FISHERY RESEARCH

Hatchery Trout Evaluations

Subproject 3: Fish Health and Performance Study

Grant # F-73-R-22

Report Period July 1, 1999 to June 30, 2000

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Project 4: Hatchery Trout Evaluations

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ABSTRACT

I compared the performance (relative tag returns) of Kamloop rainbow trout catchables from four of Idaho Department of Fish and Game's largest producing hatcheries. Additionally, I examined fish health prior to stocking to determine if prestock fish health was related to poststock performance. Fish health was evaluated using an organismic index and autopsy-based assessment of fish health. Jaw-tagged rainbow trout from Nampa, Hagerman-Riley Creek, Hagerman-Tucker Springs, and American Falls hatcheries were stocked concurrently in 16 lakes and reservoirs located throughout south-central Idaho. Only tags returned by December 31, 1999 were considered in this report. The performance of trout stocked from the four hatcheries was not equal. Overall tag returns were 15%, 14%, 12%, and 11% for Nampa, American Falls, Hagerman-Tucker Spring, and Hagerman-Riley Creek, respectively. With respect to the lowest returns (Hagerman-Riley Creek), returns were 36% greater for Nampa, followed by American Falls (27%), and Hagerman-Tucker Springs (9%). Hagerman-Riley Creek tag returns were significantly lower than those from Nampa and American Falls, but not Hagerman-Tucker Springs. This performance differential could represent a significant management consideration in the numbers stocked or the relative returns of trout stocked by Idaho Department of Fish and Game. However, overall tag returns were influenced most by the variation among waters (78%) when compared to the hatchery influence (6%). Additionally, the health of a trout before stocking was unrelated to its poststock performance.

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INTRODUCTION

Each year, Idaho Department of Fish and Game (IDFG) resident hatcheries stock approximately three million catchable rainbow trout *Oncorhynchus mykiss*, of which about one million are harvested by anglers (Teuscher et al. 1995, 1999). The IDFG hatchery program accounts for a large portion of the total fishery budget (IDFG 1995), but it also provides angling opportunity in many waters of the state where yield fisheries cannot be supported with present habitat limitations and angler demand. Given the large amount of money spent within the hatchery system, every effort should be made to maximize the angling opportunity provided by IDFG hatcheries.

In the past, IDFG has completed numerous studies designed to maximize harvest of hatchery trout. Several studies have investigated the possible relationship between fish size (Mauser 1992, 1994; Teuscher 1999), stocking time, stocking methods, fish conditions (Casey et al. 1968; Welsh et al. 1970), and fish behavior (Dillon and Alexander 1996) and angler success. However, to date no evaluations have been completed to examine the hatchery-specific quality of catchables produced.

The IDFG 1996-2000 Fish Management Plan provides guidelines to maximize the efficiency of the catchable rainbow trout program. The guidelines include: 1) concentrating releases of catchables in high use areas, 2) timing releases to coincide with fishing pressure, 3) testing strains of rainbow trout which improve returns to creel, 4) publicizing the location of stocked streams, 5) improving habitat to maximize harvest of stocked trout, and 6) producing a consistently high-quality product at the hatcheries (IDFG 1995). One definition of quality, in terms of IDFG management objectives, would be a product that provides maximum return to creel (harvest) of hatchery stocked fish. For the purposes of this study, such return rates will subsequently be referred to as performance.

The hatchery environment can affect the poststock survival of fish stocked in the natural environment. Hatchery environments can influence the expression of behavioral traits (Vincent 1960; Moyle 1969; Swain and Riddell 1990) and poststock survival. Rearing densities, the quantity and quality of the water supply, and the disease and pathogen prevalence can directly impact fish health of hatchery-reared trout. Idaho Department of Fish and Game hatcheries are not standardized in their design or management; therefore, distinctive levels of environmental stressors are found among the hatcheries. Since most IDFG hatcheries vary in physical characteristics, water supply, disease status, and management style, poststock vigor and survival to creel may also vary. For example, anecdotal observations by several IDFG regional managers suggests that many fish provided from Hagerman Hatchery in the 1980's were sickly and likely contributed very little to the fishery. Although studies directly linking prestock hatchery conditions to poststock return to creel are limited, it can be assumed that hatchery-specific fish performance exists. If IDFG can identify a hatchery facility that consistently produced lower quality trout, focus can be placed on making improvements at that facility. In addition, the recent fiscal situation has resulted in substantial cutting of hatchery budgets. If IDFG budget conditions do not change in the near future, an assessment of which hatcheries produce fish most likely to be caught by anglers will be useful if production needs to be cut.

The purpose of this study is to determine if IDFG hatcheries are providing similar quality products for use in the catchable trout program. This was the first year of a two-year study to determine if the returns of stocked trout differ among hatcheries. Specifically, this research evaluated the lentic performance (using tag returns as a surrogate for harvest) of catchable rainbow trout (CRBT) from four IDFG hatchery sources. Prestock fish health was also evaluated to determine if fish health was a good predictor of poststock returns.

RESEARCH GOAL

The goal of this research is to maximize the angler harvest of catchable rainbow trout produced at IDFG hatcheries.

OBJECTIVES

1. To determine if there are significant differences in the quality of CRBT produced at three IDFG hatcheries: Nampa, Hagerman (both Riley Creek and Tucker Springs water sources), and American Falls.

2. If a significant difference is found, determine if prestock fish health can predict the harvest of stocked trout.

DESCRIPTION OF STUDY AREA

Sixteen lakes and reservoirs were stocked throughout south central Idaho. Only locations that were managed with CRBT, known to have significant fishing pressure, and easily accessed were considered. Regional fishery managers provided angling effort information for potential study areas. Natural lakes, irrigation reservoirs, and small, high use fisheries were included in the study which spanned much of the southern portion of Idaho (Figure 1). Study waters were selected that provided a broad spectrum of lentic systems that varied in size, elevation, and productivity (Table 1). Temperature and dissolved oxygen data are reported in Appendix A.

Four IDFG sources of Kamloop CRBT were chosen for this evaluation. The hatchery sources included: 1) Nampa, 2) Hagerman-Riley Creek (Hag-R), 3) Hagerman-Tucker Springs (Hag-T), and 4) American Falls. Although not all these sources were unique facilities, they will be referred to as hatcheries from this point forward. These hatcheries were selected because they 1) reared sufficient numbers of CRBT, 2) reared a large portion of the CRBT for IDFG, and 3) were centrally located. Two sources of Hagerman CRBT were used because fish are reared in well water in Hag-T and surface water in Hag-R raceways. Historically, fish reared in the Hag-R surface water have had acute and chronic health considerations (Doug Burton, Idaho Fish and Game, personal communication).

