FISHERY RESEARCH

Wild Trout Competition Studies

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Senior Fisheries Research Biologist

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Project 2: Wild Trout Investigations
Subproject #1: Competition Between Wild and Hatchery Rainbow Trout
Subproject #2: Movement of Sterile Hatchery Rainbow Trout After Stocking in a Riverine Environment

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Subproject #1: Competition Between Wild and Hatchery Rainbow Trout

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ABSTRACT

Competition between catchable-sized sterile rainbow trout *Oncorhynchus mykiss* (catchables) released into Idaho streams and wild trout is a concern. In 2005, I searched for streams suitable for a field experiment to investigate population-level effects of stocking catchables in streams on wild rainbow trout, and collected baseline information for these populations including trout compositions, abundance, and habitat information. Potential study streams were 1) not stocked within the last 10 years, 2) had at least 5 km of similar longitudinal habitat, 3) had simple salmonid communities dominated by rainbow trout, and 4) fit into one of three regulation types: general regulation (six trout daily limit), wild trout regulation (two trout daily limit), or special regulation (no trout harvest). Of the potential study sites surveyed, observed wild trout densities ranged from 0.43 to 29.18 fish/100 m^2. Brook trout *Salvelinus fontinalis* abundance was high in Hyndman Creek, Beaver Creek, and East Fork Big Wood River, negating their use. The West Fork Weiser River was also excluded due to limited distribution and small sizes of wild rainbow trout. The remaining streams sampled appeared suitable for the competition experiment. Wild rainbow trout were collected from six streams to ascertain accuracy and precision of age designations using scales compared to otoliths and to determine if correction factors could be made for scale-based ages. Agreement between scales and otoliths decreased with fish age but averaged 69%. Coefficients of variation for otoliths (9.6%) was much lower than for scales (19%). Efforts to correct scale-based ages were largely unsuccessful. Other avenues of assessing mortality such as using program MIX, length-corrected catch curves, or improving scale reading accuracy through incremental analysis should be pursued. Target stocking densities, determined by examining current stocking levels at Silver and Birch creeks, should be about 1.3 catchables/100 m^2.

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INTRODUCTION

Hatchery fish play an important role in Idaho's stream fisheries, but potentially pose a threat to wild trout populations. Maintaining put-and-take fisheries providing angling in streams, ponds, lakes, and reservoirs that previously held no game fish is a widely accepted use of hatchery-reared fish (Utter 1994; Epifanio and Nickum 1997). However, supplementing wild trout stream fisheries with hatchery fish raises concern about potential adverse genetic and ecological effects (e.g., Krueger and May 1991; Allendorf 1991). Idaho Department of Fish and Game (IDFG) has proactively dealt with potential adverse genetic effects of introduced trout on existing populations by stocking sterile rainbow trout, but concerns about adverse competitive interactions in streams and rivers supporting wild trout are still commonly heard from many groups and individuals who remain apprehensive.

Competition is defined as when a reduction in fitness of an organism occurs due to the limited supply of a resource held in common with other organisms, or the limited ability to exploit it because of interference by other organisms (Birch 1975). Reduced fitness levels in wild trout populations could result in decreased survival, growth, and fecundity rates (Moyle and Cech 1982). Most competition studies have indirectly assessed changes in fitness levels, or found evidence of competition, by inferring causal relationships between fitness and characteristics such as ability to maintain favorable positions (Griffith 1972; Fausch and White 1986; Mesa 1991; Dewald and Wilzbach 1992; Wang and White 1994; Peery and Bjornn 1996; McMichael et al. 1999), win agonistic bouts (Griffith 1972; Mesa 1991; Dewald and Wilzbach 1992; Wang and White 1994; Peery and Bjornn 1996; McMichael et al. 1999), gain weight (Dewald and Wilzbach 1992; Harvey and Nakamoto 1996), or survive (Kocik and Taylor 1994). While these studies at the individual scale are much easier to replicate with different manipulations of fish compositions and densities for interspecific competition versus intraspecific competition comparisons, they do not directly address concerns at the population level (Fausch 1988), which are rarely performed (Schoener 1983). More specifically, relatively few experiments of competition between hatchery and wild trout have been conducted despite widespread concern (Weber and Fausch 2003). This study will look for population-scale competition effects of catchable hatchery rainbow trout on wild rainbow trout populations by monitoring changes in abundance, growth rates, survival, and recruitment over several years. Work conducted in 2005 was directed at preparing for study implementation in 2006 by: 1) selecting streams to be included in the competition experiment; 2) collecting baseline abundance, species composition, and age structure data; 3) creating correction models for scale-based ages (Downs 1995); 4) determining stocking densities representative of current management practices; and 5) quantifying dispersal of sterile hatchery catchable rainbow trout (see Subproject #2).

Study stream selection was based on four criteria: 1) not stocked within the last 10 years, 2) had at least 5 km of similar longitudinal habitat, 3) had simple salmonid communities dominated by rainbow trout, and 4) fit into one of three regulation types: general regulation (six trout daily limit), wild trout regulation (two trout daily limit), or special regulation (no trout harvest). The restrictive criteria used to select study streams was intended to limit confounding variables common to competition studies such as extraneous competitive interactions, changes in habitat, and exploitation (Fausch 1988). To avoid potential lingering or chronic competition effects, streams or stream sections stocked within recent years (last 10 years) were not included in this study. An additional requirement of wild rainbow trout dominating the salmonid composition was set to limit potentially confounding effects of interspecific competition among wild salmonid populations. The impending competition study was designed as a split-plot factorial design, blocking by stream with subplots including the control and treatment sections found as pairs on each stream. With this design, it became imperative that sufficient distance exist between the treatment and control sections to ensure independence. To account for confounding effects of exploitation, streams with different regulations were blocked for in the study design: streams managed under general regulations, streams managed with wild trout regulations, or catch-and-release streams.

OBJECTIVES

1. Identify study streams for a impending competition study describing impacts of stocking catchable rainbow trout on wild rainbow trout populations.

2. Obtain baseline data on population abundance, species composition, and age structure.

3. Create models for scale-based age corrections using otoliths validation.

4. Determine abundance of wild trout and stocking density of catchables in currently stocked streams, representative of those to be used in the study.

STUDY SITES

In 2005, I sampled fish in the following streams managed under general regulations: Fourth Fork Rock Creek (Rock Creek is a tributary to the Snake River near Twin Falls); Beaver Creek (tributary to the Weiser River near Tamarack); East Fork Weiser River; West Fork Weiser River; Hyndman Creek (tributary to the East Fork Big Wood River); East Fork Big Wood River; and the Little Weiser River (Figure 1). The following streams under wild trout regulations were sampled: Squaw Creek (tributary to the Payette River near Emmett); Clear Creek (tributary to the South Fork Payette River near Lowman); the Little Lost River; Willow Creek (tributary to Camas Creek near Fairfield); and Medicine Lodge Creek (part of the Sinks drainage; Figure 1). The following streams were sampled to represent catch-and-release streams: South Fork Boise River; Middle Fork Boise River; and Badger Creek (tributary to the Teton River near Tetonia) (Figure 1). Although none of these streams is explicitly managed as catch-and-release, the 356 mm (14 inch) minimum size limit on the Middle and South forks of the Boise River and the isolated nature of Badger Creek effectively implies catch-and-release practices. Silver Creek (a tributary to the Middle Fork Payette River near Crouch) and Birch Creek (part of the Sinks drainage) are currently stocked streams that also support wild rainbow trout populations. These two streams were sampled to determine current stocking rates and catchable:wild trout ratios in productive and unproductive streams being stocked with catchables (Figure 1).

METHODS

Fish populations were sampled using electrofishing gear for multiple-pass depletion or mark-recapture population estimates. All captured fish were identified to species and measured (TL) to the nearest mm. Scale samples and weights were collected from all rainbow trout, or a minimum of 10 individuals from each 10 mm size group. Multiple-pass depletion and mark-recapture population estimates and 95% confidence intervals for fish larger than 100 mm TL were calculated using MicroFish 3.0 (Van Deventer and Platts 1985) and Fisheries Analysis Plus (FA+) program (Fisheries Analysis + 2004), respectively.

Rainbow trout collected from the Little Weiser River, East Fork Weiser River, Rock Creek, Little Lost River, and Badger Creek were aged using sagittal otoliths and scales. Ages for otoliths and scales were independently estimated by two readers without knowledge of length of fish (Devries and Frie 1996). Sagittal otoliths were obtained using the rapid removal technique of Schneidervin and Hubert (1986) and stored dry in labeled microcentrifuge vials. Whole otoliths were aged submerged in saline and/or dry using a dissecting microscope at 30X magnification. When different ages were estimated, both readers attempted to come to consensus by rereading the otoliths or scales together and referring to fish length and length frequency charts. When both readers were unable to reconcile ages based on otoliths, otoliths were sectioned. For sectioning, otoliths were fixed in epoxy, and 60 µm slices at the focus were obtained using an Isomet low-speed saw. These sectioned otoliths were read for age estimation by using a compound microscope and immersion oil at 40X magnification. Scales were prepared for reading by separating individual scales from the sample and placing them between two 0.0015 gauge acetate sheets. The acetate sheets were placed between two pieces of metal and pressed in a Carver Laboratory Press at 121°C and 10,000 psi for 30 s. Scales were discarded, and impressions were used for age estimation using a Microfiche reader. I counted circuli to the first and second annuli in an attempt to account for missing first year annuli.

Estimated ages based on scales versus otoliths were compared graphically. Precision in age estimations were assessed using average coefficients of variation for each stream as explained by Campana (2001). Percent agreement between scale and otolith-assigned ages were calculated for the whole sample as well as each otolith-assigned age group. Finally, following the methods of Downs (1995), I attempted to create simple models to correct for underestimates of fish ages when using scales (Table 1).

To determine stocking rates for the study, I estimated densities of hatchery and wild rainbow trout in two systems, Silver and Birch creek, which are streams currently stocked by IDFG and are representative of the streams being assessed during this project. Silver Creek is an unproductive third order stream, and Birch Creek is a productive third order stream strongly influenced by large springs. In Silver Creek and Birch Creek, seven study sites in each stream were randomly sampled in 2005. Densities at these sites were then extrapolated for the stream lengths subjected to stocking. Using these extrapolations of wild fish numbers, 2004 stocking records, and habitat data, a ratio of stocked hatchery fish : wild fish was calculated as well as an aerial density of hatchery catchables.

