	3611	3228	1675	1208	2321	16702
47	1225	438	1144	347	1077	705	2697	3119	2354	1161	2358	18414
48	1161	349	316	419	459	960	1279	4096	3754	1160	2402	17933
49	1230	317	264	233	350	540	2521	3533	1318	1008	2339	15782
50	554	267	313	297	339	568	3011	1877	2241	1999	1872	15104
51	1381	385	951	543	1140	1079	3914	2530	1119	1148	1886	17736
52	1158	339	739	1252	1683	1968	2142	3591	2822	1431	2154	21010
53	1206	432	305	435	488	433	1907	2448	3321	1839	1804	16453
54	1238	331	341	360	420	819	3557	3163	1591	1519	2119	17271
55	1121	354	373	310	451	287	513	997	1622	1312	2209	11393
56	1164	353	1265	2079	1279	2592	1980	3079	2422	1226	2137	21355
57	1213	354	368	336	465	756	3362	3936	2872	1107	1970	18679
58	1047	317	344	373	431	451	2911	3167	3433	1109	2095	17512
59	1173	333	368	442	375	726	1507	2038	1694	1089	1848	13525
60	1202	522	611	315	330	519	1173	2898	3021	1029	2130	16041
61	703	348	341	360	541	516	600	1151	2567	1000	2504	12320
62	662	339	302	281	366	501	1376	2677	1593	992	1887	13284
63	1228	475	1613	375	962	483	1721	3176	2476	1081	1844	17332
64	1046	319	279	295	485	634	718	1736	3725	1314	2280	14537
65	1383	351	1246	2090	2220	1036	3058	3811	2908	1438	1606	22606
66	1369	638	561	355	467	638	837	1166	1349	963	2499	12455
67	583	366	358	414	391	647	990	2550	3153	1399	2206	14948
68	1204	307	323	321	579	591	569	1043	1931	1060	1991	11937
69	1051	376	326	837	2164	1819	2300	3087	1128	1031	1683	18021
70	1006	385	392	599	445	485	1885	2811	3920	1418	2137	17024
71	1498	480	882	1919	1971	1750	3222	3732	3765	2155	1582	24576
72	1324	316	324	656	959	3445	1981	2713	3149	1216	2043	19665
73	1378	309	480	505	400	569	518	745	812	985	2372	10576
74	766	534	1153	3145	2499	2817	2969	3175	3744	2805	1528	26875
75	1451	287	302	321	325	257	2622	1959	2359	2368	1724	15774
76	1304	661	1875	564	996	336	2765	2892	1915	1194	1997	18002
77	1321	326	499	284	561	735	1067	1084	342	1034	1657	9982
78	312	307	606	388	420	753	1257	1884	3184	2119	1911	14710
79	1669	400	443	401	395	436	640	846	1182	1028	2518	11968
80	717	285	303	391	471	500	2115	3249	3028	1350	2243	16200
81	1418	334	1280	587	645	562	828	2690	2973	1042	2207	17100
82	797	417	505	740	1984	3044	3153	3496	3 1 7 5	2841	1520	23218
83	1151	735	1538	1114	1015	2543	3547	2256	2977	2256	1681	22396
84	1230	622	1610	1132	414	1150	2841	3165	3620	1934	1895	21245
a5	1233	393	965	470	514	456	1634	2023	998	1037	2414	13804
86	1031	317	341	370	832	3414	3245	1984	2109	1010	1887	18607
87	1112	329	336	310	330	532	575	656	753	1180	1699	9196
88	591	295	355	310	330	444	681	570	400	979	1503	7820
89	513	282	313	273	283	690	1082	2039	1079	1026	2259	11661
AVG	1008	363	564	556	674	906	1803	2256	2127	1323	2112	15434