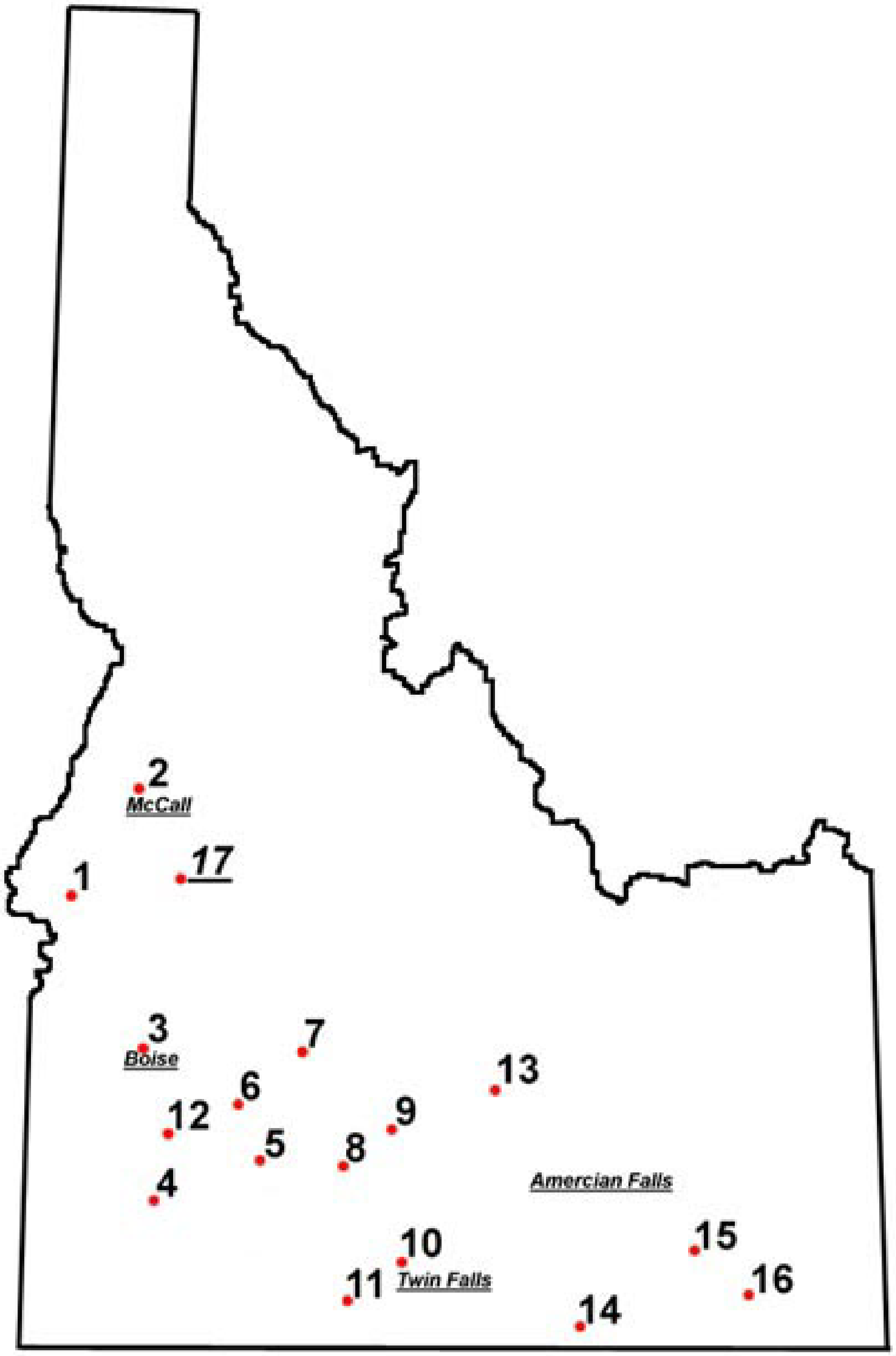

Figure 1. Location of study waters. 1) Mann Creek Res., 2) Upper Payette Lake, 3) Park Center Pond, 4) Cove Arm Res., 5) Blair Trail Res., 6) Little Camas Res., 7) Featherville Dredge Pond, 8) Dog Creek Res., 9) Magic Res., 10) Dierkes Lake, 11) Roseworth Res., 12) Mountain Home Res., 13) Lava Lake, 14) Sublett Res., 15) Hawkins Res., 16) Deep Creek Res., and 17) Horsethief Res. (will replace Upper Payette Lake in 2000).

Table 1. Description of study waters including basic water quality parameters. Water quality data were collected in August 1999.

Study waters	IDFG stocking catalog #	Elev. (m)	Surface area (acre)	pH	Cond.[a]	Secchi (m)	ZPR[b]	ZQI[c]
	Study water characteristics							
Upper Payette Lake	09-00-00-0392	1,701	315	9.4	20	8.2	0.1	0.0
Cove Arm Res.	05-00-00-0168	750	76	8.9	410	2.7	0.9	0.9
Dog Creek Res.	11-00-00-0121	1,100	95	8.5	350	2.7	0.0	0.0
Magic Res.	11-00-00-0131	1,469	3,776	8.8	185	4.5	0.5	0.1
Lava Lake [d]	11-00-00-0118	1,570	20	10.4	600	1.0	-na-	-na-
Mann Creek Res.	08-00-00-0003	878	281	8.8	160	1.9	0.3	0.1
Park Center Pond	10-00-00-0117	823	14	9.2	140	1.1	0.0	0.0
Dierkes Lake	05-00-00-0208	1,052	100	9.4	700	1.8	0.0	0.0
Mountain Home Res.	05-00-00-0180	1,000	406	9.3	70	1.7	1.0	0.6
Blair Trail Reservoir	05-00-00-0184	1,058	15	9.9	100	0.4	0.0	0.0
Little Camas Res.	10-00-00-0130	1,500	1,455	8.8	85	2.2	0.6	1.2
Sublett Reservoir	05-00-00-0228	1,625	113	9.2	450	4.8	0.1	0.1
Deep Creek Res.	14-00-00-0112	1,573	183	8.8	300	4.5	0.5	0.5
Roseworth Res.	05-00-00-0202	1,426	1,500	8.7	85	1.9	0.5	0.6
Featherville Dredge P.	10-00-00-0161	1,372	3	9.1	80	5.5	0.0	0.0
Hawkins Reservoir	05-00-00-0234	1,567	54	8.8	700	2.9	0.8	1.2

[a] Conductivity (micro siemens / cm)

[b] ZPR = zooplankton biomass (750µ mesh net) / zooplankton biomass (500µ mesh net). The greater the ZPR ratio the more favorable are the forage conditions

[c] ZQI = [zooplankton biomass (750µ) + zooplankton biomass (500µ)] * ZPR. The ZQI is a measure that includes both abundance and zooplankton size

[d] Secchi reading to bottom; too shallow to sample plankton

METHODS

The optimal sample size (study waters) needed for this study was determined in an a priori power analysis. Past tag-return data (Teuscher 1999) were used to determine the optimal sample size needed to minimize Type II errors. I estimated that a sample size of 16 sites provided adequate protection against Type II errors (1-β=0.75).