RESULTS

Overall, wild rainbow trout densities for fish >100 mm ranged from 0.43 fish/100 m^2 in Clear Creek to 29.18 fish/100 m^2 in the Little Weiser River. Rainbow trout usually dominated salmonid compositions (Figures 2, 3, and 4), but other salmonid species were also observed including brook trout *Salvelinus fontinalis*, bull trout *S. confluentus*, brown trout *Salmo trutta*, mountain whitefish *Prosopium williamsoni*, and brook trout x bull trout hybrids. Rainbow trout densities differed among the three groups of potential study streams, with the highest average density (13.5 fish >100 mm/100 m^2) found in general regulation waters and the lowest average density in the catch-and-release waters (3.0 fish >100 mm/100 m^2; Table 2). Wild rainbow trout densities were highest (>20 fish/100 m^2) in sections of the Little Weiser River, Rock Creek, Beaver Creek, and the Little Lost River.

Variability in age designations between readers was considerably higher for scales than for otoliths. As a measure of precision, coefficients of variation (CV) for otolith-based ages (9.6%) was half of that for scales (19%). Overall, percent agreement between ages assigned using otoliths and ages based on scales was 69% and was inversely related to fish age (Figure 5).

Attempts to correct for differences in ages using scales versus otoliths were largely unsuccessful. I could not increase percent agreement except at Rock Creek. Of the 175 models attempted and excluding Rock Creek, only four models increased agreement between scales and otoliths, and the increase was slight at 2.6% (Table 3). Every model attempted increased agreement between scales and otoliths for fish from Rock Creek. Model VA, with criteria of seven circuli, increased agreement the most (33%).

Average wild rainbow trout density in Silver Creek was 0.50 fish/100 m^2 while Birch Creek averaged 3.18 fish/100 m^2. In 2004, 1,120 and 1,200 hatchery catchables were stocked into Silver Creek and Birch Creek for a density of 1.26 and 0.58, hatchery trout/100 m^2, respectively.

DISCUSSION

Most streams sampled during the reporting period met the study stream criteria outlined above. The exceptions were East Fork Big Wood River, Hyndman Creek, Beaver Creek, and West Fork Weiser River. Although all of these have sufficient stream lengths available and are not currently stocked, brook trout comprised a substantial part (>20%; Figure 2) of the salmonids species compositions for the former three streams; and low abundance, limited distribution, and small sizes of rainbow trout precluded inclusion of the West Fork Weiser River.

Attempts to correct scale-based ages using circuli counts and known-age fish (fish aged with otoliths) were largely unsuccessful except at Rock Creek. This was contrary to the results of Downs (1995) who was able to increase agreement 50%. After comparing my data with those from Downs (1995), some differences were evident. The “best-fit” line bisects the 1:1 relationship line in Figure 6, which plots scale age versus otolith age for the same fish. A similar graph from Downs (1995) indicates the lines are nearly parallel, meaning Downs (1995) had simply to add a year to the scale-based ages to more closely agree with otolith ages. Therefore, it was apparent that precision was much lower for scale-based ages in this study compared with Downs (1995). This conclusion is supported by the relatively high coefficients of variation for the present study’s scale-based ages (19%) relative to the median (7.6%) of several published documents (n = 117) reading five different calcified structures reviewed by Campana (2001).

Thus, it appears that the traditional use of scales to assign ages for redband trout, especially fish age-3 and older in these potential study streams, will not yield sufficient precision for sensitive analyses. While it may be possible to simply age only the first few age classes with scales and use a length-at-age relationship based on otoliths from older-aged fish similar to Gatz et al. (1986), I recommend exploring other options for assigning ages with more precision. A possibility might be the Macdonald and Pitcher (1979) method of applying maximum likelihood to mixed distributions (length-frequency distributions) to tease out proportions belonging to different age classes in a repeatable manner. The attractive feature of this method is that proportions of the population for each age class are estimated with corresponding standard errors. In cases where zero or limited subsamples of fish are collected, Du (2002) created a user-friendly computer program that analyzes mixed distributions in the R (2004) statistical computing environment using the statistical methods of Macdonald and Pitcher (1979). Preliminary investigations indicated this methodology held promise when small subsamples of aged fish were available. With the limited number of subsamples I had available, I was able to use Du's (2002) program to estimate abundance of different age classes of fish with 95% confidence intervals (Table 4). However, because wild rainbow trout densities were naturally low in some of the study streams and the fact that subsamples would have to be drawn on an annual basis to account for treatment effects on growth, I concluded that this was not a viable option. Small subsamples from each study reach cannot be obtained annually because of potential confounding effects of this sampling on the parameters of interest for this study; namely abundance, growth, survival, and recruitment. Investigations are ongoing into the use of Program Mix (Du 2002) on mixed distributions without a subsample of known-age fish.

There are other options for using scales more precisely to assign redband trout ages. One of these methods attempts to increase the precision of reading scales by identifying and verifying the location of the first annulus in terms of number of circuli using incremental analysis (Campana 2001). Without incremental analysis, age designations using scales versus otoliths differed, but not in a consistent pattern (Figure 6). Agreement between scale and otolith ages was higher for the younger year classes. Also, a bimodal pattern was observed for circuli counts to the first annulus. Incremental analysis may increase the accuracy of determining where the first annulus occurs (Campana 2001). Lastly, it may be possible to produce better aging results using length-converted catch curves as described by Pauly (1984).

The goal of this competition experiment is to enable fishery managers to make informed decisions when stocking streams and provide them with information to better address questions from concerned members of the public. Therefore, the treatments to be used (i.e. the number of hatchery catchables stocked) must be representative of our current stocking practices. However, in a study with a similar design to that of the proposed study, Petrosky and Bjornn (1988) found that impacts to wild cutthroat trout due to competition with hatchery rainbow trout were only detectable at high stocking densities (3.4 fish/m). Thus, I will use the higher observed aerial density of hatchery catchable trout as the target for our treatment reaches. In this situation, observed effects could be qualified as a "worst-case scenario."

RECOMMENDATIONS

1. Use the following streams for the proposed study: a) General Regulation streams will be Fourth Fork Rock Creek, East Fork Weiser, and Little Weiser rivers; b) Wild Trout Regulation streams will be Squaw Creek, Clear Creek, Medicine Lodge Creek, and Little Lost River; and c) Special Regulation streams will be Badger Creek, Middle Fork Boise River, and South Fork Boise River.

2. Scales must be used to assign ages to fish, but efforts to improve precision and accuracy should continue to be explored, i.e. incremental analysis (Campana 2001), the mixed distribution analysis technique described by Macdonald and Pitcher (1979), or length-converted catch curves (Pauly 1984).

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Table 1. Definitions of models tested to see if missing annuli on scales could be accounted for, allowing for nonlethal methods for determining fish ages.

Model	Description
IA	If the number of circuli to the first distinguishable annulis is >*, add one year
IIA	If the number of circuli between the first two annuli is < the number to the first, add one year. If no second annulus, add one year if the number of circuli to the first annulus is larger than *.
IIIA	If the number of circuli between the first two annuli is ≤ the number to the first, add one year. If no second annulus, add one year if the number of circuli to the first annulus is larger than *.
IVA	If the number of circuli between the first two annuli is < the number to the first plus one, add one year. If no second annulus, add one year if the number of circuli to the first annulus is larger than *.
VA	If the number of circuli between the first two annuli is < the number to the first plus two, add one year. If no second annulus, add one year if the number of circuli to the first annulus is larger than *.

* = from 5 to 11, the seperate integers used in separate models

Table 2. Estimates of wild rainbow trout densities and species compositions (salmonids) for potential study streams sampled during 2005. Numbers in parentheses next to abundance estimates are associated 95% confidence intervals. (RBT = rainbow trout, BKT = brook trout, BRN = brown trout, and MWF = mountain whitefish)