	CENTRAL SNAKE STUDY				93. DISCHARGE NF PAYETTE RIVER				NR RANKS				(CFS)	
W- YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG	
28	1258	678	1227	993	823	1697	1305	3337	2927	1125	2082	1909	1617	
29	1230	474	460	460	472	499	608	710	678	1081	2140	1493	862	
30	762	487	544	532	558	643	669	814	548	1041	1996	1489	a43	
31	791	463	583	452	546	539	610	506	603	969	1747	1160	749	
32	632	534	653	576	583	578	1225	1739	1393	1153	1872	1804	1063	
33	1279	496	604	473	543	460	763	833	1633	1083	2189	2064	1037	
34	981	478	509	623	600	725	792	581	1068	1020	2100	1464	914	
35	759	483	453	483	492	477	889	752	601	1029	2144	1437	836	
36	751	446	650	467	477	495	1338	1638	1178	1039	2481	1981	1080	
37	754	565	490	558	566	464	686	770	526	846	1473	1408	760	
38	633	485	582	533	540	738	1920	4229	3131	1641	2196	1984	1556	
39	1408	491	466	481	477	564	1005	861	911	1037	2468	1524	978	
40	769	471	509	548	613	1222	1286	2699	966	1041	2475	1644	1191	
41	897	528	518	506	522	754	845	1014	2042	1241	2507	1681	1091	
42	1347	533	681	571	544	753	1151	2195	2302	1203	2511	2022	1322	
43	1094	349	424	590	1879	2190	3824	2857	1839	2556	1567	1730	1738	
	1562	474	509	504	667	1237	645	674	551	1062	1801	1353	923	
44	694	468	572	541	583	604	639	1193	1447	1211	2408	1978	1031	
46	1290	468	471	554	544	866	1727	3561	1675	1208	2321	1629	1366	
47	1419	632	1338	541	1271	899	1188	3442	2354	1161	2358	1787	1535	
48	1355	543	510	613	653	1154	855	3139	3985	1160	2402	1576	1497	
49	1424	511	458	427	544	734	1047	3769	1372	1008	2339	2128	1320	
50	748	461	507	491	533	762	1498	1877	2576	1999	1872	1767	1260	
51	1575	579	1145	737	1334	1273	2401	2052	1119	1148	1886	1662	1478	
52	1352	533	933	1446	1877	2162	1417	3640	2313	1431	2154	1731	1751	
53	1400	626	499	629	682	627	1007	1858	3655	1839	1804	1834	1373	
54	1432	525	535	554	614	1013	2047	3485	1591	1519	2119	1812	1443	
55	1315	548	567	504	645	481	513	997	1113	1112	1761	2227	983	
56	1358	547	1459	2273	1473	2786	1242	2555	2136	1226	2137	1779	1753	
57	1407	548	562	530	659	950	1854	4259	2872	1107	1970	1938	1559	
58	1241	511	538	567	625	645	1402	3489	3433	1109	2095	1833	1461	
59	1367	527	562	636	569	920	902	1197	1990	1089	1848	1932	1131	
60	1396	716	805	509	524	713	1173	1429	3357	1029	2130	2289	1338	
61	897	542	535	554	735	710	600	830	1721	1000	2504	1690	1028	
62	856	533	496	475	560	695	1146	1460	1903	992	1887	2309	1110	
63	1422	669	1807	569	1156	677	795	2935	2476	1081	1844	1895	1446	
64	1240	513	473	489	679	828	718	1056	3245	1314	2280	1705	1211	
65	1577	545	1440	2284	2414	1230	1813	3876	2908	1438	1606	1460	1880	
66	1563	832	755	549	661	832	837	736	756	963	2499	1612	1053	
67	777	560	552	608	585	841	675	1259	3487	1399	2206	1891	1237	
68	1398	501	517	515	773	785	569	636	1168	1060	1991	2019	995	
69	1245	570	520	1031	2358	2013	1486	2737	1128	1031	1683	2218	1496	
70	1200	579	586	793	639	679	679	2515	4255	1418	2137	1540	1421	
71	1498	480	882	1919	1971	1750	3222	3732	3765	2155	1582	1619	2046	
72	1518	510	518	850	1153	3639	1042	2349	3281	1216	2043	1538	1641	
73	1572	503	674	699	594	763	518	745	812	985	1905	1320	928	
74	544	534	880	2848	2499	2817	3276	3175	3744	2805	1528	1738	2195	
75	1645	481	496	515	519	451	1112	1959	2692	2368	1724	1799	1318	
76	1498	855	2069	758	1190	530	1245	3217	1915	1194	1997	1503	1501	
77	1515	520	693	478	755	929	589	1084	802	1034	1657	1072	931	
78	506	501	800	582	614	947	1257	1264	1488	2119	1911	1568	1133	
79	1863	594	637	595	589	630	640	846	a25	1028	2518	1730	1046	
80	911	479	497	585	665	694	1225	2443	3028	1350	2243	1548	1306	
81	1612	528	1474	781	839	756	813	1564	2973	1042	2207	2535	1429	
82	991	611	699	934	2178	3238	1900	3496	3250	2841	1520	1547	1933	
83	1345	929	1732	1308	1209	2737	2038	2579	2977	2256	1681	1582	1870	
84	1230	622	1610	1132	414	1150	2841	3165	3620	1934	1895	1632	1773	
85	1427	587	1159	664	708	650	1150	1212	998	1037	2414	1666	1143	
86	1225	511	535	564	1026	3608	1880	2308	2109	1010	1887	2066	1564	
87	1306	523	530	504	524	726	575	556	520	959	1737	1383	824	
88	785	489	549	504	524	638	681	570	400	831	1730	1363	757	
89	707	476	507	467	477	884	1082	932	699	1026	1572	1400	855	
AVG	1186	544	741	733	855	1088	1240	2003	1981	1313	2028	1726	1288	