Trout used in this study were selected from all raceways that contained catchable-sized (23-25 cm total length) Kamloop rainbow trout. In each hatchery, one raceway containing CRBT was systematically selected once per week to assure all raceways were represented in the analysis. If the selected raceway was partitioned, then fish were stocked from a randomly selected section. Two to five study waters were stocked from each of the selected raceways.

A total of 3,200 CRBT were tagged at each hatchery. Fish were crowded and randomly removed from the raceway where they were anesthetized, measured for total length (TL mm), jaw tagged (size 8 Monel butt-end tag), and held in holding pens for up to three days. The holding pens were 1.2 X 1.2 X 2.4 m (width X height X length) and were lined with 6 mm plastic hardware-cloth. Tag loss due to shedding or mortality was monitored to provide an accurate count of tagged fish stocked. Shed tags were reapplied to other fish if the shed tags were observed prior to transport. Approximately 200 CRBT from each hatchery were tagged and subsequently stocked into each water, which resulted in 800 tagged trout per water.

Transport time for each stocking effort was standardized among hatcheries. The travel time discrepancy among hatcheries may have introduced bias if no compensations were made. Therefore, transport truck drivers with the shortest drive time were required to hold the fish in the transport truck at the hatchery to even out the transport time among hatcheries. In most instances, the tagged trout were loaded into fish transport trucks simultaneously at all hatcheries. Minor differences in transport time were made up at the stocking site, and each water was usually stocked concurrently by each hatchery.

Tag return reward incentives, press releases, and signs were used to encourage angler compliance in returning tags. Newspaper, radio, and television were used to disseminate information regarding the location of the study waters, the reward incentive, and the project goal. Blaze-orange signs with information pertinent to the drawing were posted near access points in all waters. Additionally, data slips with the tag return instructions were affixed to each sign to assist anglers in the tag return process. Anglers that returned tags were entered in site-specific drawings where each winner was awarded $50.00. Angler compliance was not determined because actual harvest estimates were not needed for this study, and precise and accurate estimates of compliance are costly (Nichols et al. 1991).

All jaw tags returned before December 31, 1999 were considered in this comparison. This cutoff date was arbitrarily selected to differentiate between first year and carryover returns. Tags returned after December 31, 1999 (carryover) were not considered in this report but will be evaluated in 2000. Jaw-tag data were collected by mail, telephone, and field contacts by IDFG personnel. Tag number, angler address, and date of catch data were entered and compiled in a Microsoft® Access database.

The proportion of returned tags was statistically compared among hatcheries. Tag return data were adjusted for both transport-mortality and tag sheds. Return data were standardized (# returned / # stocked) and arcsine transformed prior to the statistical analysis.

The null hypothesis was $Nampa_R = Hag\text{-}R_R = Hag\text{-}T_R = American\ Falls_R$ where $hatchery_R$ represents the proportion of tag returns from each hatchery. The data were analyzed to determine if the basic ANOVA assumptions were met. Tag returns among hatcheries were compared with a randomized blocked ANOVA (α=0.05) where tag return was the dependent variable and water and hatchery were the independent variables (Zar 1999, SYSTAT 9.0). Confidence bounds were assigned to the proportion of tags returned using methods described in Fleiss (1981). If the null hypothesis was rejected, the interaction among independent variables (study water and hatchery) was tested with a Tukey's 1-degree test for additivity (Neter et al 1990). A posteriori pairwise comparison was conducted with a Tukey's test (α=0.05) to determine which hatcheries differed from each other. A one-way ANOVA was used to determine the relative influence that the water or the hatchery variables had upon the returns.

The relation between fish health and tag returns was investigated. Each raceway was evaluated separately since fish health may be unique among raceways. An autopsy-based fish health assessment method (HCP) was used to characterize fish health prior to stocking (Goede and Barton 1990). Twenty trout per raceway were randomly collected from each raceway population and subsequently autopsied and evaluated by IDFG fish pathologists. Several raceways were evaluated at Nampa (n=5), Hag-R (n=3), Hag-T (n=2), and American Falls (n=4). The HCP procedure included the examination of 16 health-related criteria (Table 2). Data were compiled with AUSOM software program (AUSOM 1996). The AUSOM program combines ten criteria to generate the normality index (NI), which reflects the overall health of the hatchery population sampled. Simple linear regression was used to determine if fish health before stocking could predict poststock tag returns.

Basic water quality data were collected to examine the relation between water quality and hatchery specific returns. In mid-August, dissolved oxygen, water temperature, turbidity (secci disc), pH, and conductivity data were gathered for the study waters. Additionally, plankton samples were taken to estimate the plankton productivity at each water. Plankton were collected at two to three locations with three nets of varying mesh size (153, 500, 750 μ mesh). The plankton samples were processed and reported as described in Teuscher (1999). Data are presented in Table 1 but will be discussed in the 2000 report when longer-term carryover return data can be assessed.

Table 2. Criteria used to evaluate prestock fish health in 1999 (Ausom 1996).