		Sample		Average	RBT estimate		RBT density (fish/100 m^2)		Salmonid Percent Composition				
Stream	**Site**	**date**	**Length (m)**	**width (m)**	**<100 mm**	**>100 mm**	**<100 mm**	**>100 mm**	**RBT**	**BKT**	**BLT**	**BRN**	**MWF**
					General regulation waters								
Little Weiser River	Lower	9/20/2005	613	9.1	NA	1,125[a] (1,032-1,218)	NA	20.08[a] (18.42-21.74)	1.00	-	-	-	-
Little Weiser River	Upper	9/26/2005	495	7.6	NA	1,102[a] (1,039-1,165)	NA	29.18[a] (27.51-30.85)	0.999	0.001	-	-	√
East Fork Big Wood River	Lower	8/10/2005	85	6.0	NA	10 (10-11)	NA	1.95 (1.95-2.14)	0.44	0.56	-	-	-
East Fork Big Wood River	Middle	8/10/2005	88	5.1	NA	3 (NA)	NA	0.67	0.50	0.50	-	-	-
East Fork Big Wood River	Upper	8/9/2005	84	5.4	NA	1 (NA)	NA	0.22	0.04	0.96	-	-	-
Hyndman Creek	Lower	8/9/2005	83	7.5	13 (13-15)	38 (30-55)	2.09 (2.09-2.41)	6.10 (4.82-8.84)	0.91	0.09	-	-	-
Hyndman Creek	Upper	8/9/2005	89	7.0	NA	5 (5-8)	NA	0.80 (0.80-1.28)	0.42	0.58	-	-	-
West Fork Weiser River	Lower	7/28/2005	126	13.1	0	0	0	0			-	-	-
West Fork Weiser River	Middle	7/28/2005	100	4.8	24 (9-141)	41 (35-54)	4.98 (1.87-29.25)	8.51 (7.26-11.20)	0.81	0.19	-	-	-
West Fork Weiser River	Upper	7/26/2005	100	5.7	25 (25-26)	35 (35-37)	4.41 (4.41-4.59)	6.17 (6.17-6.53)	0.92	0.08	-	-	-
East Fork Weiser River	Lower	7/21/2005	474	5.8	NA	456[a] (393-519)	NA	16.47[a] (14.20-18.75)	1.00		-	-	-
East Fork Weiser River	Upper	7/27/2005	500	6.2	NA	601[a] (523-679)	NA	19.45[a] (16.93-21.97)	0.99	0.01[b]	-	-	-
Fourth Fork Rock Creek	Lower	7/6/2005	895	5.7	NA	1,132[a] (1,037-1,227)	NA	22.19[a] (20.33-24.05)	0.974	0.004	-	0.02	-
Fourth Fork Rock Creek	Upper	7/5/2005	433	4.0	NA	478[a] (405-551)	NA	27.60[a] (23.38-31.81)	0.80	0.20	-	-	-
Beaver Creek	Lower	7/20/2005	505	3.5	NA	292[a] (252-332)	NA	16.66 (14.38-18.95)	0.79	0.21	-	-	-
Beaver Creek	Upper	7/22/2005	585	3.0	NA	370[a] (300-440)	NA	21.22[a] (17.21-25.24)	0.73	0.27	-	-	-
					Wild trout waters								
Willow Creek	1	10/5/2005	53	3.1	3 (3-6)	11 (11-12)	1.83 (1.83-3.67)	6.73 (6.73-7.34)	1.00	-	-	-	-
Willow Creek	2	10/5/2005	79	3.0	5 (5-6)	18 (18-19)	2.11 (2.11-2.53)	7.59 (7.59-8.02)	1.00	-	-	-	-
Willow Creek	3	10/6/2005	81	2.8	8 (8-9)	36 (36-37)	3.59 (3.59-4.04)	16.16 (16.16-16.61)	1.00	-	-	-	-
Willow Creek	4	10/6/2005	79	2.6	32 (29-40)	41 (41-43)	15.58 (14.12-19.47)	19.96 (19.96-20.93)	1.00	-	-	-	-
Medicine Lodge Creek	Lower	10/20/2005	174	5.3	NA	46 (44-51)	NA	4.94 (4.73-5.48)	1.00	-	-	-	-
Medicine Lodge Creek	Upper	10/20/2005	197	6.3	3 (3-6)	17 (17-18)	0.24 (0.24-0.48)	1.37 (1.37-1.45)	1.00	-	-	-	-
Little Lost River	Lower	9/28/2005	642	7.1	NA	545[a] (489-601)	NA	12.01[a] (10.77-13.24)	0.95	0.01	0.04	-	-
Little Lost River	Upper	9/27/2005	418	7.3	NA	636[a] (593-679)	NA	20.76[a] (19.35-22.16)	0.88	0.09	0.03	-	-
Clear Creek	1	9/12/2005	117	109.4	18 (17-23)	55 (51-63)	0.14 (0.13-0.18)	0.43 (0.40-0.49)	0.96	0.04	-	-	√
Clear Creek	2	9/13/2005	100	9.8	18 (18-20)	43 (42-47)	1.83 (1.83-2.04)	4.38 (4.28-4.79)	1.00	-	-	-	-
Clear Creek	3	9/13/2005	107	10.3	21 (21-23)	68 (64-75)	1.91 (1.91-2.10)	6.20 (5.84-6.84)	0.98	-	0.02	-	-
Clear Creek	4	9/13/2005	70	6.4	12 (12-13)	38 (38-40)	2.69 (2.69-2.91)	8.52 (8.52-8.97)	1.00	-	-	-	-
Squaw Creek	Lower	8/2/2005	100	9.2	2 (2-7)	38 (37-41)	0.22 (0.22-0.76)	4.14 (4.03-4.47)	1.00	-	-	-	-
Squaw Creek	Middle	8/2/2005	110	8.2	13 (13-14)	73 (69-79)	1.44 (1.44-1.55)	8.09 (7.65-8.76)	1.00	-	-	-	√
Squaw Creek	Upper	8/3/2005	51	6.7	35 (31-45)	53 (47-64)	10.30 (9.13-13.25)	15.60 (13.84-18.84)	1.00	-	-	-	-
					Catch-and-release waters								
Middle Fork Boise River	1	9/7/2005	806	24.1	NA	166 (91-241)	NA	0.85 (0.47-1.24)	1.00	-	-	-	√
Middle Fork Boise River	2	9/6/2005	1141	23.4	NA	218 (158-278)	NA	0.82 (0.59-1.04	1.00	-	-	-	√
Middle Fork Boise River	3	9/7/2005	1123	19.1	NA	363 (297-429)	NA	1.69 (1.38-2.00)	0.996	-	0.004	-	√
Middle Fork Boise River	4	9/6/2005	860	22.0	NA	237 (193-281)	NA	1.25 (1.02-1.49)	0.98	-	0.02	-	√
South Fork Boise River	Lower	8/23/2005	1250	22.8	NA	663 (509-817)	NA	2.33 (1.79-2.87)	0.93	-	0.07	-	√
South Fork Boise River	Upper	9/1/2005	1050	24.9	NA	457 (353-561)	NA	1.75 (1.30-2.15)	0.97	-	0.03	-	√
Badger Creek	Lower	9/23/2005	94	11.7	13 (13-14)	105 (100-113)	1.18 (1.18-1.27)	9.51 (9.06-10.24)	1.00[c]	-	-	-	-
Badger Creek	Upper	9/24/2005	109	18.0	52 (50-57)	109 (106-114)	2.65 (2.55-2.91)	5.56 (5.40-5.81)	1.00[c]	-	-	-	-

[a] Includes fish ≥75.

[b] Only one brook trout was observed at the mouth of a tributary.

[c] Includes cutthroat trout *O. clarki* and rainbow x cutthroat hybrids.

Table 3. Changes in percent agreement between scale-based and otolith-based age designations after using simple models to account for missing first year annuli. Positive changes are in bold.

		Values for X						
Stream	**Model**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
EF Weiser R	IA	-55.2	-47.4	-15.8	-2.6	**2.6**	0.0	0.0
Little Lost R	IA	-68.8	-62.5	-31.3	-18.8	-15.7	-3.2	-3.2
Little Weiser R	IA	-47.8	-43.5	-34.8	-34.8	-17.4	-10.9	-4.3
Rock Cr	IA	**0.9**	**12.2**	**25.1**	**28.4**	**31.6**	**31.6**	**30.0**
Willow Cr	IA	-73.0	-59.5	-18.9	-2.7	0.0	-2.7	0.0
EF Weiser R	IIA	-47.4	-44.7	-31.6	-23.7	-23.7	-23.7	-26.3
Little Lost R	IIA	-65.7	-62.5	-46.9	-34.4	-31.3	-21.9	-21.9
Little Weiser R	IIA	-34.8	-32.6	-30.4	-30.4	-19.6	-15.2	-10.9
Rock Cr	IIA	**7.4**	**10.6**	**20.3**	**17.1**	**17.1**	**17.1**	**17.1**
Willow Cr	IIA	-73.0	-64.9	-35.2	-21.6	-18.9	-21.6	-18.9
EF Weiser R	IIIA	-31.6	-28.9	-15.8	-7.9	-7.9	-7.9	-10.5
Little Lost R	IIIA	-46.9	-43.8	-28.2	-15.7	-12.5	-3.2	-3.2
Little Weiser R	IIIA	-41.3	-39.1	-36.9	-36.9	-26.1	-21.7	-17.4
Rock Cr	IIIA	**12.2**	**15.5**	**25.1**	**21.9**	**21.9**	**21.9**	**21.9**
Willow Cr	IIIA	-59.5	-51.4	-21.6	-8.1	-5.4	-8.1	-5.4
EF Weiser R	IVA	-26.3	-23.7	-10.5	-2.6	-2.6	-2.6	-5.2
Little Lost R	IVA	-46.9	-43.8	-28.2	-15.7	-12.5	-3.2	-3.2
Little Weiser R	IVA	-39.1	-36.9	-34.8	-34.8	-23.9	-19.6	-15.2
Rock Cr	IVA	**17.1**	**20.3**	**30.0**	**26.8**	**26.8**	**26.8**	**26.8**
Willow Cr	IVA	-56.8	-48.7	-18.9	-5.4	-2.7	-5.4	-2.7
EF Weiser R	VA	-21.0	-18.4	-5.2	**2.6**	**2.6**	**2.6**	0.0
Little Lost R	VA	-46.9	-43.8	-28.2	-15.7	-12.5	-3.2	-3.2
Little Weiser R	VA	-28.2	-26.1	-23.9	-23.9	-13.0	-8.7	-4.3
Rock Cr	VA	**20.3**	**23.5**	**33.2**	**30.0**	**30.0**	**30.0**	**30.0**
Willow Cr	VA	-54.1	-46.0	-16.2	-2.7	0.0	-2.7	0.0

Table 4. Abundance estimates by age class for age classes 1, 2, 3, and 4 or older obtained using Du's (2002) R program. The 95% confidence intervals are in parentheses.

Stream	Site	Age 1	Age 2	Age 3	Age 4+
Rock Creek	Lower	761 (41)	249 (41)	105 (33)	17 (22)
Rock Creek	Upper	274 (25)	171 (27)	35 (17)	1 (2)
Little Weiser River	Lower	671 (69)	295 (69)	66 (35)	93 (38)
Little Weiser River	Upper	549 (56)	397 (76)	123 (63)	33 (36)
Willow Creek	Lower	14 (1)	2 (1)	NA	NA
Willow Creek	Upper	51 (6)	12 (6)	NA	NA
Badger Creek	Lower	42 (12)	31 (12)	15 (9)	4 (6)
Badger Creek	Upper	38 (12)	26 (11)	8 (6)	NA
East Fork Weiser R.	Lower	161 (25)	158 (28)	86 (29)	51 (24)
East Fork Weiser R.	Upper	144 (40)	302 (44)	110 (31)	45 (25)