CENTRAL SNAKE STUDY 89. CONTENTS DEADWOOD RESERVOIR												(1000 AC-FTI
W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
28	73.7	83.9	90.3	95.4	99.6	107.8	119.1	166.0	166.0	130.5	96.1	70.0
29	74.3	77.6	80.3	83.6	86.7	90.4	96.5	125.2	149.1	90.0	70.0	70.0
30	73.2	76.1	81.8	84.5	87.5	91.8	115.1	146.9	162.9	90.0	70.0	70.0
31	74.1	75.2	78.1	83.3	86.7	88.7	100.9	130.5	90.7	35.0	24.1	22.8
32	25.2	28.3	32.4	35.2	37.4	42.7	56.4	121.0	166.0	127.1	107.6	70.0
33	75.2	78.1	78.7	81.2	83.9	87.7	97.4	128.2	166.0	120.8	82.9	70.0
34	75.4	81.5	85.5	91.3	94.7	108.0	149.8	166.0	166.0	90.0	70.0	67.3
35	70.5	75.8	79.8	83.3	86.8	91.8	105.6	150.7	166.0	96.2	70.0	67.0
36	68.2	69.3	72.5	76.4	79.9	83.4	106.1	166.0	166.0	90.0	70.0	67.2
37	69.7	72.3	75.6	78.8	82.2	85.3	93.2	137.0	156.0	90.0	50.0	47.9
38	53.7	59.5	62.9	64.4	69.0	74.9	93.7	160.0	166.0	139.8	115.0	74.6
39	79.6	84.2	86.8	89.8	93.8	100.5	120.6	161.3	166.0	90.0	70.0	67.0
40	70.0	72.6	77.7	82.3	87.0	94.7	121.8	163.0	166.0	90.0	70.0	67.8
41	72.5	77.8	85.1	89.1	91.6	97.5	115.1	163.6	166.0	120.1	113.5	72.9
42	77.8	85.0	96.8	103.3	107.5	112.7	134.5	166.0	166.0	134.2	115.0	70.6
43	73.9	80.0	85.9	93.1	97.8	103.1	105.0	160.0	166.0	155.0	115.0	75.7
44	77.0	82.5	86.7	90.3	95.1	99.3	108.5	137.1	154.5	90.5	70.0	67.4
45	68.8	73.3	77.4	81.3	85.3	90.0	98.1	148.9	166.0	134.7	115.0	70.7
46	74.4	80.1	86.5	92.3	96.7	102.5	126.9	166.0	166.0	136.0	115.0	71.7
47	76.8	83.5	90.4	95.4	99.9	106.1	124.6	166.0	166.0	135.6	115.0	71.5
48	78.4	83.2	87.1	92.9	98.1	105.5	115.0	163.0	166.0	134.6	114.2	70.0
49	73.4	78.8	82.2	84.4	88.8	96.7	111.2	166.0	166.0	95.7	70.0	67.2
50	69.5	74.6	78.2	82.7	86.9	93.6	107.3	148.3	166.0	147.5	115.0	76.9
51	78.2	86.3	93.0	97.0	102.0	108.7	135.5	163.0	166.0	141.2	109.7	70.0
52	76.2	112.4	86.5	92.5	97.5	102.7	105.0	163.0	166.0	137.7	115.0	70.9
53	73.3	76.4	80.1	86.6	90.7	95.5	109.7	152.2	166.0	154.4	115.0	71.0
54	73.8	79.2	83.9	89.6	94.1	99.5	122.4	163.0	166.0	142.3	115.0	70.7
55	74.7	79.3	82.4	86.1	89.8	93.8	99.9	131.4	166.0	135.7	104.6	70.0
56	74.4	80.1	91.8	99.7	105.6	112.0	117.8	163.0	166.0	137.8	114.0	70.0
57	75.3	79.9	85.0	89.3	94.3	99.9	112.7	163.4	166.0	135.6	88.7	70.0
58	75.5	78.2	83.3	87.4	91.2	95.6	105.0	166.0	166.0	134.0	99.2	70.0
59	74.3	80.3	87.0	93.2	98.0	103.0	120.0	163.0	166.0	122.5	70.0	70.0
60	78.5	84.2	88.9	93.9	97.9	104.9	122.4	162.4	166.0	97.6	70.0	67.3
61	71.5	75.5	79.0	82.8	86.5	91.9	104.0	148.8	166.0	90.0	70.0	69.5
62	74.2	78.4	82.1	86.3	90.3	94.8	116.9	163.0	166.0	120.8	73.3	70.0
63	79.5	90.0	99.4	105.9	117.9	127.2	140.0	166.0	166.0	136.1	89.5	70.0
64	74.9	81.6	86.5	91.9	95.6	100.1	109.6	149.0	166.0	138.2	115.0	72.5
65	76.7	81.5	96.1	106.4	113.1	119.3	143.6	163.0	166.0	149.5	115.0	73.3
66	78.9	84.1	80.6	94.2	98.0	103.0	116.8	158.3	166.0	90.0	70.0	67.9
67	69.8	74.2	78.3	63.0	86.5	90.9	96.4	139.8	166.0	148.1	115.0	72.3
68	79.0	84.4	89.8	93.8	98.4	104.7	116.0	154.6	166.0	95.8	70.0	70.0
69	75.2	81.6	87.3	95.5	101.3	104.4	128.1	163.0	166.0	127.9	70.0	70.0
70	74.8	78.5	83.4	90.0	93.9	99.5	107.0	150.2	166.0	145.7	115.0	73.6
71	79.0	87.9	96.6	104.3	110.5	117.6	75.0	161.2	166.0	155.0	115.0	72.9
72	77.2	82.5	88.0	93.3	98.1	107.0	118.3	163.0	166.0	139.0	115.0	70.7
73	75.7	79.8	85.4	90.8	94.6	98.7	108.4	148.9	166.0	90.0	70.0	70.0
74	75.6	86.6	92.5	102.0	108.5	123.0	75.0	136.5	166.0	155.0	115.0	72.9
75	77.3	80.8	86.3	90.8	94.3	100.0	106.3	131.8	166.0	150.6	115.0	72.7
76	78.7	84.7	93.1	99.2	104.7	109.7	124.0	166.0	166.0	137.5	115.0	73.8
77	77.8	79.4	84.5	87.1	09.7	94.7	102.3	112.7	80.0	35.0	23.4	21.9
78	25.5	29.7	36.7	41.2	45.0	52.6	74.1	128.4	166.0	140.9	115.0	74.5
79	76.9	83.0	87.5	91.7	96.3	100.8	109.9	148.6	164.4	90.0	70.0	69.9
80	74.5	77.7	81.6	86.6	91.1	96.2	117.7	166.0	166.0	142.2	115.0	75.7
81	79.8	85.6	94.3	101.3	107.5	115.4	138.9	166.0	166.0	106.7	70.0	69.4
82	72.8	79.7	86.7	92.6	99.3	107.7	105.0	159.8	166.0	155.0	115.0	75.4
83	83.2	89.7	96.6	103.1	108.8	117.7	131.6	163.0	166.0	154.5	115.0	73.6
84	79.7	09.9	97.7	103.6	109.3	115.3	128.7	163.0	166.0	145.0	115.0	77.1
85	82.4	89.1	94.5	98.9	103.1	107.7	126.5	166.0	166.0	90.0	70.0	69.1
86	75.4	81.5	86.7	92.2	99.9	116.0	146.6	166.0	166.0	124.7	75.3	70.0
87	75.0	79.9	03.8	88.3	92.0	98.2	118.0	143.8	106.6	60.0	48.0	46.7
88	48.9	51.9	56.2	59.8	62.9	67.3	04.6	117.3	128.6	71.9	40.0	47.3
89	49.6	54.0	57.6	61.4	64.5	70.2	91.2	139.3	164.7	94.1	70.0	67.9
AVG	72.6	77.8	83.2	88.2	92.7	98.8	111.8	153.4	161.1	119.2	90.7	68.2

