FISHERY MANAGEMENT INVESTIGATIONS

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REGIONAL FISHERIES MANAGEMENT INVESTIGATIONS
SOUTHEAST REGION (Subprojects I-F, II-F, III-F, IV-F)

PROJECT I. SURVEYS AND INVENTORIES
Job b. Southeast Region Lowland Lakes Investigations
Job c. Southeast Region Rivers and Streams Investigations
PROJECT II. TECHNICAL GUIDANCE
PROJECT III. HABITAT MANAGEMENT

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1994 ANNUAL PERFORMANCE REPORT

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Project I: Surveys and Inventories | Subproject I-F: Southeast Region

Job: b | Title: Lowland Lakes Investigations

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ABSTRACT

We completed the third and final year of fingerling and catchable rainbow trout *Oncorhynchus mykiss* performance evaluations. Percent returns by number or weight varied widely due to water storage, avian predation and competing species. Long-term survival was best in special regulation waters that limited harvest. Rainbow trout growth in special regulation waters was slower than in more heavily harvested waters, where both water types had no competing species. Fall stocked fingerlings did well if there was an abundance of water at the end of the irrigation season. Spring stocked catchables were more consistent in providing good returns, probably because they were available for harvest as soon as they were stocked and they were stocked at a time of year when water storage was at its maximum.

Idaho Department of Fish and Game and Idaho Division of Environmental Quality collected water quality data in American Falls Reservoir and adjacent Snake River reaches and determined that when reservoir volume decreased to near 6.17×10^7 m^3, entrained sediment violated state water quality standards for turbidity. Water quality violations continued until the reservoir storage had increased to near 18.5×10^7 m^3. Violations continued for nearly one month, impacting fisheries both in the reservoir and in the river below.

A management check station was operated at the Inkom Port-of-Entry on Interstate 15 for the three-day Memorial Day weekend. This continued a set of trend data begun in 1992. All anglers returning from fishing trips were required to stop. In 1994, 17% more anglers came through the check station, fished 5% more hours, and caught 80% more fish than in 1992.

We sampled 83 walleye *Stizostedion vitreum* at the head of Oneida Reservoir in March 1994. All walleye over 300 mm long were marked with reward tags.

Liquid rotenone was used to renovate two reservoir and two pond fisheries in the region in 1994. The renovations were necessitated by an illegal yellow perch *Perca flavescens* introduction in Little Valley Reservoir, an accidental introduction of yellow perch into Twin Lakes Reservoir and flooding from the Snake River into McTucker Pond # 8 and Rose Pond. Target species appear to have been eliminated.

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OBJECTIVES

1. Document returns to the creel of spring-stocked catchable and fall-stocked fingerling size trout.

2. Document relative growth, survival and persistence of catchable and fingerling size trout stocked in waters with and without competing species.

3. Document effects of special harvest restrictions on growth and survival of trout stocked at catchable and fingerling size.

4. Document the effects on reservoir and tail water water-quality of nearly draining American Falls Reservoir.

5. Sample the walleye *Stizostedion vitreum* spawner population at the head of Oneida Reservoir and mark them for an estimate of rate-of-exploitation.

6. Chemically renovate Twin Lakes Reservoir, Little Valley Reservoir, McTucker Pond #8, and Rose Pond to eradicate populations of undesired species (namely yellow perch *Perca flavescens*).

INTRODUCTION AND METHODS

Catchable and Fingerling Rainbow Trout *Oncorhynchus mykiss* Evaluations

We conducted creel surveys on seven Southeast Region reservoirs in 1994 as the third and final year of a performance evaluation of rainbow trout stocked at fingerling and catchable size (Table 1).

Drought returned to southeast Idaho in 1994 following a year of abundant precipitation in 1993. However, sufficient water carried over in reservoirs from 1993 to prevent any of the evaluation reservoirs from draining in 1994. Trout were the only game fish in five of the seven reservoirs studied, with only Twin Lakes and Winder reservoirs containing the warmwater species of largemouth bass *Micropterus salmoides* and bluegill *Lepomis macrochirus*. Additionally, Winder Reservoir contained yellow perch and Twin Lakes contained common carp *Cyprinus carpio*, brown bullhead *Ameiurus nebulosus* and a small population of tiger muskies *Esox lucius x E. masquinongy*.

The evaluation of fingerling and catchable size rainbow trout in these reservoirs was the cooperative effort of management, research, hatcheries and enforcement divisions of the Idaho Department of Fish and Game (Department). Creel survey statistics were estimated with the Department's "Creel" computer program. Fisheries research personnel, directed by Jeff Dillon, collected data on limnological characteristics, zooplankton size and species composition and fish community. Additionally, the following authors estimated trout population size in the trophy trout reservoirs: Dillon and Jarcik 1994, Dillon and Alexander 1995, 1996.

Table 1. Fingerling and catchable rainbow trout evaluation waters in the Southeast Region of Idaho.

Reservoir	County	Surface area (ha)	Elevation (m)	Special trout rules?	Trout only?
Chesterfield	Caribou	648	1,645	No	Yes
Daniels	Oneida	152	1,573	Yes	Yes
Springfield	Bingham	27	1,341	No	No - Utah chub, Utah sucker
Treasureton	Franklin	143	1,513	Yes	Yes
Twentyfour Mile	Caribou	18	1,801	Yes	No – mountain sucker
Twin Lakes	Franklin	181	1,435	No	No – largemouth bass, brown bullhead, bluegill, carp
Winder	Franklin	38	1,486	No	No – largemouth bass, bluegill, yellow perch

We stocked and evaluated six cohorts of rainbow trout during the three-year study. Catchables stocked in spring 1992 (C92 cohort) were adipose fin clipped; catchables stocked in spring 1993 (C93 cohort) and 1994 (C94 cohort) were marked with left and right maxillary bone clips, respectively. Fingerlings stocked in the fall of 1992 (F92 cohort), 1993 (F93 cohort) and 1994 (F94 cohort) were not marked. We assumed that we would be able to distinguish each fingerling cohort by length frequency analysis.

The purpose of this investigation was to determine relative benefits of stocking catchable size trout, about 220 mm long, in spring and fingerling size trout, about 150 mm long in fall. Spring is generally the most desirable time to stock rainbow trout. Rainbow trout grown to catchable size by spring would have been fingerling size the previous fall. Hatchery space can be used efficiently, if enough fry are raised, such that when they reach fingerling size by fall, they must be thinned to allow space for the remaining rainbow trout to grow to catchable size by the following spring. Those fingerling trout removed in the fall are then stocked. The fall-stocked rainbow trout are both smaller than catchables when stocked and are entering the open water when food supplies may be diminishing and reservoir volumes are reduced. However, since fingerlings are smaller and have spent less time in the hatchery, they cost only about 30% as much to raise per individual fish as do catchables. If survival and ultimately return to the angler's creel of fingerlings in terms of number is at least 30% of the return rate for catchables, then both groups may have equal value to the angler per license dollar spent to raise and stock these fish. However, since one group may return at a smaller size, another way to compare value would be to compare weight of fish stocked to weight of fish returned to anglers, for both the fingerling and catchable cohorts. Both comparisons are made in this report. Details of creel survey sampling methods are presented in previous annual job performance reports (Scully et al. 1995; In press) for this catchable and fingerling trout evaluation.

We stocked rainbow trout into Chesterfield, Winder and Twin Lakes reservoirs at 62 catchables/ha and 208 fingerlings/ha. This is an average stocking density for small to medium

size reservoirs in southeast Idaho. The ratio of one catchable to 3.375 fingerlings is proportional to the hatchery's cost to raise and stock them, i.e., it costs the same amount to produce one 220 mm catchable as it does to produce 3.375 150 mm fingerlings. We stocked the special regulation waters of Daniels, Twentyfour Mile and Treasureton reservoirs at half the densities of the general waters to compensate for assumed reduction in annual mortality (limited angler harvest).

We stocked Springfield Reservoir at a much higher rate, 318 catchables/ha and 1,074 fingerlings/ha, since this is how many fish were being stocked before the present investigation began, and we wanted to see how this higher density affected rainbow trout growth, fishing pressure, etc. Prior to 1994, the year in which Treasureton Reservoir changed from general to special trout rules, Treasureton had been stocked at 277 catchables/ha and 943 fingerlings/ha, slightly less than at Springfield Reservoir. This change in stocking density and harvest would be expected to change survival and growth of Treasureton Reservoir rainbow trout. Stocking history throughout the three-year study is presented in Appendix A.

American Falls Reservoir and Snake River Water Quality Investigation Relative to Significant Reservoir Drawdown

American Falls Reservoir with a full pool surface area of 22,663 ha and a volume of 2.1 $\times 10^9$ m^3 is the largest reservoir in Idaho by surface area and the second largest by volume. The U.S. Bureau of Reclamation (BOR) built it in the 1920s for irrigation storage and flood control. There has never been a minimum pool established for beneficial uses of recreation and fish and wildlife resources. In 1990 American Falls Reservoir was completely drained to the original Snake River channel. Anecdotal reports were that the river channel downstream from the dam had the appearance of a chocolate slurry for several days during the reservoir evacuation event. In 1991 anglers voiced strong complaints that trout had nearly disappeared in both the reservoir and river below. The Bureau of Reclamation maintained about 1.4×10^8 m^3 of water at the ends of both the 1991 and 1992 irrigation seasons. Then in 1993, the region experienced an abundance of precipitation and American Falls Reservoir contained over 4.9×10^8 m^3 at irrigation season completion.

Early in 1994, the Bureau of Reclamation issued a preliminary prediction that they would drain American Falls Reservoir by fall to satisfy irrigation demand and to provide water to the lower Snake River to assist the migration of juvenile salmon. Anticipating a reoccurrence of water quality problems similar to those reported for 1990, the Idaho Department of Fish and Game and the Idaho Division of Environmental Quality (DEQ) developed a plan to monitor dissolved oxygen, turbidity and temperature throughout the draining cycle of American Falls Reservoir. Fish and Game personnel collected the samples and DEQ supplied equipment to analyze the samples. Water temperatures were recorded near mid-day at the water surface. Temperatures in the river were expected to be similar from top to bottom. We found very little dissolved oxygen change throughout the water column of the reservoir. We collected the data at the head of American Falls Reservoir, within the reservoir near the dam, and in the Snake River below the dam. We began collecting data on August 16, 1994 when the reservoir volume was about 3.26×10^8 m^3 or 16% of storage capacity. Volume decreased to a low of 2.15×10^7 m^3 (1% of capacity) on September 29. Mean discharge on that date was 5,482 cfs. When downstream water demand ended in mid-October, BOR reduced the discharge to a low of 249 cfs, less than 3% of mean annual flow.

Memorial Day Weekend Interstate 15 Port of Entry Check Station

In 1992, we established a Memorial Day weekend check station at the Interstate 15 Port of Entry rest stop near Inkom. All northbound travelers returning from fishing or hunting trips were required to stop. Department personnel, reservists and volunteers asked the occupants of each vehicle where they had fished, how many hours they had fished, how many fish of what species they had caught and how many of each species they had released. If they had fish with them, we measured and recorded the lengths of each fish. We repeated the survey in 1993 and again in 1994. As the sixth consecutive year of a drought, fishery conditions in 1992 were marginal. Although 1994 also was a drought year, it followed the abundant precipitation year of 1993. Reservoirs filled early in 1993 and there was adequate water at the end of the 1993 irrigation season for reservoirs to carry over good supplies of water into 1994. Thus, the quality of fishing on Memorial Day weekend was largely influenced by conditions in 1993.

Oneida Reservoir Walleye

On March 25, 1994 we used boat-mounted electrofishing equipment to capture walleye at the head of Oneida Reservoir, within the 200-m reach of the Bear River/Oneida Reservoir estuary near and mostly downstream from the mouth of Cottonwood Creek. All electrofishing was done at night. We measured all walleye captured and attached reward tags to walleye greater than 300 mm long. Returns of reward tags were to be used to estimate exploitation levels of walleye by anglers.

Rotenone Renovations

The fisheries at Little Valley Reservoir in Bear Lake County, Rose Pond and McTucker Pond #8 in Bingham County, and Twin Lakes Reservoir in Franklin County had all deteriorated due to competition with accidental or illegal introductions of undesirable fish species. We held public meetings in all of the counties to discuss management options and received support for rotenone renovations. We applied for and received written permission from the Division of Environmental Quality for each renovation.

Little Valley Reservoir

Little Valley Reservoir, at 2,001 m elevation, was built for irrigation storage but had also been a put-and-grow fishery for cutthroat trout *Oncorhynchus clarki* and rainbow trout for many years. Yellow perch illegally stocked in the late 1980s had become abundant by the early 1990s. They did not grow large enough to provide a fishery, yet they competed with trout for food and space. We renovated Little Valley Reservoir through the ice in January 1994 with 5% rotenone liquid at an application concentration of 1.5 ppm. Fifty gallons ($1,950) of rotenone liquid were used to treat approximately 120,000 m^3 of water.

Rose Pond

Rose Pond is an approximately 8-ha gravel pond located near Interstate 15, north of Blackfoot. Rose Pond fills with groundwater during the summer irrigation season and then levels recede to about 0.8 hectares and 15,000 m^3 of water in winter. During years of abundant spring runoff, the nearby Snake River overflows its banks and floods Rose Pond. Undesirable species such as Utah sucker *Catostomus ardens*, Utah chub *Gila atraria*, common carp, redside shiner *Richardsonius balteatus*, brown bullhead, and yellow perch enter with the flooding flows and soon fill the pond to carrying capacity. The Department has stocked catchable size rainbow trout in Rose Pond and has provided a marginal put-and-take trout fishery. Rose Pond was renovated in April 1994 with 8 ppm of 5% rotenone liquid. The high concentration was needed to kill brown bullhead. Other target species could have been eliminated with 2 ppm. We applied 29.9 gallons of rotenone liquid to the pond and 1.7 gallons (total rotenone cost: $1,232) to the inlet spring as a drip throughout a period of 4 hours.

McTucker Pond #8

The Department had previously renovated the eight McTucker Ponds in the fall of 1992 to remove a mixture of undesirable fish species that had entered the ponds with high flows from the adjacent Snake River. During the spring of 1993, high water again entered the lowest lying of the McTucker Ponds, pond #8. The Bingham County Highway Department needed to remove more gravel from pond #8 in the fall of 1993 and pumped most of the water from the pond while excavating. We renovated McTucker Pond #8 at that time.

Twin Lakes Reservoir

Twin Lakes Reservoir was by far the largest rotenone project in 1994. When filled, Twin Lakes Reservoir covers 180 ha. After the Twin Lakes Canal Company had drained as much water as practical from the reservoir, 1.7×10^6 m^3 of water remained. We attempted to collect carp the day prior to renovation in order to determine what concentration of rotenone liquid would be needed to eradicate them. In two hours of electrofishing, we caught few carp with none small enough to use in the bioassay bags. Thus, we applied a concentration of 2 ppm of rotenone liquid. That should have been adequate to kill carp within a wide range of pH and water quality. The desired concentration required the use of 882 gallons ($34,398) of rotenone liquid.

RESULTS AND DISCUSSION

Catchable and Fingerling Trout Evaluations

Chesterfield Reservoir

Anglers fished an estimated 157,854 hours or 244 hr/ha on Chesterfield Reservoir in 1994 (Table 2). This compares to 28,598 hours in 1993, a 5.5 fold increase. The change in pressure was caused by changes in fishing quality over the past several years. Chesterfield Reservoir had poor fishing during the 1987 to 1992 drought, and many anglers had stopped fishing it. Chesterfield Reservoir was drained June 20, 1992. All trout in the reservoir were small in the early months of 1993 and it was not until late summer that anglers discovered a good density of 0.5-1.0 kg trout. Trout density increased with additional stocking, and trout survival and growth were excellent, at least until mid-summer of 1994. In 1994 anglers caught 116,331 trout and harvested 61% of the catch. Average catch rate was 0.7 fish/h.

Some anglers were concerned that year around fishing at Chesterfield Reservoir, and especially ice fishing, would lead to over-harvest, reduced catch rate and decreased fish size. Suggestions from some anglers included: ice fishing be prohibited, the fishery be opened only during the general season or the creel limit be reduced.

If we assume that the ice fishing season roughly corresponds with intervals 1 through 3 (January 1 through March 25) and Interval 13 (December 3 through December 31), the ice fishing catch and harvest would have been 18% and 12% of the annual total, respectively (Table 2). Percent of harvest is less than percent of catch because winter is the season when the fingerlings stocked in September at 150 mm recruit to the fishery in large numbers at 200-240 mm. Most of the winter catch is made up of these small fish with the majority being released by anglers.

Anglers who fished outside the traditional fishing season of Memorial Day weekend through November expended 23% of the annual fishing effort during this stretch of nearly 50% of the year. They caught 23% of the annual catch and kept (harvested) 16% of the annual harvest.

Based on a 1994 sample of 293 Chesterfield Reservoir anglers who were interviewed at the completion of their fishing day, if the creel limit had been 3 trout rather than 6 trout, harvest would have decreased by 24% (Table 3). This would cause a significantly greater reduction in total harvest than either closing the ice fishery or closing the fishery outside the general season. If it were desirable to further curtail the harvest, reducing the creel limit to 2 trout would decrease harvest by 43%.

Table 2. Basic creel survey statistics from Chesterfield Reservoir, ID, 1994.

1994 sampling intervals	Angling effort (hours)	Number of fish caught	Fish caught per hour	Number and (%) of fish kept
1 [01/01-01/28]	5,713	6,598	1.2	2,480 (38)
2 [01/29-02/25]	5,796	6,390	1.1	2,122 (33)
3 [02/26-03/25]	1,984	2,471	1.2	727 (29)
4 [03/26-04/22]	5,481	609	0.1	478 (78)
5 [04/23-05/20]	6,724	5,028	0.7	2,669 (53)
6 [05/21-06/17]	21,925	14,382	0.7	8,717 (61)
7 [06/18-07/15]	25,426	18,552	0.7	8,910 (48)
8 [07/16-08/12]	27,471	18,634	0.7	14,219 (76)
9 [08/13-09/09]	19,615	12,463	0.6	7,988 (64)
10 [09/10-10/07]	14,868	15,379	1.0	11,179 (73)
11 [10/08-11/04]	9,189	6,683	0.7	5,898 (88)
12 [11/05-12/02]	2,960	4,101	1.4	2,810 (69)
13 [12/03-12/30]	10,702	5,041	0.5	3,186 (63)
Totals	157,854±11%	116,331±16%		71,383±15%
Mean			0.7	

Table 3. Number of trout harvested under the current 6-trout limit at Chesterfield Reservoir, ID, in 1994 by 293 anglers who had completed their day's fishing trip and the number of fish those anglers hypothetically would have harvested with a 2-trout and 3-trout limit.

# anglers interviewed	# fish harvested under current 6-trout limit		# fish which would be harvested with a 2-trout limit		# fish which would be harvested with a 3-trout limit	
77	x 0 =	0	x 0 =	0	x 0 =	0
55	x 1 =	55	x 1 =	55	x 1 =	55
38	x 2 =	76	x 2 =	76	x 2 =	76
46	x 3 =	138	x 2 =	92	x 3 =	138
22	x 4 =	88	x 2 =	44	x 3 =	66
26	x 5 =	130	x 2 =	52	x 3 =	78
29	x 6 =	174	x 2 =	58	x 3 =	87
Totals:						
293		661	43% reduction	377	24% reduction	500

Trout grew slower in 1994 than in 1993. Fish density was higher in 1994, with one weak cohort from 1992 (F92) and two strong cohorts from 1993 (C93 and F93) with which the 1994 cohorts had to compete. Additionally, 1994 drought conditions caused irrigators to remove much of the reservoir volume by early fall. Cohorts F92 and C93 averaged around 420 mm at the end of 1993 (Table 4, interval 1). A year later, the F93 and C94 cohorts averaged around 380 mm and 370 mm, respectively (Table 4, interval 13). Also, the F93 fingerlings averaged near 230 mm by midwinter following fall stocking whereas the F94 fingerlings averaged only around 210 mm by the following midwinter (Figure 1).

As expected, very few of the F92 cohort returned to the angler. Chesterfield Reservoir was just beginning to refill after completely draining when the F92s were stocked in September 1992. The following winter brought deep snow to cover the ice and there probably were very few invertebrates available as a food source. Through 1993 and 1994, anglers harvested 1% by number and 25% by weight of the F92 cohort (Table 5).

By the end of 1994, anglers had harvested 33% of the C93 cohort by number, about half each in 1993 and 1994, and anglers harvested 218% of C93 weight stocked. In 1994, the largest contributors to catch by number were the F93s. Anglers harvested 45,083 or 33% of the number stocked. Anglers were catching good numbers of this cohort at the end of 1994, and the total number of F93s that ultimately will be harvested may be considerably greater. Percent of weight stocked of the F93 cohort, which had been harvested by the end of 1994, was 384%. The largest percent, by number, of any cohort harvested was 48% of the C94. However, since these fish had inadequate time to gain much weight before being harvested, their return to the angler by weight was only 164%. This exceeds the Department's goal of 100% by weight but is far below the 384% for the F93 cohort. We will continue the Chesterfield Reservoir creel survey at least through the first half of 1995 to see how many fish of these strong cohorts are harvested and to see how the F94 fingerlings fare after being stocked in low volume, drought conditions.

Recommendation—Maintain both fall fingerling and spring catchable stocking if water is abundant. If drought conditions are predicted, stock part of the fingerlings in the spring. If drought occurs, stock remaining fall fingerlings in other waters if beneficial to statewide fisheries program.

Springfield Reservoir

Springfield Reservoir received the highest density of stocked rainbow trout of the seven Southeast Region evaluation reservoirs, 318 spring catchables and 1,074 fall fingerlings/ha. Initially we hypothesized that anglers would fish the water heavily and that rainbow trout growth would be depressed from intraspecific competition. In 1993, anglers fished 104 hours/ha at Springfield Reservoir, which is a moderate quantity for a small reservoir. Most of the catch occurred in the winter and most of the harvest was composed of 200-230 mm F92 fingerlings. By summer 1993, anglers stopped catching the cohort. Our survey detected almost no harvest of the 8,500 C93 cohort. By the end of 1993, anglers had harvested 16% of the F92 and 0.1% of the C93 by number. We questioned the validity of the data or of their analyses. Springfield Reservoir water is of good quality and has a very desirable temperature regime because most of the water comes from nearby springs. Also, rainbow trout stomachs examined in the fall of 1992 were unusually large and full of *Gammaris* shrimp, which are considered to be a high

Table 4. Length (mm) and weight (g) growth of rainbow trout cohorts in Chesterfield Reservoir, ID, 1994.

Interval and mid-point	F92 length	F92 weight	C93 length	C93 weight	F93 length	F93 weight	C94 length	C94 weight	F94 length	F94 weight
Stocked 09/29/92	161	46								
Stocked 05/04/93			225	112						
Stocked 09/20/93					165	43				
1 [01/14/94]	421	812	426	886	232	123				
2 [02/11/97]	473[a]	1,235[a]	423	682	235	128				
3 [03/11/94]	441[a]	970[a]	425	670[a]	240	153[a]				
4 [04/08/94]			427	903	250	145				
Stocked 05/06/94							229	130		
5 [05/06/94]	462[a]	1,275[a]	463	1,250	296	332	272	224		
6 [06/03/94]	501	2,268[a]	464	1,144	315	388	285	293		
7 [07/01/94]	476	1,197[a]	485	1,031[a]	335	451	312	387		
8 [07/29/94]	513[a]	1,496[a]	484	1,282[a]	341	489	320	391		

Table 4. Continued.

Interval and mid-point	F92 length	F92 weight	C93 length	C93 weight	F93 length	F93 weight	C94 length	C94 weight	F94 length	F94 weight
9 [08/26/94]			498	1,180[a]	349	489	333	441		
Stocked 09/29/94									152	39
10 [09/23/94]	447[a]	988[a]	489	1,150[a]	364	568	350	490		
11 [10/21/94]	433[a]	934[a]	380[a]	640[a]	378	603	356	480	186[a]	72[a]
12 [11/18/94]					384	650	371	558		
13 [12/16/94]					383	631	371	563	209	92

[a] Sample size was less than 5.

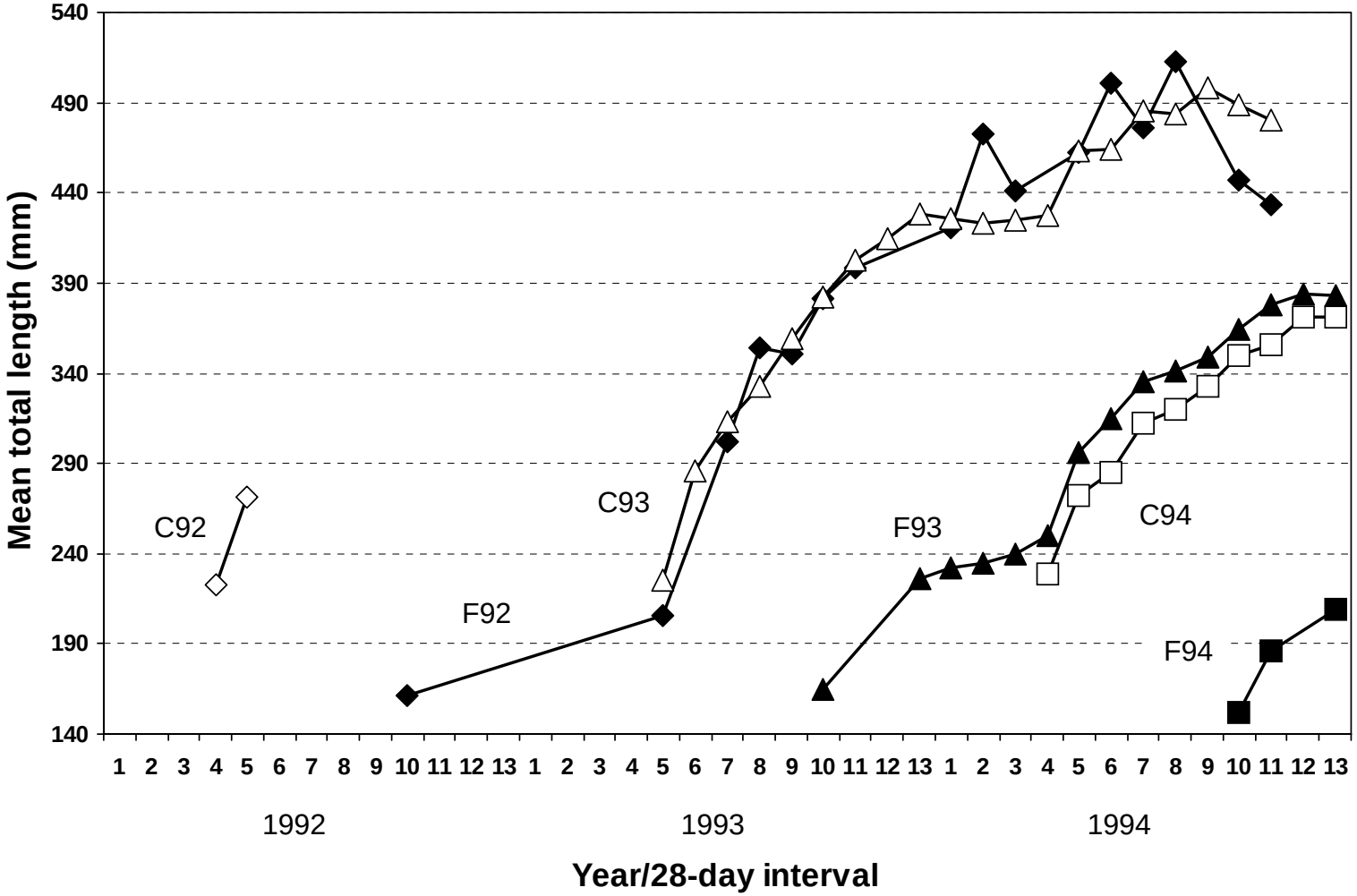


Figure 1. Growth history of rainbow trout cohorts stocked as fingerling (F) and catchable (C) size in Chesterfield Reservoir, ID, 1992 (92) through 1994 (94).

Table 5. Yield (kg) of rainbow trout from Chesterfield Reservoir, ID, by sampling interval in 1994, with cumulative summaries for 1994 and combined for 1993 and 1994.