Parameter	Evaluation criteria	Data expression
General		
Length	Total length (mm)	Integer
Weight	Weight (g)	Integer
Ktl and Ctl	Ktl = $(W * 10^5) / L^3$; Ctl is converted from Ktl and expressed as Ctl times 10 to the fourth power	Integer
Autopsy		
Eyes	Normal, exopthalmia, hemorrhagic, blind missing, other	% Normal
Gills	Normal, frayed, clubbed, marginate, pale, other	% Normal
Pseudobranch	Normal, swollen, lithic, swollen & lithic, inflamed, other	% Normal
Thymus	No hemorrhage, mild hemorrhage, severe hemorrhage	% Normal
Fins	No active erosion or pervious erosion healed over, mild active erosion with no bleeding, severe active erosion with hemorrhage and / or secondary infection	% Normal
Opercles	No shortening, mild shortening, severe shortening	% Normal
Messentary fat	Internal body fat expressed with regard to amount present	1, 2, 3, or 4
Spleen	Black, red, granular, nodular, enlarged, other	% Normal
Hind gut	No inflammation, mild inflammation, severe inflammation	% Normal
Kidney	Normal, swollen, mottled, granular, urolithic, other	% Normal
Liver	Red, light red, fatty liver, nodules, focal discoloration, general discoloration, other	% Normal
Bile	Yellow: bladder empty or partially full, yellow: bladder full and distended, light green, dark green	Integer
Gender	Male or female	M, F (%)
Blood		
Hematocrit	Volume of red blood cells	% total volume
Leucocrit	Volume of white blood cells	% total volume
Plasma protein	Amount of plasma protein	g / 100 ml
Summary		
Normality index	This index is calculated by averaging the “% Normals”	Percent
Severity index	This index is calculated by averaging the specific percent indices for the thymus, gut, fin, and opercle	Percent
Feeding index	This index is calculated by subtracting the “bile index” from 100	Percent

RESULTS

Tag returns were not equal among the four hatcheries examined (F=5.75; df=3,45; p=0.002). Overall, a total of 1,676 (13%) tags were returned from the 16 waters. Tag returns were 482 (15%), 457 (14%), 380 (12%), and 357 (11%) for Nampa, American Falls, Hag-T, and Hag-R hatcheries, respectively (Table 3). With respect to the hatchery with the lowest returns (Hag-R), the proportionate increase in tag returns was 36% for Nampa, followed by American Falls (27%), and Hag-T (9%). Results of the Tukey analysis showed Hag-R tag returns were significantly lower than those from Nampa and American Falls, but not Hag-T (MSE=0.002; df=45) (Table 4).

Table 3. Number of tagged catchable rainbow trout stocked, returned (from stock date to December 31, 1999), and percentage of tags returned from 16 waters and four hatcheries.

	AF			Hag-R			Hag-T			Nampa			Total		
Site	**Stock**	**Return**	**%** [a]	**Stock**	**Return**	**%** [a]	**Stock**	**Return**	**%** [a]	**Stock**	**Return**	**%** [a]	**Stock**	**Return**	**%** [a]
U. Payette L.	200	20	10	200	11	6	200	8	4	200	4	2	800	43	5
Cove Arm Res.	199	20	10	200	10	5	200	9	5	200	7	4	799	46	6
Dog Creek Res.	200	11	6	199	13	7	200	9	5	200	17	9	799	50	6
Magic Res.	200	23	12	200	11	6	200	13	7	200	16	8	800	63	8
Lava Lake	200	20	10	200	14	7	200	13	7	199	22	11	799	69	9
Mann Creek Res.	199	22	11	200	14	7	199	16	8	199	32	16	797	84	11
Park Center Pond	200	22	11	200	25	13	198	21	11	199	28	14	797	96	12
Dierkes Lake	196	14	7	199	23	12	200	28	14	199	34	17	794	99	12
Mt. Home Res.	198	33	17	200	23	12	198	17	9	200	28	14	796	101	13
Blair Trail Res.	200	29	15	200	23	12	198	21	11	200	35	18	798	108	14
Little Camas Res.	200	31	16	200	18	9	200	27	14	200	33	17	800	109	14
Sublett Res.	200	37	19	200	24	12	199	35	18	198	44	22	797	140	18
Deep Creek Res.	200	46	23	200	35	18	199	34	17	200	34	17	799	149	19
Roseworth Res.	199	39	20	200	33	17	200	28	14	199	55	28	798	155	19
Featherville P.	200	46	23	200	38	19	200	42	21	200	46	23	800	172	22
Hawkins Res.	200	44	22	200	42	21	198	59	30	199	47	24	797	192	24
Total	3,191	457	14	3,198	357	11	3,189	380	12	3,192	482	15	12,770	1,676	13
95% CI			13-16			10-12			11-13			14-16			13-14

[a] Proportion of tags returned (%)

Most of the variation in tag returns can be explained by water-specific and hatchery-specific influences. Eighty-four percent (R^2=0.84; p=0.002) of the variation in tag returns was explained by the combined influence of water-to-water and hatchery-to-hatchery variation (p<0.002). Water-to-water variation had the most influence (78%) on tag return variation (R^2=0.78; p<0.01), whereas the hatchery-to-hatchery variation (6%; R^2=0.06; p=0.29) provided relatively little influence. Within a given water, there was no hatchery-specific influence on tag returns (F=0.07; df=1,46; p=0.793). This indicates there was not a specific quality of water that offered a hatchery-specific advantage.

There was substantial variation in hatchery-specific tag returns among and within waters. The overall tag returns within each water ranged from 5% at Upper Payette Lake to 24% at Hawkins Reservoir (Table 3). Differences in tag returns among hatcheries within each water ranged from 3%-14%. The greatest site-specific range in tag returns was found in Roseworth (14%), Sublett (10%), Hawkins (9%), and Mann Creek (9%) reservoirs. The smallest return range was found in Park Center Pond (3%), Featherville Dredge Pond (4%), Lava Lake (4%), and Dog Creek Reservoir (4%). No single hatchery consistently provided the most tag returns among the various waters (Table 3).

Table 4. Results (p values) from a Tukey's multiple comparison test, which compared tag returns among hatcheries. Significant differences are denoted with an asterisk (*).

	Hatchery			
	American Falls	Hag-R	Hag-T	Nampa
American Falls	1.00			
Hag-R	0.02*	1.00		
Hag-T	0.06	0.97	1.00	
Nampa	0.99	0.01*	0.03*	1.00

There was no relation between fish health and tag returns. Results of the HCP analysis are presented in Table 5. The normality index, as generated from the HCP, ranged from 87%-96%. Hatchery specific normality indices were not related to tag returns (R^2=0.003; p=0.53; Figure 2). Most raceway populations tested (57%, n=14) were found to be in acceptable health (NI from 90%-100%). Of the five raceway populations below 90% (i.e. health concern), four were from American Falls Hatchery and one from Hag-T.

The rate and timing of tag returns varied among hatcheries. Generally, the majority of the tagged trout were caught within the first 100 days after stocking (DAS) (Figure 3). There were two pulses of heavy harvest: one within the first 30-50 DAS (late July to early August) and a second approximately 140-170 DAS (October to November). The second harvest pulse was proportionately lower than the first for fish stocked from Nampa, Hag-R, and Hag-T. However, trout stocked from American Falls Hatchery were caught in high numbers in the second pulse, with little difference in the number caught between the first and second pulse.