CENTRAL SNAKE STJDY 93. CONTENTS DE:ADWOOD RESERVOI

(1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	70.3	77.2	80.3	82.0	83.0	87.8	99.1	166.0	166.0	130.5	96.1	70.0
29	70.9	70.9	70.3	70.2	70.2	70.5	76.6	105.4	129.2	90.0	50.3	50.7
30	50.5	50.1	52.5	51.8	51.7	52.7	76.0	107.8	123.8	90.0	50.0	50.4
31	51.1	49.0	48.6	50.4	50.7	49.2	61.4	91.1	80.0	35.0	24.1	22.8
32	21.8	21.6	22.3	21.8	20.8	22.8	36.4	101.0	153.4	114.4	70.0	70.0
33	71.8	71.4	68.7	67.8	67.4	67.8	77.5	108.3	166.0	120.8	82.9	70.0
34	72.0	74.8	75.5	77.9	78.2	88.1	129.9	161.5	166.0	90.0	50.0	47.3
35	47.1	49.1	49.7	49.9	50.3	52.0	65.7	110.8	142.1	90.0	50.0	47.0
36	44.8	42.6	42.4	43.0	43.3	43.4	66.1	134.8	161.3	90.0	70.0	67.2
37	66.3	65.6	65.5	65.4	65.7	65.4	73.3	117.1	136.1	87.8	48.0	45.9
38	48.3	50.8	50.8	49.0	50.5	53.0	71.7	138.0	166.0	139.8	115.0	74.6
39	76.3	77.5	76.7	76.3	77.2	80.6	100.7	141.4	149.0	90.0	60.1	57.1
40	56.7	56.0	57.7	59.0	60.5	64.8	91.9	151.6	166.0	90.0	70.0	67.8
41	69.1	71.1	75.0	75.6	75.0	77.5	95.1	143.6	166.0	120.1	113.5	72.9
42	74.4	78.3	86.7	89.8	91.0	92.8	114.6	149.1	166.0	134.2	115.0	70.6
43	73.9	80.0	85.9	93.1	97.8	103.1	105.0	160.0	166.0	155.0	115.0	75.7
44	73.7	75.9	76.7	76.9	78.5	79.4	88.6	117.2	134.5	90.0	50.0	47.4
45	45.4	46.7	47.3	47.9	48.9	50.2	58.3	109.0	145.6	114.3	91.5	70.0
46	70.4	72.8	75.8	78.2	79.5	82.0	106.4	166.0	166.0	136.0	115.0	71.7
47	73.5	76.9	80.4	82.0	83.4	86.3	104.8	166.0	166.0	135.6	115.0	71.5
48	75.1	76.6	77.1	79.5	81.5	85.6	95.1	149.3	166.0	134.6	114.2	70.0
49	70.0	72.1	72.2	71.0	72.3	76.8	91.3	162.8	166.0	95.7	70.0	67.2
50	66.1	67.9	68.1	69.3	70.4	73.7	87.3	128.3	166.0	147.5	115.0	76.9
51	74.9	79.6	82.9	83.6	85.5	88.9	115.7	163.0	166.0	141.2	109.7	70.0
52	72.8	75.7	76.5	79.1	80.9	82.7	102.0	163.0	166.0	137.7	115.0	70.9
53	70.0	69.8	70.1	73.2	74.2	75.7	89.9	132.3	166.0	154.4	115.0	71.0
54	70.5	72.6	73.9	76.2	77.6	79.7	102.6	163.0	166.0	142.3	115.0	70.7
55	71.4	72.7	72.4	72.6	73.3	74.0	80.1	111.6	154.1	123.8	70.0	68.4
56	69.4	71.8	80.2	84.7	87.4	90.4	120.0	163.0	166.0	137.8	114.0	70.0
57	71.9	73.2	75.0	75.9	77.9	80.1	92.8	163.4	166.0	135.6	88.7	70.0
58	72.1	71.5	73.4	74.0	74.8	75.8	85.2	166.0	166.0	134.0	99.2	70.0
59	70.9	73.6	77.0	79.8	81.5	83.1	100.1	145.4	166.0	122.5	70.0	70.0
60	75.1	77.5	78.9	80.5	81.4	84.9	102.4	142.5	166.0	97.6	70.0	67.3
61	68.1	68.8	68.9	69.5	70.1	72.1	84.1	128.9	159.2	90.0	70.0	69.5
62	70.8	71.7	72.0	72.9	73.8	74.9	97.0	144.6	166.0	120.8	73.3	70.0
63	76.1	83.3	89.4	92.5	101.4	107.3	120.1	166.0	166.0	136.1	89.5	70.0
64	71.5	74.9	76.4	78.4	78.9	80.0	89.5	129.0	166.0	138.2	115.0	72.5
65	73.4	74.9	86.0	92.9	96.6	99.5	123.7	163.0	166.0	149.5	115.0	73.3
66	75.6	77.5	78.6	80.8	81.5	83.2	97.0	138.5	157.7	90.0	70.0	67.9
67	66.4	67.5	68.2	69.5	70.0	71.0	76.5	119.9	166.0	148.1	115.0	72.3
68	75.6	77.7	79.7	80.4	81.8	84.8	96.1	134.6	166.0	95.8	70.0	70.0
69	71.8	74.9	77.3	82.1	84.9	84.6	108.2	163.0	166.0	127.9	70.0	70.0
70	71.4	71.8	73.3	76.5	77.3	79.5	87.0	138.3	166.0	145.7	115.0	73.6
71	79.0	87.9	96.6	104.3	110.5	117.6	75.0	161.2	166.0	155.0	115.0	72.9
72	73.9	75.9	78.0	79.8	81.5	87.1	98.4	155.1	166.0	139.0	115.0	70.7
73	72.3	73.2	75.3	77.3	78.1	78.9	88.6	129.0	150.8	90.0	50.0	51.7
74	57.3	68.3	74.3	83.7	90.2	104.7	75.0	136.5	166.0	155.0	115.0	72.9
75	74.0	74.2	76.3	77.4	77.8	80.2	86.5	112.0	166.0	150.6	115.0	72.7
76	75.4	78.1	83.1	85.7	88.1	89.7	104.0	166.0	166.0	137.5	115.0	73.8
77	74.5	72.8	74.5	73.7	73.2	74.9	75.0	85.4	80.0	35.0	23.4	21.9
78	22.1	23.0	26.6	27.8	28.6	32.8	54.2	108.5	166.0	148.9	115.0	74.5
79	73.6	76.4	77.5	78.3	79.8	81.0	90.0	128.7	144.5	90.0	70.0	69.9
80	71.1	71.1	71.6	73.3	74.6	76.3	97.7	166.0	166.0	142.2	115.0	75.7
81	76.5	79.0	84.3	87.9	91.0	95.6	119.1	166.0	166.0	106.7	70.0	69.4
82	69.4	73.0	76.6	79.2	82.8	87.8	100.5	155.3	166.0	155.0	115.0	75.4
83	79.9	83.1	86.5	89.6	92.3	97.9	111.8	163.0	166.0	154.5	115.0	73.6
84	79.7	89.9	97.7	103.6	109.3	115.3	128.7	163.0	166.0	145.0	115.0	77.1
85	79.1	82.5	84.5	85.5	86.7	88.0	106.7	157.3	166.0	90.0	70.0	69.1
86	72.0	74.8	76.6	78.8	83.4	96.1	126.7	166.0	166.0	124.7	75.3	70.0
87	71.6	73.2	73.8	74.9	75.5	78.3	98.1	124.0	80.2	35.0	25.3	24.0
88	22.8	22.5	23.4	23.6	23.5	24.6	41.8	74.5	85.9	35.0	25.1	24.4
89	23.3	24.4	24.6	25.1	25.1	27.4	48.4	96.5	121.9	90.0	50.0	47.9
AVG	66.6	68.7	70.9	72.8	74.4	77.3	91.4	139.3	155.3	117.2	86.0	65.0