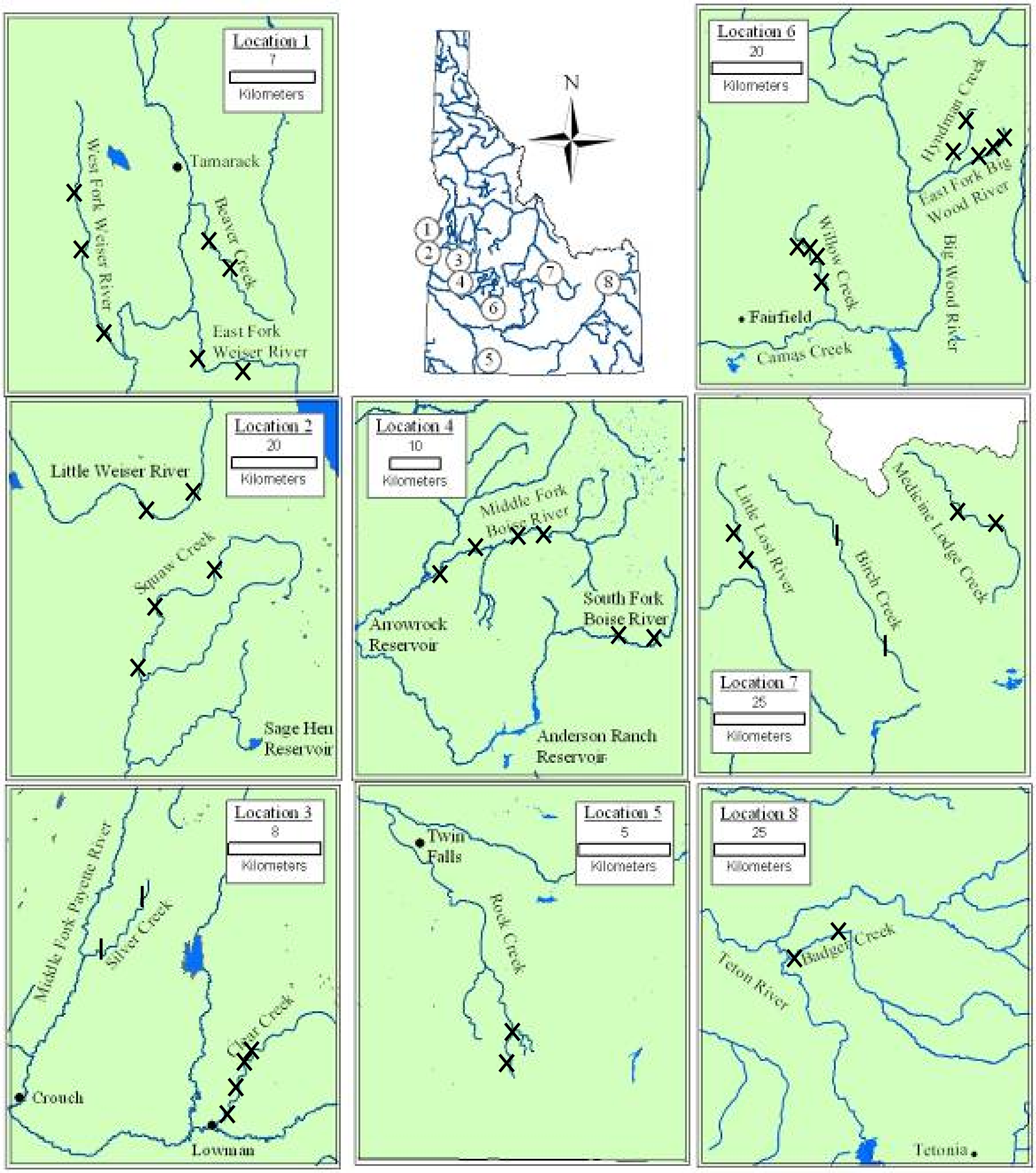

Figure 1. Study streams, general areas (| |), and locations (X) sampled during the 2005 field season.

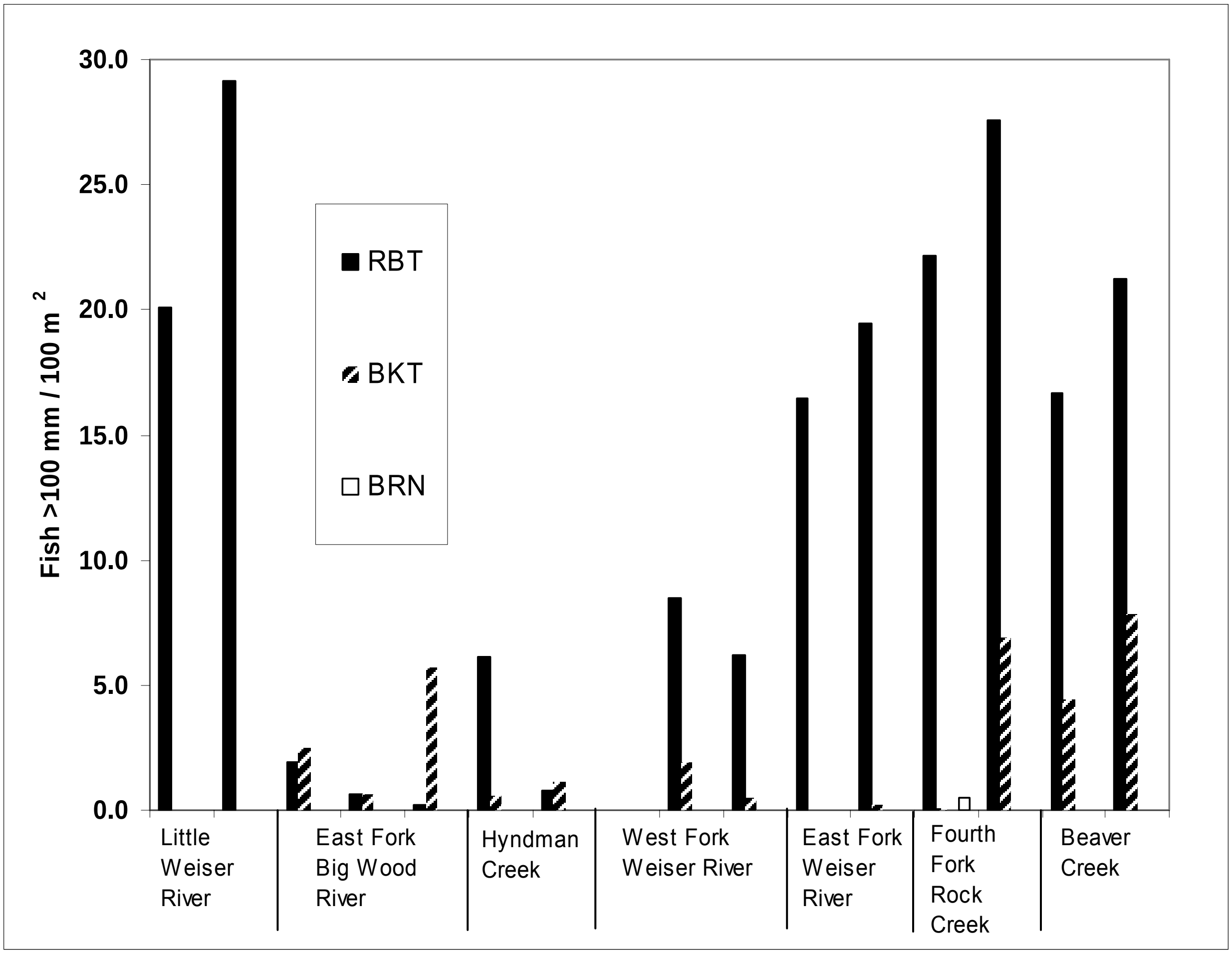

Figure 2. Estimated trout densities for sampled streams managed under general regulations. (RBT = rainbow trout, BKT = brook trout, and BRN = brown trout).

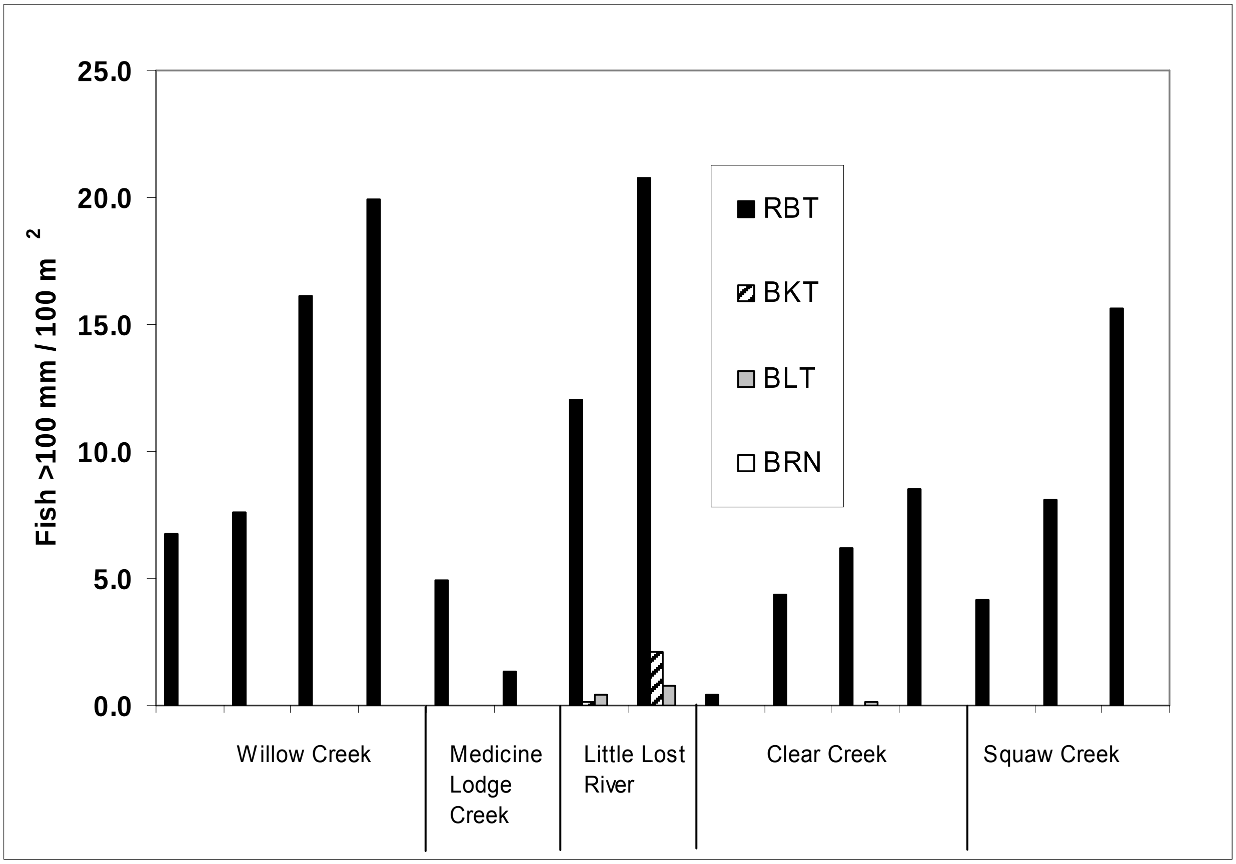

Figure 3. Estimated trout densities for sampled streams managed under wild trout regulations. (RBT = rainbow trout, BKT = brook trout, BLT = bull trout, and BRN = brown trout).