Interval and mid-point	F92 number	F92 wt.	C93 number	C93 wt.	F93 number	F93 wt.	C94 number	C94 wt.	F94 number	F94 wt.
1 [01/14/94]	34	28	1,077	954	1,364	168				
2 [02/11/94]	8	10	1,045	713	1,091	140				
3 [03/11/94]	14	14	296	198	419	64				
4 [04/08/94]	0	0	275	248	202	29				
5 [05/06/94]	17	217	208	260	1,872	622	503	113		
6 [06/03/94]	99	225	663	759	6,746	2,617	1,168	342		
7 [07/01/94]	226	271	668	689	6,167	2,781	1,560	604		
8 [07/29/94]	43	64	503	648	9,500	4,646	3,831	1,498		
9 [08/26/94]	581	574	186	220	3,433	1,679	3,554	1,567		
10 [09/23/94]	0		189	217	7,206	4,093	4,523	2,216		
11 [10/21/94]	0		592	379	4,216	2,542	1,360	653	47	3
12 [11/18/94]	363	339	212	233	1,611	1,047	625	349		
13 [12/16/94]			17	19	1,256	793	2,061	1,160	353	33
Totals	1,425	1,545	5,931	5,533	45,083	21,219	19,185	8,502	400	36
1994 yield as % of that stocked	1	25	15	123	33	382	48	164	<1	1
1993 and 1994 yield as % of that stocked	2	30	33	218	35	384	NA	NA	NA	NA

quality trout food. We questioned landowners around the reservoir about possible pesticide contamination. Although a herbicide violation was documented in the spring of 1993, the concentration would have been too low to kill trout, and no fish-kill had been observed.

By mid-summer 1994, we had determined that avian predation was removing most of the spring catchables from Springfield Reservoir shortly after they were stocked in May. Additionally, migratory birds took many of the fall-stocked fingerlings the following spring when they returned from their winter habitat. Double crested cormorants *Phalacrocorax auritus* appeared to be the major species contributing to mortality of the stocked rainbow trout. After collecting evidence of piscivorous bird effects (Appendix B), we terminated the 1994 creel survey.

In 1994, we surveyed Springfield Reservoir from January through mid-July (intervals 1-7). Catch rates were highest in intervals 1 and 2 and decreased rapidly after that to near zero by interval 5. Fishing effort peaked in intervals 4 and 5 as weather warmed but quickly declined when anglers could not find fish (Table 6).

The only cohort represented in the 1994 survey was F93. None of the 8,500 C94s stocked in interval 5 were observed. Even catch of the F93 cohort had ceased by interval 7 (Table 7). Anglers harvested 1,168 (4% by number of those stocked) of the F93 cohort and 202 kg by weight (17% of that stocked).

Seasonal electrofishing samples conducted by Department research biologist Jeff Dillon's team and by regional management documented growth through short intervals by the C92, F92, C93 and F93 cohorts (Figure 2) but encountered no C94 trout to measure.

During the truncated 1994 creel survey, 73% of interviewed anglers who had completed their trips had caught no fish and 88% had caught two or less. Anglers fishing from the bank accounted for 90% of the total and 85% fished with bait. Less than 1% of anglers were nonresidents.

Recommendation—Alter stocking programs to manage around the piscivorous bird problems, stocking small numbers of fish frequently rather than infrequent stocking of large numbers of trout.

Treasureton Reservoir

A creel survey in 1991 documented rapid rainbow trout growth at Treasureton Reservoir (Scully et al. 1993). Rainbow trout growth at nearby Condie Reservoir was much slower, yet Condie Reservoir was managed with trophy trout rules. Trophy rules were eliminated at Condie Reservoir in 1992 and quality trout rules were implemented at Treasureton Reservoir in 1994. The change at Treasureton Reservoir also led to a large decrease in stocking density from 276 catchables and 934 fingerlings/ha in 1993 to 31 catchables and 104 fingerlings/ha in 1994.

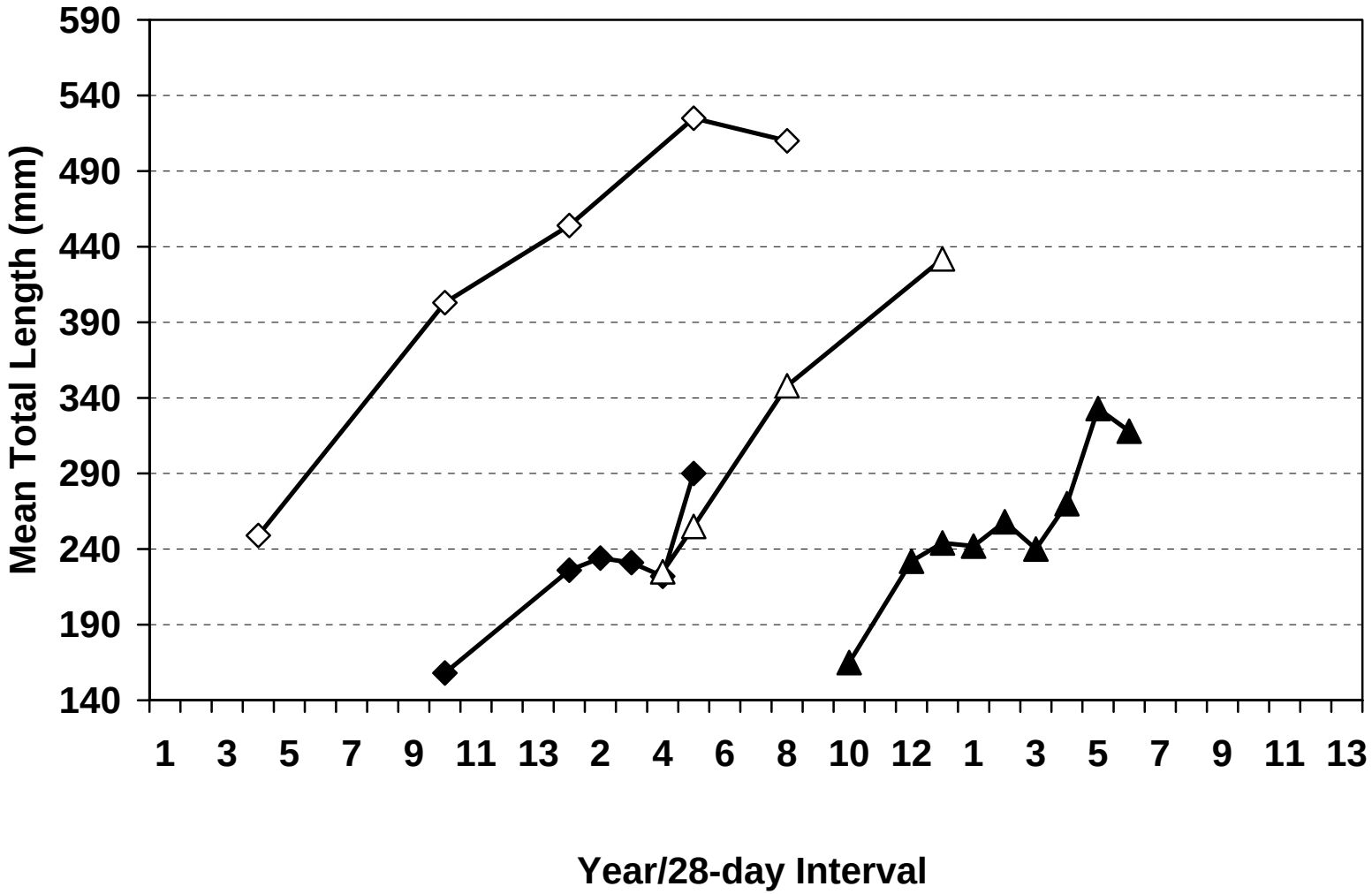
Table 6. Basic creel survey statistics from Springfield Reservoir, ID, 1994.

1994 sampling intervals	Angling effort (hours)	Number of fish caught	Fish caught per hour	Number and (%) of fish kept
1 [01/01-01/28]	942	1,094	1.2	715 (65)
2 [01/29-02/25]	590	273	0.5	184 (67)
3 [02/26-03/25]	860	34	0.04	0 (0)
4 [03/26-04/22]	2,358	620	0.3	444 (72)
5 [04/23-05/20]	1,028	27	0.03	27 (100)
6 [05/21-06/17]	903	70	0.1	70 (100)
7 [06/18-07/15]	620	0	0	0 (NA)
Totals:	7,301±33%	2,118±67%		1,440 (68)
Mean:			0.3	

Table 7. Average length, weight, number and weight harvested of F93 rainbow trout during the interval 1-7 survey at Springfield Reservoir, ID, in 1994. No other cohorts were represented in the survey.

Interval and mid-point	F93 length (mm)	F93 weight (g)	Number harvested	Weight (kg) harvested
1 [01/14/94]	242	128	624	80
2 [02/11/97]	258	139	169	23
3 [03/11/94]				
4 [04/08/94]	270	215	278	60
5 [05/06/94]	333	403	27	11
6 [06/03/94]	318	404	70	28
7 [07/01/94]				
Totals:			1,168±79%	202
Return to the creel:			4%	17%

Figure 2. Growth history of rainbow trout cohorts stocked as fingerling (F) and catchable (C) size in Springfield Reservoir, ID, 1992 (92) through 1994 (94).



The new rules reduced the creel limit to two trout that must be either less than 12 or over 16 inches long. Once the new rule took effect, most anglers did not keep trout under 12 inches long, which in effect resulted in a 16-inch minimum size limit. Therefore, the large number of fingerlings stocked in September 1993 (F93) suffered very little fishing mortality during 1994.

Rainbow trout grew slower in 1994 than in 1993. Contributing factors would have been: 1) the high density of unharvested F93s with which 1994 stocked trout had to compete; 2) the change from 1993's abundant precipitation to 1994's drought conditions; and 3) the draining of Treasureton Reservoir in 1992 followed by complete filling the following spring, which provided vacant habitat for rapid growth in 1993.

For the above reasons, we discontinued the creel survey at Treasureton Reservoir in 1994. However, we did collect trout seasonally to document growth rates (Figure 3). Catchables stocked in May at 229 mm in both 1993 and 1994 grew at much different rates during their first summer. By fall 1993 the C93s averaged 381 mm. By fall 1994, the C94s averaged only 292 mm (Table 8). The F93s also grew slowly in 1994 only reaching 300 mm a year after stocking. Reports from anglers in the fall of 1994 were that fishing was excellent, but fish over 16 inches long were rare. A fish that large would have been a C93, and that cohort was heavily harvested in 1993 before the rule change. Since stocking density was greatly reduced in 1994, there should be a density dependent growth response in 1995.

Recommendation—Maintain both fall fingerling and spring catchable stocking if water is abundant. If drought conditions are predicted, stock part of the fingerlings in the spring. If drought occurs, stock remaining fall fingerlings in other waters if beneficial to statewide fisheries program.

Twin Lakes Reservoir

The Twin Lakes Reservoir fish community was a mix of rainbow trout, largemouth bass, bluegill, brown bullhead and common carp. In the mid-1980s Twin Lakes had a good bluegill fishery (Schill and Heimer 1988). Late in the 1980s, common carp entered the reservoir, possibly through the canal system. The stretch of time carp had been in the reservoir also coincided to a large extent with the 1987-1992 drought. During that time, the bluegill fishery collapsed. The angling public supported renovating Twin Lakes Reservoir as soon as drought conditions caused the Twin Lake Irrigation Company to greatly reduce reservoir volume. The reduced volume situation occurred in 1994, and the Department renovated the reservoir in October. We continued the creel survey evaluation of fingerlings and catchables until the renovation.

Most (58%) anglers fished from the bank, 18% fished from boats, 1% from float tubes and 23% ice fished. Out of all the anglers, 84% fished with bait. A significant portion (41%), but not the majority, of anglers were nonresidents. Anglers fished an estimated 38,289 hours (212 h/ha) at Twin Lakes Reservoir from January through the first week of October 1994 (Table 9). They caught 28,740 rainbow trout, 1,143 largemouth bass, 4,659 bluegill and 112 tiger muskies. Anglers kept 66% of the rainbow trout, 11% of the largemouth bass, 67% of the bluegill and 0% of the tiger muskies. The small percent harvest on largemouth bass and tiger muskies was due

to the 12- and 30-inch minimum legal harvest sizes on the two species, respectively. The Department stocked 1,500 tiger muskies into Twin Lakes in October 1991.

No C92s were observed in the 1994 survey. F92s had grown to about 410 mm by late summer 1994, after two growing seasons in the reservoir (Table 10). C93s were 330 mm a year after stocking. F93s were 310 mm by fall 1994, a year after stocking (Figure 4).

Over half the C92s were harvested and 101% were returned by weight (Table 11). All harvest of the cohort was completed in 1993 as none were observed in the 1994 survey. Less of the C93s were harvested, even though their natural mortality should have been lower due to good water quantity conditions through most of the time they were available for harvest. The full reservoir in 1993 may have made them less vulnerable to harvest. The cohort that benefited anglers most was F93. Even though it only returned 26% by number (compared to 56% by number for the C92 cohort), the total harvest of 9,786 was half again as much as returned from the C92 release. In this instance, fingerlings outperformed catchables.

Recommendation—Maintain the catchable and fingerling program until a mature largemouth bass population develops, then discontinue the fingerling-stocking program.

Winder Reservoir

Winder is a 38 ha reservoir adjacent to a graveled county road midway between state highways 91 and 34 in Franklin County north of the Bear River. Most (80%) of Winder Reservoir anglers were Idaho residents. The majority (57%) of interviewed anglers had caught six or more fish, while 22% had caught nothing. Of the total fishing effort, 21% occurred during the ice fishery. The catch was 75% bluegill, 11% yellow perch, 8% largemouth bass and 6% rainbow trout in 1994. Of the anglers, 72% fished by themselves or with one other person. Even at this mainly "panfish" reservoir with good angler access, there was not a great deal of "family fishing."

The 1994 creel survey at Winder Reservoir ended with interval 11 due to poor angler and surveyor access (snow pack). Little effort is believed to have occurred in intervals 12 and 13. Anglers fished an estimated 17,360 hours or 465 hours/ha on Winder Reservoir. They caught 57,585 fish and kept 60% of them (Table 12). Best catch rates occurred in intervals 5 (5.7 fish/h) and 8 (6.9 fish/h).

Rainbow trout grew slowly in Winder Reservoir in 1994 (Table 13). F93s stocked in September 1993 at 150 mm only grew to 280 mm by fall of 1994. Fish stocked as 220 mm catchables in May 1994 (C94) had only grown to 270 mm by interval 11 and appeared to have lost weight since mid-summer (Figure 5).

Three factors likely contributed to the rate of return to anglers of the different cohorts at Winder Reservoir. First, the 1992 drought followed by deep, long lasting snow the following winter may have decreased dissolved oxygen causing a winterkill of both 1992 cohorts. Second, good carryover of water at the end of the 1993 irrigation season allowed the 1993 cohorts to survive well and contribute to the 1994 fishery. This was especially significant with the F93 cohort (Table 14). Most rainbow trout yield in 1994 came from the F93 cohort,

Figure 3. Growth history of rainbow trout cohorts stocked as fingerling (F) and catchable (C) size in Treasureton Reservoir, ID, 1992 (92) through 1994 (94).

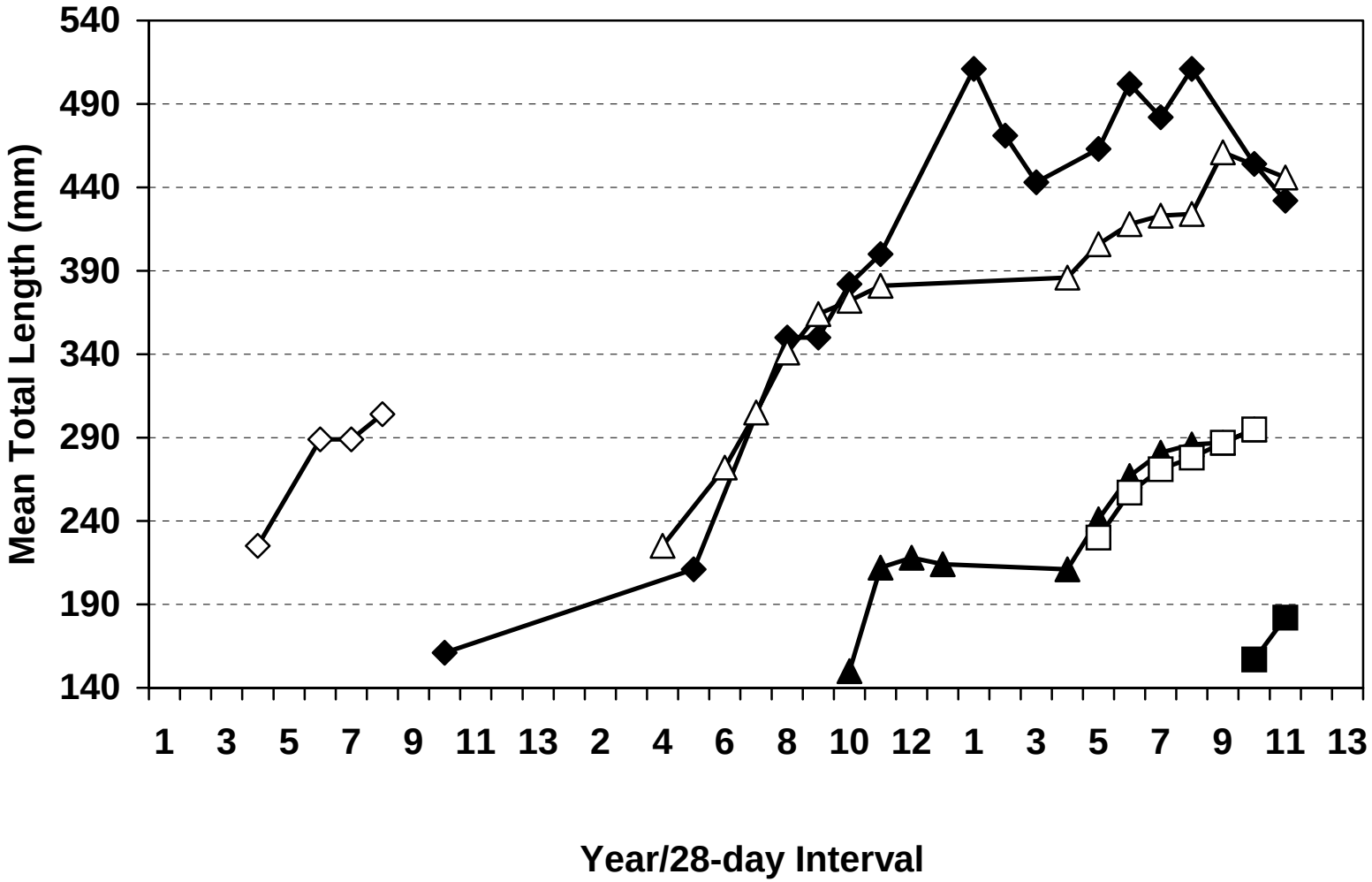


Table 8. Growth in length (mm) of four rainbow trout cohorts stocked from May 1993 (C93) through September 1994 (F94) in seven southeast Idaho reservoirs.

Sampling dates	C93 stocked May 1993	F93 stocked Sept. 1993	C94 stocked May 1994	F94 stocked Sept. 1994
1993				
06-09-93	272			
07-12-93	305			
08-03-93	341			
09-09-93	364	152		
10-06-93	372	173		
11-05-93	381	193		
1994				
04-09-94	386	211		
04-30-94	370	231		
05-09-94	406	241	230	
06-08-94	418	267	257	
07-05-94	423	281	271	
08-02-94	424	286	278	
09-07-94	461	287	287	
09-27-94				157
10-24-94	446	295	292	182

Table 9. Basic creel survey statistics from Twin Lakes Reservoir, ID, 1994.

1994 sampling intervals	Angling effort (hours)	Number of fish caught	Fish caught per hour	Number and % of fish kept
1 [01/01-01/28]	2,778	2,373	0.9	1,385 (58%)
2 [01/29-02/25]	1,932	2,743	1.4	1,164 (42%)
3 [02/26-03/25]	476	267	0.6	264 (99%)
4 [03/26-04/22]	4,752	1,152	0.2	1,060 (92%)
5 [04/23-05/20]	5,933	4,609	0.8	2,015 (44%)
6 [05/21-06/17]	9,842	11,892	1.2	8,420 (71%)
7 [06/18-07/15]	6,118	3,118	0.5	2,495 (80%)
8 [07/16-08/12]	3,063	1,413	0.5	1,065 (75%)
9 [08/13-09/09]	2,525	723	0.3	595 (82%)
10 [09/10-10/07]	870	450	0.5	450 (100%)
11 [10/08-11/04]	Rotenone renovation			
12 [11/05-12/02]				
13 [12/03-12/30]				
Totals	38,289±19%	28,740±34%		18,916±33%
Mean			0.8	

Table 10. Length (mm) and weight (g) growth of rainbow trout cohorts in Twin Lakes Reservoir, ID, 1994.

Interval and mid-point	C92 length	C92 weight	F92 length	F92 weight	C93 length	C93 weight	F93 length	F93 weight	C94 length	C94 weight
Stocked 05/07/92	244	160								
Stocked 09/28/92			163	47						
Stocked 05/04/93					229	113				
Stocked 09/21/93							152	38		
Stocked 05/05/94									129	130
1 [01/14/94]			379	554	389	599	255	192		
2 [02/11/97]			381	590	381	572	255	180		
3 [03/11/94]			398		365					
4 [04/08/94]			382	652	383	623	286	259		
5 [05/06/94]			409	708	307	332	303	322	278	242
6 [06/03/94]			409	750	343	527	318	354	282	261
7 [07/01/94]			414				319	380	276	213
8 [07/29/94]			412		320	360	331	325	286	236
9 [08/26/94]							330	358	303	290
10 [09/23/94]							314	290	290	185

Figure 4. Growth history of rainbow trout cohorts stocked as fingerling (F) and catchable (C) size in Twin Lakes Reservoir, ID, 1992 (92) through 1994 (94).

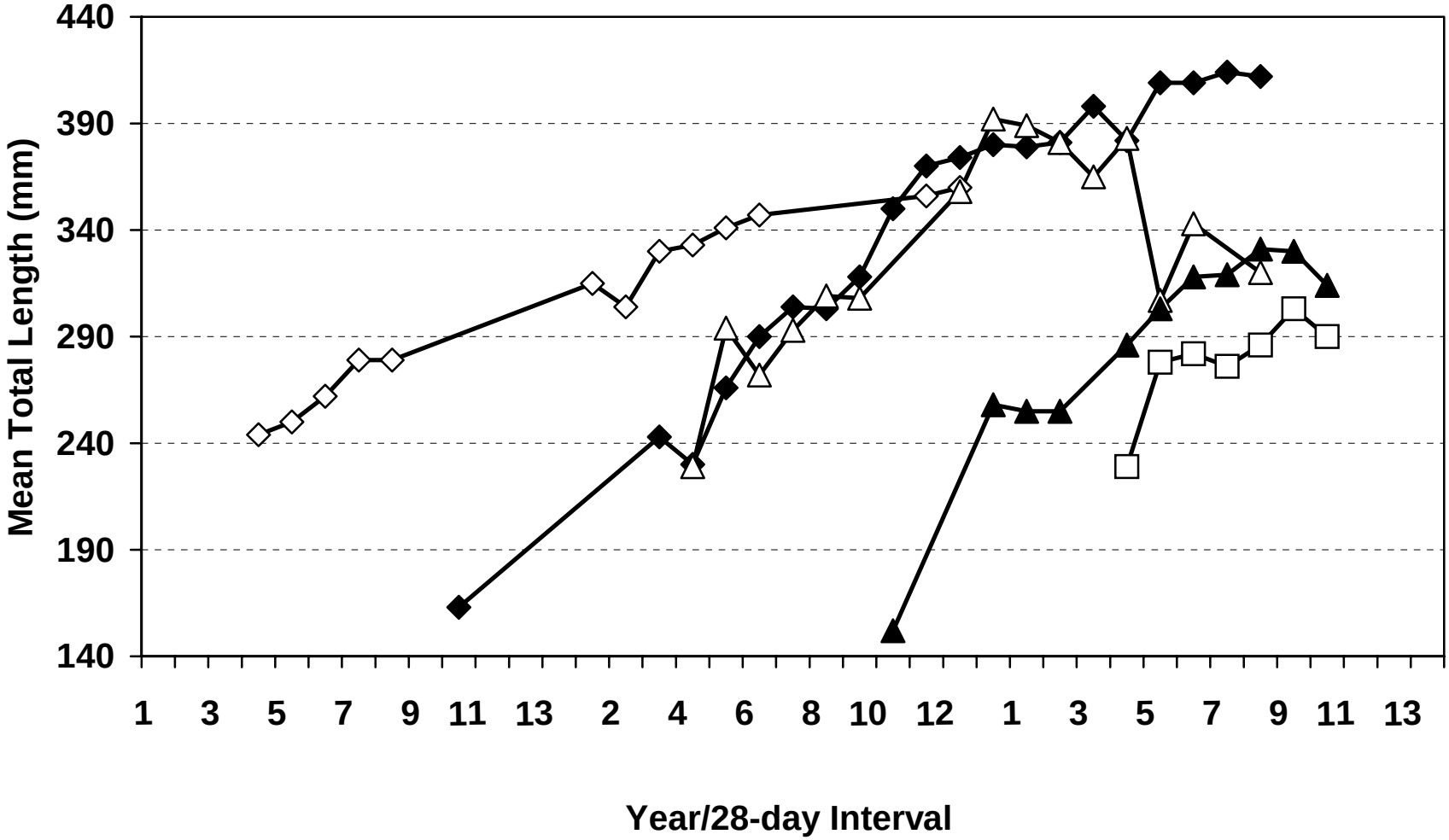


Table 11. Yield (kg) of rainbow trout from Twin Lakes Reservoir, ID, by sampling interval in 1994, with cumulative summaries for 1994 and combined for 1992 through 1994.

Interval and mid-point	C92 number	C92 wt.	F92 number	F92 wt.	C93 number	C93 wt.	F93 number	F93 wt.	C94 number	C94 wt.
1 [01/14/94]			413	229	222	133	747	143		
2 [02/11/97]			153	90	271	155	741	133		
3 [03/11/94]			244	151	23	14				
4 [04/08/94]			289	188	272	169	500	130		
5 [05/06/94]			104	74	104	35	1,486	478	272	66
6 [06/03/94]			132	99	182	96	4,037	1,429	976	255
7 [07/01/94]			23	17			1,358	516	1,018	217
8 [07/29/94]			65	49	33	12	618	201	314	74
9 [08/26/94]							86	31	58	17
10 [09/23/94]							150	44	300	56
11 [10/21/94]	ROTENONE RENOVATION									
12 [11/18/94]										
13 [12/16/94]										
Totals			1,423	897	1,107	614	9,723	3,105	2,938	685
1994 yield as % of that stocked			4	50	10	49	26	224	26	47
1992-1994 yield as % of that stocked	56	101	12	96	21	80	26	225	26	47

Table 12. Basic creel survey statistics from Winder Reservoir, ID, 1994.

1994 sampling intervals	Angling effort (hours)	Number of fish caught	Fish caught per hour	Number and % of fish kept
1 [01/01-01/28]	1,249	2,093	1.7	1,359 (65)
2 [01/29-02/25]	861	1,979	2.3	1,457 (74)
3 [02/26-03/25]	387	858	2.2	858 (100)
4 [03/26-04/22]	452	920	2.0	263 (29)
5 [04/23-05/20]	1,486	8,495	5.7	3,112 (37)
6 [05/21-06/17]	5,376	8,766	1.6	5,516 (63)
7 [06/18-07/15]	4,615	16,570	3.6	8,296 (50)
8 [07/16-08/12]	1,968	13,515	6.9	10,910 (81)
9 [08/13-09/09]	597	3,001	5.0	1,990 (66)
10 [09/10-10/07]	64	0	0.0	0 (0)
11 [10/08-11/04]	305	1,388	4.6	1,036 (75)
12 [11/05-12/02]				
13 [12/03-12/30]				
Totals	17,360±22%	57,585±31%		34,797 (60)
Mean			3.3	

Table 13. Length (mm) and weight (g) growth of rainbow trout cohorts in Winder Reservoir, ID, 1994.

Interval and mid-point	C92 length	C92 wt.	F92 length	F92 wt.	C93 length	C93 wt.	F93 length	F93 wt.	C94 length	C94 wt.	F94 length	F94 wt.
Stocked 5/07/92	242	156										
Stocked 9/29/92			162	45								
Stocked 5/08/93					229	112						
Stocked 9/21/93							127	30				
Stocked 5/05/94									229	130		
1 [01/14/94]					310	250	213	100			152	38
2 [02/11/97]					328	365	330	108				
3 [03/11/94]							225	113				
4 [04/08/94]							276	229				
5 [05/06/94]					257	180	278	230	247	146		
6 [06/03/94]					345	448	290	224	259	155		
7 [07/01/94]							285	218	249	162		
8 [07/29/94]									250	180		
9 [08/26/94]									253	145		
10 [09/23/94]												
11 [11/21/94]					352	360	283	175	270	137	169	48

Figure 5. Growth history of rainbow trout cohorts stocked as fingerling (F) and catchable (C) size in Winder Reservoir, ID, 1992 (92) through 1994 (94).

