BULL TROUT LIFE HISTORY INVESTIGATIONS IN THE NORTH FORK CLEARWATER RIVER BASIN

REGIONAL FISHERIES MANAGEMENT INVESTIGATIONS
NORTH FORK CLEARWATER RIVER BULL TROUT

Contract No. DACW68-96-D-0003
Delivery Order 0022

PREPARED FOR:

Department of the Army
Corps of Engineers
Walla Walla District
201 North Third Avenue
Walla Walla, Washington 99362

PREPARED BY:

Idaho Department of Fish and Game
Ed Schriever, Regional Fishery Manager
Danielle Schiff, Senior Fishery Technician

UNDER SUBCONTRACT TO:

Normandeau Associates
1921 River Road, P.O. Box 10
Drumore, Pennsylvania 17518

JANUARY 2003

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

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ABSTRACT

From April to October 2001, we collected 131 bull trout *Salvelinus confluentus,* in Dworshak Reservoir. Total length of these fish ranged from 240 to 620 mm (mean 382mm) and weight ranged from 100 to 2,250 g (mean 548 g). Radio transmitters were surgically implanted into 83 fish in spring and 15 in the fall. Seventy-three of the initial 83 radio tagged bull trout were detected after initial tagging. Mobile and fixed site tracking documented distance and timing of migration, distribution within the drainage, and spawning locations. We documented that eighteen (24.7%) of these tagged bull trout remained within the reservoir for the duration of the study period. We speculate that a proportion of the 11 detected radio-tagged bull trout also remained in Dworshak Reservoir, below detectable radio depth. We used migratory patterns to delineate between subadult and adult bull trout at 350 mm total length. There are fluvial adult bull trout utilizing Dworshak Reservoir as an overwintering area and subadult bull trout utilizing the reservoir throughout the year. Alternate year spawners accounted for 23-50% of the adult bull trout population that overwintered in Dworshak Reservoir. We found 75 bull trout redds in 7 tributaries.

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INTRODUCTION

In 1971 the construction of Dworshak Dam was completed near the mouth of the North Fork Clearwater River (NFCR). The 218 m tall dam inundated greater than 100 km of riverine habitat on the mainstem of the North Fork Clearwater River and its tributaries. In the absence of any fish passage facilities anadromous fish runs have been eliminated from the NFCR above Dworshak Dam. Impacts on resident fish species in the basin are not as clear.

The construction of Dworshak Dam may have significantly reduced the distribution, abundance, and population viability of native resident fish populations in Dworshak Reservoir and its upstream tributaries (CBFWA 1997). However, information that is needed to support this assumption is limited.

Historical observations document bull trout *Salvelinus confluentus* throughout the NFCR basin. Bull trout were found in the basin prior to construction of Dworshak Dam (Cannon 1970) and are still found in the NFCR, many of its tributaries and Dworshak Reservoir (Lindland 1987, Statler 1989, Schriever and Cochnauer 1996, Weigel and Cross 1997; Weigel and Zakrajsek 1998). However, measuring changes in bull trout population abundance and distribution in the basin is difficult because of the lack of pre- and post-dam data. There is also a lack of information on bull trout populations in basins without dam and reservoir influences to use as comparable controls. As a result, direct assessment of the change in bull trout population dynamics is likely not feasible. However, assessment of the viability of the current bull trout population remaining in the NFCR basin is possible. Determining whether their viability and movements are affected by operations of Dworshak Dam and its physical attributes can also be determined. The investigation of these issues will help provide the information necessary to assess the need for, and determination of strategies to protect and perpetuate a viable population of bull trout in the NFCR basin.

Although bull trout have been observed and collected throughout the basin prior to this study, little quantitative information is available on their life history, distribution, and abundance. More importantly, other than documenting presence or absence, no information is available regarding the role Dworshak Reservoir plays in the life history and distribution and abundance of bull trout in the drainage.

Bull trout populations are susceptible to habitat disruption and fragmentation (Rieman and McIntyre 1993). Dworshak Dam has possibly isolated bull trout population(s) in the NFCR from the rest of the basin and caused fragmentation of remaining populations. The impact(s) of severing the migratory corridor between the NFCR and mainstem Clearwater River may be crucial in sustaining a viable bull trout population upstream of Dworshak Dam. Without more information, the disruption of this migratory corridor can be viewed as a threat to the persistence of the North Fork Clearwater River bull trout population.

This study was designed to document and describe bull trout temporal and spatial distribution and life history within the NFCR drainage. This information will be used to develop and implement strategies to protect and perpetuate bull trout populations in the NFCR drainage with regards to operation of Dworshak Dam and project area.

OBJECTIVES

1. Determine migration patterns of bull trout within the NFCR.
2. Determine spatial and temporal distribution of bull trout within Dworshak Reservoir and the NFCR drainage.
3. Identify bull trout spawning sites within the NFCR.
4. Obtain basic biological and life history information on bull trout in Dworshak Reservoir and the NFCR drainage.

STUDY AREA

The NFCR is a fourth order stream located in north central Idaho (Figure 1). It has a total drainage area of 739,982 ha with the headwaters extending into the Bitterroot Mountains and forming the western border of Montana. The majority of the drainage is under public ownership by the U.S. Forest Service, Clearwater National Forest. The major tributaries of the NFCR are Little North Fork Clearwater River (LNF), and Kelly, Cayuse, Skull, Quartz, Orogrande, and Weitas creeks (Figure 1).