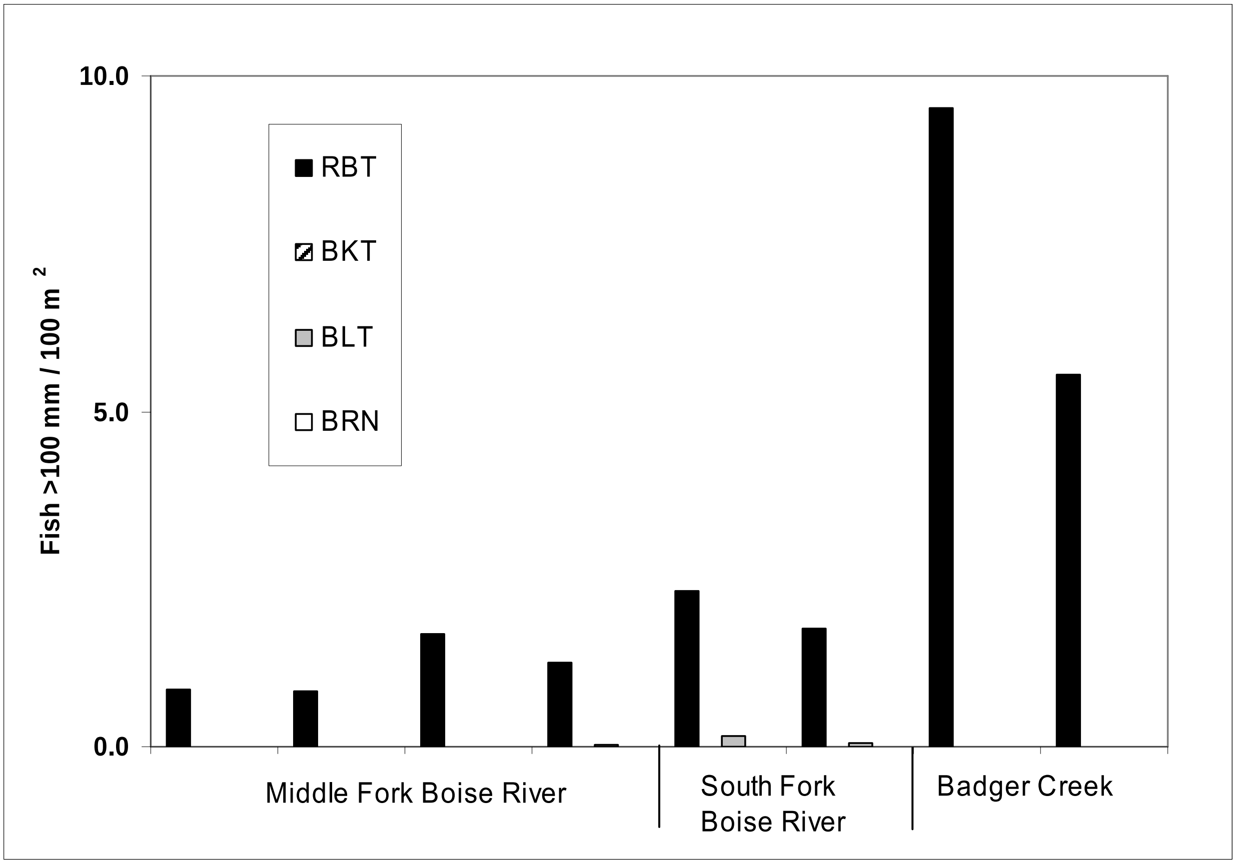

Figure 4. Estimated trout densities for sampled streams managed under restrictive regulations implying catch-and-release or have limited access and therefore low exploitation. (RBT = rainbow trout, BKT = brook trout, BLT = bull trout, and BRN = brown trout).

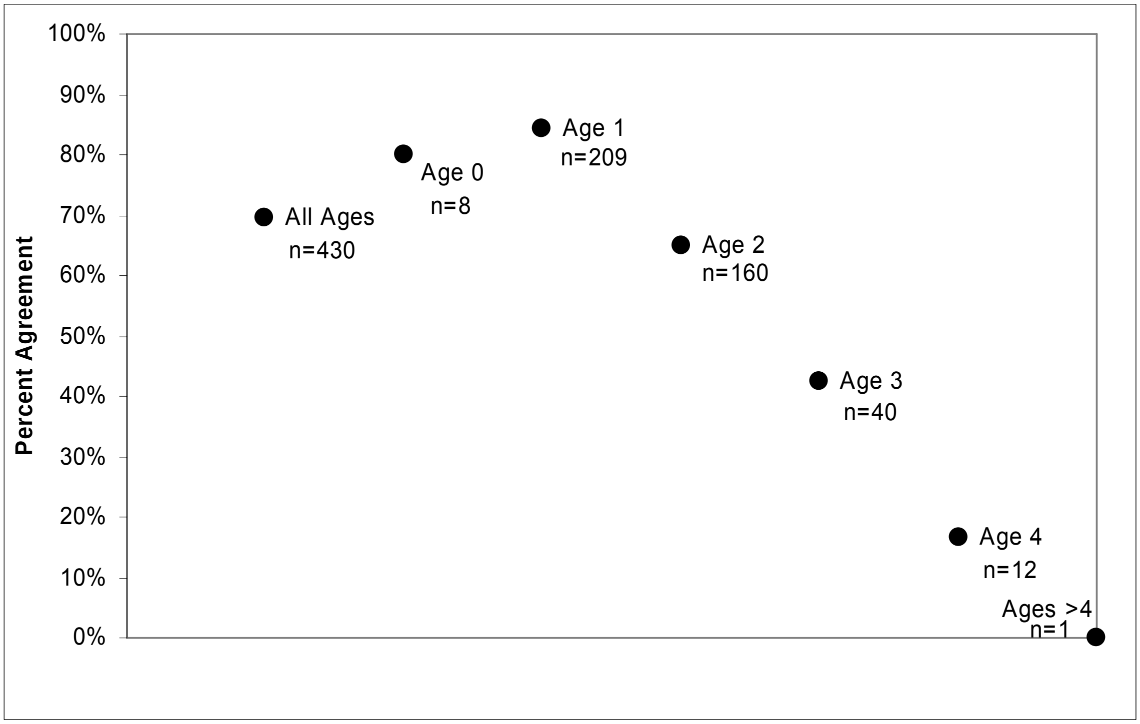

Figure 5. Percent agreement between ages assigned using scale impressions and sagittal otoliths from fish from the Little Weiser River, the East Fork Weiser River, Rock Creek, the Little Lost River, and Willow Creek.

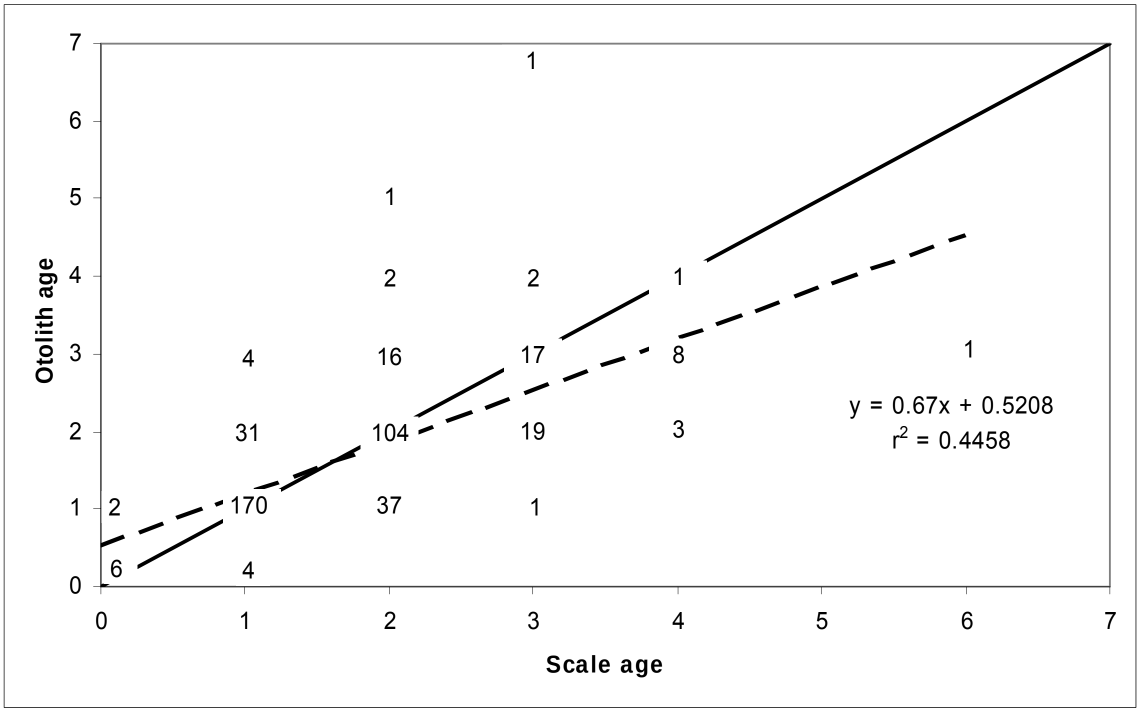

Figure 6. Scatterplot of age agreement between otoliths and scale based ages. The solid line represents 100% agreement and the dashed line represents the best-fit line. Numbers in figure represent sample sizes.

ANNUAL PERFORMANCE REPORT
SUBPROJECT #2: MOVEMENT OF STERILE HATCHERY RAINBOW TROUT AFTER STOCKING IN A RIVERINE ENVIRONMENT

State of: Idaho

Grant No.: F-73-R-27, Fishery Research

Project No.: 2

Title: Wild Trout Competition Studies

Subproject #2: Movement of Sterile Hatchery Rainbow Trout After Stocking in a Riverine Environment

Contract Period: July 1, 2005 to June 30, 2006

ABSTRACT

Investigations into dispersal of hatchery-reared fish began nearly a century ago. Factors shown to influence dispersal distances include stream size, water temperature, species, and strain, but triploidy is likely another factor affecting dispersal distances in a stream environment that has not been studied. I monitored movements of 200 triploid hatchery rainbow trout *Oncorhynchus mykiss* (catchables) stocked into the Middle Fork Boise and Middle Fork Payette rivers using highly visible Floy® tags and a combination of snorkel surveys and angler reports. An average of 27 tagged fish were observed during the four weekly snorkel surveys on the Middle Fork Boise River where 83% of the observed fish were within 1.5 km of the stocking point. Observations of fish on the Middle Fork Payette River were scarce within 4 km of the stocking point after only 3 d. While strong conclusions cannot be drawn, it appears when suitable habitat and flow conditions are present, planted catchable triploid trout remain near (within 1.5 km) the stocking point. Additionally, the new toll-free tag reporting hotline appears to be the preferred avenue for anglers wishing to report catches of tagged fish.

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INTRODUCTION

Maintaining independent experimental units (study stream reaches) during an upcoming competition study investigating effects of stocking sterile hatchery rainbow trout *Oncorhynchus mykiss* (catchables) in streams supporting wild trout is vital to the viability of the experiment. Since no physical barriers will be used to keep catchables within the intended treatment reaches, it is imperative that sufficient stream lengths separate control and treatment reaches. The question is, “How long is sufficient?” Researchers have investigated post-stocking movements and survival of hatchery-reared trout since the early twentieth century (Cobb 1933) and have concluded catchable hatchery trout typically move little and do not persist long after being stocked into a river environment (Cresswell 1981; Miller 1958). After a review of several articles, Cresswell (1981) concluded that usually a large proportion of the stocked fish remain near the stocking point and that most post-stocking movement occurred in the downstream direction. When movement does occur, it seems to be influenced inversely by both stream size (Ratledge and Cornell 1953) and water temperature (Cooper 1953) and occurs in a predominately downstream direction for rainbow trout (Cobb 1933; Cresswell 1981).