The average size of stocked trout varied slightly among hatcheries. Mean total lengths of stocked CRBT were 237 (SE=0.45), 233 (SE=0.39), 228 (SE=0.33), and 244 mm (SE=0.38) for American Falls, Hag-R, Hag-T, and Nampa hatcheries, respectively. Mean lengths differed only slightly (<2.0 cm) among hatcheries, but this difference was statistically significant (F=310.14; df=3,12,795; p<0.01) (Appendix B).

Table 5. 1999 fish health evaluation results from each of the four hatcheries examined. Data are summarized by raceway.

	Nampa[a]					Tucker[b]		Riley[c]			American Falls[d]			
	C1	C4	C6	C3	C5	10	9	17	21	22	14	13	16	15
Mean Returns	**20.0**	**15.8**	**15.0**	**12.9**	**12.5**	**12.8**	**11.2**	**12.2**	**10.6**	**-na-**	**17.3**	**15.9**	**15.8**	**10.1**
n=	**3.0**	**2.0**	**4.0**	**5.0**	**2.0**	**7.0**	**9.0**	**6.0**	**10.0**	**0.0**	**3.0**	**3.0**	**5.0**	**5.0**
TL (mm)	246.0	213.0	218.0	243.0	213.0	203.0	202.0	218.0	215.0	202.5	222.0	259.0	209.0	211.0
CV (%)	9.0	8.0	8.0	9.0	13.0	9.0	8.0	10.0	9.0	9.0	8.0	9.0	8.0	7.0
Weight (g)	188.0	122.0	125.0	194.0	124.0	100.0	101.0	125.0	126.0	101.0	146.0	225.0	118.0	124.0
CV (%)	28.0	24.0	23.0	24.0	32.0	24.0	23.0	33.0	22.0	35.0	26.0	30.0	25.0	22.0
Ktl	1.3	1.3	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3
CV (%)	9.0	8.0	6.0	17.0	8.0	8.0	9.0	8.0	7.0	22.0	8.0	6.0	8.0	5.0
Ctl	4.5	4.5	4.3	4.9	4.5	4.2	4.4	4.2	4.5	4.3	4.7	4.6	4.6	4.7
Hematocrit	44.0	42.8	43.7	41.5	42.6	36.8	37.6	38.7	36.3	40.8	41.0	43.7	40.3	43.5
CV (%)	10.0	8.0	10.0	11.0	11.0	11.0	11.0	11.0	12.0	11.0	9.0	11.0	13.0	8.0
Leucocrit	1.6	1.4	1.2	2.1	1.8	1.5	1.0	.9	1.4	.8	1.0	1.5	1.0	1.2
CV (%)	99.0	69.0	71.0	41.0	56.0	54.0	55.0	83.0	55.0	102.0	73.0	34.0	77.0	58.0
plasma protein	3.6	4.2	3.2	3.7	4.5	4.8	4.9	4.5	4.2	3.9	4.9	3.8	3.8	4.0
CV (%)	22.0	21.0	43.0	19.0	22.0	17.0	13.0	13.0	17.0	30.0	15.0	36.0	33.0	35.0
Eyes	100.0	100.0	100.0	95.0	100.0	100.0	100.0	100.0	100.0	95.0	100.0	100.0	100.0	100.0
Gills	100.0	100.0	95.0	100.0	100.0	100.0	80.0	80.0	100.0	100.0	100.0	100.0	100.0	100.0
Pseudobranch	100.0	100.0	100.0	100.0	100.0	100.0	95.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Thymus	100.0	75.0	65.0	60.0	60.0	60.0	55.0	80.0	70.0	65.0	35.0	65.0	40.0	55.0
Messentary fat	3.6	3.4	3.4	3.2	3.2	3.3	3.3	3.4	3.3	3.0	3.5	3.7	3.4	3.5
Spleen	100.0	100.0	90.0	100.0	100.0	100.0	95.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hind gut	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Kidney	100.0	100.0	100.0	100.0	100.0	100.0	90.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Liver	100.0	100.0	100.0	100.0	100.0	100.0	100.0	95.0	100.0	100.0	100.0	100.0	100.0	100.0
Bile	1.7	1.5	1.1	1.4	1.1	1.0	1.0	1.1	1.3	1.0	1.0	1.1	1.0	1.0
Fin	60.0	60.0	60.0	30.0	75.0	100.0	85.0	100.0	95.0	95.0	35.0	25.0	35.0	35.0
Opercle	100.0	100.0	95.0	100.0	100.0	100.0	80.0	90.0	95.0	100.0	100.0	100.0	100.0	100.0
Percent female	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent male	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Normality index [e]	**96.0**	**93.5**	**90.5**	**88.5**	**93.5**	**96.0**	**88.0**	**94.5**	**96.0**	**95.5**	**87.0**	**89.0**	**87.5**	**89.0**
Severity index [f]	**8.8**	**10.6**	**13.1**	**20.6**	**10.6**	**5.0**	**10.0**	**4.4**	**5.6**	**5.0**	**21.3**	**21.3**	**16.3**	**15.6**
Feeding index [g]	**43.3**	**51.7**	**64.9**	**52.9**	**65.0**	**66.7**	**66.7**	**65.0**	**58.3**	**66.7**	**66.7**	**63.3**	**66.7**	**66.7**

[a] No pathogens were detected

[b] IHN: IHNV detected in 1/20 samples from raceway #9, asymptomatic

[c] No pathogens were detected

[d] CWD: Flavobactrium psychrophilum detected in 2/16 samples, carrier only

[e] Average of the "percent normals" excluding bile and messentary fat; expressed as percent

[f] Average of the "percent normals" including thymus, gut, fin, and opercle; expressed as percent