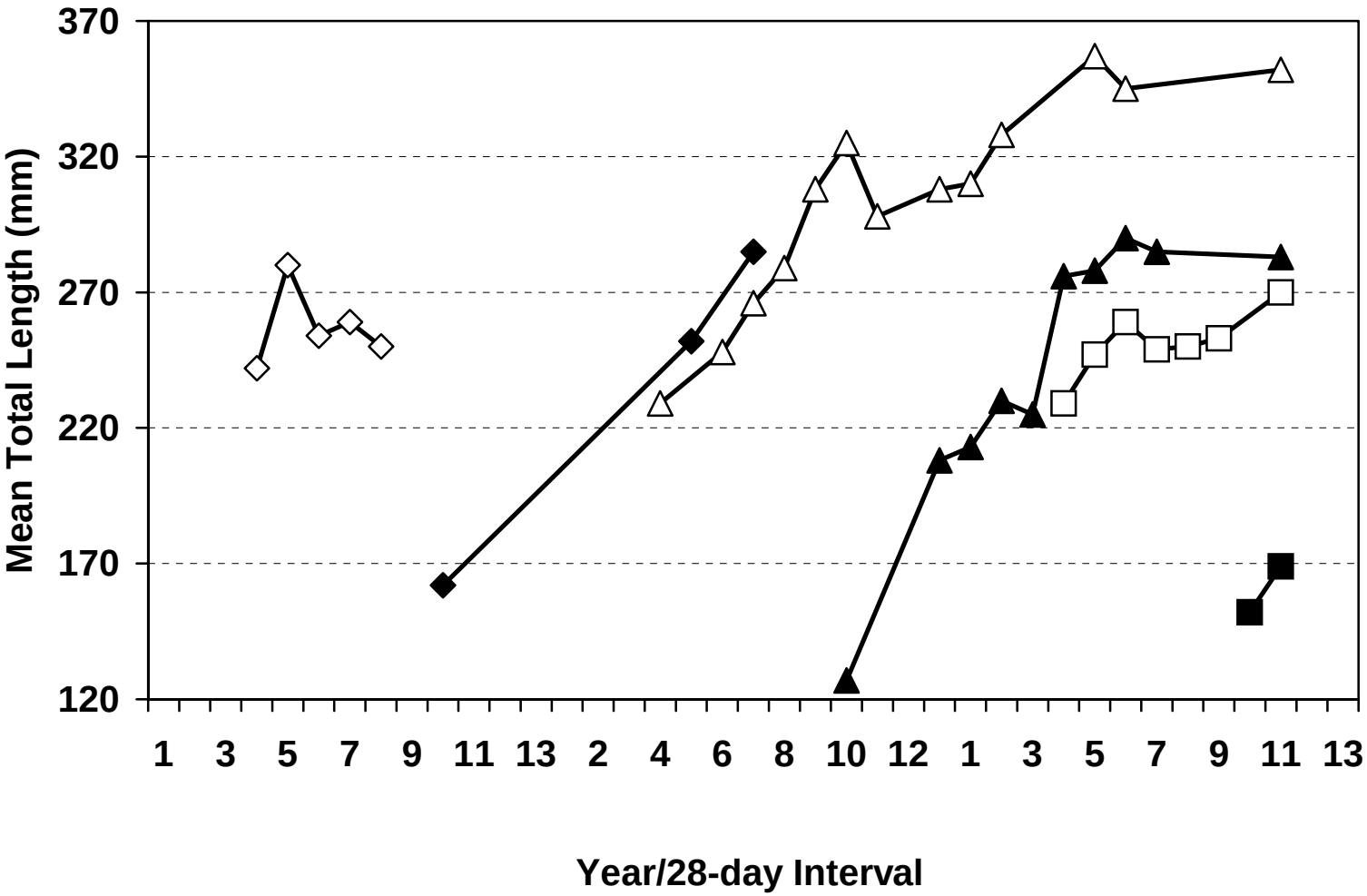


Table 14. Yield (kg) of rainbow trout from Winder Reservoir, ID, by sampling interval in 1994, with cumulative summaries for 1994 and combined for 1992 through 1994.

Interval and mid-point	C92 Number	C92 Wt.	F92 Number	F92 Wt.	C93 Number	C93 Wt.	F93 Number	F93 Wt.	C94 Number	C94 Wt.	F94 Number	F94 Wt.
1 [01/14/94]					34	9	19	2				
2 [02/11/97]					32	12	149	16				
3 [03/11/94]							191	22				
4 [04/08/94]							27	8				
5 [05/06/94]							104	24	175	26		
6 [06/03/94]					25	9	253	57	374	58		
7 [07/01/94]							245	53	148	24		
8 [07/29/94]												
9 [08/26/94]									61	9		
10 [09/23/94]							137	24	78	11		
11 [10/21/94]												
12 [11/18/94]												
13 [12/16/94]												
Totals	0	0	0	0	91	30	1,125	206	836	128	20	1
1994 yield as % of that stocked	0	0	0	0	4	11	17	106	36	42	0.2	0.3
1992-1994 yield as % of that stocked	47	58	0.7	3	29	65	18	109	36	42	0.2	0.3

followed by the C94 cohort. Total trout yield in 1994 (365 kg) was 56% by weight of the trout stocked in 1994. Due to slow rainbow trout growth at Winder Reservoir, fall fingerlings make almost no contribution to the fishery until the following year. If the year the fall fingerlings are stocked is a drought year, then the fall fingerlings will make little or no contribution at all. Slow growth is probably attributable to competition with spiny ray fish, especially yellow perch. Also, even with the best water conditions, fall fingerlings (1993) were only harvested 18% by number. Predation by largemouth bass may also have contributed to the low return rate. Most fish yield came from spiny ray fish. Anglers harvested 3,356 kg of fish (88.3 kg/ha) from Winder Reservoir in 1994. Bluegill, rainbow trout and yellow perch accounted for 79%, 11% and 10% of the harvest by weight, respectively. Harvest of legal size largemouth bass (≥305 mm) was insignificant.

Recommendation—Discontinue the fall fingerling-stocking program but maintain the spring catchable program. If reductions in hatchery production are needed, trout stocking at Winder Reservoir should be one of the first places to cut. The fishery there will be maintained with bluegill, yellow perch and largemouth bass.

Twentyfour Mile Reservoir

Anglers fished an estimated 4,396 hours or 247 h/ha on 18 ha Twentyfour Mile Reservoir. They caught 2,000 trout for an average catch rate of nearly 0.5 trout/h (Table 15). All fish caught by interviewed anglers were released. Minimum legal length for harvest was 20 inches (508 mm). Most angling occurred from intervals 4 through 11. Ice fishing comprised only 4% of total fishing effort. There is no snow removal on the 2-mile access road, and at 1,800 m elevation the road is often impassible during winter. Float tubers expended 73% of fishing effort. Use of boat motors on 24-Mile Reservoir was prohibited.

Only two C92 rainbow trout were sampled at Twentyfour Mile Reservoir in 1994. The fish were relatively small at 420 and 461 mm (Table 16) for having been stocked at 230 mm over two years earlier. Their condition was slightly less than average at 90% and 99% of standard weight (Table 16). C93 rainbow trout were relatively abundant in 1994 samples. Very little growth occurred within the cohort during the 1994 growing season, beginning at 410 mm in June and ending at 430 mm in October (Figure 6). C94 rainbow trout stocked at 230 mm in May 1994 grew to 350 mm by October 1994, at which time they had a percent of standard weight of 108%.

Much of the 1994 catch was unmarked, with carryover trout averaging around 470 mm. The fish could have been a mix of F92 stocked fingerlings and any trout stocked prior to 1992. Most sampled individuals were shorter than the 20-inch (508 mm) minimum harvest size.

Condition of rainbow trout stocked in the spring of 1993 (C93) or more recently had better than average relative weights, ranging from 103% to 108%. Trout sampled from the C93 cohort were about the same length as those sampled from the C92 cohort. Perhaps the slower growing trout survived longer and most C92s had already died. Better condition in the younger cohorts may also indicate that better water conditions in 1993 and 1994 than in 1992 had allowed better growth or that the reduced stocking density begun in 1992 was now causing a compensatory increase in growth rate and condition.

Table 15. Basic creel survey statistics from Twentyfour Mile Reservoir, ID, 1994.

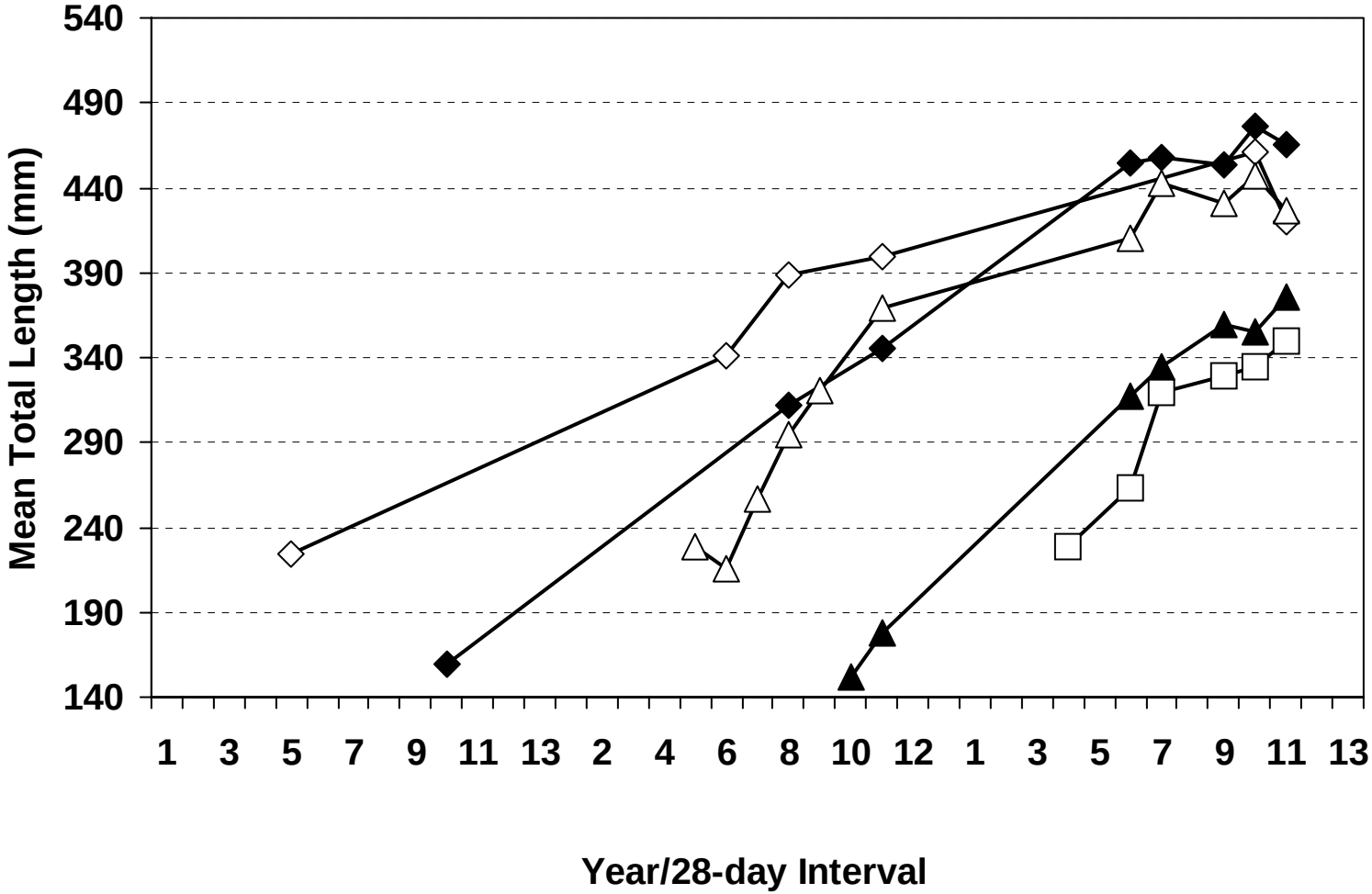
Interval	Hours fished	Trout/hour	Trout caught
1 [01/01-01/28]	NA		NA
2 [01/29-02/25]	158	0	0
3 [02/26-03/25]	NA		NA
4 [03/26-04/22]	264	0.2	61
5 [04/23-05/20]	170	0	0
6 [05/21-06/17]	1,320	0.2	261
7 [06/18-07/15]	996	0.4	390
8 [07/16-08/12]	582	1.2	691
9 [08/13-09/09]	179	1.3	239
10 [09/10-10/07]	640	0.6	358
11 [10/08-11/04]	87	0	0
12 [11/05-12/02]	NA		NA
13 [12/03-12/31]	NA		NA
Totals	4,396±36%		2,000±53%
Mean		0.5	

Table 16. Sample size (n), mean length (L), mean weight (W) and relative weight (W_r) of trout cohorts sampled at Twentyfour Mile Reservoir, ID, 1994. Percent of carryover trout that exceeded 410 mm is also listed for each sample.

Date	C92	F92 and older unmarked trout	C93	F93	C94	Brook trout
06/09/94 [38% ≥410 mm]		n=13 L=455 mm W=1,247 g W_r=114%	n=1 L=410 mm W=700 g W_r=88%	n=8 L=317 mm W=383 g W_r=107%	n=18 L=263 mm W=238 g W_r=118%	n=2 L=432 mm W=1,025 g
07/07/94 [58% ≥410 mm]		n=11 L=458 mm W=1,108 g W_r=99%	n=9 L=443 mm W=1,036 W_r=102%	n=3 L=335 mm W=482 g W_r=113%	n=12 L=320 mm W=412 g W_r=112%	
08/10/94 [57% ≥410 mm]	n=1 L=461 mm W=1,025 g W_r=90%	n=7 L=453 mm W=979 g W_r=90%	n=5 L=431 mm W=894 g W_r=96%	n=3 L=359 mm W=648 g W_r=123%	n=7 L=329 mm W=423 g W_r=105%	n=4 L=437 mm W=928 g
09/18/94 [58% ≥410 mm]	n=1 L=420 mm W=850 g W_r=99%	n=31 L=476 mm W=1,138 g W_r=90%	n=16 L=447 mm W=988 g W_r=95%	n=16 L=355 mm W=483 g W_r=95%	n=15 L=335 mm W=403 g W_r=95%	
10/04/94 [57% ≥410 mm][a]		n=18 L=465 mm W=1,191 g W_r=101%	n=3 L=426 mm W=983 g W_r=110%	n=17 L=376 mm W=628 g W_r=103%	n=9 L=350 mm W=526 g W_r=108%	n=2 L=472 mm W=1,167 g
Unweighted Mean W_r =	95%	99%	98%	108%	108%	

[a] Does not include newly stocked C94 fingerlings which were too small (L=173 mm) for anglers to catch.

Figure 6. Growth history of rainbow trout cohorts stocked as fingerling (F) and catchable (C) size in Twentyfour Mile Reservoir, ID, 1992 (92) through 1994 (94).



Excluding the F94s, which were newly stocked at 150 mm in September 1994, 4 (2%) of the 182 trout sampled by electrofishing equaled or exceeded the 20-inch (508 mm) minimum harvest size. The large trout ranged from 510 to 550 mm. Three of the legal size trout were rainbow/cutthroat hybrids *O. mykiss x O. clarki*, which would have been stocked in 1991 or earlier. Brook trout *Salvelinus fontinalis* had not been stocked in Twentyfour Mile Reservoir since 1991. Eight brook trout were sampled and they ranged from 410 to 510 mm.

A goal for "trophy" trout management is for at least 20% of the catch to be 410 mm or larger. The percent of trout ≥410 mm in the 1994 electrofishing samples ranged from 38% in June to 58% in July and September. This estimate included the catch of C94, none of which would have grown to 410 mm by early fall.

Recommendation—Continue the fingerling-stocking program, but discontinue catchable stocking. Begin stocking part of the fingerlings in the spring.

Daniels Reservoir

Daniels Reservoir, like Twentyfour Mile Reservoir, has trophy trout rules, i.e. a limit of two trout, which must be a least 20 inches long and use of bait is prohibited. In 1994, anglers fished an estimated 29,555 hours (195 h/ha) on 152 ha Daniels Reservoir (Table 17). Boat and tube anglers accounted for 78% of fishing effort and 74% of the catch. Catch rates averaged 0.7 trout/h. Anglers harvested an estimated 39 trout or 0.1% of their catch. Harvested trout average 515 mm (20.3 inches). Creel survey statistics were calculated with Colorado's Creel Survey. May through September were the most heavily fished months; however, best catch rates occurred early in the ice fishing season during December, when anglers average 2.3 trout/h. If the ice-fishing season roughly corresponded to the months of January, February, March and December, then ice fishing would have accounted for 18% of effort and 27% of the catch for 1994.

Jeff Dillon's research team electrofished the Little Malad Springs inlet stream to Daniels Reservoir on September 7, 1994 and sampled 144 juvenile trout ranging from 70 to 210 mm in length, with most being less than 150 mm (Figure 7). Since we stocked fingerlings that averaged 150 mm late in September, the trout in the stream would have come from natural reproduction. Most of the sampled fish were cutthroat trout with some rainbow/cutthroat trout hybrids.

Research biologists sampled the trout populations in May through October 1994 by electrofishing. Mean lengths and weights of catchable cohorts are presented in Table 18. The C92 rainbow trout sampled were not much larger than the C93 cohort, and the C92s demonstrated a trend of no growth from June to October 1994. Sample sizes ranged from 32 in May to 137 in September. Percent of each collection which exceeded 406 mm (16 inches) were 31% (n=32) in May, 47% (n=107) in June, 60% (n=99) in July, 42% (n=129) in August, 55% (n=137) in September and 54% (n=116) in October. The values are significantly above the minimum goal of at least 20% of trout at least 16 inches long for trophy trout waters. The calculations did not include trout less than 200 mm, which were uncommon except immediately following the 150-mm fingerling release in late September. The smaller fish would have been too small to recruit to angler catch.

Table 17. Monthly fishing effort, catch rate and catch of trout at Daniels Reservoir, ID, 1994.

Months in 1994	Fishing effort (h)	Catch rate (fish/h)	Number caught
January	2,004	0.8	1,683
February	579	0.5	288
March	1,704	0.8	1,306
April	2,392	0.5	1,182
May	5,654	0.6	3,568
June	3,855	0.4	1,689
July	4,704	0.8	3,641
August	2,879	1.2	3,535
September	2,510	0.4	929
October	2,145	0.4	904
November	120	0.4	45
December	1,009	2.3	2,339
Totals	29,555		21,109
Mean		0.7	

Figure 7. Length frequency of naturally spawned trout (cutthroat and rainbow) in the Little Malad springs inlet to Daniels Reservoir, ID.

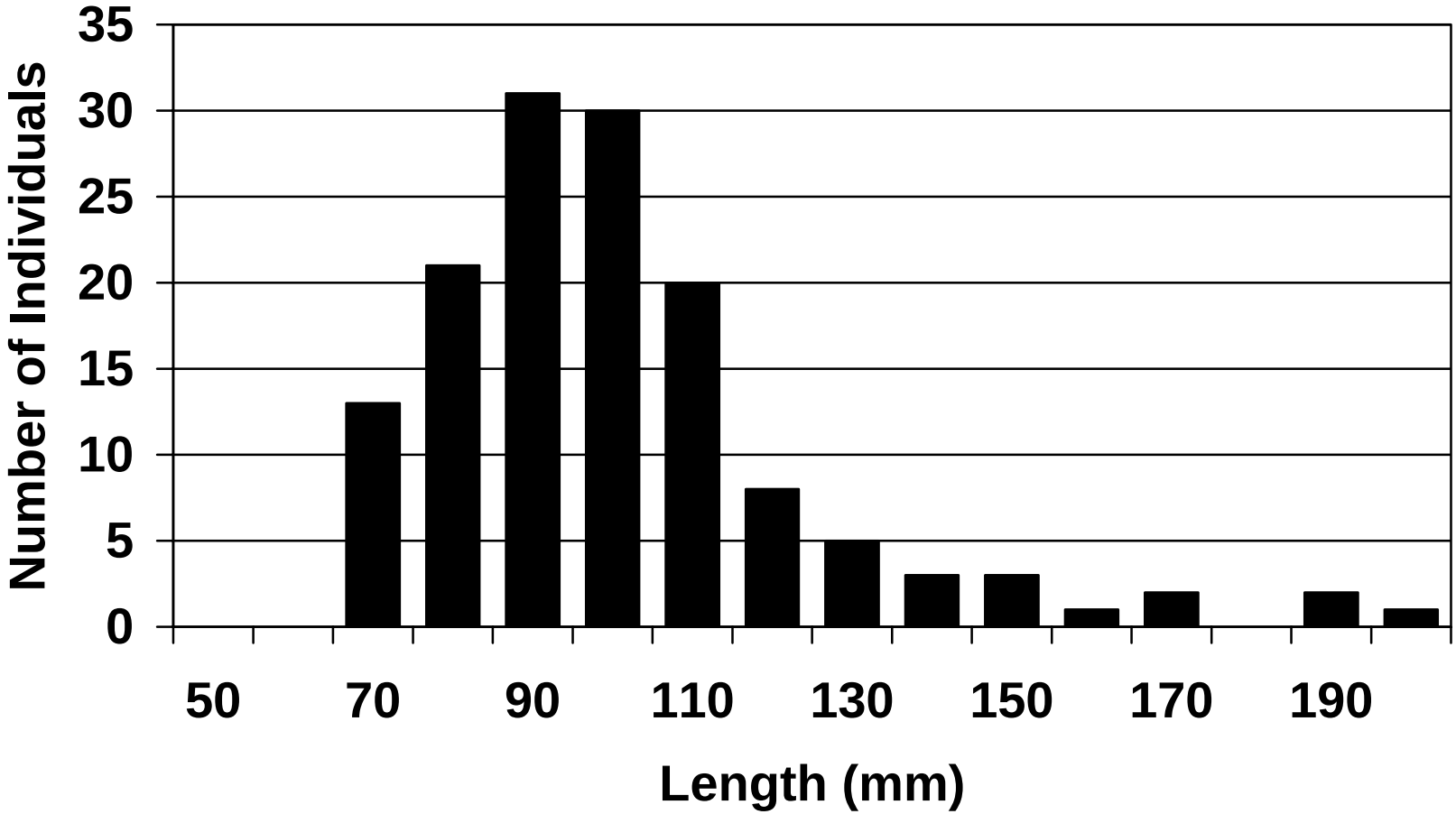


Table 18. Sample size (n), mean length (L) in mm, mean weight (W) in grams and relative weight (W_r) of marked rainbow trout cohorts, 1992, 1993 and 1994 at Daniels Reservoir, ID.

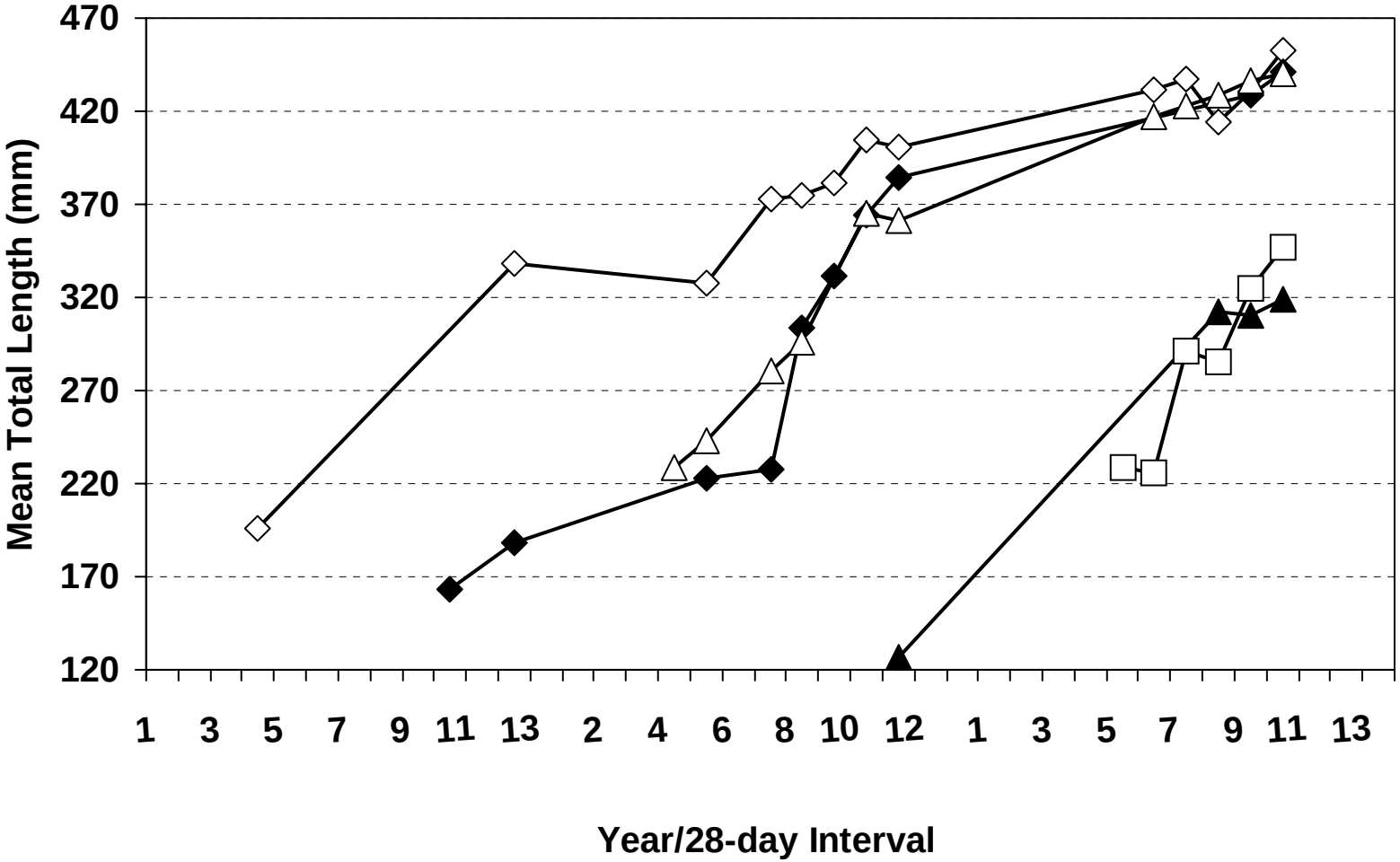
Interval & midpoint	C92 rainbow trout	C93 rainbow trout	C94 rainbow trout
Interval 6 06-07-94	N=6, L=432, W=922,W_r=99%	n=10, L=417, W=840, W_r=100%	n=30, L=226, W=213, W_r=102%
Interval 7 07-05-94	N=3, L=437, W=1,173, W_r=121%	n=6, L=423, W=818, W_r=93%	n=8, L=291, W=291, W_r=106%
Interval 8 08-08-94	N=3, L=414, W=920, W_r=112%	n=8, L=429, W=856, W_r=94%	n=30, L=285, W=319, W_r=124%
Interval 9 09-06-94	N=6, L=431, W=769, W_r=83%	n=11, L=436, W=832,W_r=86%	n=24, L=325, W=382, W_r=99%
Interval 10 10-05-94	n=1, L=453, W=840, W_r=78%	n=3, L=440, W=907, W_r=92%	n=9, L=347, W=456, W_r=96%

Trout at Daniels Reservoir grew at intermediate rates compared to the faster growth at Chesterfield and Springfield reservoirs and slower growth at Twin Lakes and Winder reservoirs. Catchables stocked at 230 mm in May typically grew to about 360 mm by the end of their first growing season and were around 420 mm a year after stocking. Fingerlings stocked at 150 mm typically grew to a length range of 320-360 mm a year later (Figure 8).

There was no obvious growth trend for the C92s in 1994. Their relative weight declined noticeably from mid-summer to fall. Younger trout (C94s) were much better at maintaining their relative weight into the fall. A possible explanation is that smaller food items such as zooplankton, which are more efficiently used by smaller fish, may be more abundant than the large food items needed by the larger (older) rainbow trout.