While rainbow trout seem to be more predisposed to post-stocking movement than other resident salmonids species commonly planted in streams, movement distance may not be so great as to preclude the possibility of having a control and treatment section on the same stream where hatchery catchables are planted in and around the treatment reach. Previous research in Idaho streams indicate that the vast majority of planted diploid catchable rainbow trout remained within approximately 1.5 km of the stocking point (Bjornn and Mallet 1964; Chapman 1983; Mauser 1994). However, just as environmental conditions appear to influence when movement occurs, the distance of movement can be influenced by differences in broodstock (Moring 1982) and rearing conditions (P. Coonts, IDFG personal communication). It is likely, then, that triploidy versus diploidy may affect movement distances similar to strain and rearing environment. The purpose of this work is to describe movements of stocked triploid catchables so that study sites in the forthcoming competition study can be selected far enough apart to ensure independence, but close enough to effectively utilize available stream lengths.

OBJECTIVE

1. Define lengths of stream utilized by catchables around a single stocking point.

METHODS

Catchables from Nampa Hatchery were tagged with 5 cm pink Floy® tags just below the dorsal fin on the left side. Tags were angled back towards the posterior of the fish to reduce resistance. Tags were marked with unique 4-digit numbers and the toll-free phone number inscription. Although the present study was not oriented toward collecting harvest information, the use of Floy® tags to allow for easy identification of fish allowed me to collect ancillary tag return data. After tagging, fish were held within an enclosure placed in a raceway for approximately 24 hr. The holding cage was inspected for shed tags before and after loading tagged fish into the stocking truck.

Catchables were planted into the middle forks of the Boise and Payette rivers. In the Middle Fork Boise River, fish were planted off the bridge near Sheep Creek, approximately 3 km downstream from the mouth of the North Fork Boise River. In the Middle Fork Payette River, fish were planted near the mouth of Boon Creek approximately 5 km upstream of the Boise National Forest boundary (Figure 7).

Following stocking, tagged catchables were located by snorkeling. Once tagged fish were observed, their number and location was marked using a GPS unit. The starting and endpoints of the snorkel survey were dependent on the location of tagged catchables, such that at least 500 m upstream and 500 m downstream of the first and last observed catchable was observed, respectively. Tag returns were quantified by calculating the percentage of tagged fish caught and reported by anglers relative to the total number of tagged catchables released.

RESULTS

Tag retention for 24 hr was high. No shed Floy® tags were observed within the holding pen. Catchables were transported to the release sites and planted at single points in the Middle Fork Boise River on July 19, 2005 and the Middle Fork Payette River on August 17, 2005; each site received 200 fish. The Middle Fork Boise River was sampled via snorkeling four times at roughly weekly intervals starting July 25, 6 d after the stocking event. Sampled stream lengths increased from 6.5 km for the first event to over 9.5 km for the last sampling event. During the four snorkel surveys, an average of 27 tagged catchables were observed with 22 (11%), 40 (20%), 27 (13.5%), and 17 (8.5%) for the four sampling events, respectively (Figures 8–11). Sampling was terminated after the fourth week due to the decline of observations. Of the fish that were observed farther than 1.5 km away from the stocking point, two were observed downstream (max. distance 2.8 km) and 14 were observed upstream (max. distance 4.1 km). However, the majority (83%) of the observed tagged catchables were within 1.5 km of the stocking point (Figures 8–11).

The Middle Fork Payette River was sampled three times after stocking. The first two sampling events occurred within 3 d of the stocking event. Ninety-three (46.5%) tagged catchables were observed the day after stocking, all near the stocking point (Figure 12). However, two days later, only four (2%) fish were observed. These catchables moved slightly upstream of the stocking point up to 1.5 km (Figure 13). Two weeks later, an attempt was made to locate some of the numerous missing fish. Large pools along approximately 10 km of the Middle Fork Payette River centered on the stocking point were sampled. Only three (1.5%) tagged fish were observed, two within 0.5 km of the stocking point and one approximately 4 km upstream.

Of the 400 Floy® tags released, 47 (12%) were reported by 27 anglers. Of these fish, 36 were caught in the Middle Fork Boise River, nine were caught in the Middle Fork Payette River, and two were caught in the South Fork Payette River, downstream of the Middle Fork confluence. Four fish (9%) of the reported catch were released, and all four of these fish were caught in the Middle Fork Boise River. Most tags (25) were reported through the new toll free hotline, while the others were either mailed (20) or e-mailed (2).

DISCUSSION

Movement of triploid catchables used in the present study was similar that of diploids used by Mauser (1994) in the upper Salmon River where the majority of the tagged fish were observed within 1.5 km of the release site. While movement occurred in both directions, more tagged catchables were observed upstream than downstream, contrary to the results of Cobb (1933) and Cresswell (1981). Nonetheless, the majority of the observed tagged catchables were within 1.5 km of the stocking point, suggesting that a distance of 3 km between treatment and control reaches should be sufficient to maintain independence over a 4 week interval. However, total numbers of observed tagged catchables were low (<20%) relative to the number released. The large proportion of catchables unaccounted for introduces uncertainty into my conclusions, but two facts help support them: results were similar to a previous study with similar design, and numbers of observations universally declined as surveyors moved away from the stocking point.

My conclusions are based largely on results observed in the Middle Fork Boise River. Due to the lack of observations of tagged fish in the Middle Fork Payette River, I cannot draw strong conclusions about the movements of those fish. Based on ancillary tag return data, it is possible that many of the catchables stocked into the Middle Fork Payette River moved downstream significant distances (>22 km), which may explain why few fish were later observed. Unfortunately, I only received two tag returns from this downstream zone. Habitat and predation may have influenced catchable movement in the Middle Fork Payette River. The Middle Fork Payette River is a smaller stream than the Middle Fork Boise River, averaging only 105 cubic feet per second (cfs) during the month of August compared to 463 cfs for the Middle Fork Boise River (USGS 2006). The amount of pool habitat also appeared to be lower, but was not quantified. Additionally, there was an active osprey nest within 2 km of the stocking point on the Middle Fork Payette River, which may have affected catchable behavior (Grassley et al. 2002). Therefore, while 3 km appears sufficient longitudinal distance to maintain independence between stream reaches in terms of stocking hatchery catchables, other variables including habitat suitability and diversity, predation, cover, and stream size may affect movement distances of recently stocked catchables.

RECOMMENDATIONS

1. Work should continue to be focused on movement of hatchery catchables post-stocking. Radio telemetry would be useful in more accurately assessing dispersal distances. Additional efforts should include movement distances in streams with variable habitat conditions and multiple fish strains differentially marked.

ACKNOWLEDGEMENTS

Partial funding was provided by the Sport Fish and Restoration Act. Helpful comments were provided by David Venditti, Melo Maiolie, and Kevin Meyer on earlier drafts of this report. Steve Elle, Jeremiah Wood, Dave Banks, and Joseph Aranda assisted with data collection and analysis.

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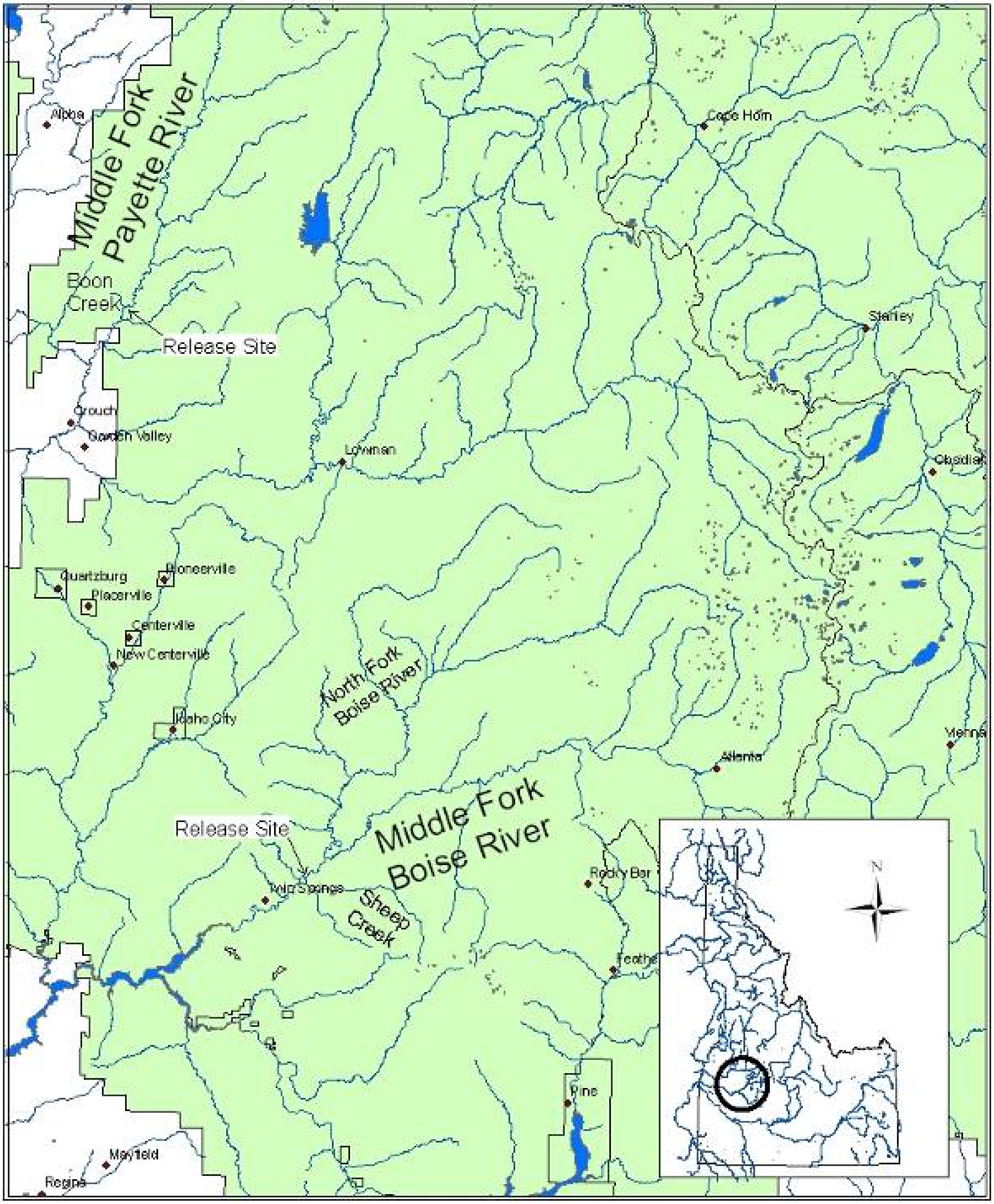

Figure 7. Study area map of the Middle Fork Payette River and Middle Fork Boise River and release sites.