[g] Calculated by subtracting the bile index from 100; expressed as percent

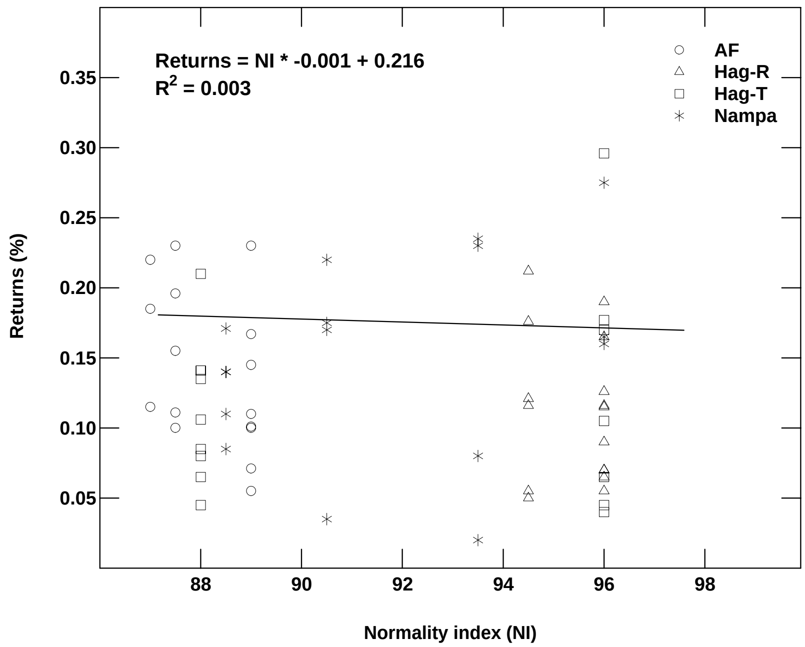

Figure 2. Simple linear regression depicting the relation between the Normality index and associated returns (%) of CRBT from American Falls, Hag-R, Hag-T and Nampa hatcheries.

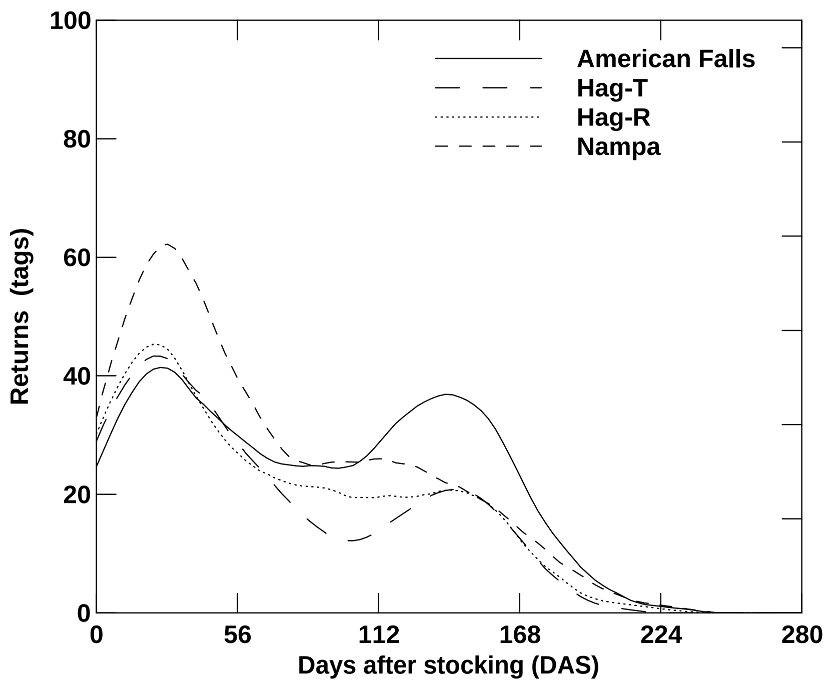

Figure 3. The timing of tag returns compared among the four hatcheries. The DAS represents the difference between the stock date and the harvest date as reported by anglers. All tagged CRBT were released and returned in 1999.

DISCUSSION

Although efforts were made to standardize the stocking protocol among the hatcheries examined, some differences were apparent. Some of these differences included trout size at stock time and fish transport truck disparity. The overall mean difference in fish size among hatcheries was less than 2 cm, although in some individual waters this discrepancy was slightly larger. However, Teuscher (1999) showed similar returns from trout that differed by 5 cm in length, and it is unlikely the small difference in length in this study substantially impacted returns. American Falls and Nampa hatcheries were able to use one-ton fish transport trucks, but Hagerman fish (Hag-T and Hag-R) were hauled in a dual compartment, two-ton transport. It would have been preferred that each hatchery planted trout with similar transports; however, fish transport densities among the hatcheries were similar. It was more important that the fish were held in the transport for equal periods prior to stocking.

I determined there were unequal first-year returns of CRBT among the four hatcheries examined. A potential performance difference of 36% represents a significant management concern considering the sheer numbers and cost (1.1 million dollars in 1999) of producing and stocking catchables (IDFG 1999).

The differential returns among hatcheries may result in substandard fisheries. In 1999, Hagerman Hatchery reared and stocked approximately 740,000 catchables, or about 22% of all catchables stocked by IDFG. If equal numbers of Hag-R and Nampa trout were stocked, we could expect 88,000 less Hag-R trout returned to the creel when compared to Nampa trout. Another way to consider these data is that IDFG managers would have to increase stocking requests by an additional 36% when using Hag-R catchables to produce a first-year fishery equal to that provided by Nampa. If IDFG hatchery budgets require a significant reduction in production, it would seem a reduction at Hagerman would impact Idaho's fisheries the least.

The same consideration may be applied to fingerlings if similar performance differences can be applied to the 1.3 million fingerlings reared at Hagerman. Because fingerlings must rear longer in the wild prior to capture by anglers, the potential for magnification of return reductions would seem more probable, if not likely. It is very important to note that the differential return among hatcheries has not been duplicated to confirm the consistency of the hatchery-specific performance. Any management decision should be delayed until after 2000 when the results of the second year of the study are compiled.

There was no relation between the prestock fish health (as measured in the HCP) and the poststock tag returns. None of the individual parameters included in the HCP appeared to be correlated with tag returns. This is not to say there is not a link between the prestock health of fish and harvest, but perhaps the HCP evaluation is not an effective predictor. Although the HCP assessment is designed to evaluate whether a fish population is coping successfully with its environment, short-term stress can bias the evaluation. A below-average NI could result from a short-term health consideration (e.g. overcrowding just prior to expanding a raceway), and may not reflect chronic poor health. Additionally, the HCP is not based on a universal standard of fish health; therefore, what is “abnormal” at one hatchery may be “normal” at another (Doug Burton, IDFG personal communication). An example of this would be that American Falls fish showed an average NI lower than the other hatcheries, yet those fish did not provide the lowest returns. With only one year of data available, it is unknown if these fish are actually in poor health relative to that specific hatchery environment. Low NI values at American Falls hatchery were due to active fin erosion (hemorrhage present). However, all hatcheries evaluated showed evidence of active fin erosion. Most fin erosion was healed at Hagerman and Nampa hatcheries and was not considered a health risk according to the HCP criteria. Perhaps if a baseline NI were established at a each hatchery, annual departures from that baseline would prove to be more useful in predicting the return potential of the stocked trout.