Recommendation—Continue the fingerling-stocking program, but discontinue catchable stocking. Begin stocking part of the fingerlings in the spring.

Figure 8. Growth history of rainbow trout cohorts stocked as fingerling (F) and catchable (C) size in Daniels Reservoir, ID, 1992 (92) through 1994 (94).



Summary of the Seven Reservoir Catchable/Fingerling Rainbow Trout Evaluation

Fishing effort in terms of hours/hectare fished per year might be a good statistic to compare the relative desirability of several fisheries. There is a loose relationship between catch rate and hours fished per hectare, but fishing intensity is also somewhat related in an inverse way to surface area. However, when the reservoir is relatively small and has a high catch rate, as with Winder Reservoir, then fishing effort will likely be high (Table 19). There most likely is a relationship between quality of fish and fishing intensity. Chesterfield Reservoir had an intermediate catch rate (0.7 fish/h), and even though it was over four times the size of any of the other six reservoirs, it maintained an intermediate level of fishing effort (244 hours/ha).

We could not follow any cohort return-to-angler in Daniels or Twentyfour Mile reservoirs because of the minimum size limit, which likely protected the cohorts during the survey. We were able to follow the C92 cohort in only Twin Lakes and Winder reservoirs because Chesterfield and Treasureton reservoirs were drained in 1992 and because fish-eating birds removed most of the catchables soon after they were stocked in Springfield Reservoir. Over half of the C92s stocked into Twin Lakes and Winder reservoirs were harvested, but because they grew slowly in the mixed species fisheries, their return rates by weight were not high. The C92s met return goals of at least 40% by number, but only at Twin Lakes did they meet the 100% return rate by weight.

The F92s can only be evaluated at Twin Lakes and Winder reservoirs. Carryover was very poor at Winder Reservoir as indicated by poor return rates. Only 13% of the F92s by number returned to the creel at Twin Lakes, but they had grown enough so that the return rate by weight exceeded the management goal (100%).

The C93 and F93 cohorts provided the best comparisons between reservoirs as they were not affected by the severe drought conditions of 1992 and were in the reservoirs for at least one year prior to the survey's end. C93s returned over 200% by weight at both Chesterfield and Treasureton reservoirs where there were no competing species. Additionally the two reservoirs had been drained and refilled during the year previous to stocking the C93s. Thus, both interspecific and intraspecific competition was reduced due to a lack of pre-existing year classes. At Treasureton Reservoir, 80% by number of the C93s returned within a single season. Return of C93s at the mixed-species Twin Lakes and Winder reservoirs were only fair with neither achieving goals by number or weight.

Table 19. Comparison of creel survey statistics, return to creel by number and weight and growth of three cohorts in seven southeast Idaho reservoirs.

	Chesterfield	Springfield	Treasureton	Twin Lakes	Winder	Daniels	24-Mile
Hectares	648	27	58	180	38	152	18
Effort (hours/ha)	244	104	NA	212	457	195	247
Catch rate (fish/h)	0.7	0.3	NA	0.8	3.3 (0.2 trout/h)	0.7	0.5
1992-1994 % return C92 by:	number = 11	number = 13	number = 35	number = 56	number = 47	number = NA	number = NA
	weight = 41[a]	weight = 29	weight = 60[c]	weight = 101	weight = 58	weight = NA[g]	weight = NA[g]
1992-1994 % return F92 by:	number = 2	number = 16	number = NA	number = 13	number = 1		
	weight = 30[b]	weight = 45	weight = NA[d]	weight = 108	weight = 3		
1993-1994 % return C93 by:	number = 34	number <1	number = 80	number = 21	number = 29		
	weight = 218	weight <1	weight = 274	weight = 81	weight = 65		
1993-1994 % return F93 by:	number = 34	number = 6	number = NA	number = 26	number = 12		
	weight = 384	weight = 24	weight = NA[e]	weight = 225	weight = 108		
1994 % return C94 by:	number = 48	number = NA[h]	number = NA	number = 26	number = 36		
	weight = 164	weight = NA	weight = NA	weight = 47	weight = 42		
1994 % return F94 by:	number <1	number = NA	number = NA	number = NA	number <1		
	weight = 1	weight = NA	weight = NA	weight = NA[f]	weight <1		
Mid-1994 Length C92						433	441
Early 1994 Length C93	426	430	381	389	310		
Late 1994 Length C93	489	NA	446	320	352	440	440
Late 1994 Length C94	371	NA	292	290	270	347	376

[a] Chesterfield Reservoir was drained on June 20, 1992, so yield potential was greatly reduced.
[b] Chesterfield Reservoir F92s were stocked when the reservoir was first refilling. There was very little water, very little food and the following winter had deep ice cover; survival would have been low.
[c] Treasureton Reservoir was drained on August 10, 1992, so yield potential was greatly reduced.
[d] The F92s were not stocked because Treasureton Reservoir was empty during fall 1992.
[e] Treasureton Reservoir survey was discontinued in 1994 due to major change in fishing rules and stocking density.
[f] Twin Lakes was renovated in October 1994 to remove rough fish, so the F94s were not stocked.
[g] Due to the trophy trout 20-in minimum size limit, there was no measurable yield of trout from Daniels and 24 Mile reservoirs during the survey.
[h] The Springfield Reservoir survey was discontinued in mid 1994 due to excessive predation on evaluation fish by birds.

F93s greatly exceeded the goal by weight at Chesterfield (384%) and Twin Lakes (225%) reservoirs and met the goal at Winder (108%) Reservoir. A change from general to quality trout management rules at Treasureton Reservoir beginning January 1994 prevented us from evaluating returns to the creel of F93s there. The C94s achieved both number and weight-returned goals at Chesterfield Reservoir during the 1994 season. Whether stocking dollar-equivalents of fall fingerlings or spring catchables is best is not clear from the results of the study. Dillon et al. (1996) concluded that if reservoirs are low in the fall (such as 1992), then fall fingerlings will perform poorly. Conversely, if there is an abundance of water in the fall (such as in 1993), then fall-stocked fingerlings will have better returns to the creel than spring-stocked catchables. Our creel survey results support that hypothesis.

Growth in length of C92s could only be followed into 1994 at Daniels and Twentyfour Mile reservoirs. Reasons for the limiting of water bodies include: Chesterfield and Treasureton reservoirs were drained in 1992, birds ate most of the cohort soon after stocking at Springfield Reservoir, and long term survival was poor at mixed-species Twin Lakes and Winder reservoirs. In addition, the very low exploitation rate at Daniels and Twentyfour Mile reservoirs would increase the chance that a fish would survive for at least two years in a reservoir. It is informative to note that even where harvest is almost nonexistent, few of the spring-stocked rainbow trout catchables survived longer than two years. C92s sampled in 1994 had an average length of 420 mm at Daniels and 440 mm at Twentyfour Mile reservoirs. These lengths are about the same as the C93s sampled late in 1994. It appears that the average rainbow trout, if it survives two years or more in these two reservoirs, stopped growing at or near 440 mm. Nevertheless, some trout reach the legal harvest size of 508 mm. With the reduced stocking rate initiated in 1992, condition and growth of individual fish should improve.

We obtained growth data through the 13-interval yearly creel surveys and with periodic electrofishing. We plotted all available data points from C93 observations on a single graph (Figure 9). The display shows what has already been presented about various locations: rainbow trout grew fastest at Chesterfield and Springfield reservoirs. Growth was good at Treasureton Reservoir until a large cohort of F93s was followed by special regulations that greatly reduced harvest. Growth rate then appeared to be suppressed because of high fish density. Rainbow trout had intermediate growth rates at the trophy regulation waters. We decreased stocking rate in 1992 but earlier stockpiling may have continued to depress growth through much of the 1992-1994 evaluation period. Slowest growth occurred at the mixed-species waters of Twin Lakes and Winder reservoirs with Winder being the slower of the two reservoirs.

American Falls Reservoir and Snake River Water Quality Investigation Relative to Significant Reservoir Drawdown

Dissolved oxygen was not a limiting factor during the study interval with concentration at all three locations generally increasing from near 7 mg/l in early August to near 10 mg/l by the end of October 1994. The only significant exception to the trend occurred near the end of September in the Snake River below the reservoir when dissolved oxygen declined to 6.5 mg/l (Figure 10).

Figure 9. Growth comparisons of the 1993 stocked catchables (C93) among the seven Southeast Idaho Region evaluation reservoirs, May 1993 through November 1994.

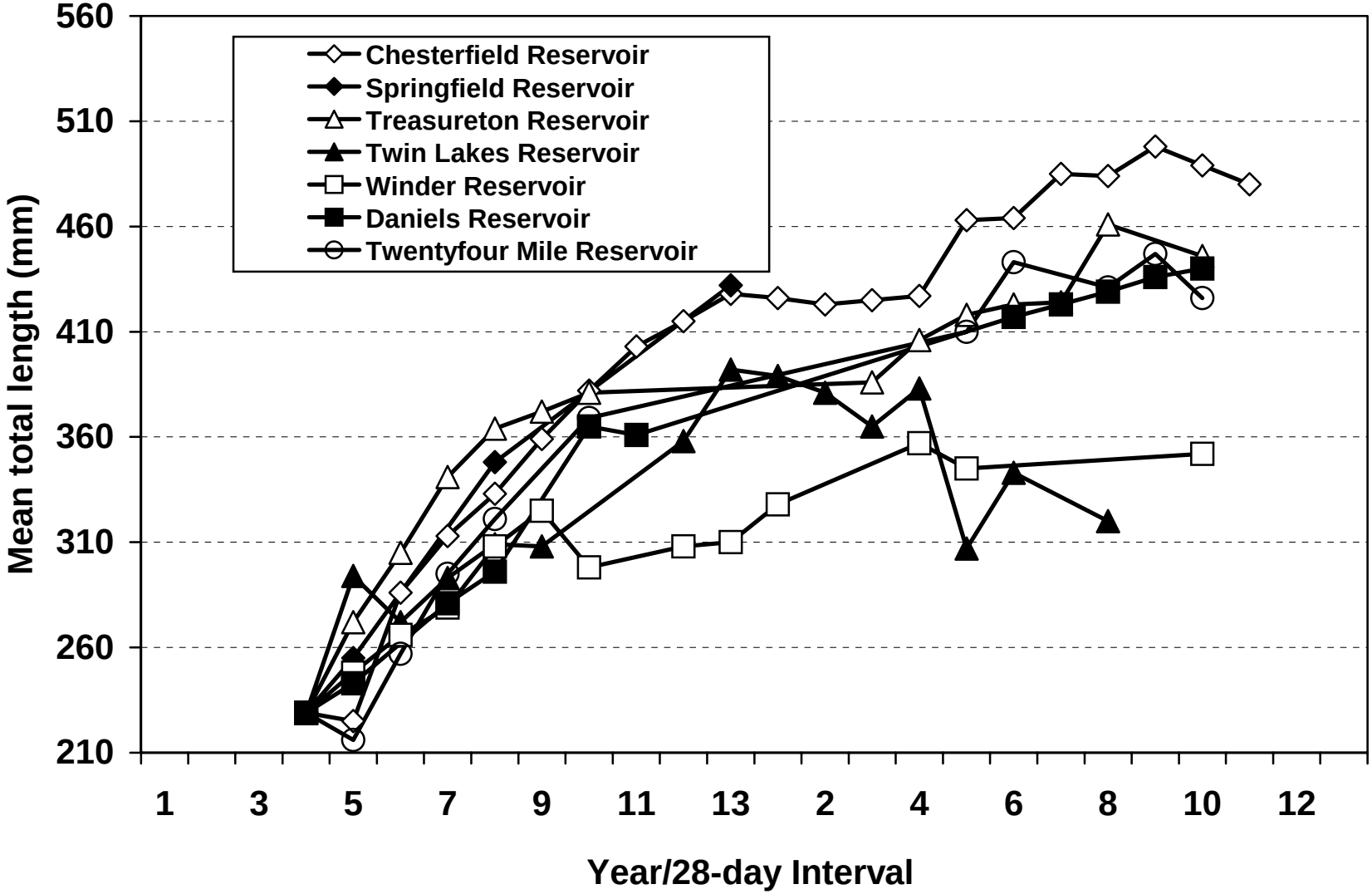
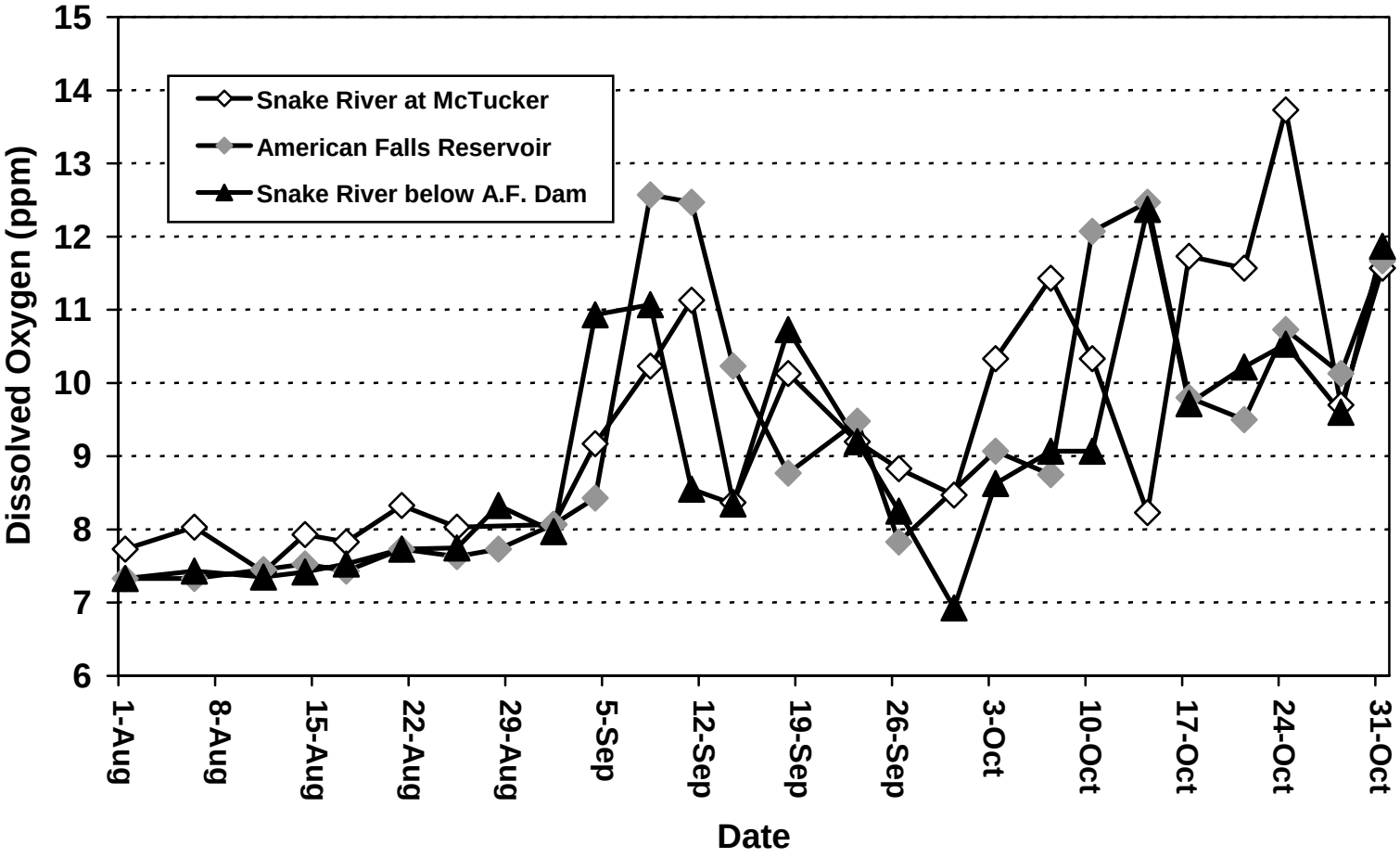


Figure 10. Dissolved oxygen concentrations at the head of American Falls Reservoir, ID (Snake River at McTucker), in the reservoir near the dam and in the Snake River below the dam, early August through late October 1994.



Surface water temperatures were warmest the beginning of August and consistently trended downward through October. Temperatures August 1, 1994 at McTucker landing, lower reservoir and Snake River below the dam were 22°C, 24°C and 23.5°C, respectively. During late September, when reservoir volume was at its lowest, temperatures were near 12°C at all three locations (Figure 11). Temperatures below 20°C when dissolved oxygen levels are above 6 mg/l are considered to be good trout habitat. Trout habitat, as influenced by these two parameters, was adequate for the 1994 period of study (with marginally high water temperatures in early August).

We monitored turbidity at the three locations from August 16 through October 24, 1994. For each daily sample, nephelometric turbidity units (NTU) were always lowest at the McTucker site at the head of American Falls Reservoir. This site was considered to indicate the background level of turbidity. Levels of turbidity higher than the McTucker site recorded in the reservoir and in the river below the reservoir were attributed to the presence and operation of the reservoir that altered the main river flow. The NTU ranged from 0.9 to 2.0 at McTucker. Lowest recorded values in the reservoir and river below were 12 and 15 NTU, respectively. Additionally, the lowest values occurred early when reservoir volume was greatest. The NTU values increased to a recorded high of 412 in the reservoir and 210 in the river below the dam on October 3 (Table 20). The NTU values at both the lower reservoir and the river below were consistently above 40 from September 23 through October 18. The Bureau of Reclamation (BOR) also monitored turbidity and the correlated, suspended sediment during the reservoir-draining event and found similar results. A graph of their results is presented in Appendix C.

The BOR also monitored turbidity as well as the correlated, suspended sediment in the Snake River below American Falls Dam in 1994. The BOR data mirrored the data collected by the state agencies, although their (BOR) peak of turbidity was about half (90 NTU) that recorded by the state. However, the 'true' peak in turbidity may have occurred between their September 30 and October 5 sample dates. Turbidity and sediment levels began climbing after mid-September, increased sharply, peaked near the end of the month, remained high for the first week of October and then slowly decreased to near pre-event levels by October 20, 1994. After American Falls Reservoir reached its lowest volume and volume began to increase, turbidity and suspended sediment in the river below the reservoir remained high for several days.

Idaho Rules and Regulations (Appendix D) provide water quality standards for turbidity whereby a violation is designated should any activity result in a minimum increase of 25 NTU over background levels for ten (10) consecutive days or 50 NTU over background levels instantaneously. The American Falls Reservoir project would have been in violation of the turbidity rules from September 26 through October 11 (Table 20), based on the instantaneous levels exceeding a difference of 50 NTU. It would also have been in violation from September 13 through October 21 by exceeding 25 NTUs above background for more than 10 consecutive days. Water volume in American Falls Reservoir on September 13 was12.2×10^7 m^3. Turbidity began to rise rapidly between September 19 and September 23 when reservoir volumes were 7.51×10^7 m^3 and4.32×10^7 m^3, respectively. However, turbidity remained elevated above violation levels until sometime between October 21 and October 24, at which times volumes were 19.2×10^7 m^3 and 22.2×10^7 m^3, respectively. It appears that once volume decreases below 7.40×10^7 m^3, violations for turbidity will follow. Although it is possible that at greater volumes, similar to the 19.2×10^7 m^3 level of October 21, future violations may occur without any further volume reduction, it just may require more time for the sediment entrainment to

Figure 11. Surface water temperatures at the head of American Falls Reservoir, ID (Snake River at McTucker), in the reservoir near the dam and in the Snake River below the dam, early August through late October 1994.

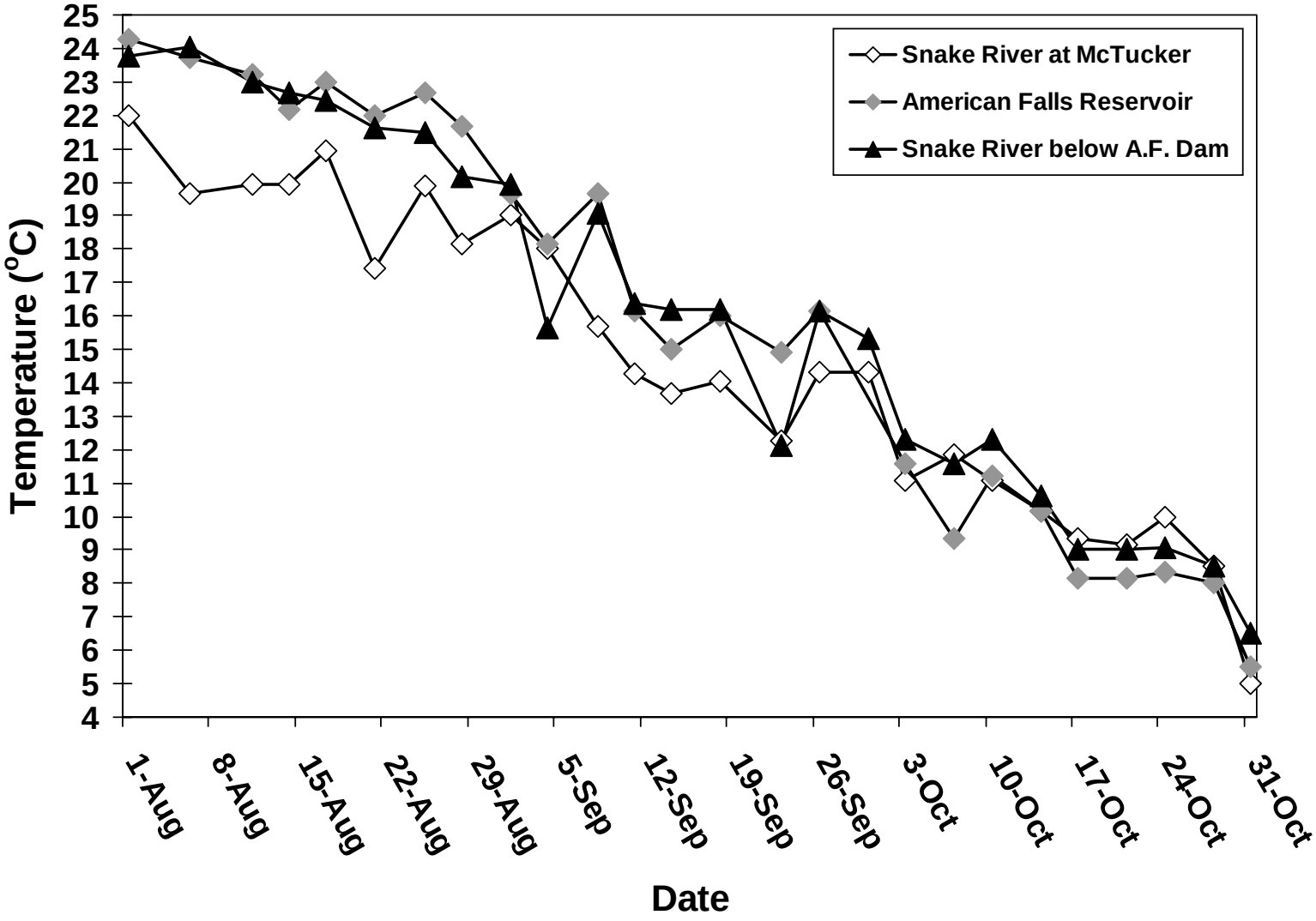


Table 20. Turbidity (NTU) at the head of the American Falls Reservoir, ID, in the reservoir near the dam and below the dam; and volume and percent of reservoir capacity through a major drafting event, mid-summer through early fall 1994.

Date in 1994	Turbidity at head of reservoir	Turbidity near dam	Turbidity below dam	Reservoir volume in acre-feet[a]	Remaining reservoir storage (%)
08-16	1.75	12.00	15.00	263,880	15.5
08-17	1.85	14.00	16.50	260,598	15.3
08-22	1.30	17.50	25.00	228,292	13.4
08-25	1.20	11.40	16.50	212,497	12.5
08-29	1.35	18.00	25.00	188,345	11.1
09-01	1.23	15.50	17.00	174,062	10.2
09-06	1.80	24.75	15.00	146,869	8.6
09-08	1.30	22.25	19.25	135,861	8.0
09-13	1.45	24.25	31.00	98,981	5.8
09-14	0.90	18.25	29.50	87,039	5.1
09-19	0.95	21.25	28.10	60,829	3.6
09-23	1.15	49.00	43.00	34,972	2.1
09-26	1.25	69.00	83.50	23,169	1.4
09-29				17,459	1.0
09-30	2.05		140.00	22,620	1.3
10-03	2.40	412.00	210.00	39,729	2.3
10-07	2.00	163.00	150.00	77,363	4.6
10-11	1.50	41.00	91.50	103,697	6.1
10-14	3.00	68.50	50.00	107,886	6.3
10-18	1.30	48.50	51.75	141,626	8.3
10-21	1.45	50.00	34.00	155,439	9.1
10-24	1.50	19.00	25.50	180,156	10.6

[a] 1 acre-foot=1,233.6 m^3 or 0.12335 hectare-meters

begin at the higher water levels. A letter of February 28, 1995 from the DEQ regional administrator to the BOR stated:

> ”In light of these monitoring results it appears necessary for the BOR to adopt reservoir water management policies and practices which would serve to protect water quality and avoid future violations of these standards.” (Appendix D).”

It appears that in order to prevent water quality violations; BOR should establish a minimum volume at American Falls Reservoir somewhere between 7.40×10^7 m^3 (3.5% of capacity) and 19.7×10^7 m^3 (9.4% of capacity).

A letter of August 16, 1994 from the DEQ administrator to the BOR Regional Director stated the following concerning significance of the state rules and regulations on turbidity:

> "...we recognize the bureau's difficulty trying to meet state water quality standards in face of water releases driven by drought conditions and endangered species. I understand the bureau's operations are governed by congressionally authorized contracts and the federal Endangered Species Act. For the record, however, I do not believe either federal law exempts bureau operations from compliance with state water quality standards adopted pursuant to the federal Clean Water Act. Rather, I believe requirements stemming from the laws in question are all on an equal footing and must be given equal consideration." (Appendix E).

At the time of writing this report, the BOR had taken no action to establish a permanent minimum pool in American Falls Reservoir.

Recommendation--Pursue a minimum pool of 10% of storage capacity, to maintain water quality in the reservoir and the Snake River below and to prevent excessive loss of fish through the dam.

Memorial Day Weekend Interstate 15 Port of Entry Check Station

We checked 819 anglers returning from lakes and reservoirs at the 1994 Memorial Day weekend check station (Table 21). The number of anglers was 17% more than came through the check station in 1992 (Scully et al. 1995). The 1994 anglers fished 5% more hours and caught 80% more fish than in 1992. At the Southeast Region's most heavily fished water, Chesterfield Reservoir, the number of hours fished by anglers who came through the check station increased from 1,030 in 1992 to 1,843 in 1994 (increase of 79%). Catch rate at Chesterfield increased from 0.1 trout/hour to 1.0 trout/hour from 1992 to 1994. Although the first fish restocked in Chesterfield Reservoir after draining in 1992 were 150-mm rainbow trout in September 1992 and 225-mm rainbow trout in May 1993, 400-500 mm trout were well represented in the 1994 Memorial Day weekend catch (Figure 12). The most popular mixed warmwater and trout fisheries in 1994 were Twin Lakes, Johnson and Winder reservoirs.

The 1994 data were summarized separately for Saturday and were combined for Sunday and Monday (Appendix F). We wished to see what portion of the total weekend's data represented the first day, and if it were relatively small as hypothesized, then we would consider surveying only Sunday and Monday in future years. The Sunday and Monday survey obtained 82% of angler data and 89% of fishing hour data.

Oneida Reservoir Walleye

Most of the 83 walleye captured were likely ages 2+ (260-350 mm) and 3+ (390-450 mm). Of the total catch, 12% ranged from 490 to 670 mm and were likely between four and eight years old. No age 1+ walleye were captured and it is unlikely that they would have been in the area with spawning adults (Figure 13). We inserted numbered anchor tags in the 66 walleye that exceeded 300 mm in the sample. A message written on each tag gave the Department's Southeast Region address and stated that the Department would pay $5 for each returned tag.

Table 21. Creel survey statistics of anglers returning from lakes and reservoirs to the Memorial Day weekend check station on Interstate 15 at Inkom, ID.