	CENTRAL SNAKE STUDY 89. DISCHARGE DEADWOOD RIVER BLW DEADWOOD RES (CFS)												
W-YR	OCT	NOV	DEC	JAN	FEE	MAR	APR	MAY	JUN	JUL	AUG	SEPT	CPS-MONTHS
28	2	2	2	2	2	2	2	647	585	765	656	514	3181
29	2	2	2	2	2	2	2	2	100	1106	398	57	1677
30	2	2	2	2	2	2	2	2	100	1301	394	57	1868
31	2	2	2	2	2	2	2	2	790	1010	200	50	2066
32	2	2	2	2	2	2	2	2	223	700	370	697	2006
33	2	2	2	2	2	2	2	2	552	872	666	223	2330
34	2	2	2	2	2	2	2	251	208	1324	342	50	2189
35	2	2	2	2	2	2	2	2	367	1258	425	50	2117
36	2	2	2	2	2	2	2	144	546	1356	356	50	2461
37	2	2	2	2	2	2	2	2	100	1166	665	50	1997
30	2	2	2	2	2	2	2	2	1033	700	508	750	3007
39	2	2	2	2	2	2	2	2	150	1301	329	50	1845
40	2	2	2	2	2	2	2	304	405	1337	333	50	2443
41	2	2	2	2	2	2	2	2	451	880	200	750	2298
42	2	2	2	2	2	2	2	50	598	700	380	750	2493
43	2	2	2	2	2	2	607	44	1062	719	764	750	3959
44	2	2	2	2	2	2	2	2	100	1163	350	50	1679
45	2	2	2	2	2	2	2	2	426	700	368	750	2261
46	2	2	2	2	2	2	2	612	770	700	427	750	3273
47	2	2	2	2	2	2	2	490	660	700	399	750	3014
48	2	2	2	2	2	2	2	103	943	700	374	746	2079
49	2	2	2	2	2	2	2	273	588	1253	466	50	2644
50	2	2	2	2	2	2	2	2	888	700	645	750	2999
51	2	2	2	2	2	2	2	592	738	700	524	704	3271
52	2	2	2	2	2	2	287	444	899	700	417	750	3509
53	2	2	2	2	2	2	2	2	998	700	764	750	3228
54	2	2	2	2	2	2	2	484	748	700	508	750	3204
55	2	2	2	2	2	2	2	2	234	700	623	605	2177
56	2	2	2	2	2	2	401	681	1084	700	513	748	4140
57	2	2	2	2	2	2	2	359	960	700	860	329	3221
58	2	2	2	2	2	2	2	432	1008	734	725	501	3414
59	2	2	2	2	2	2	2	38	706	929	a73	94	2735
60	2	2	2	2	2	2	2	2	634	1269	530	50	2499
61	2	2	2	2	2	2	2	2	319	1350	368	50	2102
62	2	2	2	2	2	2	2	26	768	920	894	81	2710
63	2	2	2	2	2	2	2	458	794	700	832	383	3182
64	2	2	2	2	2	2	2	2	617	700	456	750	2540
65	2	2	2	2	2	2	2	783	1486	700	686	750	4418
66	2	2	2	2	2	2	2	2	294	1345	342	50	2047
67	2	2	2	2	2	2	2	2	788	700	621	750	2874
68	2	2	2	2	2	2	2	2	444	1316	466	87	2330
69	2	2	2	2	2	2	2	708	763	833	952	50	3321
70	2	2	2	2	2	2	2	2	1256	700	606	750	3328
71	2	2	2	2	2	2	952	2	1670	706	820	750	4991
72	2	2	2	2	2	2	2	199	1351	700	505	750	3519
73	2	2	2	2	2	2	2	2	178	1343	392	19	2009
74	2	2	2	2	2	2	1139	2	1326	1034	a13	750	5076
75	2	2	2	2	2	2	2	2	666	700	713	750	2845
76	2	2	2	2	2	2	2	379	832	700	434	750	3109
77	2	2	2	2	2	2	2	2	666	805	200	50	1737
78	2	2	2	2	2	2	2	2	436	700	669	750	2572
79	2	2	2	2	2	2	2	2	100	1294	377	50	1837
80	2	2	2	2	2	2	2	398	694	700	487	750	3043
81	2	2	2	2	2	2	2	365	645	1113	645	50	2632
82	2	2	2	2	2	2	26:	2	1484	782	704	750	4074
83	2	2	2	2	2	2	2	451	1423	700	708	750	4047
84	2	2	2	2	2	2	2	300	1138	700	637	750	3538
85	2	2	2	2	2	2	2	183	514	1338	319	50	2476
86	2	2	2	2	2	2	2	587	1022	828	876	190	3517
87	2	2	2	2	2	2	2	2	756	785	237	50	1844
a0	2	2	2	2	2	2	2	2	100	936	427	50	1529
89	2	2	2	2	2	2	2	2	100	1269	417	50	1853
A V G	2	2	2	2	2	2	61	175	683	915	534	417	2797

CENTRAL SNAKE STUDY 93. DISCHARGE DEADWOOD RIVER BLU DEADWOOD RES (CFS)

U- YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
28	57	57	57	57	57	57	2	322	585	765	656	514	266
29	57	57	57	57	57	57	2	2	100	782	720	50	169
30	57	57	57	57	57	57	2	2	100	665	719	50	159
31	57	57	57	57	57	57	2	2	307	836	200	50	146
32	57	57	57	57	57	57	2	2	100	700	776	66	167
33	57	57	57	57	57	57	2	2	217	872	666	223	196
34	57	57	57	57	57	57	2	2	133	1324	667	50	213
35	57	57	57	57	57	57	2	2	100	969	651	50	179
36	57	57	57	57	57	57	2	2	100	1280	356	50	180
37	57	57	57	57	57	57	2	2	100	878	662	50	172
38	57	57	57	57	57	57	2	2	664	700	508	750	248
39	57	57	57	57	57	57	2	2	100	1025	490	50	170
40	57	57	57	57	57	57	2	2	214	1337	333	50	192
41	57	57	57	57	57	57	2	2	116	880	200	750	192
42	57	57	57	57	57	57	2	2	314	700	380	750	208
43	2		2	2	2		607	44	1062	719	764	750	330
44	57	57	57	57	57	57	2	2	100	848	667	50	169
45	57	57	57	57	57	57	2	2	100	700	418	367	162
46	57	57	57	57	57	57	2	279	770	700	427	750	273
47	57	57	57	57	57	57	2	167	660	700	399	750	252
48	57	57	57	57	57	57	2	2	712	700	374	746	239
49	57	57	57	57	57	57	2	2	534	1253	466	50	223
50	57	57	57	57	57	57	2	2	553	700	645	750	250
51	57	57	57	57	57	57	2	270	738	700	524	704	274
52	57	57	57	57	57	57	2	395	899	700	417	750	292
53	57	57	57	57	57	57	2		665	700	764	750	269
54	57	57	57	57	57	57	2	167	748	700	508	750	268
55	57	57	57	57	57	57	2	2	100	700	992	50	185
56	57	57	57	57	57	57	2	717	1084	700	513	748	342
57	57	57	57	57	57	57	2	37	960	700	860	329	270
58	57	57	57	57	57	57	2	110	1008	734	725	501	286
59	57	57	57	57	57	57	2	2	490	929	873	94	230
60	57	57	57	57	57	57	2	2	299	1269	530	50	210
61	57	57	57	57	57	57	2	2	100	1239	368	50	177
62	57	57	57	57	57	57	2		458	928	894	81	228
63	57	57	57	57	57	57	2	137	795	700	832	383	267
64	57	57	57	57	57	57	2	2	280	700	456	750	211
65	57	57	57	57	57	57	2	459	1486	700	686	750	369
66	57	57	57	57	57	57	2	2	100	1210	342	50	173
67	57	57	57	57	57	57	2	2	453	700	621	750	240
68	57	57	57	57	57	57	2	2	108	1316	466	87	196
69	57	57	57	57	57	57	2	386	763	833	952	50	280
70	57	57	57	57	57	57	2	2	921	700	606	750	277
71		2	2	2	2	2	952	2	1670	786	820	750	415
72	57	57	57	57	57	57	2	2	1219	700	505	750	292
73	57	57	57	57	57	57	2	2	100	1096	717	50	195
74	2	2	2	2	2	2	832	2	1326	1034	813	750	397
75	57	57	57	57	57	57	2	2	333	700	713	750	238
76	57	57	57	57	57	57	2	54	832	700	434	750	259
77	57	57	57	57	57	57	128	2	206	805	200	50	146
78	57	57	57	57	57	57	2	2	103	700	669	750	215
79	57	57	57	57	57	57	2	2	100	970	377	50	156
80	57	57	57	57	57	57	2	74	694	700	487	750	254
81	57	57	57	57	57	57	2	42	645	1113	645	50	239
82	57	57	57	57	57	57	2	2	1408	782	784	750	339
83	57	57	57	57	57	57	2	128	1423	700	708	750	338
84	2	2	2	2	2	2	2	300	1138	700	637	750	295
85	57	57	57	57	57	57	2	2	368	1338	379	50	209
86	57	57	57	57	57	57	2	263	1022	828	876	190	295
87	57	57	57	57	57	57	2	2	865	763	200	50	186
88	57	57	57	57	57	57	2	2	100	840	200	50	129
89	57	57	57	57	57	57	2	2	100	639	677	50	153
AVG	53	53	53	53	53	53	43	71	546	851	579	391	235

CENTRAL SNAKE STUDY 89. DISCHARGE PAYETTE RIVER NR EMMETT

(CFS)

W-YR	OCT	NOV	O E C	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	CFS-MONT
28	1728	2286	2396	2094	1843	4964	5962	11467	5758	1900	2000	2018	44415
29	1500	1030	936	880	906	1370	1876	2884	3049	1800	1850	1000	19082
30	923	850	1257	B00	1331	1632	2946	2832	1970	1714	1850	1141	19247
31	1025	1030	900	839	900	1401	2158	2011	1000	805	B00	650	13520
3 2	700	850	886	800	900	2499	4845	7685	7500	2232	2000	2100	32997
33	1456	1098	900	857	900	1401	2982	3467	9281	1900	2000	1800	28041
34	969	1056	1112	1657	1412	2442	3513	2195	1100	1416	1850	1000	19782
35	1053	1029	917	954	1047	1162	3494	3829	3602	1900	1850	1255	22092
36	855	935	900	840	998	1471	6349	9129	4590	1877	1850	1458	31251
37	756	850	900	800	900	1424	2521	3719	1661	1530	1748	993	17802
38	757	1054	1961	1244	1317	3322	8191	10609	9028	3037	2000	2100	44619
39	1719	1227	1032	954	1002	2335	3456	3187	1100	1577	1850	1076	20514
40	720	850	1115	1154	1923	4291	7270	7882	2978	1847	1850	1291	33172
41	1235	1242	1244	1182	1225	2231	2790	4551	5531	1900	2000	2100	27230
42	1527	1506	2265	1569	1801	1800	4642	6549	5393	1924	2000	2100	33077
43	1361	1306	1681	2629	3448	4383	13283	8856	8626	5668	2024	2100	55366
44	1900	1294	1029	910	1200	1800	2163	2557	2569	1900	1850	1000	20173
45	905	1042	900	1054	1664	1575	2609	5335	6392	2009	2000	2100	27585
46	1561	1185	1468	1509	1468	3260	9167	9603	5356	1962	2000	2100	40640
47	1900	1773	3060	1324	2338	2810	5364	8937	6075	1978	2000	2100	39659
48	1900	1306	1166	1462	1375	1800	4021	9101	9319	1941	2000	2100	37490
49	1668	1113	1009	824	1490	2565	5888	9470	4514	1900	1850	1800	34091
50	1146	1111	900	1213	1571	2619	6414	6195	8432	4296	2000	2100	37997
51	1900	1397	1992	1516	3034	2582	8530	8726	5457	2622	2000	2100	41856
52	2002	1341	2520	2081	3207	3340	9182	11736	8472	2679	2000	2100	50659
53	1605	1000	913	2020	1998	1811	4790	6210	11010	4161	2000	2100	39617
54	1641	1192	1044	1359	1863	2709	7075	9101	5605	3115	2000	2100	38802
55	1500	1000	900	883	1000	1074	2007	4327	5408	2331	2000	1973	24403
56	1741	1262	4029	4104	2517	4840	7433	11240	9082	2606	2000	2100	52953
57	1900	1247	1435	800	2052	3532	7339	12267	8803	2059	2000	1800	45235
58	1539	1000	1141	1219	2514	1905	5899	11859	8836	1900	2000	1917	41731
59	1500	1140	1300	1486	1466	1800	3853	4885	5759	1900	1969	2100	29160
60	2188	1352	1334	1055	1487	2146	4385	6127	6686	1900	1850	1791	32901
61	958	1045	957	971	1771	1998	2286	3934	4891	1646	1850	1335	23642
62	1100	1000	1057	1013	1693	1705	4944	6001	5689	1900	2000	1800	29901
63	2521	1622	2786	1179	3291	1842	4184	7632	6886	2043	2000	2100	38031
64	1548	1346	1094	914	1200	1800	3466	5663	8961	2491	2000	2100	32581
65	1714	1155	4483	4557	4424	2898	8925	11237	11231	3941	2186	2276	59027
66	1900	1462	1399	1258	1200	1800	2625	3524	2413	1659	1850	1000	22151
67	847	1000	1048	1442	1348	1800	2015	6287	8944	2570	2000	2100	31402
68	1900	1128	1000	923	2233	2112	1700	2867	4354	1900	1850	1809	23775
69	1558	1392	1232	2844	3419	3518	7764	10231	5262	1900	1850	1800	42770
70	1515	968	900	3283	2127	2255	3369	7513	11641	3307	2000	2100	40979
71	1900	1731	2311	3887	3977	4146	8955	12479	13167	5160	2000	2100	61813
72	1900	1096	1346	2286	2413	7662	4736	8621	11378	2751	2000	2100	48295
73	1900	1094	1572	1654	1223	1800	1896	3390	2284	1792	1850	1212	21667
74	1264	2129	2139	5605	4017	6041	9314	9381	14595	5962	2000	2100	65148
75	1900	1007	1011	1117	1405	2231	4494	6539	9245	5361	2000	2100	38409
76	1900	1594	3094	1583	2104	1800	6396	9225	6022	2076	2000	2100	39894
77	1900	1000	1000	849	1141	1357	1052	850	850	800	800	650	12248
78	777	983	2257	1709	2104	3564	5222	6352	7986	4120	2000	2100	39174
79	1900	1000	1000	834	1430	1938	2138	3530	2307	1551	1850	1279	20157
80	918	1000	900	1885	2173	2323	6041	9437	7866	2746	2000	2148	39444
81	1900	1239	2747	1609	2678	2450	3897	6317	6197	1900	1850	1716	34498
82	1336	1494	2120	1669	5310	6146	7742	10742	11456	6341	2048	2100	58504
83	1984	1769	2960	3007	3090	6899	7656	9784	11100	4880	2200	2100	57430
84	1900	2132	2760	2046	1775	4143	6939	9392	10788	4171	2000	2100	50146
85	1900	1571	1870	1139	1200	1800	4991	5575	3170	1813	1850	1800	28678
86	1847	1279	1037	1297	4841	8531	7628	7033	8046	1900	2000	2100	47539
87	1937	1161	936	930	1265	2040	1700	1600	1100	1042	800	650	15162
88	700	850	900	876	1068	1338	2072	1884	1132	1042	800	650	13312
89	922	1074	900	893	995	3398	5323	5351	3238	1900	1850	1422	27264
AVG	1500	1230	1548	1570	1953	2778	5030	6789	6326	2499	1879	1750	34853