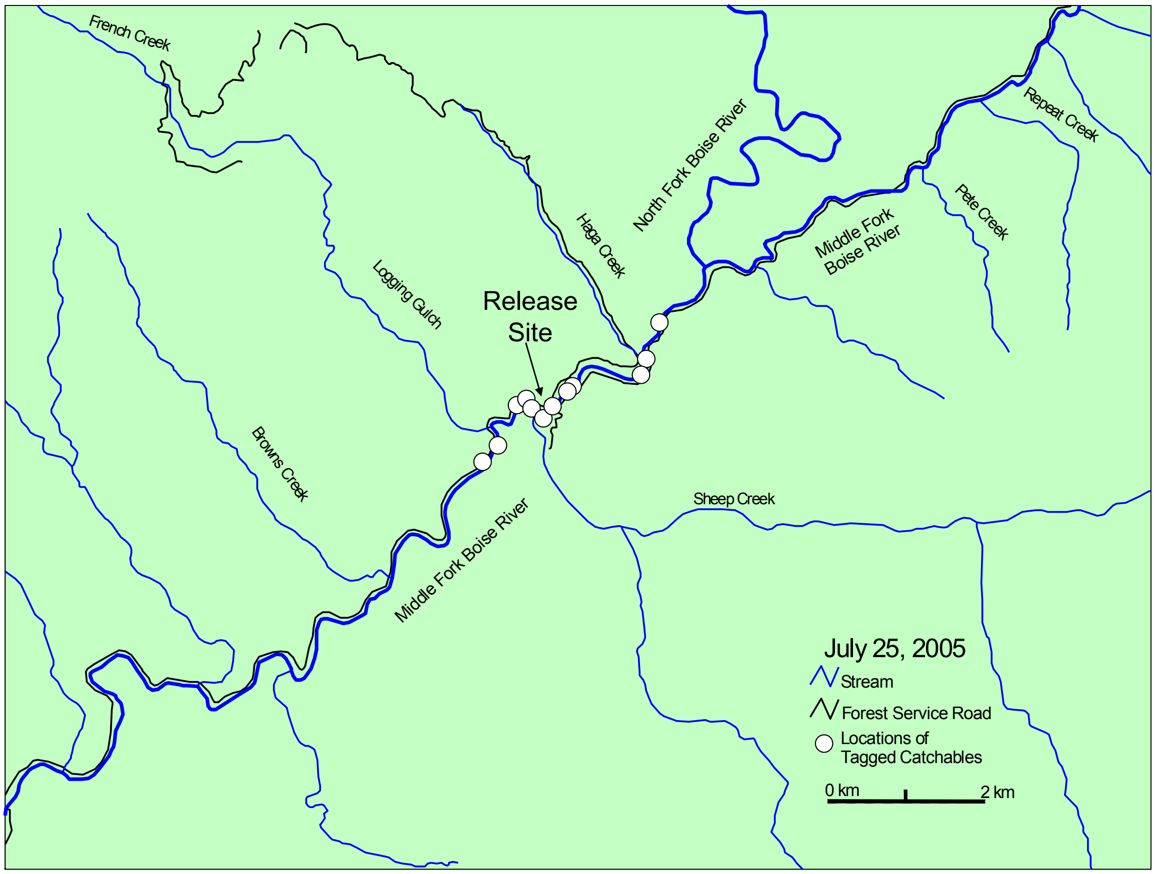

Figure 8. Locations of Floy®-tagged fish observed while snorkeling the Middle Fork Boise River on July 25, 2005.

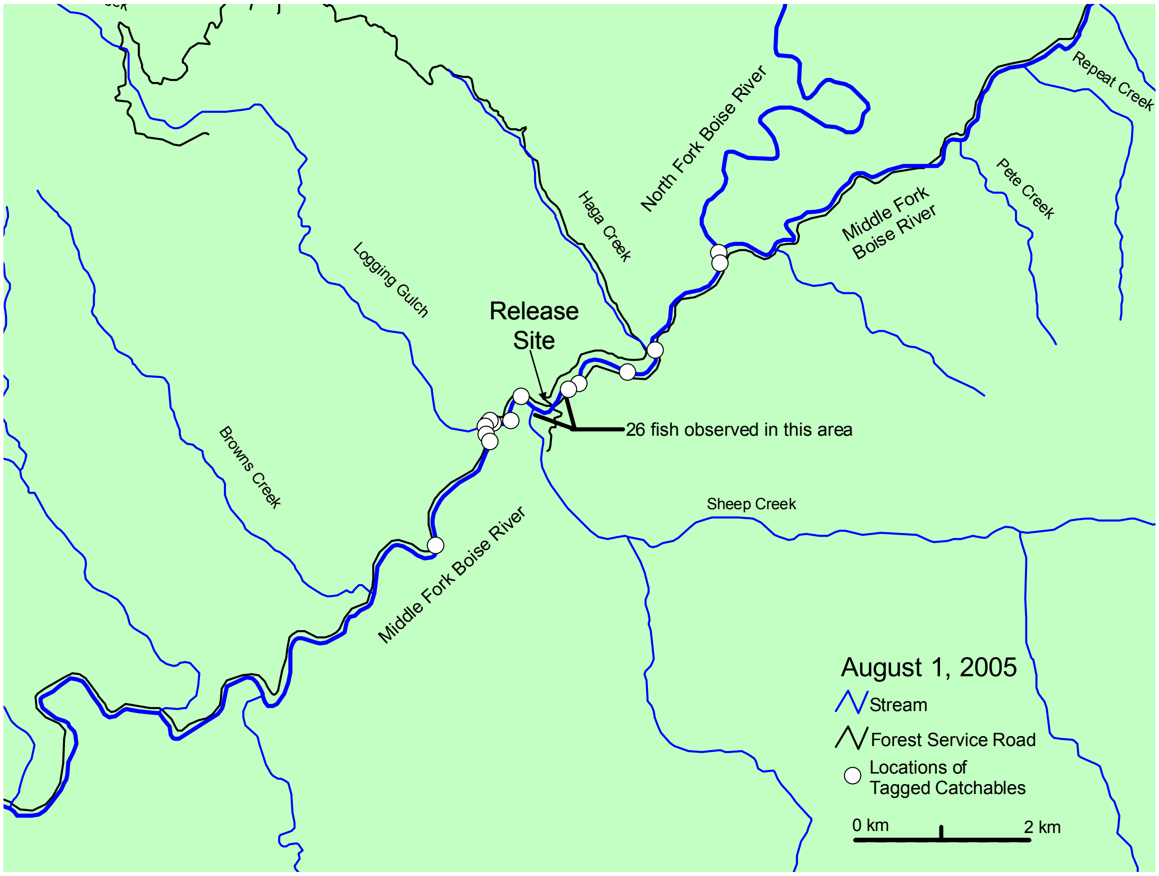

Figure 9. Locations of Floy®-tagged fish observed while snorkeling the Middle Fork Boise River on August 1, 2005.

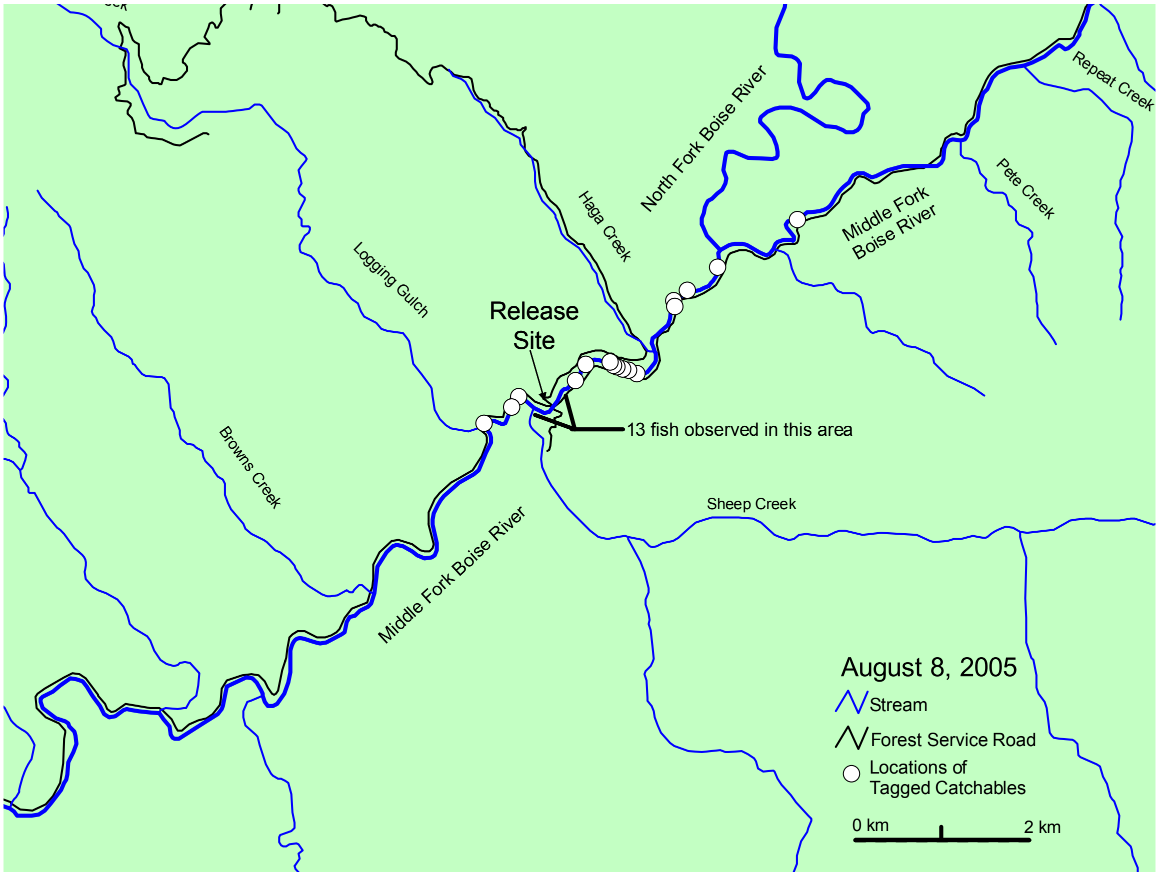

Figure 10. Locations of Floy®-tagged fish observed while snorkeling the Middle Fork Boise River on August 8, 2005.