Lake or reservoir	Number of anglers	Hours fished	Fish caught	Fish caught/h
American Falls	3	3	5	1.0
Bear Lake	15	50	6	0.1
Blackfoot	73	714	170	0.2
Chesterfield	308	1,843	1,896	1.0
Condie	16	38	112	3.0
Daniels	8	235	16	0.7
Deep Creek	14	52	83	1.6
Devils Creek	38	196	140	0.7
Glendale	21	113	110	1.0
Hawkins	105	454	270	0.6
Johnson	29	241	72	0.3
Lamont	3	6	84	14.0
Montpelier	8	19	3	0.2
Oneida	4	18	4	0.2
Pleasantview	6	36	50	1.4
St. Johns	17	71	64	0.9
Treasureton	5	25	190	7.6
24-Mile	7	21	14	0.7
Twin Lakes	45	303	209	0.7
Weston	24	90	320	3.6
Winder	60	221	658	3.0
Wiregrass	10	35	10	0.3
Totals	819	4,572	4,484	

Figure 12. Length frequency of rainbow trout harvested from Chesterfield Reservoir, ID, Memorial Day weekend, 1994.

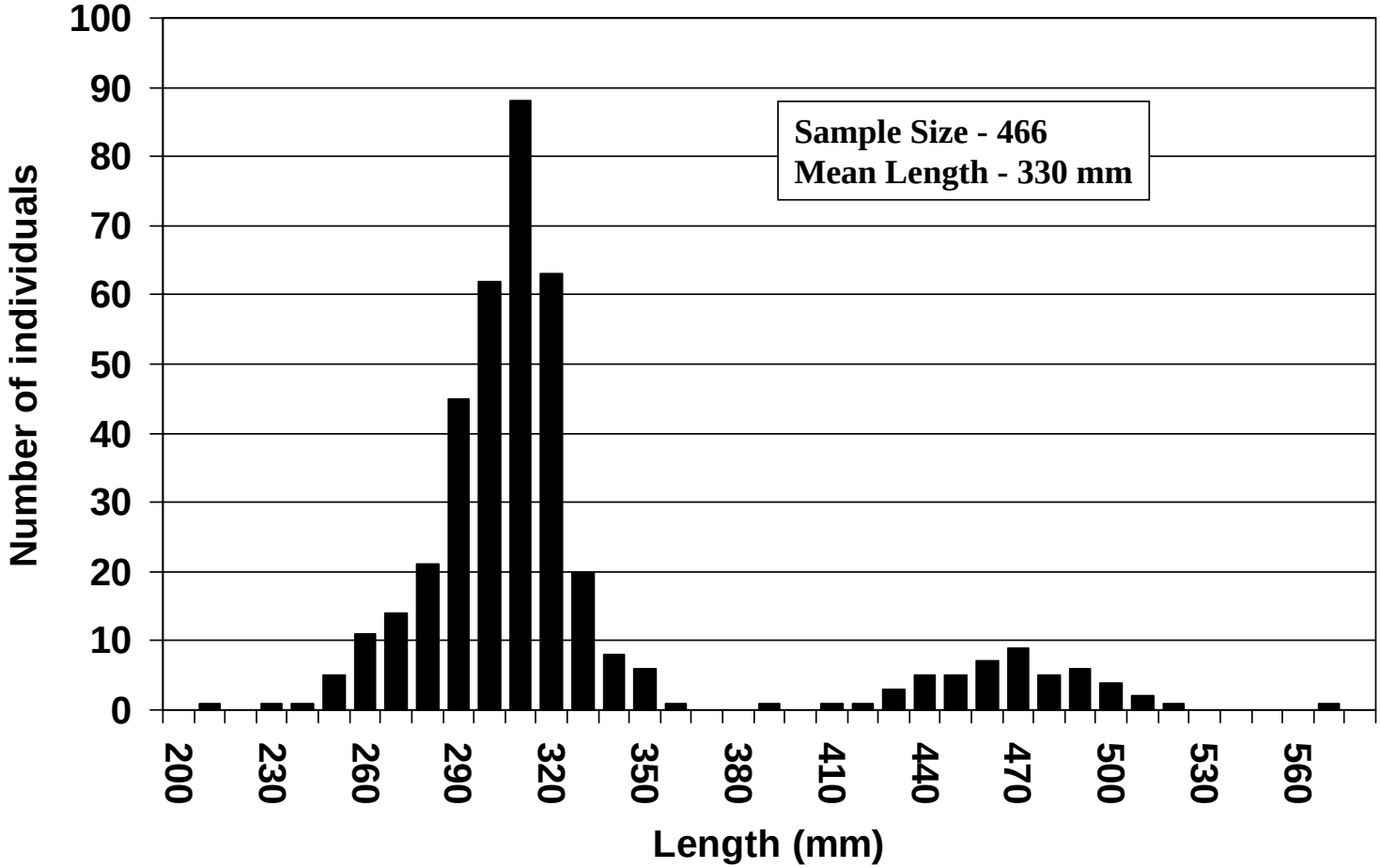
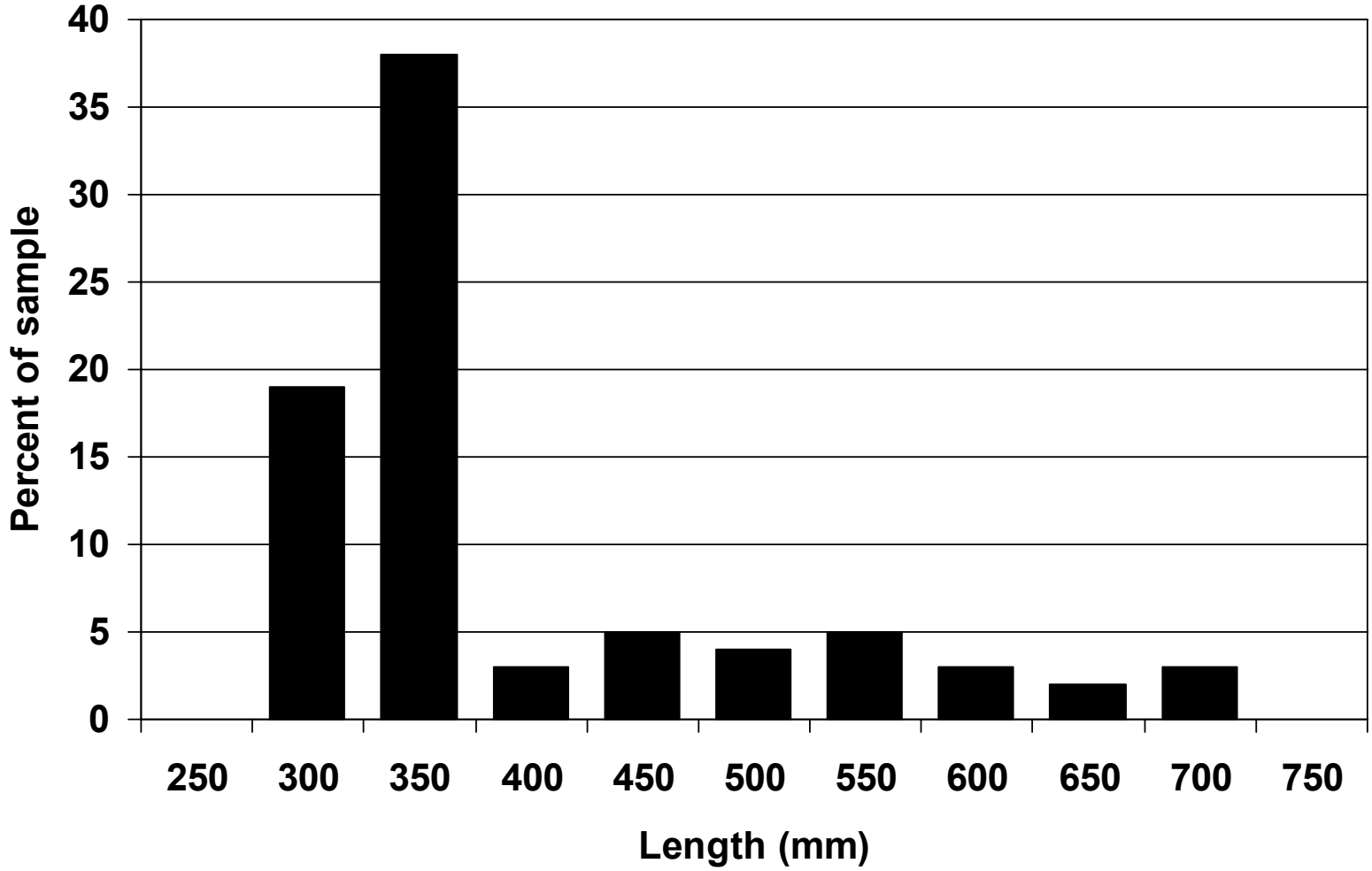


Figure 13. Length frequency distribution of 83 walleye sampled from the head of Oneida Reservoir, ID, March 1994.



Rotenone Renovations

In the spring of 1994, following the mid-winter rotenone renovation, fisheries personnel set several experimental gill nets in Little Valley Reservoir overnight and caught no fish. Little Valley Reservoir was restocked in May 1994 with rainbow trout and Bear Lake cutthroat trout *O. clarki utah*.

In May as the rising water table filled Rose Pond, we restocked the pond with rainbow trout, largemouth bass and bluegill.

Approximately 250 carp and one channel catfish *Ictalurus punctatus* were removed with the McTucker Pond #8 renovation.

We applied 1.5 mg/l of 5% rotenone liquid to Twin Lakes when water volume was reduced to its lowest point at the end of the 1994 irrigation season. Shallow areas were sprayed from an airboat. The renovation revealed that most of the fish biomass in Twin Lakes Reservoir had been adult carp. Very few harvestable size bass or carryover trout were observed. Fish were not restocked at Twin Lakes Reservoir until May 1995.

Department senior research biologist Jeff Dillon measured distances between annuli on scales of 30 bluegill taken from Twin Lakes during the September 1994 rotenone renovation. His analyses of bluegill age and growth are presented in Table 22.

Schill and Heimer (1988) aged bluegill from Twin Lakes in 1987, prior to development of the carp population in that reservoir and at a time when the bluegill fishery was considered good. These authors found what first appeared to be extremely fast growth to the first annulus, then postulated that due to slow growth these fish had failed to form annuli at age 1. Bluegill from most northern populations are less than 50 mm long at the time of first annulus formation (Calhoun 1966). Reconstructing Schill and Heimer's age and growth table but changing what they had written as ages 1-3 to more likely 2-4, the back-calculated ages for bluegill in Twin Lakes Reservoir in 1987 were age 2: 87 mm, age 3: 127 mm and age 4: 156 mm. These average lengths at ages 2, 3 and 4 for bluegill in 1987 were still 24%, 14% and 11% longer than for the same ages of Twin Lakes Reservoir bluegill in 1994. The reduced growth in 1994 was likely due to the effects of high-density carp numbers.

Table 22. Average back-calculated length for each age class of bluegill in Twin Lakes Reservoir, ID, 1988 to 1993.

Year class	Age	N	1	2	3	4	5	6
1993	1	0						
1992	2	0						
1991	3	13	41.5	66.3	99.1			
1990	4	3	37.2	65.4	106.7	126.4		
1989	5	10	37.3	75.1	130.4	145.5	160.9	
1988	6	4	40.4	72.6	110.5	137.4	150.4	171.6
All classes			39.5	70.0	111.8	140.3	157.9	171.6
N		30	30	30	30	17	14	14

LITERATURE CITED

Calhoun, A., Editor. 1966. Inland fisheries management. Page 546. California Department of Fish and Game, Sacramento.

Dillon, J.C., and C.B. Alexander. 1995. Put-and-grow trout evaluations. Idaho Department of Fish and Game, Annual Progress Report, Project F-73-R-17, Boise.

Dillon, J.C., and C.B. Alexander. 1996. Hatchery trout evaluations. Idaho Department of Fish and Game, Job Performance Report, Project F-73-R-18, Boise.

Dillon, J.C., and K.A. Jarcik. 1994. Put-and-grow trout evaluations. Idaho Department of Fish and Game, Job Performance Report, Project F-73-R-16, Boise.

Schill, D.J., and J.T. Heimer 1988. Regional fisheries management investigations. Idaho Department of Fish and Game, 1987 Job Performance Report, Project F-71-R-12, Boise.

Scully, R.J., J. Mende, and M. Arms. 1993. Regional fisheries management investigations. Idaho Department of Fish and Game, 1991 Job Performance Report, Project F-71-R-16, Boise.

Scully, R.J., J. Mende, and M. Arms. In press. Regional fisheries management investigations. Idaho Department of Fish and Game, 1993 Job Performance Report, Project F-71-R-18, Boise.

Scully, R.J., J. Mende, M. Arms, and S. Wright. 1995. Regional fisheries management investigations. Idaho Department of Fish and Game, 1992 Job Performance Report, Project F-71-R-17, Boise.

APPENDICES

Appendix A-1. Number and weight of all cohorts of trout stocked into Chesterfield Reservoir, ID, 1992 through 1994.

Cohort name	Date stocked	Number stocked	Kilograms stocked	Mean weight (g)	Mean length (mm)
Fall 1992 (F92) fingerling rainbow trout	09/29/92	134,995	6,226	46	161
Fall 1992 (BF92) fingerling brown trout	10/02/92	4,596	178	39	152
Spring 1993 (C93) catchable rainbow trout	05/04/93	39,995	4,491	112	225
Fall 1993 (F93) fingerling rainbow trout	09/20/93	129,850	5,557	43	150
Fall 1993 (BF93) fingerling brown trout	10/18/93	1,020	39	38	150
Spring 1994 (C94) catchable rainbow trout	05/05/94	40,005	5,185	130	229
Fall 1994 (F94) fingerling rainbow trout	09/29/94	134,994	5,275	39	152

Appendix A-2. Number and weight of all cohorts of trout stocked into Treasureton Reservoir, ID, 1993 and 1994.

Cohort name	Date stocked	Number stocked	Kilograms stocked	Mean weight (g)	Mean length (mm)
Spring 1993 (C93) catchable rainbow trout	05/06/93	16,002	1,746	109	225
Fall 1993 (F93) fingerling rainbow trout	09/21/93	54,060	2,043	38	150
Spring 1994 (C94) catchable rainbow trout	05/04/94	1,788	232	130	229
Fall 1994 (F94) fingerling rainbow trout	09/29/94	6,030	268	44	152

Appendix A-3. Number and weight of all cohorts of trout stocked into Springfield Reservoir, ID, 1992 through 1994.

Cohort name	Date stocked	Number stocked	Kilograms stocked	Mean weight (g)	Mean length (mm)
		3,070	634		
	02/18/92	2,001	303	206	265
Spring 1992 (C92)	05/22/92	1,680	272	151	239
catchable rainbow trout	06/04/92	6,754	1,209	162	244
Fall 1992 (F92) fingerling rainbow trout	10/02/92	25,008	1,089	44	158
Spring 1993 (C93) catchable rainbow trout	05/05/93	8,500	976	115	225
Fall 1993 (F93) fingerling rainbow trout	09/21/93	28,885	1,202	42	165
Spring 1994 (C94) catchable rainbow trout	05/06/94	8,505	1,102	130	229
Fall 1994 (F94) fingerling rainbow trout	not stocked				

Appendix A-4. Number and weight of all cohorts of trout stocked into Twin Lakes Reservoir, ID, 1992 through 1994.

Cohort name	Date stocked	Number stocked	Kilograms stocked	Mean weight (g)	Mean length (mm)
Spring 1992 (C92) catchable rainbow trout	05/07/92	11,076	1,769	160	244
Fall 1992 (F92) fingerling rainbow trout	09/28/92	37,630	1,782	47	163
Spring 1993 (C93) catchable rainbow trout	05/04/93	11,141	1,247	113	229
Fall 1993 (F93) fingerling rainbow trout	09/21/93	37,637	1,388	38	152
Spring 1994 (C94) catchable rainbow trout	05/05/94	11,148	1,445	130	229
Fall 1994 (F94) fingerling rainbow trout	not stocked				

Appendix A-5. Number and weight of all cohorts of trout stocked into Winder Reservoir, ID, 1992 through 1994.

Cohort name	Date stocked	Number stocked	Kilograms stocked	Mean weight (g)	Mean length (mm)
Spring 1992 (C92) catchable rainbow trout	05/07/92	13,187	2,053	156	242
Fall 1992 (F92) fingerling rainbow trout	09/29/92	9,944	450	45	162
Spring 1993 (C93) catchable rainbow trout	05/08/93	2,349	263	112	229
Fall 1993 (F93) fingerling rainbow trout	09/21/93	6,450	195	30	127
Spring 1994 (C94) catchable rainbow trout	05/05/94	2,350	305	130	229
Fall 1994 (C94) fingerling rainbow trout	09/24/94	7,930	352	44	152

Appendix A-6. Number and weight of all cohorts of trout stocked into Daniels Reservoir, ID, 1992 through 1994.

Cohort Name	Date stocked	Number stocked	Kilograms stocked	Mean weight (g)	Mean length (mm)
Spring 1992 (C92) catchable rainbow trout	03/31/92	4,690	390	80	196
Fall 1992 (F92) fingerling rainbow trout	09/28/92	15,829	742	50	163
Spring 1993 (C93) catchable rainbow trout	05/07/93	4,688	511	110	229
Fall 1993 (F93) fingerling rainbow trout	10/25/93	15,951	461	30	127
Spring 1994 (C94) catchable rainbow trout	05/05/94	4,690	608	130	229
Fall 1994 (F94) fingerling rainbow trout	09/28/94	15,820	704	45	152

Appendix A-7. Number and weight of all cohorts of trout stocked into Twentyfour Mile Reservoir, ID, from 1992 through 1994.

Cohort name	Date stocked	Number stocked	Kilograms stocked	Mean weight (g)	Mean length (mm)
Spring 1992 (C92) catchable rainbow trout	05/07/92	1,136[a]	181	160	244
Fall 1992 (F92) fingerling rainbow trout	09/28/92	1,859	87	47	160
Spring 1993 (C93) catchable rainbow trout	05/12/93	550	59	113	229
Fall 1993 (F93) fingerling rainbow trout	09/22/93	1,860	68	38	152
Spring 1994 (C94) catchable rainbow trout	05/03/94	550	71	129	229
Fall 1994 (F94) fingerling rainbow trout	09/27/94	1,860	83	45	152

[a] The C92 cohort was accidentally stocked at twice the planned number.

Appendix B. Memorandum to Al Van Vooren and Jeff Dillon on Springfield Reservoir, Idaho, bird predation.

State of Idaho
Department of Fish and Game
Region 5, Pocatello

MEMORANDUM August 24, 1994

From: Dick Scully
To: Al Van Vooren, Jeff Dillon

Subject: Springfield Reservoir - bird predation

Fisheries Research and Southeast Region management with assistance from Wildlife Research evaluated the effects of piscivorous birds on the hatchery trout fishery at 66 acre Springfield Reservoir in Bingham County. Nine inch long rainbow trout stocked the first week of May, 1994 at 129/acre (8,500 fish), disappeared from the reservoir prior to the Memorial Day weekend. Jeff Dillon was unable to find any of these fish during an electrofishing survey the first week of June. Angry anglers have accused the Department of not stocking any fish. Anglers and local residents said that 200-300 "large black birds" (probably double-crested cormorants) concentrated on the water within a week of the stocking date and stayed for several days. A number of white pelicans also worked with the cormorants.

In order to learn what happens to trout when stocked in Springfield Reservoir, American Falls Hatchery stocked another 8,500 trout on June 6. They were marked with an adipose fin-clip to identify them. The evening of June 6 two cormorants were observed at Springfield Reservoir and on the evening of June 7 only one cormorant was observed. On June 8, Larry Monsen, a local resident called the Department to report that he counted 10 pelicans and 30 to 40 cormorants at Springfield Reservoir. On June 9 a maximum of 102 cormorants and 13 pelicans were counted. Marsha Reeder, who manages a bar/restaurant near Springfield Reservoir called in mid-afternoon to say that there were 20 pelicans and at least 25 cormorants on the reservoir that she could see from her restaurant. That evening Mr. Monsen called to say that "cormorants and pelicans had the water boiling that morning and that 10 pairs of pelicans had arrived at dusk and appeared to be feeding in the reservoir at night. On June 10 peak counts were 182 cormorants, 24 pelicans and 9 Great Blue Herons.

The evening of June 11 between 6:30 and 8:30 pm one cormorant was observed. On the morning of June 12 between 8:00 and 10:00 am, a peak of 35 cormorants and 10 pelicans were observed.

The evening of June 13, fisheries research personnel electrofished Springfield Reservoir extensively to obtain an density index of the trout stocked on June 6. Several chubs were seen along with five adult suckers in the main inlet area. Only five trout were seen of which two were successfully netted and examined. Both were the freshly stocked adipose-clipped trout. It appeared that most of the

newly stocked trout were already gone.

On June 14, a peak of 139 cormorants were observed. However they arrived at 6:45 am and were gone again by 7:30 am. During most of the observation period from 5:50 am to 11:40 am there were less than 10 cormorants. The observer noted that no birds were seen eating fish all morning. On June 16 Springfield Reservoir was observed from 5:30 am to 11:40 am. Most of the time there were less than 5 cormorants on the reservoir. The peak number was 28 cormorants and 4 pelicans at 7:30 am. Again, no birds were seen eating fish all morning. Another observer, made a count at 3:00 pm and saw 9 cormorants and 1 pelican.

The evening of June 16, fisheries research personnel set gillnets in Springfield Reservoir and retrieved them the morning of June 17. The large meshes of the experimental gillnets were rolled up to prevent capture of large hold-over trout. The catch contained one of the May stocked trout, none of the June stocked trout and six unmarked trout. The nets also contained 129 chubs, eight to 10 inches long and 28 suckers. Creel checks in the outlet stream revealed none of the 1994 reservoir stocked trout in anglers catch, and very little fishing effort. Twenty cormorants were observed on Springfield Reservoir on June 17 at 8:00 am.

Table 1. Bird observations after trout were stocked on June 6, 1994

Date	Time Interval	Peak Counts Cormorants	Pelicans	Herons
06/06	1700-2000	2	0	0
06/07	1800 (one count)	1	0	0
06/08	0830 (one count)	30-40	20	0
06/09	0515-1245	102	13	4
	1620 (One count)	25	20	0
	2100		20	
06/10	0525-1238	182	24	9
06/11	1930-2100	1	0	1
06/12	0800-1000	35	10	4
06/14	0550-1138	139	2	3
	1500 (one count)	9	1	0
06/16	0530-1140	28	4	2
	1455-1634	9	1	0
06/17	0800 (one-count)	20		

***Observations were made by several Fisheries Management employees with single counts or multiple counts over through a one to two hour interval. Incidental counts were also made by local residents. Andy Lindbloom of Wildlife Research dedicated four complete work days to obtain

piscivorous bird counts. Andy arrived early in the morning on four days and made repeated counts for several hours through the peak morning feeding period. Andy's counts provide the best information, demonstrating that cormorant counts quickly rose to over 100 birds within three days of fish stocking and dropped off to only 28 by the tenth day after stocking. His observations on the latter two observation days that the birds were not catching fish was consistent with what Jeff Dillon's fishery research crew found in both electrofishing and gillnet samples. We were unable to get estimates of feeding frequency and number of fish caught by individual cormorants. Cormorants fed in flocks and several would be under the water at once, often coming back to the water surface at unpredictable locations within the flock.

Avian piscivory studies indicate that cormorants and pelicans eat approximately 1.5 and 3.5 lbs of fish/day, respectively. Rainbow trout stocked in May at Springfield Reservoir weighted about 0.3 lbs each. One study estimated that 88% of rainbow trout stocked in May at 5.5 inches were gone by October with no other significant sources of mortality besides avian predation.

We had hoped that the trout stocked June 6 at Springfield Reservoir would survive bird predation better than those stocked May 6 and there were reasons to believe that this would occur. There was much more submerged vegetation where fish could hide in June than in May. Also, the headwaters of American Falls Reservoir, which is about 4 miles from Springfield Reservoir had become shallower (and fish more concentrated) do to irrigation withdrawals, so there were more feeding opportunities for piscivorous birds in the Springfield area in June.

My conclusion from the above information is that predaceous birds, mostly double-crested cormorants, removed nearly all the rainbow trout catchables stocked in Springfield Reservoir in May and June of 1994. Reasons for this might include:

1. the nearness of 66 acre Springfield Reservoir to 56,000 acre American Falls Reservoir which may support a large number of cormorants throughout the spring and summer months.

2. the high density of fish stocked, making predation very easy.

3. The timing, i.e., after cormorants have migrated to their summer habitat but at a time when nearby reservoirs and rivers are near their fullest and therefore fish density is at its lowest.

4. The shallowness of Springfield Reservoir. Because of sedimentation from irrigation canal breaches in the past,

Springfield reservoir bottom is covered with several feet of silt. Most of the reservoir is less than 10 feet deep.

Additionally, it appears that cormorants selectively feed on freshly stocked rainbow trout. Gillnet catches 10 days after the last batch of trout were stocked, found almost none of the freshly stocked trout, but an abundance of chubs of the same size as the freshly stocked trout. Additionally, once the trout were nearly gone, the cormorants begin to abandon Springfield Reservoir, even though there still were plenty of chubs to eat.

Future Management Options

1. Begin stocking catchable size trout as soon as a trout-food source is available in the spring, and prior to the arrival of cormorants.

2. Stock trout more often but in smaller batches during the spring-summer cormorant season.

3. Try alternate species that are associate more with the reservoir bottom rather than with mid-water column or the surface. Perhaps brown trout, brook trout or brook trout -lake trout hybrids.

4. Stock fewer but larger trout. Minimum size should be 14" (and I am not sure if this is large enough to escape cormorant predation).

5. Work with landowners and the Department of Water Resources to raise the elevation of Springfield Reservoir dam.

6. Provide cracker shells to local residents to haze cormorants from the reservoir.

Bibliography

Krail, R. 1993. Fish-eating birds and anglers: a table for two? North Dakota Outdoors. April-May 1993. pp 10-13.

McCoy C. 1992. Sea Lions, protected by law are thriving, but at trout's expense. Wall Street Journal (4/3/92). Vol CXXVI No. 66.

Hepworth, D. 1992. Fisheries Management Briefs. Low survival of trout attributed to cormorants. Utah Div. of Wildl. Resources.

Hanebrink, E. and Byrd W. 1987. Predatory birds in relation to aquaculture farming. Aquaculture magazine. March/April 1989. pp. 47-51.

Smothers, R. 1989. Its fish farmers vs. birds and birds are winning. The New York Times National. (11/5/89)

Utah Division of Wildlif Resources. 1989. Assumptions and

calculations for the effects of cormorants, great blue herons, pelicans and loons on the number of Utah chub in Mantua Reservoir.

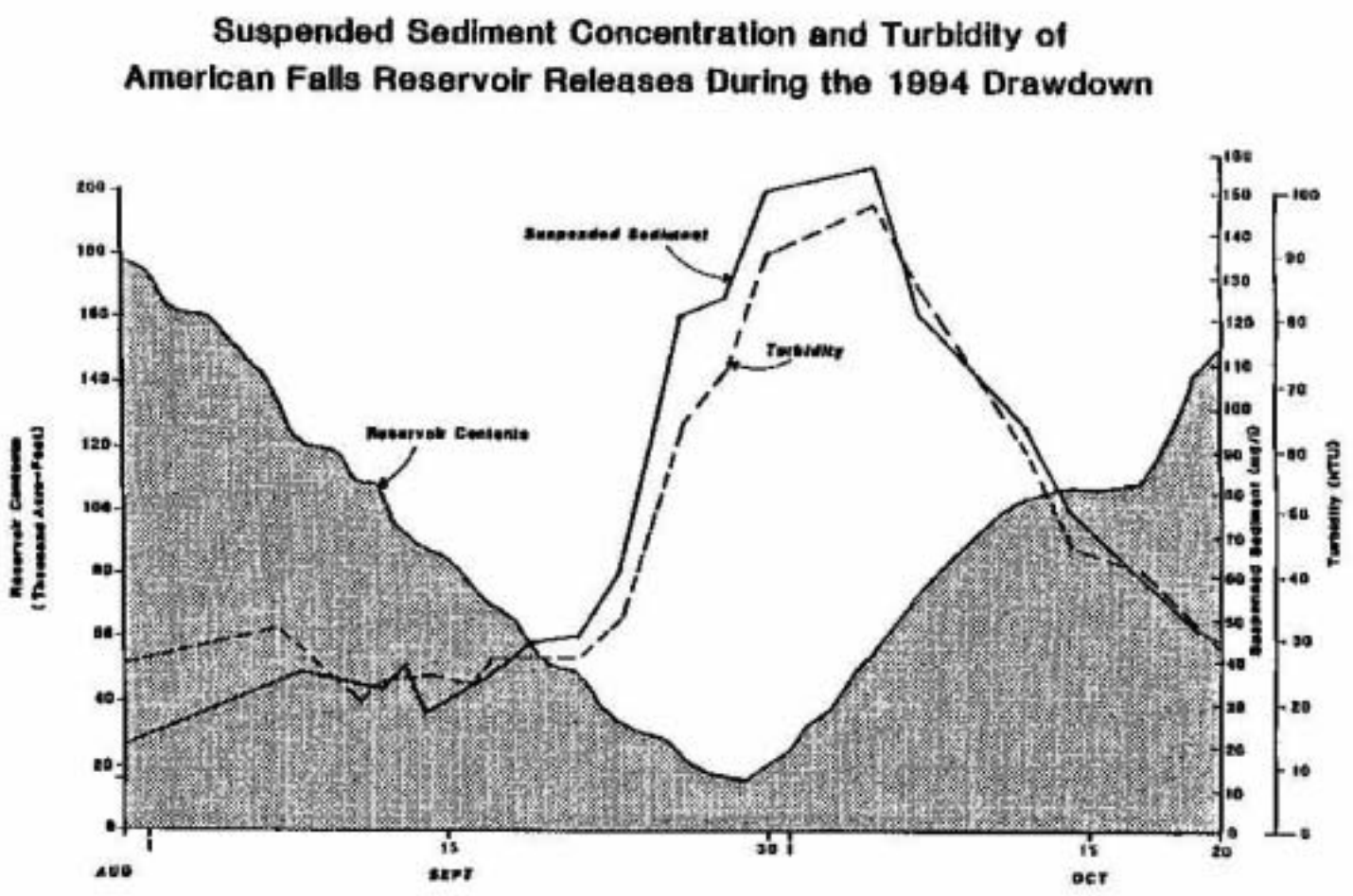
Matkowaski, M.D. 1989. Differential susceptibility of three species of stocked trout to bird predation. North American Journal of Fisheries Management 9:184-187.