CENTRAL SNAKE STUDY 93. DISCHARGE PAYETTE RIVER NR EMMETT (CFS)													
W- YR	OCT	NOV	DEC	JAN	FEE	MAR	APR	MAY	JUN	JUL	AUG	SEP	AVG
28	1977	2535	2645	2343	2091	5213	4443	11467	5758	1900	2000	2018	3708
29	1749	1279	1186	1128	1156	1620	1876	2884	2696	1477	1850	1000	1662
30	1172	1098	1505	1049	1580	1880	2946	2832	1590	1078	1744	1000	1623
31	1274	1279	1149	1088	1149	1650	2158	2011	850	800	800	650	1239
32	949	1099	1134	1049	1149	2747	4845	7038	5624	2232	1850	1438	2597
33	1705	1346	1149	1106	1149	1651	2982	3467	7214	1900	2000	1800	2287
34	1218	1305	1361	1907	1721	2691	3513	1946	1100	1416	1585	939	1725
35	1303	1278	1165	1203	1296	1410	3494	3829	2956	1611	1820	978	1863
36	1104	1183	1149	1090	1247	1720	6349	7298	3864	1801	1850	1458	2509
37	1004	1100	1149	1049	1149	1673	2521	3719	1602	1042	945	909	1491
38	1006	1304	2210	1493	1566	3572	6645	10609	9028	3037	2000	2100	3720
39	1968	1476	1281	1203	1251	2584	3456	3187	1100	1301	1850	857	1798
40	969	1099	1365	1403	2172	4539	5657	6997	2787	1847	1850	1482	2683
41	1485	1491	1492	1432	1474	2480	2790	4159	4423	1900	2000	2100	2271
42	1777	1755	2514	1819	2050	2049	4635	5093	5393	1924	2000	2100	2757
43	1361	1306	1681	2629	3448	4383	13283	8856	8626	5668	2024	2100	4605
44	2149	1543	1278	1159	1449	2049	2163	2557	2189	1584	1478	1000	1718
45	1154	1291	1150	1302	1913	1823	2609	5335	5086	2009	2000	1843	2292
46	1810	1434	1717	1757	1717	3508	7283	9603	5356	1962	2000	2100	3360
47	2149	2021	3310	1573	2587	3058	3855	8937	6075	1978	2000	2100	3307
48	2148	1555	1414	1711	1625	2048	3597	8043	9319	1941	2000	2100	3122
49	1917	1361	1258	1073	1739	2815	4413	9435	4514	1900	1850	1800	2847
50	1395	1360	1149	1462	1820	2869	4901	6195	8432	4296	2000	2100	3165
51	2149	1646	2241	1765	3283	2831	7018	8726	5457	2622	2000	2100	3482
52	2252	1590	2769	2329	3457	3588	8171	11736	7963	2679	2000	2100	4216
53	1854	1250	1163	2268	2246	2059	3889	5620	11010	4161	2000	2100	3297
54	1889	1441	1293	1608	2111	2958	5565	9101	5605	3115	2000	2100	3236
55	1749	1248	1150	1132	1249	1323	2007	4327	4765	2131	1922	1800	2069
56	1989	1511	4278	4353	2766	5089	6296	10752	8796	2606	2000	2100	4384
57	2148	1495	1684	1049	2300	3782	5830	12267	8803	2059	2000	1800	3772
58	1787	1248	1390	1468	2763	2154	4390	11859	8836	1900	2000	1917	3475
59	1749	1389	1549	1735	1716	2049	3249	4008	5759	1900	1969	2100	2429
60	2436	1601	1583	1305	1735	2995	4385	4658	6686	1900	1850	1791	2740
61	1208	1295	1207	1219	2020	2247	2286	3613	3826	1534	1850	1335	1967
62	1349	1249	1306	1262	1943	1954	4714	4760	5689	1900	2000	1800	2489
63	2777	1870	3035	1428	3539	2090	3257	7068	6886	2043	2000	2100	3168
64	1797	1595	1344	1162	1449	2050	3466	4982	8144	2491	2000	2100	2710
65	1962	1404	4732	4807	4673	3147	7680	10979	11231	3941	2186	2276	4912
66	2148	1711	1648	1507	1449	2049	2625	3094	1686	1524	1850	1000	1862
67	1096	1249	1297	1692	1596	2049	1700	4996	8944	2570	2000	2100	2606
68	2150	1376	1249	1172	2481	2361	1700	2460	3256	1900	1850	1809	1977
69	1808	1640	1481	3093	3668	3766	6949	9559	5262	1900	1850	1800	3560
70	1765	1218	1149	3532	2376	2504	2163	7217	11641	3307	2000	2100	3413
71	1900	1731	2311	3887	3977	4146	8955	12479	13167	5160	2000	2100	5146
72	2149	1345	1595	2535	2662	7911	3797	8060	11378	2757	2000	2100	4025
73	2150	1343	1821	1903	1472	2049	1896	3390	2206	1545	1708	1000	1880
74	1042	2129	2466	5308	4017	6041	9314	9381	14595	5962	2000	2100	5356
75	2149	1255	1261	1365	1654	2479	2985	6539	9245	5361	2000	2100	3204
76	2149	1843	3342	1832	2353	2049	4877	9225	6022	2076	2000	2100	3323
77	2149	1249	1250	1097	1390	1606	700	850	850	800	800	650	1116
78	1026	1232	2507	1958	2353	3812	5222	5732	5957	4120	2000	2100	3170
79	2149	1250	1248	1083	1680	2187	2138	3530	1950	1227	1850	1000	1777
80	1166	1248	1149	2133	2423	2573	5158	8306	7866	2746	2000	2148	3238
a l	2149	1487	2996	1857	2927	2700	3882	4868	6197	1900	1850	1716	2872
82	1585	1743	2370	1918	5559	6394	6231	10742	11456	6341	2048	2100	4863
83	2233	2018	3209	3256	3338	7148	6147	9784	11100	4880	2200	2100	4790
84	1900	2132	2760	2046	1775	4143	6939	9392	10788	4171	2000	2100	4178
85	2149	1821	2118	1387	1449	2049	4506	4584	3024	1813	1850	1800	2382
86	2095	1528	1286	1547	5089	8780	6263	7033	8046	1900	2000	2100	3958
87	2186	1411	1185	1179	1514	2289	1700	1500	976	800	800	650	1350
88	950	1099	1150	1126	1316	1586	2072	1884	1132	800	800	650	1213
89	1171	1323	1150	1142	1244	3647	5323	4244	2858	1270	1422	1000	2152
AVG	1730	1463	1776	1798	2186	3011	4449	6432	6043	2426	1841	1708	2904