I did not determine what hatchery-specific characteristic influenced the differences among the hatcheries. Since a fish's environment is hatchery specific and often inconsistent through time, identifying the exact cause would be difficult. Many aspects of a hatchery's design, location, and management directly influence the fish's environment. Additionally, the causative agent may be a combination of influences that may not be apparent. However, the significant difference in returns among hatcheries is likely a result of different poststock survival, behavior, or the combination (Ginetz and Larkin 1976; Forgerlund et al 1981; Olla and Davis 1989; Ryer and Olla 1991, 1992, 1995a, 1995b; Olla et al. 1995, 1998).

Most of the overall tag return variation was due to water-to-water variation; a smaller portion was attributed to hatchery-specific influences. Although a 36% difference in returns is important, the data suggests that overall hatchery trout returns are strongly influenced by the environment in which the fish are stocked. Regional fish managers are aware of the different fishery potential of each water stocked by IDFG, and the strong influence of the water-water variation is not surprising. What is important is that overall statewide returns could be better enhanced by a reduction (or elimination) of stocking in waters that provide poor fisheries than if the return potential was improved at Hagerman Hatchery. The results of this study emphasize the need to evaluate stock waters regularly, especially in the light of a reduced hatchery budget, and adjust stocking requests accordingly.

Although this study was not designed to provide harvest estimates from the tag return data, a rough harvest estimate can be provided. Most harvest estimates derived from tag or band returns require the use of reward tags (Reimers 1963; Henry and Burnham 1976; Reeves 1979; Conroy 1984; Nichols et al. 1991, 1995). The present study used a drawing that offered $50.00 to the winner as incentive to increase tag return compliance. The relation between the drawing incentive ($50.00) and angler compliance is not known; however, the return compliance likely falls between that of a $50.00 reward tag and that of a nonreward (standard) tag. Past studies provide compliance estimates associated with a $50.00 reward and standard tags (Table 6). The reward compliance estimates ($50.00 reward) were adjusted to the equivalent buying power of $50.00 in the year the study was published. Using the average of reported incentives, I determined a range (minimum and maximum) between which the true harvest likely resides (Table 7). If only the conservative (maximum compliance) harvest estimates were considered, none of the waters investigated have met the 40% goal (by number) described in the IDFG management plan. The liberal harvest estimates (nonreward tag) indicate that nearly half of the study waters have met the IDFG harvest goal. Poststock tag shed, poststock mortality, and the influence of the publication effort were not incorporated into the harvest estimates, which may have biased the harvest estimate.

Table 6. Band or tag reporting rates from past reports. Estimated tag return reporting rates (compliance) are listed for standard (no reward) and $50.00 reward tags

Reference	Species	Incentive[a] ($)	Estimated compliance (%)
Standard tag or band[b]			
Nichols et al. 1991	Duck	None	32
Nichols et al. 1991 – adjusted for bias	Duck	None	26
Henry and Burnham 1976	Duck	None	38
Nichols et al. 1995	Duck	None	38
Conroy and Blandin 1984	Duck	None	43
Reeves 1979	Dove	None	38
Average			36
$50.00 reward tag or band			
Nichols et al. 1991	Duck	$39.78	75
Average			75

[a] Adjusted buying power of $50.00 in 2000 relative to the year of the publication
[b] Nonreward tag

Table 7. Estimate of first-year harvest from catchable rainbow trout stocked into 16 waters by American Falls, Nampa, Hag-R, and Hag-T hatcheries in 1999. Harvest estimates of trout from the stock date until December 31, 1999.

	Tag returns			Harvest estimate (%)	
Site	**Stock**	**Return**	**%[a]**	**Min[b]**	**Max[c]**
U. Payette L.	800	43	5	7	14
Cove Arm Res.	799	46	6	8	17
Dog Creek Res.	799	50	6	8	17
Magic Res.	800	63	8	11	22
Lava Lake	799	69	9	12	25
Mann Creek Res.	797	84	11	15	31
Park Center Pond	797	96	12	16	34
Dierkes Lake	794	99	12	16	34
Mt. Home Res.	796	101	13	17	37
Blair Trail Res.	798	108	14	19	39
Little Camas Res.	800	109	14	19	39
Sublett Res.	797	140	18	24	51
Deep Creek Res.	799	149	19	25	53
Roseworth Res.	798	155	19	25	53
Featherville P.	800	172	22	29	62
Hawkins Res.	797	192	24	32	67
Total	12,770	1,676	13	17	37

[a] Proportion of tags returned (%)
[b] Average standard tag compliance
[c] $50.00 reward tag compliance