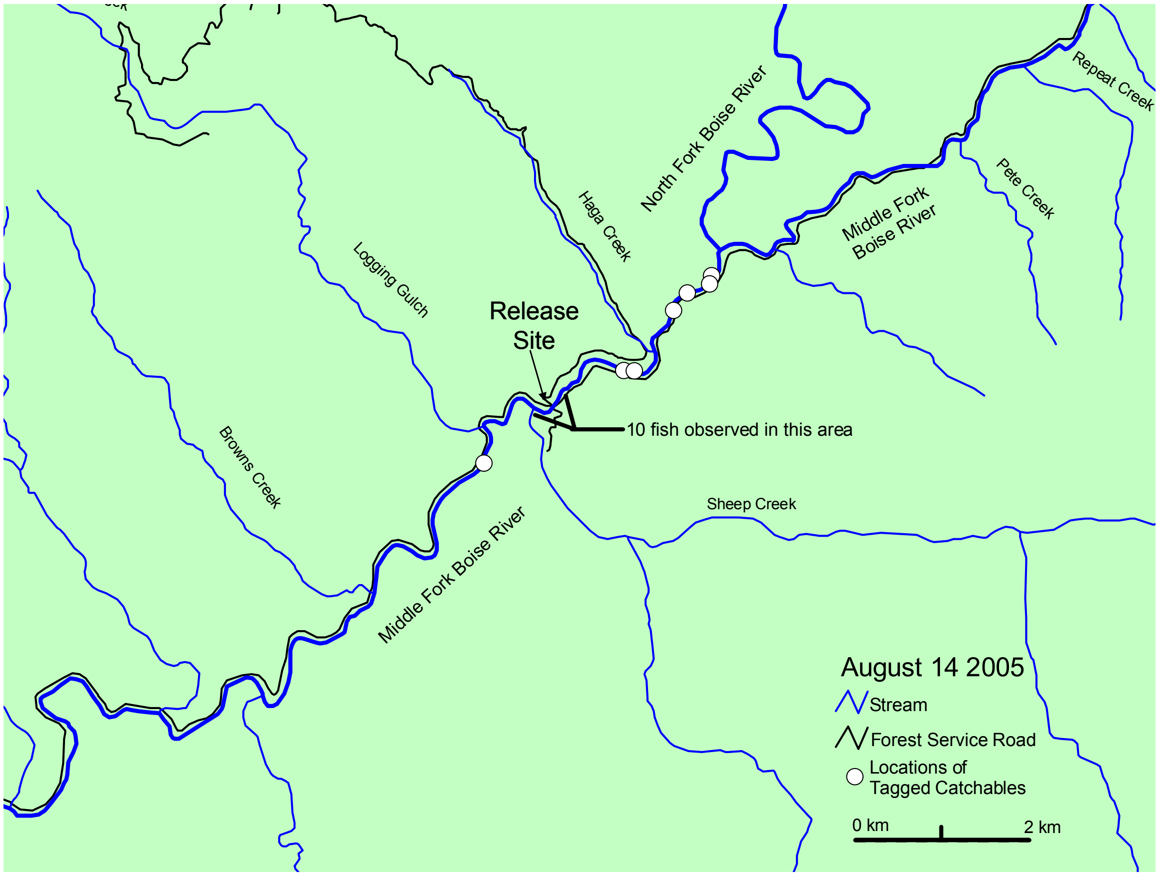

Figure 11. Locations of Floy®-tagged fish observed while snorkeling the Middle Fork Boise River on August 14, 2005.

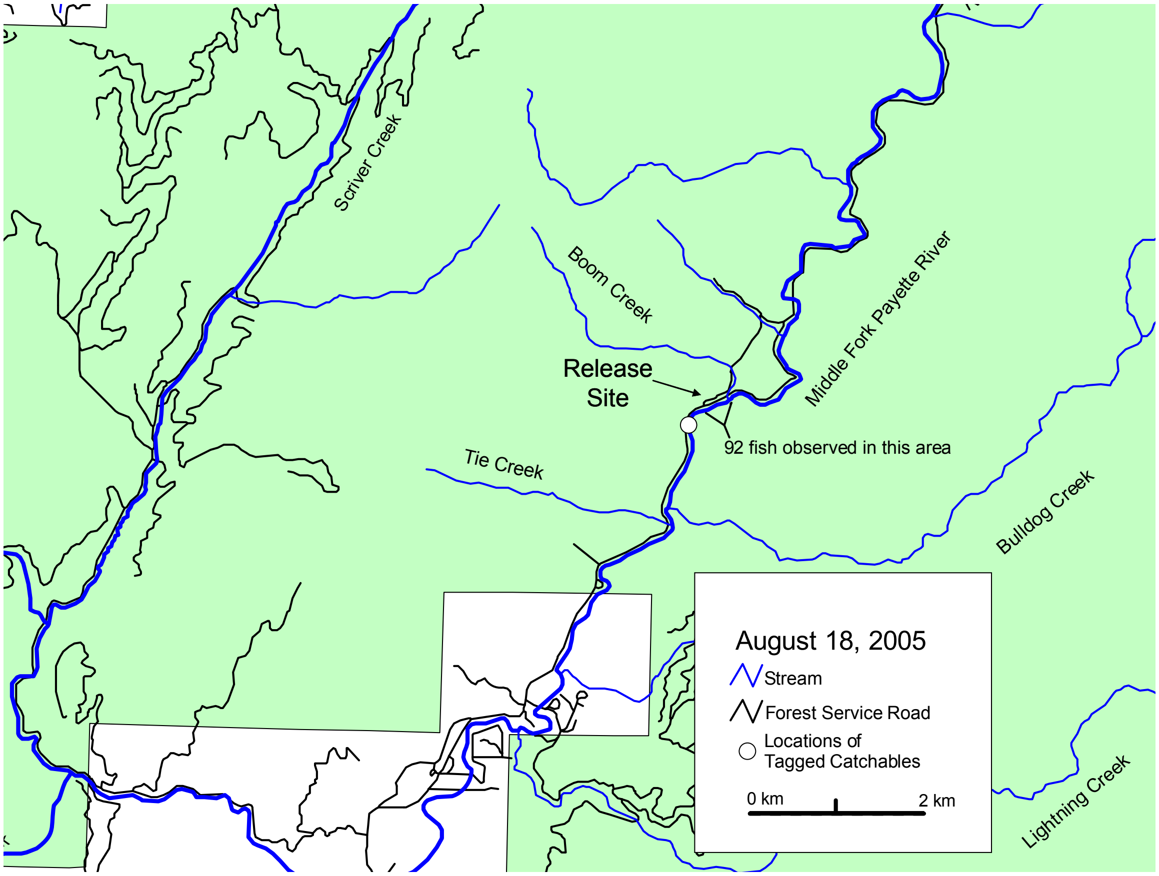

Figure 12. Locations of Floy®-tagged fish observed while snorkeling the Middle Fork Payette River on August 18, 2005.

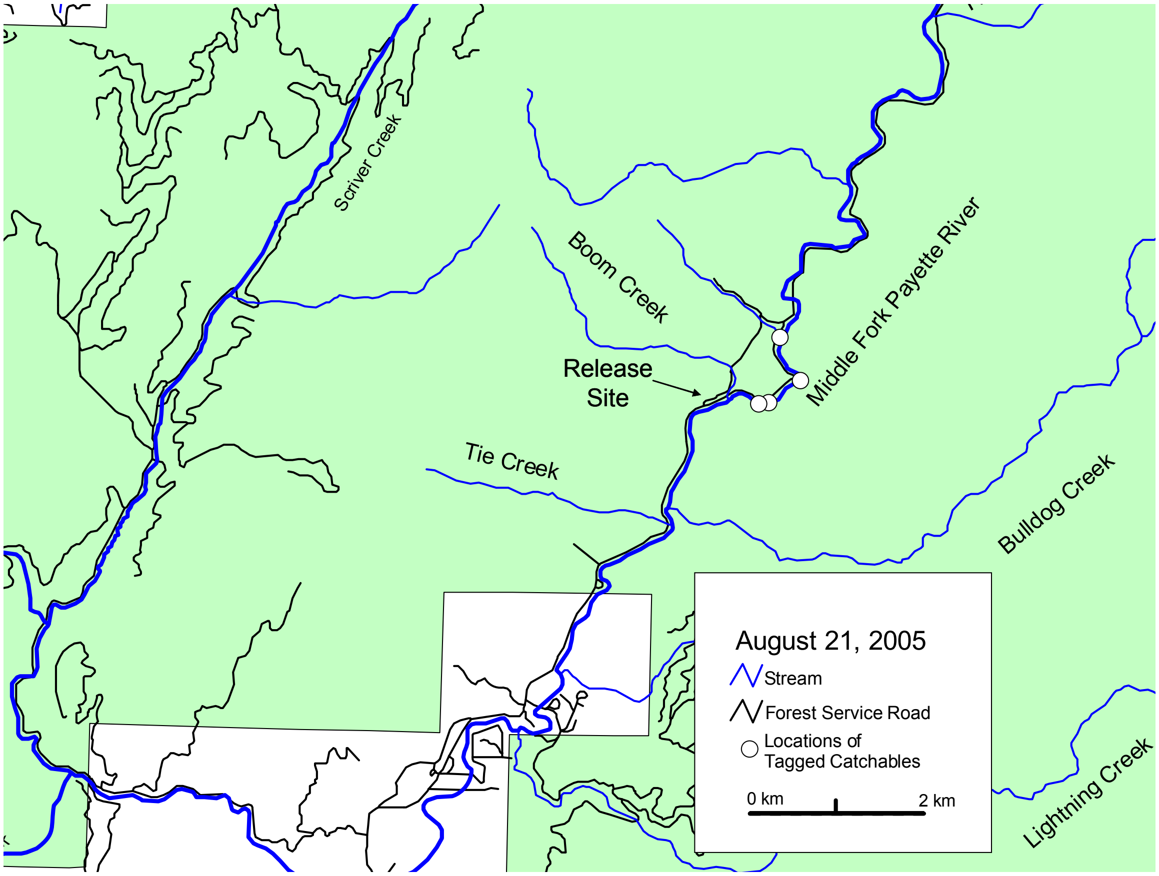

Figure 13. Locations of Floy®-tagged fish observed while snorkeling the Middle Fork Payette River on August 21, 2005.

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