Wasowicz, A.F. 1989. Influence of fish and bird predators on the trout population of a southern Utah reservoir. Masters of Science thesis. Utah State University. Logan, UT. 43 p.

Shrader, T.M. 1990. Summary of 1989 Mantua Reservoir fisheries investigations. 36 p.

Pelican, Cormorant and heron piscivory literature review compiled by Inez Hopkins.

Appendix C. U.S. Bureau of Reclamation graph on suspended sediment concentration and turbidity of American Falls Reservoir, Idaho, releases during the 1994 draw down.



Appendix D. February 28, 1995 letter to Karl Wirkus of the U.S. Bureau of Reclamation from the Idaho Division of Environmental Quality.

IDAHO DEPARTMENT
OF HEALTH AND WELFARE
DIVISION OF
ENVIRONMENTAL QUALITY

224 South Arthur, Pocatello, ID 83204-3202, (208) 236-6160

Philip E. Batt, Governor

Mr. Karl Wirkus
U.S. Bureau of Reclamation
1359 Hansen
Burley, Idaho 83318

February 28, 1995

Dear Mr. Wirkus:

In August of 1994 Jerry Conley, Director of the Idaho Department of Fish & Game (IDF&G) drafted a letter to John Keys, Regional Director for the U.S. Bureau of Reclamation in which he expressed his agencies concern with the planned drawdown of the American Falls Reservoir in Power County, Idaho in relation to water quality and beneficial use designations (cold water biota, including fish). He went on to suggest that the BOR initiate efforts to establish a minimum conservation pool for both this and other BOR regulated reservoirs throughout the state. However, at the time no data existed with which to estblish a minimum pool level for the American Falls Reservoir. Subsequently, the reservoir was drained to approximately 22,000 acre feet volume by mid-September.

In response to the need for data this Department, in conjunction with the IDF&G, conducted a joint water quality monitoring program in order to document any detrimental water quality impacts in the reservoir or the Snake River below the dam which might occur as a result of the drawdown. Enclosed with this letter please find copies of both our and BOR data recorded during the time of the 1994 drawdown.

Idaho Rules and Regulations now provide water quality Standards for turbidity whereby a violation is designated should any activity result in a minimum increase of 25 NTU over background levels for ten (10) consecutive days or 50 NTU instantaneously. Both data sets clearly establish that turbidity violations did in fact occur in both the reservoir and the Snake River immediately below the dam as water levels in the reservoir dropped.

The BOR turbidity values recorded at the dam discharge indicate a dramatic rise in turbidity (and associated suspended sediment) beginning at about mid-September as the reservoir pool dropped to approximately 50,000 acre feet and below. The DEQ/IDF&G turbidity data for both in-reservoir and downstream locations clearly reveal the same pattern. It appears that under early summer conditions as encountered in 1994 the residual turbidity levels in the reservoir are approximately 10 to 20 or so NTU's higher than the Snake River inflow as recorded near McTucker Creek. These higher levels are probably due to the natural biological and physical conditions in the reservoir.

Ltr.to Mr. Karl Wirkus frm. DHH/GS/nk re:Am. Falls reservoir A:WirkusMr.Cnt

Appendix D. Continued.

Continued
Mr. Wirkus
Ppg. 2

However, this situation appears to be exacerbated as the reserve pool in the reservoir is reduced, as illustrated by the DEQ/IDF&G in-reservoir turbidity readings from September 19th to September 23rd

The feedback loop is a process defined in the state water quality standards for managing nonpoint source pollution through implementation of best management practices. The evaluation of those practices and subsequent modifications, if necessary, to achieve water quality standards and beneficial use support is the key element of "on the ground" antidegration efforts. This communique is intended to provide the BOR with at least part of the information required to implement and close the feedback loop regarding water quality impacts related to reservoir drawdowns in general and American Falls Reservoir in particular.

In light of these monitoring results it appears necessary for the BOR to adopt reservoir water management policies and practices which would serve to protect water quality and avoid future violations of these standards. To that end, we are open to discussion as to how best to achieve that goal and are looking forward to hearing from you regarding this matter in the near future, prior to the beginning of the next drawdown cycle. We do strongly support any attempts to establish a minimum reservoir pool based on sound science and of course, continued monitoring to document baseline conditions and provide the necessary information on which to base proper management of American Falls Reservoir water reserves. So that we may have a long enough window in which to produce a mutually satisfactory plan, it is imperative that we meet as soon as possible. I would appreciate hearing from you by April 1, 1995 with your response to these concerns.

If you have any questions or need clarification, don't hesitate to call (236-6160) or write.

Thank You
Sincerely,

George Spinner
Regional Administrator

w/enclosures
cc: Walt Poole, DEQ/CO, Boise
Audrey Cole, DEQ/SEIRO
Dave Hull, DEQ/SERIO
Greg Tourtlotte, IDF&G, Pocatello
Matt Nelson, DEQ/EIRO

Ltr.to Mr. Karl Wirkus frm. DRR/GS/sh recdn. Falls reservoir A:WirkusMr.Ont

Appendix E. August 16, 1994 letter to John Keys of the U.S. Bureau of Reclamation from the Idaho Division of Environmental Quality.

IDAHO DEPARTMENT OF HEALTH AND WELFARE
DIVISION OF ENVIRONMENTAL QUALITY

1410 North Hilton, Statehouse Mail, Boise, ID 83720-9000, (208) 334-5882

Cecil D. Andrus, Governor

August 16, 1994

Mr. John Keyes
Regional Director
Bureau of Reclamation
1150 North Curtis Street
Boise, Idaho 83706

Subject: *Relationship of Bureau Operations and State Water Quality Standards*

Dear John:

Thanks to you and your staff for meeting with me, Walt Poole, and Kevin Beaton last week to discuss the relationship between bureau operations and state water quality standards.

As I indicated at that meeting, we recognize the bureau's difficulty trying to meet state water quality standards in face of water releases driven by drought conditions and endangered species. I understand the bureau's operations are governed by congressionally authorized contracts and the federal Endangered Species Act. For the record, however, I do not believe either federal law exempts bureau operations from compliance with state water quality standards adopted pursuant to the federal Clean Water Act. Rather, I believe requirements stemming from the laws in question are all on an equal footing and must be given equal consideration.

DEQ would rather not contest this issue in court or through administrative enforcement action. Nevertheless, it is apparent endangered species concerns will be with us for some time, and drought conditions may continue for some time as well. That suggests to me the bureau and DEQ should work together to develop an operations plan and water quality standards which are compatible and mutually attainable rather than independent or mutually exclusive.

The bureau is about to begin reviewing its operations plan. DEQ needs to update state water quality standards. I would like to suggest we assign staff to develop a specific proposal to undertake the efforts simultaneously and in close consultation with one another. As I mentioned, I will be recuperating from surgery for about a month. However, I would be happy to have Walt Poole and Kevin Beaton work with your staff to develop a proposal you and I could review when I return.

Appendix E. Continued.

I appreciate your continuing personal commitment to protection of Idaho's water quality.

With best wishes.

Sincerely,

JOE NAGEL

Joe Nagel
Administrator

cc: Governor Andrus
Walt Poole
DEQ Regional Administrators
Larry Koenig
Kevin Beaton
Keith Higginson
Andy Brunelle

Appendix F. Memorial Day weekend 1994 catch rate and relative species composition of lakes and reservoirs in southeast Idaho. Data are presented separately for Saturday and combined for Sunday and Monday.

					Catch rate (fish/h)														
	Water	Total anglers	Total hours	Total fish	Total	Trout	Trout release %	RBT	CUT	BRN	BRK	LKT	Total warmwater	Warmwater release %	LMB	BG	YP	WE
Sat.	Blackfoot	7	31	7	0.2	0.2	14	0.2	[a]									
	Chesterfield	65	211	443	2.1	2.1	72	2.1										
	Condie	3	3	17	5.7	3.3	50	3.3					2.4	86		2.4		
	Daniels	2	0.5	0														
	Deep Creek	3	12	39	3.3	2.9	30	2.9										
	Devils Creek	5	20	24	1.2	1.2	100	1.2										
	Glendale	1	5	0														
	Hawkins	37	126	55	0.4	0.4	38	0.4										
	Johnson	3	9	6	0.6	0.2	100	0.2					0.4	75	0.4			
	Lamont	3	6	84	14.0								14.0	48		14.0		
	24 Mile	1	0.5	0														
	Twin Lakes	3	12	19	1.6	1.6	32	1.6										
	St. Johns	5	31	30	1.0	0.3	0	0.3					0.7	57	0.3	0.1	0.3	
	Weston	2	8	26	3.3	1.3	70	1.3					2.0	88	1.2		0.8	
	Winder	11	36	52	1.4	0.1	0	0.1					1.3	88	0.1	1.0	0.2	
Sun & Mon	American Falls	3	3	0														
	Bear Lake	15	50	6	0.1	0.1	67	0.1	[a]									
	Blackfoot	66	683	163	0.2	0.2	28	0.2	[a]									
	Chesterfield	243	1,632	1,453	0.9	0.9	67	0.9										
	Condie	13	35	95	2.7	1.7	0	1.7					1.0	74	0.4	0.6	[a]	
	Daniels	6	23	16	0.7	0.7	100	0.7	[a]									
	Deep Creek	11	40	44	1.1	1.1	36	1.1										
	Devils Creek	33	176	116	0.7	0.7	38	0.6		[a]		[a]						
	Glendale	20	108	110	1.0	0.1	6	0.1					0.9	100	0.9			
	Hawkins	68	328	215	0.7	0.7	34	0.6			[a]							
	Johnson	26	232	66	0.3	0.2	23	0.2					0.1	47	[a]	[a]	[a]	
	Montpelier	8	19	3	0.2	0.2	67	0.2										
	Oneida	4	18	4	0.2								0.2	0			[a]	0.2
	Pleasant View	6	36	50	1.4	1.4	50	1.4										
	St. Johns	12	40	34	0.9	0.3	8	0.3					0.5	100	0.2	0.1	0.2	
	Treasureton	5	25	190	7.6	7.6	100	7.6										
	24 Mile	6	20	14	0.7	0.7	100	0.7										
	Twin Lakes	42	291	190	0.7	0.4	21	0.4					0.3	70	0.1	0.2		
	Weston	22	91	294	3.3	1.1	36	0.7					2.2	92	1.8		0.4	
	Winder	49	185	606	3.3	0.2	31	0.2					3.1	85	0.5	2.4	0.2	
	Wiregrass	10	35	10	0.3	0.3	67	0.3										

[a] Catch rate is <0.1.

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1994 ANNUAL PERFORMANCE REPORT

State of: Idaho | Program: F-71-R-19

Project I: Surveys and Inventories | Subproject I-F: Southeast Region

Job: c | Title: Rivers and Streams Investigations

Contract Period: July 1, 1994 to June 30, 1995

ABSTRACT

Southeast Region fisheries personnel evaluated the benefits of the Area 6 Cutthroat Trout Slot Limit in terms of changes in cutthroat trout *Oncorhynchus clarki* density and size. Due to improved water conditions between the 1991 and 1994 samples, cutthroat trout populations improved in both the experimental and control streams. The only stream in which cutthroat trout *size* increased was the Cub River, and it is suspected that this was because Cub River was larger than the other 11 streams evaluated.

We surveyed anglers during the Memorial Day weekend at a check station on Interstate 15 near Inkom. A smaller percent of surveyed anglers fished on rivers and streams in 1994 (22%) than in 1992 (31%). Waters were higher and less fishable in 1994 and fishing had improved on lakes and reservoirs with increases in water volume in 1993. Catch rates on rivers and streams decreased slightly from 1992 (0.8 fish/h) to 1994 (0.7 fish/h).

An opening day (July 1) fishery monitoring survey was initiated for the upper Blackfoot River in 1994. We interviewed 36 anglers who fished 155 hours and caught 288 trout of which 77% were cutthroat trout. Anglers averaged 1.9 trout/h. Most fish were released because of 18-inch (457 mm) minimum size limit on cutthroat trout. Anglers stated that most of the trout they had caught and released ranged from 12-17 inches (305-432 mm). Surveyed anglers harvested three cutthroat trout that measured between 446 and 490 mm.

Bonneville cutthroat trout *O. clarki utah* density was estimated in two long sections of the Thomas Fork of the Bear River. In the upper section near the Wyoming border, Bonneville cutthroat trout density was 2.0/100 m^2. In the lower reach of the river, cutthroat trout density was only 0.1/100 m^2. Habitat degradation and water diversions are major impediments to cutthroat trout survival in the Thomas Fork.

We salvaged 440 Bonneville cutthroat trout from a section of the Cub River dewatered for irrigation storage. Most of the fish were juveniles, but many were between 200 and 300 mm. We transported the fish several miles upstream from the dewatered section and released them back into the Cub River.

Authors:

Richard Scully
Regional Fishery Manager

James Mende
Regional Fishery Biologist

Marc Arms
Fishery Technician

OBJECTIVES

1. Evaluate benefits of the Area 6 Cutthroat Trout Slot Limit within the Southeast Region based on changes in cutthroat trout density and size distributions between 1991 and 1994.

2. Update Memorial Day weekend trends in catch rate and size of fish caught in Southeast Idaho waters as indexed at the Interstate 15 Port of Entry check station near Inkom.

3. Update July 1 opening day trend in catch rate and size of cutthroat trout *Oncorhynchus clarki* caught in the upper Blackfoot River.

4. Estimate game fish population density and size distribution in upper and lower reaches of the Thomas Fork of the Bear River.

5. Salvage cutthroat trout stranded in a dewatered section of the Cub River in Franklin County.

INTRODUCTION AND METHODS

Cutthroat Trout Slot Limit Evaluation

As a measure to perpetuate wild cutthroat trout populations in the Upper Snake and Southeast regions, the Department initiated the Area 6 Cutthroat Trout Slot Limit in 1990. The cutthroat trout limit on all rivers and streams was reduced from six to two and all cutthroat trout between 8-16 inches had to be released. Angler opposition to the new rule was significant and persistent in the Southeast Region. In response, Southeast Region fisheries personnel initiated an evaluation of the rule and told anglers that we would report the results to them in 1995. If there had been biological benefits we would recommend the rule be continued. If little or no benefits accrued and the public continued to be dissatisfied, we would recommend that less restrictive rules be implemented.

We selected six stream pairs for the evaluation. One stream of each pair continued to be managed with the slot limit while the other stream was returned to a general 6-trout limit in 1992. The exception to this was Rapid Creek, which previous to 1990 had been managed with the wild trout limit of two. Beginning in 1992, Rapid Creek again had the wild trout limit.

In 1991 fisheries personnel backpack electrofished four, approximately 100-m sections of each creek. Two of the four sections were located in the lower reach and the remaining two sections in the upper reach of each creek. All electrofishing was done under mid to late summer base flow conditions. Surface areas and trout population numbers were estimated for each stream section sampled. We estimated trout populations using either a mark-and-recapture or multiple pass population depletion method. The method chosen depended on assumed sampling efficiency of the first electrofishing pass through a section.

Sampling locations selected in 1991 were marked for later identification. The same stream sections were sampled again in 1994, two and one-half growing seasons after fishing rules changed in 1992, which allowed anglers to fish one stream in each pair with the slot limit and one stream in each pair with harvest of any size cutthroat trout. Water levels in streams were low in 1991 and 1992. Streams would have been very fishable but survival of eggs and fry would likely have been reduced. In 1993 stream flows were high. Harvest opportunity would have been low and survival of eggs and fry good. Flows were moderate in 1994 and sampling conditions were good. Conditions in 1993 should have produced numerous age 1+ cutthroat trout for sampling in 1994. If there had been a significant increase in the density of cutthroat trout spawners during 1993 in the slot limit streams, then there should have been a significant increase in age 1+ and older trout in the same streams in 1994.

Sampled stream section dimensions, depth, substrate quality and habitat for each stream section sampled were presented in (Scully et al. 1993). Descriptions of the section locations are on file in the Southeast Region office.

Memorial Day Weekend Interstate 15 Port of Entry Check Station

In 1992 we established a Memorial Day weekend check station at the Interstate 15 Port of Entry near Inkom. All northbound travelers returning from fishing or hunting trips were required to stop. Department personnel, reservists and volunteers asked the occupants of each vehicle where they had fished, how many hours they had fished, how many fish of what species they had caught and how many of each species they had released. Additionally if they had fish in possession, we measured and recorded the lengths of each fish by water where caught. We repeated the survey in 1993 and again in 1994. As the sixth consecutive year of a drought, fishery conditions in 1992 were marginal. Although 1994 was also a drought year, it followed the abundant precipitation year of 1993. The quality of fishing on Memorial Day weekend was largely influenced by water conditions in 1993.

Upper Blackfoot River Opening Day Creel Survey

The upper Blackfoot River was famous for its wild Yellowstone cutthroat trout *O. clarki bouvieri* fishery, especially from the 1940s through the 1960s. The cutthroat trout fishery then entered a period of decline due in part to over fishing, especially in the nursery water of Blackfoot Reservoir, habitat deterioration and finally drought conditions from 1987 through 1992. In 1990, Fisheries Management proposed a plan to restore the upper Blackfoot River and Reservoir fishery. It included prohibition of wild cutthroat trout harvest on Blackfoot Reservoir, and limited harvest of cutthroat trout on the Blackfoot River. Additionally, the Department sought habitat restoration projects and considered artificial spawning of wild fish and release of unfed fry into under-seeded tributaries of the upper Blackfoot River.

As one index of restoration status, the Department began opening day creel surveys in 1994. The surveys will be repeated annually to follow trends in angler numbers, catch rate, size distribution and relative species composition of trout caught and percentage of cutthroat trout caught that are harvested.

A mandatory check station was established near the lower end of the upper Blackfoot River Road and was operated from 9:00 AM until 8:00 PM on July 1, 1994. Anglers arriving at the check station were asked how many hours they had fished the upper Blackfoot River, how many trout of each species they caught and released, and what size their catch had been to the nearest inch. We measured and recorded the length of each harvested trout by species.

Thomas Fork of the Bear River Fish Density Study

The Thomas Fork, Bear River tributary in Bear Lake County, contains wild Bonneville cutthroat trout *O. clarki utah*. This cutthroat trout subspecies was classified as Endangered by the Idaho Department of Fish and Game, a category 2 candidate species for Threatened and Endangered listing by the U.S. Fish and Wildlife Service and Sensitive by the U.S. Forest Service and Bureau of Land Management. Declines in abundance have been attributed to irrigation diversion, impassable diversion structures, livestock grazing in riparian areas, and the recent drought cycle. Angling in the Thomas Fork drainage was discontinued in 1992 in an attempt to reduce total mortality.

The Department has periodically sampled fish populations in the Thomas Fork tributaries of Giraffe, Preuss and Dry creeks since 1979. Cutthroat trout populations in the tributaries have declined dramatically, especially since 1985. The most recent samples taken, in 1993, documented the lowest cutthroat trout densities (Scully et al. In Press).

The U.S. Forest Service constructed a demonstration cattle exclosure on Giraffe Creek in 1979 and on Preuss Creek in 1981. Cutthroat trout density within the exclosures has been slightly higher than outside (Scully et al. In Press), but both areas experienced similar precipitous declines in fish density. Even though cutthroat trout densities are slightly higher in the livestock exclosures, because of improved channel morphology and cover, water temperature extremes and recruitment of sediment from upstream reaches will continue until longer stretches of the streams receive similar protection.

In 1994, two sections of the main stem Thomas Fork were sampled by electrofishing for fish species composition and estimation of trout population density. A Peterson mark and recapture analysis was used to estimate population size within sampled sections. Trout were marked on July 20 and 21 and recaptured on July 28 and 29.

The upper section was 320 m long and located immediately downstream from the Wyoming/Idaho border. The stream reach was narrow and shallow enabling us to collect fish with backpack electrofishing equipment. The longer lower section was sampled with boat-mounted electrofishing equipment because it was too deep to safely wade. The lower section began approximately 8.4 km upstream from the Thomas Fork's mouth and extended 3.86 km downstream.

Cub River Bonneville Cutthroat Trout Salvage

Cub River water rights are for both 'natural flow' and 'storage.' During the irrigation season of April through September the senior rights of natural flow are in effect. During the

non-irrigation season, irrigation companies exercise their storage rights. Storage rights on the Cub River are for a fixed volume of 6,000 acre-feet rather than a flow limit in cubic feet/second as would be defined in a natural flow water right. The state has established no instream water right for fish and wildlife in the Cub River and if it did now, these rights would be junior to existing rights.

At the end of the irrigation season, the Preston-Whitney Irrigation Company dams the Cub River with rock and plastic sheets and in this manner diverts as much as possible of the Cub River flow into their diversion canal near the Moser Camp Ground above the U.S. Forest Service boundary. Through discussions among the company, local residents and the Department, the Company voluntarily releases 2 to 4 cfs of this flow back into the Cub River approximately 100 m downstream from the main diversion. This leaves about 100 m of the Cub River completely dewatered and a flow downstream from this section that is less than 10% of the natural flow. For a distance of about 2 km, until additional flow enters from seeps and small tributaries, trout are stranded in isolated pools. In October 1994, Cub River valley resident Jim Dougherty notified the Department that the Company had dewatered the Cub River and asked that the trout be salvaged and released into reaches of the stream that had not been dewatered.

RESULTS AND DISCUSSION

Cutthroat Trout Slot Limit Evaluation

There were no obvious trends in cutthroat trout density distinguishing streams with the slot limit from those without. Both groups experienced mean density increases from 1991 to 1994. Within the six-creek sample of each treatment, there were individual creeks that had no change or a decrease in cutthroat trout density (Table 1). Mean percent increase in density was 234% for streams with the slot limit and 356% for streams without the slot limit. Approximate 95% confidence limits for the two values were 191% and 267%, respectively. Thus there was much variation in percent density change within treatments and confidence intervals of the two treatments would widely overlap.

The only creeks in the comparison that were relatively large, in the 20 to 40 cfs range, were Cub River and Mink Creek, both tributaries of the Bear River. Cub River is the larger of the two. Among the 12 evaluation streams, cutthroat trout had the greatest likelihood of growing to large size in the two largest streams. At Mink Creek, there was a large decrease in the number of cutthroat trout over 203 mm (8 inches) long in the 1994 sample compared to the 1991 sample, and the percent over 254 mm (10 inches) long also decreased. (However, there was a similar decrease in the number of cutthroat trout seen in Pebble Creek, which kept the slot limit during the evaluation years).

Of the six streams managed with the slot limit, only Cub River appeared to benefit from the more restrictive regulations. Based on adequate sample sizes of cutthroat trout at least 203 mm long (49 in 1991 and 69 in 1994), the percentage of cutthroat trout over 254 mm long increased from 35% to 59% from 1991 to 1994. Also, the percent of cutthroat trout over 305 mm (12 inches) long increased from 7% to 11%. Percent of cutthroat trout over 356 mm (14 inches) long decreased slightly, from 2% to 1% (Figure 1).

Table 1. Trout densities in Idaho Southeast Region cutthroat trout slot-limit evaluation streams during the second year of the rule (1991), which also was the year prior to removing the rule from half the evaluation streams, and three years later in 1994. Values are average number of (age 1+ and older trout)/100 m^2 from four approximately 100-m sections of each stream. The percent of the sample that was cutthroat trout is also presented in parentheses.

Stream	Year	Cutthroat number	-(%)	Wild rainbow	Brook	Brown	Hatchery rainbow	Total trout
Pebble[a]	1991	18.5	(94)	0.2	0.1	0.0	0.8	19.6
	1994	7.9	(92)	0.0	0.0	0.0	0.7	8.6
Rapid[a]	1991	5.6	(88)	0.6	0.0	0.2	0.0	6.4
	1994	38.7	(99)	0.0	0.0	<0.1	0.0	38.8
Montpelier[a]	1991	0.3	(6)	0.3	2.2	2.0	0.2	5.0
	1994	1.1	(3)	0.0	3.7	27.7	0.7	33.2
Georgetown[a]	1991	0.0	(0)	0.0	4.7	0.0	2.2	6.9
	1994	0.0	(0)	0.0	7.3	0.0	2.8	10.1
Cub River[a]	1991	5.3	(61)	0.0	2.5	0.7	0.2	8.7
	1994	8.0	(78)	0.0	2.0	0.0	0.2	10.2
Rawlins[a]	1991	2.2	(100)	0.0	0.0	0.0	0.0	2.2
	1994	15.0	(95)	0.0	0.0	0.0	0.8	15.8
Brush	1991	0.2	(1)	0.0	30.0	0.0	0.0	30.2
	1994	2.8	(9)	0.0	27.6	0.0	0.0	30.4
Toponce	1991	0.0	(0)	7.5	0.0	0.0	0.3	7.8
	1994	0.3	(8)	2.7	0.0	0.0	0.7	3.7
Mink (Portneuf R.)	1991	0.6	(43)	0.0	0.0	0.8	0.0	1.4
	1994	1.4	(9)	0.0	0.0	13.6	0.2	15.2
Bloomington	1991	<0.1	(6)	0.0	1.6	0.0	0.1	1.7
	1994	0.0	(0)	0.0	3.5	0.0	2.9	6.4
Eight Mile	1991	2.3	(12)	0.1	15.9	0.0	0.7	19.0
	1994	0.0	(0)	0.0	11.2	0.0	3.0	14.2
Mink (Bear R.)	1991	2.9	(62)	0.0	1.6	0.2	0.0	4.7
	1994	5.5	(66)	0.0	2.8	0.0	0.0	8.3

[a] Continued to be managed with the cutthroat trout slot limit throughout the study interval.