MANAGEMENT RECOMMENDATIONS

1. Repeat the evaluation in 2000 to determine if the 1999 results are consistent.

2. Determine if ZQI or ZPR is related to long-term survival (carryover) of stocked catchable rainbow trout.

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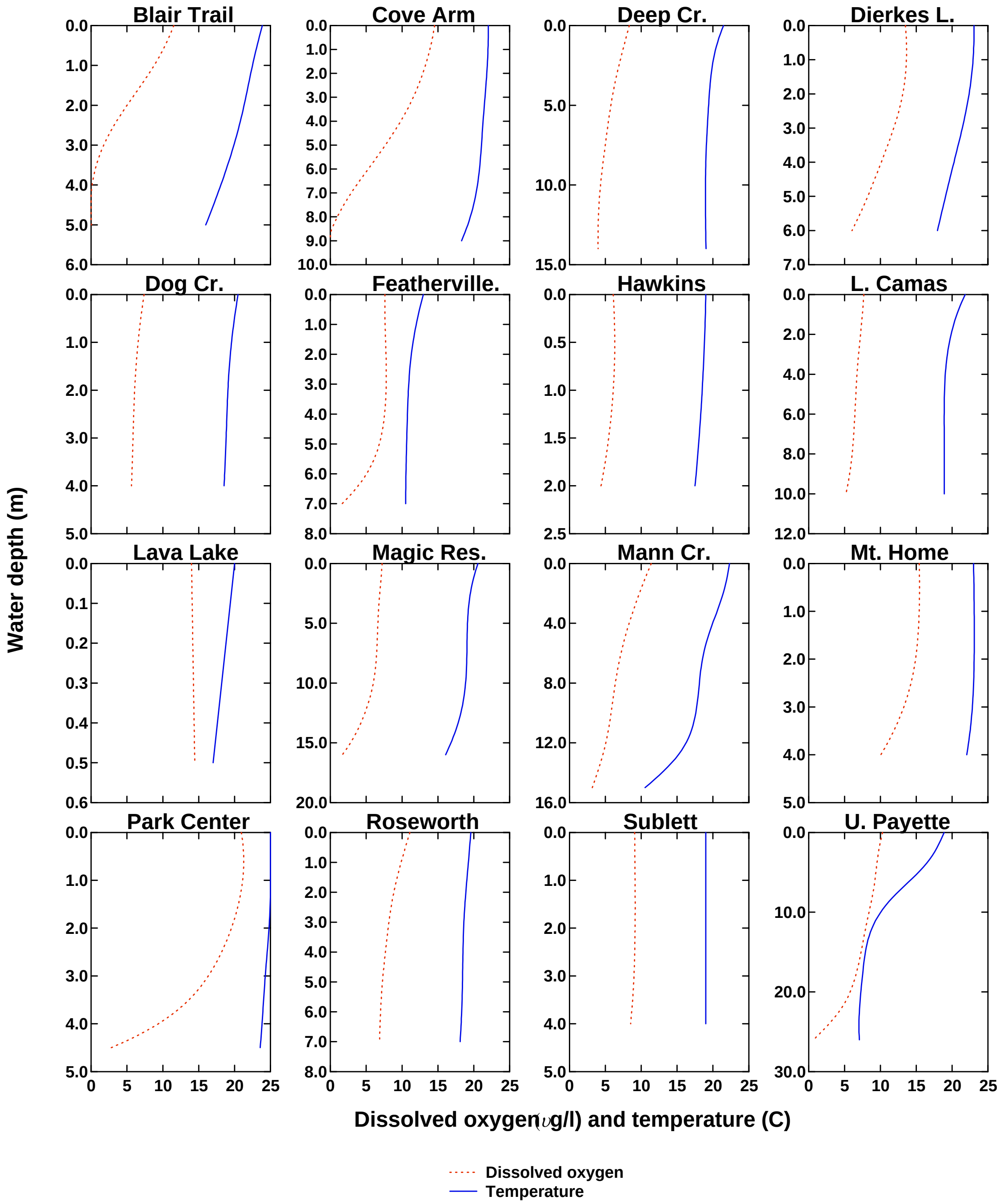
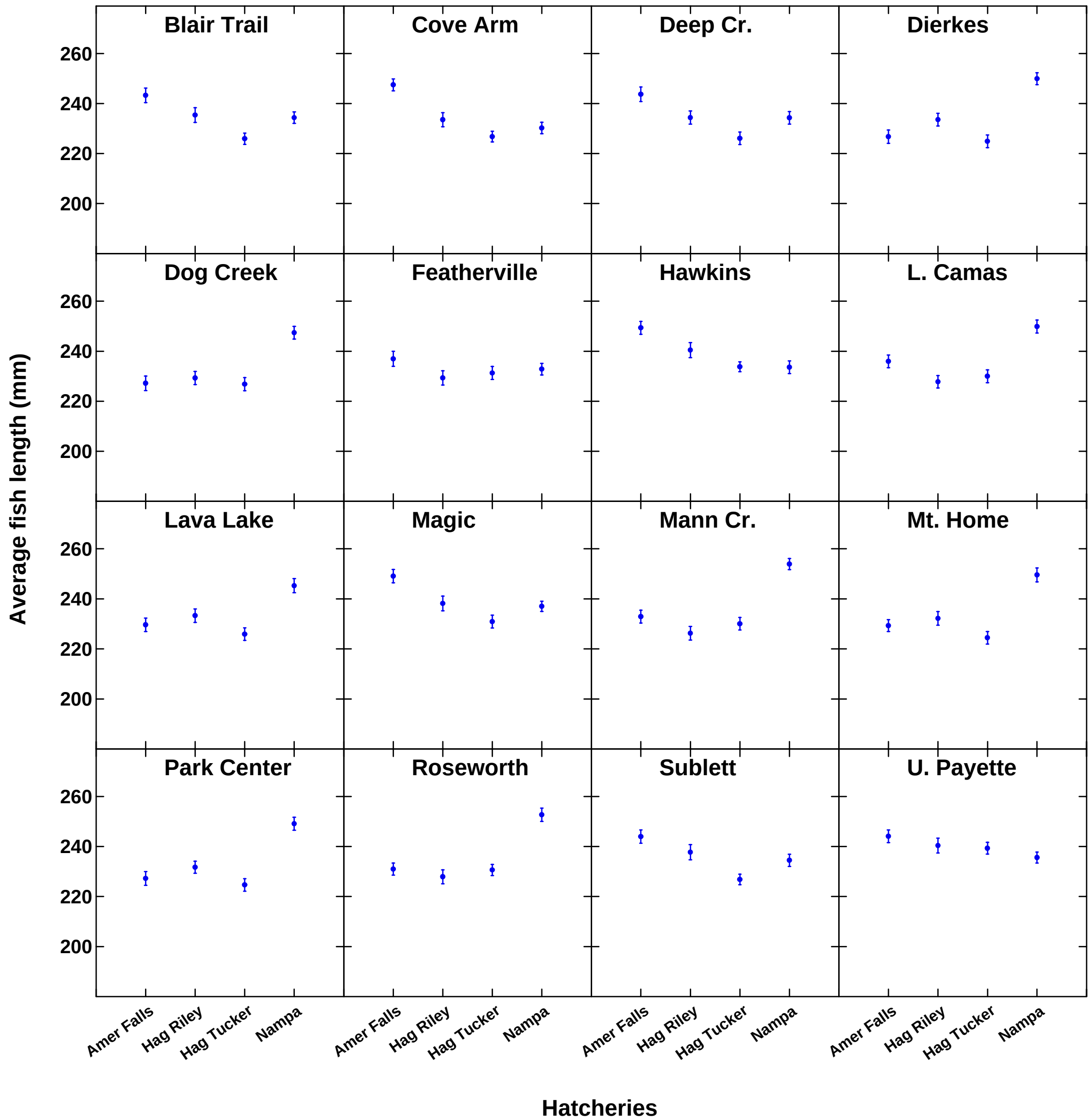
APPENDICES

Appendix A. Temperature and dissolved oxygen profiles for each of the study water stocked in August 1999.



Appendix B. The average lengths of CRBT stocked from four hatcheries in 16 lakes and reservoirs in spring, 1999. Error bars represent two standard errors.



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