Appendix C:

Fish and wildlife species mentioned in text

Bluegill	<u>Leopomis macrochirus</u>
Carp	<u>Cyprinus carpio</u>
Atlantic salmon	<u>Salmo salar</u>
Redside shiner	<u>Richardsonius balteatus</u>
Pumpkinseed	<u>Lepomis gibbosus</u>
Brown bullhead	<u>Ictalurus nebulosus</u>
Channel catfish	<u>Ictalurus punctatus</u>
Smallmouth bass	<u>Micropterus dolomieu</u>
Largemouth bass	<u>Micropterus salmoides</u>
Snake River cutthroat trout	<u>Salmo clarki</u>
Black crappie	<u>Pomoxis nigromaculatus</u>
Yellow perch	<u>Perca flavescens</u>
Coho salmon	<u>Oncorhynchus kisutch</u>
Kokanee salmon	<u>Oncorhynchus nerka</u>
Mountain whitefish	<u>Prosopium williamsoni</u>
Rainbow (Steelhead) trout	<u>Oncorhynchus mykiss</u>
Brown trout	<u>Salmo trutta</u>
Bull trout	<u>Salvelinus confluentus</u>
White sturgeon	<u>Acipenser transmontanus</u>
Sockeye salmon	<u>Oncorhynchus nerka</u>
Chinook salmon	<u>Oncorhynchus tshawytscha</u>
Redband trout	<u>Oncorhynchus mykiss gibbsi</u>
Largescale sucker	<u>Catostomus macrocheilus</u>
Bald eagle	<u>Haliaeetus leucocephalus</u>
California quail	<u>Callipepla californica</u>
Canada goose	<u>Branta canadensis</u>
Great blue heron	<u>Ardea herodias</u>
Mallard	<u>Anas platyrhynchos</u>
Osprey	<u>Pandion haliaetus</u>
Prairie falcon	<u>Falco mexicanus</u>
Ring-necked pheasant	<u>Phasianus colchicus</u>
Hungarian partridge	<u>Perdix perdix</u>
S andhill crane	<u>Grus canadensis erthrorhynchos</u>
Rocky Mountain	
Trumpeter Swan	<u>Cygnus buccinator</u>
Badger	<u>Taxidea taxus</u>
Beaver	<u>Castor canadensis</u>
Mink	<u>Mustela vison</u>
Muskrat	<u>Ondatra zibethica</u>
River otter	<u>Lutra canadensis</u>
Elk <u>elaphus</u> _____	
Mule deer	<u>Odocoileus hemionus</u>
Bliss Rapids snail	family Hydrobiidae
Banbury Springs Limpet	<u>Lanx sp.</u>
Idaho Springsnail	<u>Pyrgulopsis (Fontelicella) idahoensis</u> Pilsbry 1933
Snake River Physa	<u>Physa (Haitia) natricina</u> Taylor 1988
Utah Valvata snail	<u>Valvata utahensis</u> Call 1884

Appendix D:
Whitewater classifications

<u>Class</u>	<u>Definition</u>
I	Moving water with a few riffles and small waves. Few or no obstructions.
II	Easy rapids with waves up to three feet, and wide, clear channels that are obvious with scouting. Some maneuvering is required.
III	Rapids with high, irregular waves often capable of swamping an open canoe. Narrow passages that often require complex maneuvering. May require scouting from shore.
IV	Long, difficult rapids with constricted passages that often require precise maneuvering in very turbulent waters. Scouting from shore is often necessary, and conditions make rescue difficult. Generally not possible for open canoes. Boaters in covered canoes and kayaks should be able to Eskimo roll.
V	Extremely difficult, long and very violent rapids with highly congested routes which nearly always must be scouted from shore. Rescue conditions are difficult and there is significant hazard to life in event of mishap. Ability to Eskimo roll is essential for kayaks and canoes.
VI	An unrun rapid.