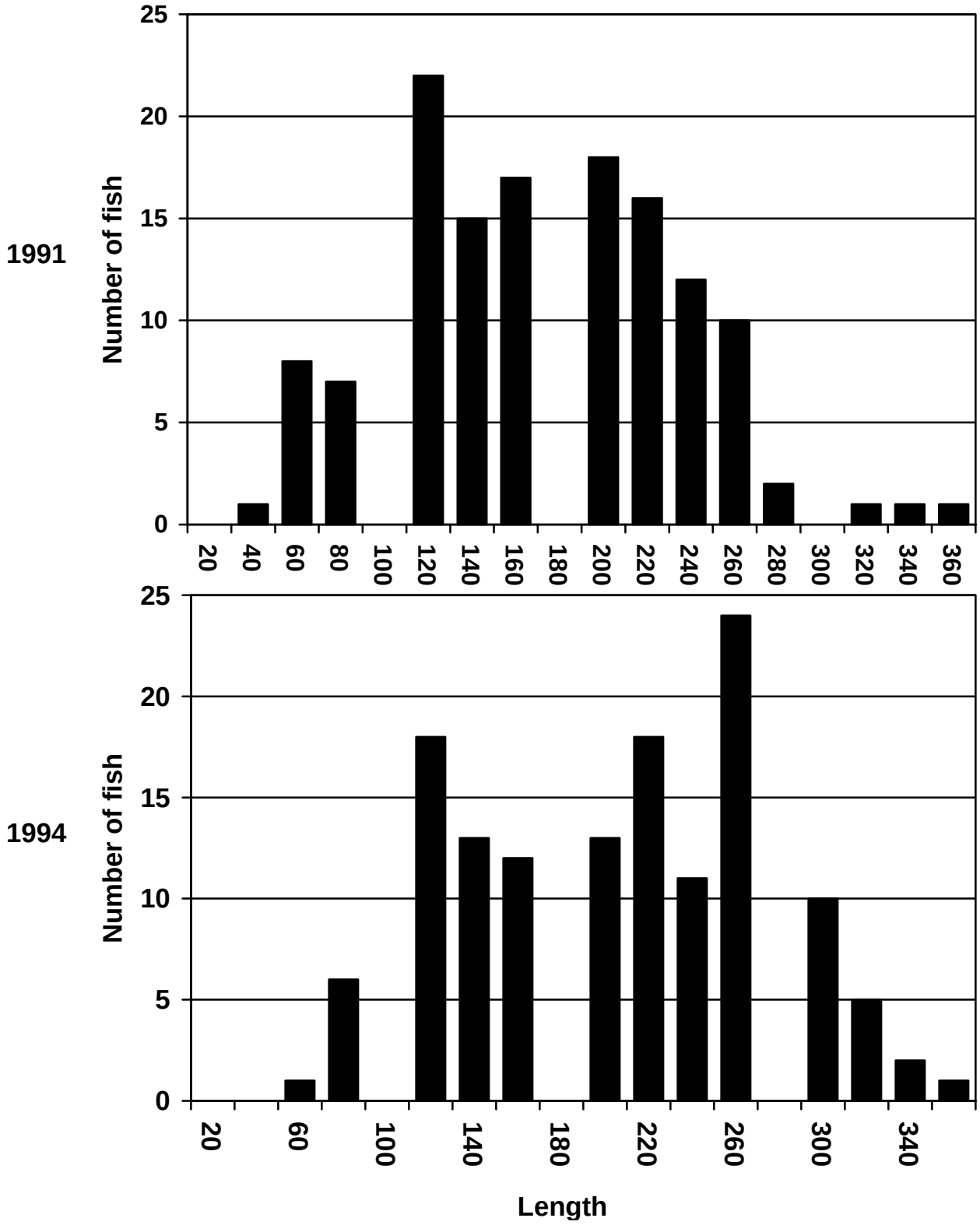

Figure 1. Length frequency distribution of cutthroat trout sampled in Cub River, ID, 1991 and 1994.

Cutthroat trout shared the waters of each of the 12 evaluation streams with other trout and char species. Rainbow trout *O. mykiss* were observed in at least one sample in all evaluation streams except Brush Creek and the Bear River tributary of Mink Creek. At least one of the following three species of rainbow trout, brook trout *Salvelinus fontinalis* and brown trout *Salmo trutta* were found in all 12 evaluation streams.

Our conclusion from the evaluation is that the Area 6 Cutthroat Trout Slot Limit had little if any benefit in terms of increasing cutthroat trout density or age distribution except in the largest stream, the Cub River. Based on this information, anglers may want to discontinue the slot limit in Southeast Idaho. However, since the fish of concern is a native salmonid and stream habitat is generally impaired in Southeast Idaho, anglers may find acceptable a more moderate harvest restriction i.e. a two cutthroat trout limit, with no size restrictions.

Recommendation--Consider fishing regulation options that would provide special protection for native cutthroat trout, but would not be so restrictive as to eliminate all harvest opportunities.

Memorial Day Weekend Interstate 15 Port of Entry Check Station

Although the number of anglers stopping at the check station in 1992 and 1994 was about the same, 1,023 and 1,049 respectively, the percentage of those anglers fishing rivers and streams decreased from 31% in 1992 to 22% in 1994. Improved fishing conditions at area reservoirs (see check station information in Lowland Lakes and Reservoirs section of this report) and increased spring runoff flows in streams may have drawn some anglers away from rivers and streams in 1994.

Anglers at the check station reported fishing at 19 and 17 rivers and streams in 1992 and 1994, respectively. Surveyed anglers fished nine of the same streams in both 1992 and 1994. Average catch rates among the nine streams changed little, being 0.8 trout/hour in 1992 and 0.7 trout/hour in 1994 (Table 2). The species reported in the river and stream catch were rainbow, cutthroat, brown and brook trout. Wild cutthroat trout were reported from the upper Portneuf River, McCoy Creek, Bob Smith Creek, Cottonwood Creek and Rapid Creek. Most of the river and stream catch was made up of hatchery rainbow trout.

Table 2. Comparison of average catch rates for trout caught in nine Idaho rivers and streams during Memorial Day weekend, 1992 and 1994.

Water fished	Trout/hour in 1992	Trout/hour in 1994
8-Mile Creek	0.3	0.7
Bob Smith	0.9	1.7
Cub River	1.3	1.8
Montpelier Creek	2.0	0.2
McCoy Creek	0.3	0.3
Pebble Creek	0.9	0.6
Portneuf River	0.4	0.8
Stump Creek	0.5	0.0
Toponce Creek	0.7	0.5
Means	0.8	0.7

Upper Blackfoot River Opening Day Creel Survey

Thirty-six anglers came through the check station; all but three were Idaho residents. They fished a total of 155 hours and caught 288 trout (1.9 trout/hour) of which 77% were wild cutthroat trout. The remaining catch was made up of 60 rainbow trout and a single brook trout. The Department stocked catchable size rainbow trout in the lower 8 km of the 56-km long river. Only 5 (2%) of the trout caught were harvested. The harvested trout observed at the check station were two rainbow trout, each 375 mm long and three cutthroat trout, 490, 446 and 446 mm long. Although two of the measured cutthroat trout were shorter than the 18-inch (457-mm) minimum legal harvest length, they could have been 18 inches long when caught. Anglers fished an average of 4.3 hours to catch 8 trout or 1.9 trout/hour. Anglers' estimates of the size of cutthroat trout they released were generally in the range of 12-17 inches, with only one cutthroat trout greater than 18 inches long reported released.

Recommendation-- Annually monitor creel survey statistics of the wild cutthroat trout fishery on the July 1 opening day.

Thomas Fork of the Bear River Fish Density Study

Fish species composition in both sections included Bonneville cutthroat trout, mountain whitefish *Prosopium williamsoni*, Utah sucker *Catostomus ardens*, redside shiner *Richardsonius balteatus*, Utah chub *Gila atraria* and sculpins *Cottus sp.* In the upper section, we estimated Bonneville cutthroat trout density to be 1.98 parr/100 m^2 and average size to be 196 mm. Density of mountain whitefish was 3.01 fish/100 m^2.

In the lower section we estimated a Bonneville cutthroat trout density of 0.08 parr/100 m^2. Cutthroat trout from the lower section were larger than those observed in the upper section and averaged 348 mm in length. Cutthroat trout densities less than 4 parr/100 m^2 should be considered poor. Good to excellent population densities of age 1+ and older cutthroat trout should be between 10 and 20 per 100 m^2. Degraded stream channel and riparian habitat, significant diversion of water for irrigation, and irrigation dams which block upstream and at times downstream migration of cutthroat trout are likely causes for the suppressed cutthroat trout population in the Thomas Fork drainage.

We are cautiously optimistic that, with normal or above normal precipitation and improved riparian and stream channel habitat management, Bonneville cutthroat trout populations in the Thomas Fork of the Bear River will begin to recover.

Recommendation--Seek opportunities to improve fish passage, water quantity and riparian habitat restoration.

Cub River Bonneville Cutthroat Trout Salvage

Department personnel and volunteers captured 440 Bonneville cutthroat trout from isolated pools with backpack electrofishing equipment and dip nets. We transferred the fish in water buckets to a fish transport truck, then drove the truck several kilometers upstream and released the trout back into the Cub River. One hundred and three of the salvaged trout were age 0+, $\leq$79 mm long. Most (285) were between 80 and 209 mm with 51 between 210 and 299 mm. Only one salvaged trout was larger than 300 mm (330 mm).

LITERATURE CITED

Scully, R.J., J. Mende and M. Arms. 1993. Regional fisheries management investigations. Idaho Department of Fish and Game, 1991 Job Performance Report, Project F-71-R-16, Boise.

Scully, R.J., J. Mende and M. Arms. In Press. Regional fisheries management investigations. Idaho Department of Fish and Game, 1993 Job Performance Report, Project F-71-R-18, Boise.

1994 ANNUAL PERFORMANCE REPORT

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Project II: Technical Guidance

Subproject II-F: Southeast Region

Contract Period: July 1, 1994 to June 30, 1995

ABSTRACT

We reviewed proposals and provided written and verbal comments on activities influencing fish and anglers. We coordinated with personnel of various agencies on hydropower, mining, road building, stream alteration, grazing allotments, National Pollution Discharge and Elimination System permits, fill/excavation, and other projects. The Southeast Region fisheries personnel worked with anglers in the region to improve rapport and open more channels of communication with agencies and the public.

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1994 ANNUAL PERFORMANCE REPORT

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Project III: Habitat Management | Subproject III-F: Southeast Region

Contract Period: July 1, 1994 to June 30, 1995

ABSTRACT

In 1992, the eight McTucker Ponds were renovated with rotenone to remove undesired species that had entered the system during high spring flows from the adjacent Snake River. After renovation, six of the eight ponds were stocked with largemouth bass *Micropterus salmoides*, bluegill *Lepomis macrochirus*, and channel catfish *Ictalurus punctatus*. We collected donated Christmas trees from the community and with the help of volunteers and reservists used them to create new bass and bluegill habitat in four of the McTucker Ponds.

We fenced riparian areas on St. Charles Creek and the upper Portneuf River. We also planted willows on both of the waters. We also applied for and received a $38,000 Section 319 Clean Water Act grant to restore a 4-mile section of Marsh Creek.

American Fisheries Society volunteers conducted stream channel and riparian zone habitat surveys on a section of the upper Blackfoot River and its tributary, Diamond Creek. Both the sections were on Idaho Department of Lands property. Habitat was generally in badly degraded condition in both sections.

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INTRODUCTION AND METHODS

McTucker Ponds Fishery Development

The eight McTucker Ponds were renovated with rotenone in 1992. Six of the eight ponds were restocked with largemouth bass *Micropterus salmoides*, bluegill *Lepomis macrochirus* and channel catfish *Ictalurus punctatus* in 1993. The deepest pond (#8) was restocked with rainbow trout *Oncorhynchus mykiss*. Levees around pond #7 are insufficient in height and water from McTucker Creek frequently contaminates the pond. Therefore pond #7 was not restocked.

The bass and bluegill introduced were broodstock to initiate self-sustaining populations. Although bass stocked were only about 200 mm long, they did spawn in the spring of 1993, as evidenced by numerous schools of bass fry in McTucker ponds later that summer (observation). Channel catfish were stocked at 200 mm and were intended to establish a put-and-grow fishery. The rainbow trout were stocked at 225-250 mm and were intended as a put-and-take fishery.

We asked Pocatello residents to deposit their used Christmas trees at the Fish and Game office in Pocatello for use in creating fish habitat. Fish and Game Department personnel, reservists and volunteers transported the trees to the McTucker area in February 1994 and drug them out onto the ice-covered ponds. Trees were tied into groups of six and weighted with cinder blocks. On ponds #1, #3, #4 and #6 we positioned 24, 22, 12 and 8 clumps, respectively. Each clump would cover about 14 m^2 and should initially provide cover for about 10 adult bass.

Riparian Habitat Improvement

Portneuf River

The upper Portneuf River, from the downstream end of the Portneuf-Marsh Valley Canal Company's 'outlet canal' below Chesterfield Reservoir downstream to the mouth of Pebble Creek, was historically a high quality rainbow trout and cutthroat trout *O. clarki* fishery. The Friends of the Portneuf (FOP) and the Department initiated riparian fencing projects in sections of the 6.4-km long reach as early as 1987. Buck-and-rail fences were constructed on properties belonging to Cohen Croney, Beth Call, Donna Rae Maybey and the Milward family.

In 1991, the Department established an agreement with the King Creek Grazing Association. In exchange for providing a stock-watering well approximately 0.8 km upland from the river, the Association would permit construction and maintenance of a livestock exclusion, riparian corridor fence along the Association's approximately 3.2-km stretch of the Portneuf River. In 1993, the FOP was awarded a Section 319 of the Clean Water Act grant for fence construction and materials costs. In 1994 the FOP and the Department worked together to complete a post-and-rail fence on the Association's property and to replace a non-functional buck-and-rail fence with a new electric fence on the approximately 0.8 km Maybey property.

Marsh Creek

In 1994, regional fishery personnel applied for and received a $38,000 Section 319 grant for construction of a riparian corridor fence along 4.8 km of Marsh Creek on the Arimo Ranch. The fence was constructed in 1995. The Arimo Ranch fence project included an experiment to evaluate effectiveness of several riparian plant community restoration methods including planting individual willow stems, vertical willow bundles and, horizontal willow bundles. The project also included installation of hawthorn and choke cherry revetments. Alternate sections of the Arimo Ranch reach of Marsh Creek now have the instream habitat treatments. Sections between treatment areas were allowed to recover naturally. In addition to the instream treatments, livestock were excluded (corridor fences) from about 40% of the Arimo Ranch reach of Marsh Creek. The animals were allowed to graze the remaining 60% under riparian pasture technology as a method for riparian restoration. The Department and the Natural Resource Conservation Service are working together to monitor effectiveness of the fence, instream projects and riparian pasture system.

St. Charles Creek and Little Malad River

Department personnel, Natural Resources Conservation Service personnel, Friends of the Portneuf members and volunteers, and Department reservists cut and planted approximately 3,000 willows along the little arm of St. Charles Creek. They also cut and planted 1,000 willows along the Little Malad Creek headwater spring and 1,300 willows along the upper Portneuf River in 1994. All plantings were an attempt to protect the waterways from erosive forces. Along lower St. Charles Creek, Department personnel built a riparian corridor, electric fence to protect the planted willows from livestock and to encourage natural colonization of riparian plants. We had intended to construct a riparian corridor fence on the Little Malad River springs, but the landowner wanted to apply herbicides and graze horses within the proposed corridor. Consequently, we abandoned the proposed fencing project. Willows planted on the upper Portneuf River were within the riparian corridor created with the Friends of the Portneuf's Section 319 fence project.

Upper Blackfoot River State Land Riparian and Stream Bed Health Survey

American Fisheries Society (Idaho Chapter) volunteers surveyed a section of the upper Blackfoot River and its tributary, Diamond Creek to assess stream health and to provide those interested in managing streams on State Lands with examples of methods, time needed, and values of assessing management impacts on streams. A calibrated ocular estimation was used (Colin et al. 1992). One person of a two-person crew estimated dimensions and other parameters of the survey. At predetermined intervals, the parameters were measured. The estimates were mathematically compared to the measurements and the estimates were then converted (calibrated) to most likely values. An advantage of this system is that most transect data can be estimated, and the accuracy of the estimates can be enhanced with the calibration process. This allows survey data to be collected more rapidly. The surveyors sampled relatively large stream and river sections (at least 800 m) to reduce bias in habitat selection. Sampling methods are listed in Appendix A.

RESULTS AND DISCUSSION

Upper Blackfoot River State Land Riparian and Stream Bed Health Survey

Blackfoot River Reach

Surveyors began at the point where the Blackfoot River enters the northern boundary of Section 16 (Township 7S, Range 44E). The survey continued downstream approximately 869 m. The Blackfoot River in this reach is a C-channel type (Rosgen 1994a). The river is slightly entrenched, low gradient, meandering, and has a fairly high width-depth ratio, i.e., it is shallow (Table 1). The river section had a high sinuosity (1.6) and a low gradient (<2%).

Table 1. The factors used to determine the broad channel types on the surveyed reach of the Idaho State Land section of the upper Blackfoot River.

Bankfull width	Average bankfull depth (m)	Maximum bankfull depth (m)	Flood-prone width (m)	Entrenchment ratio (FPW/BFW)	Width-depth ratio	Channel type
47	2.1	4.2	>200	>4 (slight)	24	C
32	2.0	3.6	>200	>6 (slight)	16	C
45	NA	NA	>200	>4 (slight)	NA	C

The particle size classes of the substrate were estimated for riffles and pool tails. These are stream areas that may be used by cutthroat trout for spawning and ideally should not accumulate fine sediment during low flow. A comparison of measured and estimated values determined that estimated percent of fines in the substrate were 178% less than actual (measured) values and thus estimates of percent substrate as larger particles were too high. After calibration, fines comprised 75% of the substrate and the remaining 25% was comprised of medium-size gravel. The dominant particle size (D50) was less than 8 mm, and was likely to be less than 1 mm, for although not measured, surveyors' recollections and photographs attest to the large quantity of very fine material in the substrate.

Using the D50, the surveyors further classified the channel type in the surveyed section as C6. A C6 river is rated as 'very high' in its sensitivity to disturbance, has good recovery potential, high stream bank erosion potential, and is rated as 'very high' relative to the importance vegetation plays in controlling width-depth ratios and stability (Rosgen 1994b). The surveyors sampled approximately 869 m or 90% of the State Land river reach. Along the riverbanks, only 6% of the lengths were undercut to a depth of at least 0.15 m. The deepest undercut measured 0.2 m. This is extremely low, but expected considering the lack of bank

stability and the sensitivity of this channel type. Fallau (1993) found 80% of banks undercut in low gradient channels within livestock exclosures on streams with similar land types approximately 50 km away. Undercut banks provide excellent cover for fish, and overhead cover exerts a strong influence on trout carrying capacity (Bjornn and Reiser 1991).

Pool and riffle habitat comprised 88% and 12% of the surveyed reach, respectively. The low percentage of riffles may limit fish production because riffles typically are the food producing areas of a river (Hunter 1991). The extremely high percentage of fine sediment in this river section (76%) will also tend to produce fewer of the invertebrate prey items that trout prefer (Furniss et al. 1991). The high level of fine sediments (76%) in riffles and pool tails will likely eliminate embryo survival if trout spawn in this river section (Bjornn and Reiser 1991).

Two of the seven possible pool types were found in this river section, i.e., glides and lateral scour pools. Glides are shallow and slightly faster flowing than typical pools, but are deeper and slower than riffles. Glides accounted for 22% of the pools. Lateral scour pools are created by the force of water scouring the outside bend of the stream, and are expected in C-type channels. The average of the maximum residual pool depth was greater than 0.9 m in the lateral scour pools, which is deep enough to provide trout cover. Lateral scour pools accounted for 78% of the pools. The large amount of fine sediment in the riffles and pool tails provides a basis for concern that accumulated sediments may degrade pools, i.e. pool filling.

In this survey, banks were considered stable if all the following features were absent:

1. Breakdown--obvious blocks of banks broken away and lying adjacent to the bank source.

2. Slumping--bank has slipped down, cracks may or may not be obvious, but the slump feature is obvious.

3. Fracture--a crack is visible on the bank indicating that the block of the bank is about to slump or move into the stream.

4. Vertical and eroding--the bank is mostly uncovered as defined below and the bank angle is steeper than 80° from the horizontal.

Following the criteria of Bauer and Burton (1993), 51% of the banks surveyed were considered stable. The cumulative effect of nearly half the stream banks being unstable significantly degrades this river section and the trout habitat downstream. Livestock grazing and chemical herbicide application have removed the vegetation necessary to stabilize stream banks and trap sediments. Cattle heavily used one 2.5-m high bank reach in this section and there was no vegetation present. This 60-m long, eroding bank likely contributed several cubic meters of sediment to the river substrate annually. Vegetation traps sediments by reducing water velocity over inundated banks, and causes suspended sediments to settle and rebuild banks. When cattle graze on unstable banks, erosion from trampling and bank crumbling occurs. Deeply rooted plants, such as willow and sedges, are essential to stabilize and rebuild banks (Platts 1991).

During the winter of 1994-1995, the Idaho Department of Fish and Game purchased the Revee Stocking Ranch on the upper Blackfoot River. The ranch renamed the Blackfoot River Wildlife Management Area (WMA). The ranch contains approximately 10 km of the upper

Blackfoot River and includes the State Land section surveyed in 1994. Land management goals changed and livestock grazing was not authorized on the WMA from 1995 through 1997. Any possible grazing in the foreseeable future will not likely be in the riparian zone. We now have the opportunity to see how rapidly and to what degree riparian and substrate changes will occur after cessation of livestock grazing. We anticipate that without livestock grazing, the river section should recover to a condition approximately 90% vegetated and with stable banks, which is similar to conditions observed by Fallau (1993) in the nearby Bear River drainage cattle exclosures.

Diamond Creek Reach

Approximately 4 km upstream from the surveyed Blackfoot River section is another State Land section that contains a reach of the Blackfoot River tributary, Diamond Creek. We began the Diamond Creek survey at the State Land property boundary and the north end of Section 36 (Township 7S, Range 44E). The survey continued upstream 998 m, covering about two-thirds of the State Land section stream reach. The upstream endpoint can be identified as the point perpendicular to the first power pole on the south side of Diamond Creek Road.

Channel types in the Diamond Creek reach were primarily F and C (Table 2). The F-channel in this section of Diamond Creek is partially due to the obvious straightening of the stream that occurred in the past (see USDA-FS aerial photo #890-107). Sinuosity was <1.1 and gradient was <2%.

As with the Blackfoot River section, substrate particle size information was collected for riffles and pool tails only. Calibration measurements showed that the estimator underestimated fines by 195% and tended to overestimate the coarse gravel and cobble size classes. After calibration, the fines comprised 34% of the substrate, sand <1%, gravels (fine through coarse) 59%, small cobble 8% and large cobble <1% (Table 3). Over 80% of the substrate particles were less than 3.0 mm in diameter, small enough to smother buried trout eggs. The dominant particle size (D50) was around 3 mm; thus, the major stream types of the Diamond Creek reach are F4 and C4. Table 4 displays the management interpretation of these stream types. Sensitivities to disturbance are very high (C4) to extreme (F4), recovery potential is good (C4) and poor (F4), stream bank erosion potential is very high and the degree to which vegetation is a controlling influence is moderate (F4) and very high (C4).

The extent of F channel type in the section is alarming. In this geographic region poor stream and riparian management practices typically form F channel types. The channel type occurs after or during disturbance and may require major actions to return it to a productive fishery.

It is expected and, to some degree, known that this section of Diamond Creek was once very sinuous, not nearly as wide, much deeper (low width-depth ratio), slower (due to less slope), and a productive trout fishery. This scenario describes the evolution to an E channel type. Due to disturbance, a continual adjustment of the stream has occurred. Rosgen (1994a) describes the evolution of a channel that is adjusting to disturbance. Diamond Creek, in this section, is now in C4 and F4 channel types. Fish habitat quality has deteriorated. The narrowing of floodplains and the lowering of the water table also reduce riparian habitat and forage for wildlife and livestock.

Table 2. Factors used in determining the broad channel types on the surveyed reach of the Idaho State Land section of the upper Blackfoot River. The F-channel types may not fit perfectly into the classification because of channel straightening. The six cross-sections listed were evenly spread across the surveyed section.

Bankfull width	Average bankfull depth (m)	Maximum bankfull depth (m)	Flood-prone width (m)	Entrench-ment ratio (FPW/BFW)	Width-depth ratio	Channel type
26	1.01	1.2	30	1.15 entrenched	25-high	F*
28	0.94	2.2	36	1.28 entrenched	30-high	F*
29	0.83	1.3	34	1.17 entrenched	35-high	F*
18	1.16	2.0	24	1.33 entrenched	15-moderate	F*
18	1.28	2.2	25	1.39 entrenched	14-moderate	F*
25	1.04	1.9	54	2.16 slight entrenched	24-high	C*

* See last page of Appendix A, channel type diagram.

Table 3. Substrate particle size classes in riffles and pool tails of sample reach of Diamond Creek, ID. The combined totals from the six measured cross-sections are shown as well as the calibrated estimates for the entire surveyed area.

	Silt/clay	Sand	Fine gravel	Medium gravel	Coarse gravel	Small cobble	Large cobble
Size in cm	fines	<0.2	0.2-0.7	0.8-2.9	3.0-6.5	6.6-12.9	13-16
Calibrated percents	34	<1	24	22	13	8	<1

Table 4. Management interpretations of the stream types identified in the surveyed reach of Diamond Creek, ID.

Stream type	Sensitivity to disturbance	Recovery potential	Stream bank erosion potential	Vegetation controlling influence
C4	very high	good	very high	very high
F4	extreme	poor	very high	moderate

Along the stream length surveyed, 3% of the banks had developed undercuts; the deepest undercut was 0.3 m. This is an extremely small percent, yet expected considering the channel types involved and the present lack of bank stability. Similar streams undisturbed by livestock and not mechanically straightened may have as much as 75% undercut banks (Fallau 1993). Undercut banks provide excellent cover for fish and the overhead bank cover exerts a strong influence on trout carrying capacity in small streams (Wesche et al. 1987).

Pools and riffles each comprised about 50% of the surveyed portion of Diamond Creek. This ratio should provide adequate amounts of resting/rearing habitat (pools) and food producing/spawning habitat (riffles). Residual pool depth (depth of pools when flow is theoretically dropped to the point where water is not flowing in or out of the pools) is used to quantify pool depths so that the survey can be repeated at various flow rates and still be comparable. Of the 26 pools in the surveyed section, the deepest residual pool depth was 0.9 m and only two pools had residual depth greater than 0.6 m.

Fish use some pool types preferentially over other pool types. Therefore, pools were categorized into seven possible types: lateral scour pools, beaver dammed pools, pools formed by other dams, plunge pools, mid-channel pools, under scour pools and glides. Only three pool types were found in the categorization of this portion of Diamond Creek: glides (19%), lateral scour pools (35%) and mid-channel pools (46%). The reach is not very diverse and lacks pools that are deep enough to provide cover relative to other reaches (Brassfield 1992).

This Diamond Creek reach lacked cover. Logs and boulders are not expected here because of the shrub and herbaceous nature of the riparian area, adjacent upland vegetation, and geology of the region. The absence of undercut banks, deep pools and over-hanging vegetation, is a function of past management practices (grazing, herbicide application and channel straightening) and ongoing grazing practices.

Abundant fine sediments within riffles lower their quality. Riffles produce the majority of invertebrates that trout rely on for food (Hunter 1991). Riffles with large quantities of fine sediment, like those surveyed in the Diamond Creek reach, produce fewer and less desirable prey for trout.

In the Diamond Creek survey, banks were considered stable if they were vegetated and were not showing signs of instability from the water level to the estimated bankfull stage [bankfull = the height to which the water level will reach 2 out of 3 years (Rosgen 1994b)]. This method of estimating bank stability substantially underestimates the potential erosion during flows that exceed the bankfull stage. In future surveys, we recommend using the methods described by Bauer and Burton (1993).

Using the methods described by Rosgen (1994b), 67% of the left bank (facing upstream) and 79% of the right bank were considered stable. Combining averages, 73% of the banks were classified as stable. Even under this very liberal estimate (relative to calling banks stable when in fact they may not be), greater than one-quarter of the banks are considered to be in an unstable condition. In an undisturbed setting (very light or no grazing, no channel straightening, etc.) under similar climatic and geologic conditions, there should be less than 10% unstable banks (Fallau 1993).

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LITERATURE CITED

Bauer, S.B. and T.A. Burton. 1993. Monitoring protocols to evaluate water quality effects of grazing management on western rangeland streams. Pages 96-107. EPA 910/R-93-017. U.S. Environmental Protection Agency, Seattle, WA.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. in Meehan, W. R. ed. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitat. American Fisheries Society, Bethesda, MD.

Brassfield, R. 1992. Diamond Creek aquatic habitat survey. Soda Springs Ranger District, Caribou National Forest, Soda Springs, ID.

Collin, T. M., A. H. Windward, D. Duff and H. Forsgren. 1992. Integrated Riparian Evaluation Guide. USDA Forest Service, Intermountain Region, Ogden, UT.

Fallau, S. 1993. Biological evaluation of the Bonneville cutthroat trout and fine spotted cutthroat trout for the Montpelier-Elk Valley cattle and horse grazing allotment. Montpelier Ranger District, Caribou National Forest, Montpelier, ID.

Furniss, M. J., T. D. Roelofs and C. S. Yee. 1991. Road construction and maintenance. in Meehan, W. R., ed. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitat. American Fisheries Society, Bethesda, MD.

Hankin, D.G. and G.H. Reeves. 1989. Visual methods for estimating fish abundance and habitat areas in small streams. Northwest Experiment Station, Corvallis. OR.

Hunter, C.J. 1991. Better trout habitat: a guide to stream restoration and management. Page 318. Montana Land Reliance, Island Press, Washington, D. C.

Platts, W. S. 1991. Livestock grazing. in Meehan, W. R., ed. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitat. American Fisheries Society, Bethesda, MD.

Rosgen, D.L. 1994a. A classification of natural rivers. Catena 22(3): 169-199.

Rosgen, D.L. 1994b. Applied fluvial geomorphology. Page 400. Wildland Hydrology Consultants, Pagosa Springs, CO.

Wesche, T.A., C.M. Goertler, and C.B. Frye. 1987. Contribution of riparian vegetation to trout cover in small streams. North American Journal of Fisheries Management 7:151-153

APPENDICES

Appendix A. Riparian assessment methods.

Methods

Unless otherwise noted, these are the Methods for the stream surveys on the Soda Springs R.D.

The 1992 Integrated Riparian Evaluation Guide (IREG) was used as a reference. The Calibrated Ocular Estimation Survey (IREG, pg.25) was used as the data collection method. Appendix H of the IREG explains the general methods used. Exceptions to this method are noted below.

Observer/Recorder: One person was the observer throughout the length of the survey to maintain consistency. This person made all the estimations and most of the measurements. Measurements on every 10th estimated sample could not be concealed from the observer as recommended by Hankin and Reeves (1989). This could effect the consistency of estimates and the accuracy of the "correction factor" that correlates estimated with measured dimensions

Measured units: Every tenth unit was measured. Measurement pattern (ie. riffles were measured at 6, 16, 26, 36,...) was randomly selected by randomly selecting a single digit number at the beginning of the project.

Sequence #: Refer to IREG p.H-3

Habitat Type: Refer to Refer to IREG p.H-3

Length: Thalweg length. Estimated on every wet unit, and measured on every 10th unit. Dry channel lengths were measured with a hip-chain.

Ave. Width: Width was measured three times and averaged. Once at 1/4, 1/2, and 3/4 through the unit.

Ave. Depth: Measured to the nearest tenth of an inch below 3 feet and nearest 1/2 foot above 3 feet. A total of nine measurements are taken, three spaced evenly at each spot width was measured. Zeros, for the edges were not put into the equation.

Max. Depth: Deepest spot, measured.

Percent of Bank Length Stable: The percent of the bank length that does not show tension cracking, shearing, or slumping was estimated. This included the banks at bankful width. Estimates were made for right and left banks separately.

Percent of Bank Length Vegetated: Bare or essentially bare ground is considered unvegetated. Sparse annuals that would have little effect on bank stability was also considered unvegetated.

Undercut Banks: Length (parallel with bank) and width (perpendicular to bank) of undercut banks were measured with a rod.

Max. Pool Tail Crest Depth: Depth measured at the point the pool would drain out if it were filled just beyond its capacity.

Appendix A. Continued.

Substrates: Percent of the surface of the stream bed that is occupied by each substrate class (Sand/Silt <0.1", Gravel 0.1"-3", Cobble 3"-6", Small Boulders 6"-12", Boulders >12", and Bedrock). Pebble counts at each Nth unit are used to help verify the estimates precision. Particle size was recorded for approximately 50 sample points spaced evenly across width transect lines.

On Measured Only:

Average Bankful Width: The width during an average high water event. This measurement was difficult to measure in many units due to low, gradually sloping banks.

Maximum Bankful Depth: Measured the estimated maximum depth during an average high water event. This measurement was difficult to measure in many units due to low, gradually sloping banks.

Embeddedness: Randomly select enough 1' diameter sample sites to get about 50 total samples. At each site, observe the embeddedness percentage on gravel, cobble, or small boulders. Observed the embeddedness of all the particles that are visible from the surface, not just the top few. Refer to Wolman (1954).

Comments: Comments are meant to explain anomalies, discussions with locals, fish observed, photos, reference points, and any other characteristics.

Measurements Not Collected

Percent of Cover in Pools by Type: Not measured. Information gathered in this column for Stump Creek (1991) showed that most pools were beaver dams and contained very little cover. Undercut banks and percent of bank length vegetated was collected and these could be correlated with pool cover.

Bank Length Steep: Bank stability identifies bank steepness concerns.

Shape of Bankful Channel: This information appeared to be similar, rectangular and trapaziodal, throughout Stump Creek. Diamond Cr. appears similar.

Shore Depths: Not collected. Undercut banks would account for shore depths greater than 0.

Appendix A. Continued.

Level III Riparian-Aquatic Calibrated Ocular Estimation Survey

INTRODUCTION

As noted in the Integrated Riparian Evaluation Guide, issues driving the Level III riparian evaluation should be used to determine the specific type of aquatic community habitat evaluation to be conducted. The calibrated ocular estimation (COE) survey approach described by Hankin and Reeves (1989) will typically be used where quantitative information on existing and potential aquatic community habitat conditions are needed.

This Appendix describes a recommended core set of habitat attributes that are useful when employing a COE survey to meet Level III complex characterization objectives. A corresponding data form is included in Appendix A. Explanation of data entries and sample protocols follows in the next section.

This Appendix also describes a set of other habitat attributes which may be appropriate to characterize a complex in a given ecological setting or to address specific monitoring or evaluation objectives. A standard protocol for evaluating each attribute is suggested.

LEVEL III RIPARIAN/AQUATIC COMPLEX CHARACTERIZATION

Data are collected on the entire length of stream within a riparian complex (and frequently for the set of complexes within a watershed). For each riparian complex, the following information should be documented to characterize the complex. Letters and numbers correspond to data entries on the Level III Riparian/Aquatic Data Sheet for Complex Characterization.

LOCATOR DATA

A. **Forest:** Use two digit numerical code for Forest, if defined, otherwise spell out the Forest name.

B. **District:** Use two digit numerical or alpha-numerical code for Ranger District, if defined, otherwise spell out the District name.

C. **Stream:** Spell out the stream name as it appears on the topographic map.

D. **Catalog Number:** Enter the Stream Catalog number per Region 4 Handbook Supplement 2609.23.

E. **Complex Name:** Enter the name of the riparian complex.

F. **Complex Number:** Enter the unique complex identification number (see instructions for Level II Integrated Riparian Evaluation Guide).

G. **Complex Location:** Identify the range, township, and section that contains the lower bound of the riparian complex being evaluated. Include the name of the quad sheet containing the lower boundary of the complex.

SAMPLE INFORMATION

H. **Survey Date(s):** Identify the date or dates the inventory was conducted. Dates are to be entered as Month/Day/Year.

I. **Unit of Measure**: Indicate if the units of measure are reported in feet (ft) or meters (m).

J. **Estimator**: List the name of the person on the inventory team making visual estimates of dimensions.

K. **Recorder**: List the name of the person taking and recording measurements of dimensions on a sub-set of habitat units.

L. **Measure Dimensions at every "N"th: Riffle/Glide/Pool/Side Channel**: Visually estimated dimensions are calibrated using measurements of the same dimensions at a stratified random subset of habitat units. "n" equals the sample interval at which the various aquatic habitat types are measured. Measurements should be taken frequently enough so that at least 10 habitat units of each type are measured per complex. If habitat units in the stream are relatively large, a higher portion of total units will need to be measured to meet this criteria (e.g., sample 1 of every 3-5 units). If habitat units are relatively small, which is often the case in small streams with abundant structure, a smaller portion of total units will need to be measured to meet this criteria (e.g., sample 1 of every 20 units). **(NOTE: If stream length within a complex is relatively short, it may not be feasible or desirable to measure at least 10 habitat units of each type. This will pose no significant analysis problem if other complexes in the watershed are also being characterized.)** The first habitat unit to be measured (for each type) is determined randomly by the throw of a die.

M. **Measure Substrate at every "N"th: Riffle/Glide/Pool/Side Channel**: Substrate composition is measured using a pebble counting technique at a stratified random subset of habitat units. "N" equals the sample interval at which substrate composition is measured.

COMPLEX SCALE DATA

N. **Gradient**: Channel gradient is measured to the nearest 0.5 percent over one or more stream meander cycles within the complex.

O. **Sinuosity**: The ratio of stream length to valley length to the nearest 0.1, as measured over one or more stream meander cycles within the complex.

P. **Confinement**: Channel confinement is defined as the ratio of floodplain width to bankfull width. Confined (Cnf) = <1.5; Moderate/Partial (Mod) = 1.2-2.5; Unconfined (UnC) = >2.5.

Q. **Discharge**: Measure discharge at the time of survey to the nearest cubic foot per second (cfs).

R. **Flow Stage**: Select the term that best reflects the flow stage at the time of the survey. Bankfull (BkF); Mid-flow and rising (MFr); Mid-flow and falling (MFf); Base-flow (BsF).

S. **Alkalinity**: As measured (to the nearest 0.5 mg/l) in the field at the time of the survey.

T. **Temperature/Time**: Measure water temperature periodically through the day while conducting the inventory. It is desirable to take temperature measurements above each major tributary. At a minimum, temperature measurements should be taken in the morning, at mid-day, and in the late afternoon. In the blank space below the Temperature/Time entry, identify the natural sequence number of the habitat unit the measurement was taken in.

AQUATIC COMMUNITY HABITAT UNIT ATTRIBUTE DATA (CORE SET)

Aquatic habitat units are the basic sample unit of the calibrated ocular estimation survey approach. Three basic aquatic habitat unit types are recognized: "riffle," "glide," and "pool." In some instances "side channel" may be recognized as a fourth aquatic habitat unit type.

In general the COE survey approach gathers data by estimating habitat attribute values at all units and accurately measuring the same attributes at a sub-set of units to develop (via correlation analysis) a correction factor for the estimated values. Habitat attributes that are not well suited to visual estimation are measured on a sub-sample basis.

The recommended minimum set of habitat attributes includes:

1. **Natural Sequence/Order:** Each habitat unit encountered is numbered sequentially (i.e., the most downstream habitat unit in the complex is number 1, the next number 2, etc.).

2. **Habitat Type and Number:** An alpha-numeric identifier is used to indicate aquatic habitat type and number in row two. For example, if the first four habitat units encountered in the complex were a riffle, a glide, a riffle and a pool they would be designated R-1, G-1, R-2, P-1).

Three (or four) aquatic habitat types are recognized as discussed below:

a. ***Riffle (R)***: A portion of the stream where water flows swiftly over completely or partially submerged obstructions to produce surface agitation.

b. ***Glide (G)***: A portion of the stream with moderate to swift velocity and without surface agitation (i.e., displays laminar or near laminar flow patterns). Do not confuse glides with tails of pools. Pool tails upstream of the pool tail crest will be counted as part of the pool.

c. ***Pool (P)***: A portion of the stream with reduced current velocity (i.e., average velocity is generally less than 1 foot per second) and often (but not always) with water deeper than surrounding areas.

Habitat units are viewed as occupying the full water width, and must be at least as long or wide as the average water width to be counted as a distinct unit. Units that are not at least as long or wide as the average water width are lumped with the most similar adjacent habitat unit. Because of their importance to many species of salmonids three exceptions to this general rule are noted:

Off-Channel Pools: Slack water areas separated from the main channel by a sand/gravel bar, or other feature should be considered as a separate habitat unit (P) if greater than 20 square feet in size.

Pocket Pools: Pocket pools are created behind obstructions as inclusions in glide and riffle habitat units (i.e., they do not meet the minimum size criteria to be counted as a distinct unit). The number of pocket pools (greater than 10 square feet in size) should be recorded for the glide and riffle units they occur in (see item number 19).

Side Channel: At a minimum clearly indicate the habitat unit where the side channel leaves and enters the main channel. Using this "minimum approach" habitat attributes are evaluated and recorded as if the side channel is one habitat unit. If side channels are identified as a separate aquatic habitat type, code them with an "S".

If side channels are large (e.g., contain greater than 1/3 of the total flow) or of particular value to the species in the system (as they frequently are), riffle/glide/pool habitat units within the side channel should be evaluated. **Side channel habitat unit data should be entered on the data form so that it is clearly separable from the habitat units** in the main channel. Multiple side channels pose a particular data recording challenge.

8-14. **Habitat Unit Water Dimensions**: Existing horizontal water dimensions are visually estimated for all habitat units and measured on a sub-set of habitat units. Horizontal dimensions of interest include:

8. **Average Habitat Unit Length**: (thalweg length to nearest unit of measure).
9. **Average Habitat Unit Width**: (to nearest unit of measure). Estimate at a specific point in the habitat unit you believe represents the average width of the habitat unit. Average measured width is determined by measuring and summing widths at points 1/4, 1/2, and 3/4 of the way along the unit length, and dividing by three.

Vertical dimensions are not readily visually estimated. For each habitat unit, *at a cross section with a water width that approximates the average water width*, use a graduated rod to quickly measure:

10. **Maximum Water Depth**: (at that cross section, to the nearest 0.1 unit of measure).
11. **Habitat Unit Shore Depths**: (left and right, at that cross-section, to the nearest 0.1 unit of measure).
12. **Shape of the Wetted Channel**: (item 12) should be indicated from among:

- R = Rectangular
- T = Triangular
- Z = Trapazodial (bankfull channel width < stream bottom width)
- IZ = Inverted Trapazoid (bankfull channel width > stream bottom width)

For all *pool units* use a graduated rod to quickly measure:

13. **Maximum Pool Depth**: (where ever it occurs in the habitat unit, to the nearest 0.1 unit of measure).
14. **Maximum Pool Crest Depth**: (to the nearest 0.1 unit of measure).

15. **Bank Length by Vegetation/Stability Class**: Length of bank (to the nearest unit of measure) by vegetation/stability class is visually estimated at all habitat units and measured at a sub-set of habitat units. In making this evaluation, view the bank as if it were composed of 1 foot/meter long pieces. A practical way of doing this is to FIRST estimate the length of streambank that is vegetated and the length that is unvegetated THEN partition those lengths between stable and unstable. Partitioning *within* vegetated/unvegetated classes is readily accomplished by estimating the length of stable or unstable, which ever is shorter; the balance of the length is the longer stability class. Both banks should be considered in making this assessment.

If collection of bank vegetation/stability data at this intensity is not needed or practical, at a minimum, measure length of bank by vegetation/stability class at the sub-set of habitat units where dimension measurements are made.

Bank vegetation/stability classes include:

- Veg/St = Vegetated/Stable
- Veg/US = Vegetated/Unstable
- UnV/St = Unvegetated/Stable
- UnV/US = Unvegetated/Unstable

Bare, or essentially bare ground is considered unvegetated. If any vegetation is present it is limited to sparse annual forbs. Streambanks that are not bare ground are considered vegetated. Bank vegetation is generally viewed at the green line (or where the green line should be). A "stable" streambank (as viewed at the steepest sloped portion of the channel between the bankfull and existing water level) shows no evidence of active erosion, breakdown, tension cracking, shearing, or slumping. An "unstable" streambank shows evidences of

active erosion and/or sloughing. Undercut banks are considered *stable* until tension fractures show on the ground surface at the back of the undercut.

16. **Bank Length by Shape Class:** Length of bank (to the nearest unit of measure) by shape class is visually estimated at all habitat units and measured at a sub-set of habitat units. In making this estimate, view the bank as if it were composed of 1 foot/meter long pieces. Both banks should be considered in making this assessment.

If collection of bank shape data at this intensity is not needed or practical, at a minimum, measure length of bank by shape class at the sub-set of habitat units where dimension measurements are made.

Bank shape classes include:

- Undrct = Undercut (<90 degree angle from water surface)
- Gntslp = Gently Sloping (>135 degree angle from water surface)
- Stpslp = Steeply Sloping (90-135 degree angle from water surface)

17. **Substrate Percent:** Substrate composition *may* be estimated at each habitat unit, but often is only measured on a subset of habitat units using a 'Pebble Counting' technique. Pebbles are to be tallied by seven classes - sand/silt (SS = .1 inch or smaller); coarse fines are greater than .1, but no larger than .25; gravel (GR = greater than 0.25 inch, but no larger than 3 inches); rubble (RB = greater than 3 inches, but no larger than 6 inches); cobble (CB = greater than 6 inches, but no larger than 12 inches); boulder (BL = greater than 12 inches, but no larger than 36 inches); large boulder (LB = greater than 36 inches) includes bedrock. All dimensions refer to the intermediate axis of the particle.

Pebble counts are typically made over the width of the bankfull channel (wetted or dry). A work sheet for pebble counts is provided on the back of the survey form. Pebble count transects are typically located perpendicular to stream flow, randomly along an axis parallel to stream flow. For the purposes of this survey, transects may be located at the 1/4, 1/2, and 3/4 points of the length of the habitat unit. (Note: If substrate is being measured at the same frequency that dimension measurements are taken, these three transects correspond to the points where widths are measured.) If the channel is too narrow to secure 100 pebbles along the three transects, locate transects at the 1/5, 2/5, 3/5, 4/5 points of the length of the habitat unit, or some other suitable frequency.

18. **LWD (Large Woody Debris):** The amount of large woody debris is estimated for each habitat unit. To be counted, some portion of the individual pieces must be within the bankfull channel prism and a piece must be at least as long as 75 percent of the average bankfull width. Large woody debris will be tallied as:

- number of pieces acting individually
- number of small aggregations (groups of 2-4 pieces)
- number of jams (groups of 5 or more pieces)

19. **Number of Pocket Pools:** Pocket pools are created behind obstructions as inclusions in glide and riffle habitat units (i.e., they do not meet the minimum size criteria to be counted as a distinct unit). The *number* of pocket pools (greater than 10 square feet/1 meter square in size) should be recorded for the glide and riffle units that have pocket pools.

COMMENTS

Use the space provided to record pertinent comments. Locatable features, such as tributary streams, road crossings, Level III riparian vegetation characterization sites, etc., should be tied to specific habitat units in the comments (this is particularly important if GIS applications of the data are anticipated). Also, include

information about sediment sources, habitat improvement opportunities, and subjective evaluations of land-use effects. Photograph numbers may be recorded in the comments, or added as a row of data following Item 19.

OPTIONAL HABITAT UNIT ATTRIBUTES

A number of other habitat attributes may be appropriate to characterize a complex in a given ecological setting or to address specific monitoring or evaluation objectives. Examples of optional attributes, recommendations for their use, and standard sample protocols are described below. Selected optional habitat attributes may be added to the data form in the rows provided below Item 19.

It should also be noted that the basic aquatic habitat unit types (i.e., pool, glide, and riffle) may be further divided into sub-types. A set of sub-types has been defined by the Pacific Southwest Region (Overton 1990).

Embeddedness (by Spawning, Rearing, Overwintering): Embeddedness measurements may be taken to assess the quality of spawning, rearing, or overwintering habitats. This requires knowledge of spawning, rearing, and overwintering habitat requirements for the specie or species being evaluated. Methods described by Skille and King (1989) are used to measure embeddedness within areas meeting the specified life history habitat requirements.

Embeddedness is a factor that has the potential to limit the productivity of aquatic ecosystems within many geologic regions. The amount of embeddedness can also be significantly influenced by land management activities. Usefulness of embeddedness measurements is somewhat limited due to high natural variability over space and time. A sophisticated (and expensive) sampling strategy is likely necessary to describe relationships between changes in embeddedness and management activities.

Interstitial Space Index (ISI): ISI, uses the same sample protocols and measurements as those described for embeddedness, but analyzes the data in a different way. ISI, has been shown to be a less variable metric than embeddedness. This technique may prove to be an effective tool for evaluating rearing and overwintering habitat quality, and land management effects.

Percent Surface Fines: Percent surface fines can be used as a quick indicator of overall salmonid rearing habitat quality (and sediment deposition). Percent surface fines are measured using a pebble count technique in riffles with gradients less than 4 percent, and at pool tail outs, immediately (within 2-3 feet) upstream of the pool crest.

Large Woody Debris Input Potential: Generally, determining large woody debris input potential involves enumeration of numbers of trees by species, size, and condition within a specified distance (e.g., average height of mature trees at the site) of the stream channel. The specified distance may vary with side slope gradient, and proximity of the side slope to the channel. Large woody debris input potential may be an important factor to consider when evaluating the effects of timber management activities or proposals.

Aquatic Vegetation Amount and Characteristics: Aquatic vegetation may be an important indicator of organic enrichment, early stream recovery processes, or be a significant component of instream cover/food production. Calibrated visual estimation techniques can be used to evaluate area of streambed or length of stream margin supporting specific types of aquatic vegetation.

Canopy Closure/Stream Shading: Loss of stream shading due to changes associated with vegetation manipulation can significantly influence stream temperature in some ecologic settings. Platts, et. al. (1983), describes a technique for quantifying canopy closure/stream shading.

Bank Stability and Morphology Characteristics by Streamside Vegetation Community Type: Streambank stability and morphologic characteristics have been shown to be of extreme importance to the productivity

of aquatic ecosystems. Bank stability and shape are readily influenced by many land use activities. Within soil types, streamside community types appear to have "inherent" capabilities to provide stability to streambanks and help determine bank shape. When bank data are collected by streamside community type, two types of management activity influences can be examined. The first level of analysis addresses how management activities may have changed "streamside" vegetative community types (and, therefore, existing bank stability potential). The second level of analysis addresses how management activities have reduced the inherent bank stabilizing ability within community types (e.g., through reduced plant vigor, etc.). Using this approach, the amount of increased bank instability attributable to land use effects may be more effectively estimated. Calibrated visual estimation, or green line pacing techniques can be used to evaluate streambank characteristics within streamside community types.

Suitable Spawning, Rearing, Overwintering Habitat Area: One approach to "limiting factors" analysis is to define habitat requirements (i.e., type and amount) by critical season and life stage and then use calibrated visual estimation techniques to quantify how much of each habitat is available. Habitat "bottlenecks" may then be apparent. It is perhaps important to note that all assumptions on types and amounts of habitat required by critical season and life stage should be thoroughly documented. It should also be noted that this technique only evaluates potential physical habitat-related limiting factors. Other factors such as water quality, food production, etc., may actually limit fisheries productivity.

Macroinvertebrate Community Characteristics: One approach to cumulative effects analysis is to look at macroinvertebrate community characteristics (e.g., species composition and relative abundance). Sampling techniques are referenced in an Intermountain Region Handbook Supplement (FSH 2609.23) and elsewhere.

Overhanging Terrestrial Vegetation: Overhanging terrestrial vegetation can be an important cover component, provide high flow streambank protection/sediment filtering, and can be an important source of energy input to the stream. Streamside vegetation composition and condition can be influenced by a number of land management uses. Calibrated visual estimation techniques can be used to quantify the length of streambank with overhanging terrestrial vegetation. These assessments are best made at the end of the growing or grazing season, whichever occurs latest. A clear definition of what constitutes "overhanging vegetation" must be made, for assessment of this metric to be repeatable. This guide suggests that to provide effective cover terrestrial vegetation must be within one foot of the water surface and hang beyond the bank at least one foot.

Green Line Non-Woody Vegetation Height: Height of non-woody vegetation (as measured at the green line) at the end of the growing or grazing season, whichever occurs last, can also be used effectively to monitor land-use management effects on riparian/aquatic resources.

Cover Area by Formative Feature: Amount and type of cover may be useful in predicting fish abundance (i.e., habitat quality). Calibrated visual estimation techniques can be used to quantify the area within habitat units with cover. Cover types may include that associated with substrate, aquatic vegetation, terrestrial vegetation, woody debris, surface turbulence, undercut banks, water depth, etc.)

Cover Complexity: Quality or complexity of cover may be as important, or more important, as cover area in influencing fish use and production. Cover complexity has generally been evaluated using "subjective" rating categories. A sample, cover complexity rating for pools is shown on the following page. It is based on habitat unit features for which data are frequently collected.

Value scores can be adjusted based on species and life history stage habitat requirements. The individual scores may be summed as an index to pool cover complexity, but should be retained and compared with fish population information from the same habitat units to gain insight to the actual value of different cover components to different species and life stages (i.e., gather the data in a way that will allow the fish to "identify" what is important). If values for individual cover components are retained, it is also possible to define the mean and expected variability of cover components within a riparian complex or ecological setting.

Appendix A. Continued.

SAMPLE COVER COMPLEXITY RATING FOR POOL UNITS: Using this scheme, cover complexity would be reported as a 5-digit code. "Values" may be adjusted to better reflect the habitat requirements of a particular species or life stage. Individual component values may be summed to provide an index to cover complexity. The mean and associated variability of the index may be calculated for management influenced riparian complexes and compared to reference complexes. Similarly, by retaining individual values, means and standard deviations can be calculated for each cover component. Used in conjunction with habitat unit specific fish population data, inferences may be drawn about species/life history stage habitat preferences and requirements.

Percent values shown below for substrate, submerged, and overhead cover relate to percent of pool area.

COVER FEATURE	*CLASS*	*VALUE*
Max Residual Pool Depth	≤0.5'	0
	>0.5-1.5'	1
	>1.5-3.0'	2
	>3.0-6.0'	3
	>6.0'	4
Substrate Cover (i.e., associated with cobble/boulder/bedrock and/or aquatic veg.)	≤10%	0
	>10-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
Submerged Cover (i.e., organic debris within the water column)	≤10%	0
	>10-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
Overhead Cover (i.e., associated with terrestrial vegetation and/or surface turb.)	≤10%	0
	>10-25%	1
	>25-50%	2
	>50-75%	3
	>75%	4
Undercut Bank Cover (i.e.,% of pool stream bank undercut.)	≤10%	0
	>10-25%	2
	>25-50%	3
	>50%	4

Appendix A. Continued.

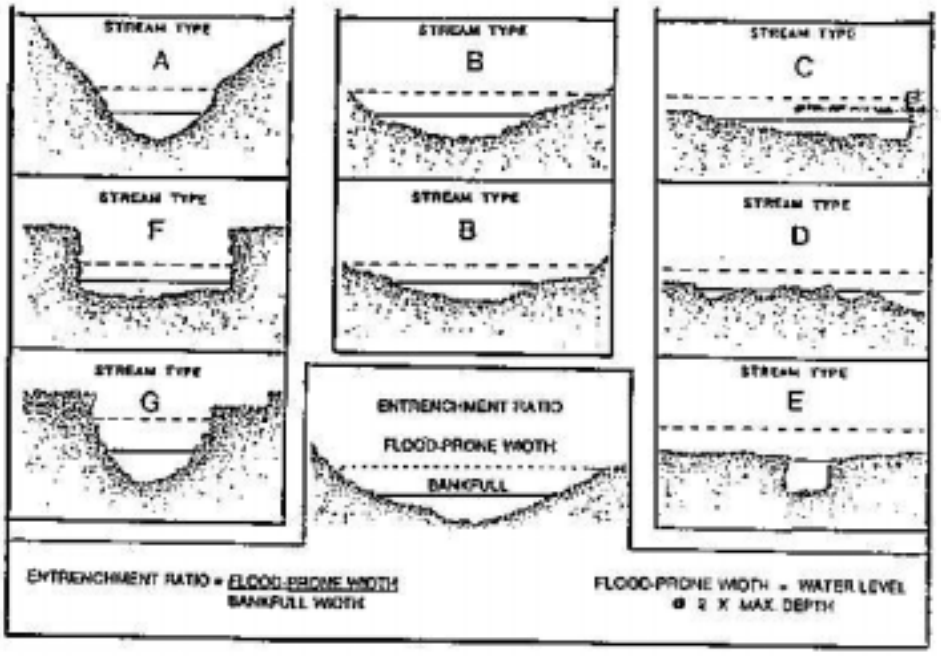
Intergravel Dissolved Oxygen: Monitoring intergravel dissolved oxygen, and measuring egg to emergence survival in an artificial red has been described by Burton et. al (1989). The technique may be useful for evaluating spawning habitat quality. This technique is perhaps most appropriately applied in those geologic types which produce fine sediments that readily affect intergravel dissolved oxygen. Application of the technique will require coordination and participation of the state fish management agency.

Water Chemistry Parameters: A variety of water chemistry parameters (e.g., heavy metals, indicators of organic enrichment, toxic substances, etc.) may be important in evaluating the effects of land use activities on aquatic community habitat productive capability. In most cases, water samples will be collected and submitted to a certified lab for processing. Sampling and handling methods are generally prescribed by the processing lab.

POOL TYPES: Lateral Scour (LS), Beaver Dammed (BD), Other Dammed (OD), Plunge Pool (PP), Mid-Channel Pool (MC), Under Scour Pool (US), Trench Pool (TP).

Vegetation Types:
R – Rock,
B – Bare Soil,
G – Annuals and Grasses,
S – Sedges and Rushes,
W – Willows,
U – Upland Shrubs,
C – Conifers,
D – Deciduous Trees

Unstable Banks are: Exposed bare soil, Banks with tension cracks, and obvious bank sloughing.



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