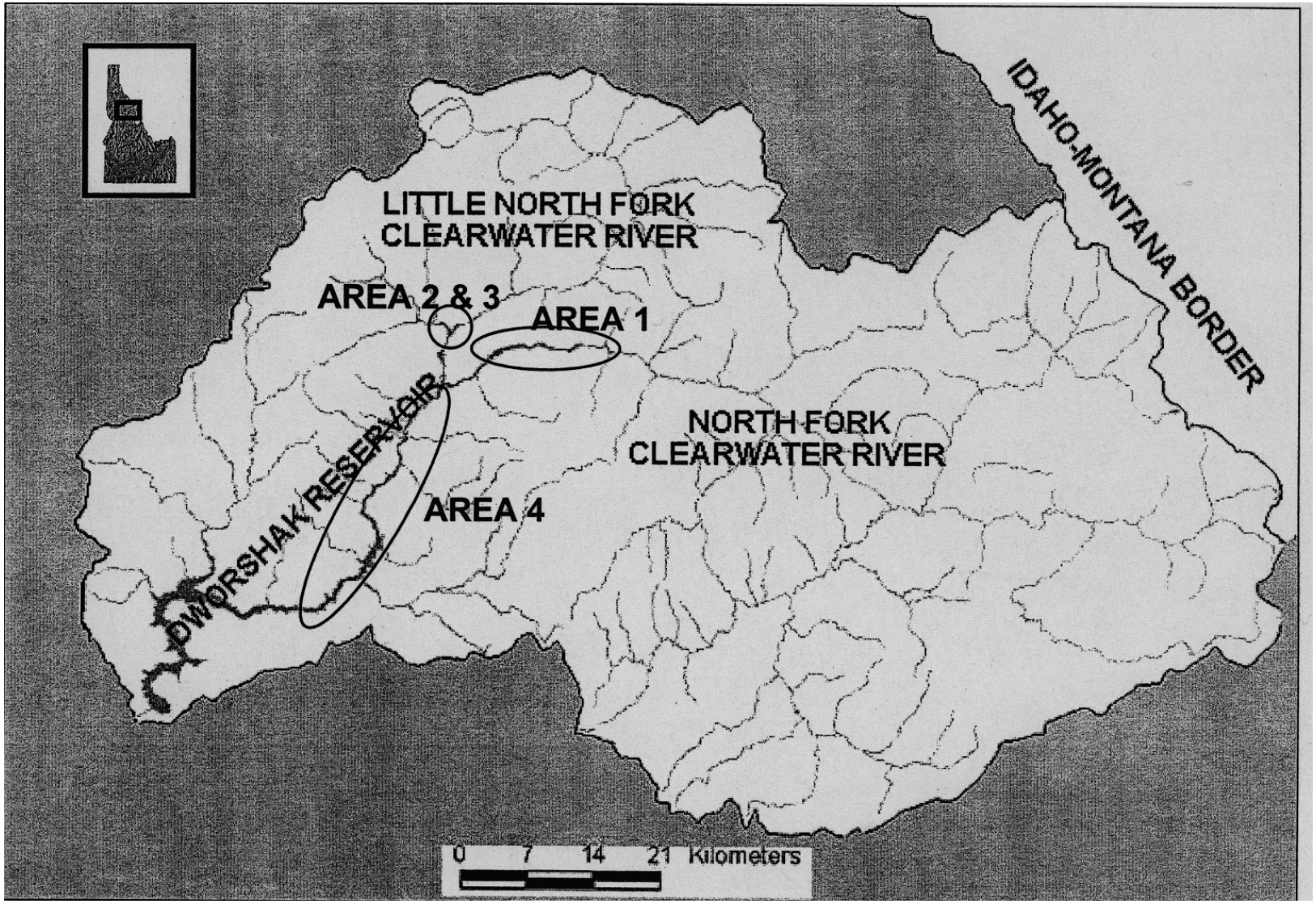

Figure 1. Study area, North Fork Clearwater River drainage. Locations of bull trout capture are the circled regions.

At full pool Dworshak Reservoir is 86.2 km long and has 295 km of steep shoreline. It has a total volume of 4.28 x 10^9 m^3 that corresponds to a maximum depth of 194 m, mean depth at full pool of 56 m, and a surface area of 6,644 ha (Maiolie and Elam 1994). The main arms of the reservoir are Elk Creek, the LNF, and the NFCR.

Native resident salmonids found within the drainage include bull trout, westslope cutthroat trout *Oncorhynchus clarki lewisi*, rainbow trout *O. mykiss* and mountain whitefish *Prosopium williamsoni.* Anadromous fish have been eliminated from the system since the construction of Dworshak Dam. Prior to that time, chinook salmon *O. tshawytscha* and steelhead *O. mykiss* were found throughout the drainage. The system has been stocked with kokanee *O. nerka,* rainbow trout, brook trout *Salvelinus fontinalis,* westslope cutthroat trout, bull trout, smallmouth bass *Micropterus dolomieui,* and largemouth bass *M. salmoides.*

METHODS

Bull trout were captured with hook-and-line in the NFCR and LNF arms of Dworshak Reservoir near the slack water/flowing water interface, where bull trout concentrate in early spring. Sampling was conducted in the NFCR arm between rkm 74.1 and rkm 85.8 (area 1), in the LNF arm 5.5-8.0 km above, the confluence of the LNF and NFCR (area 2), at the slackwater interface in Breakfast Creek, approximately a 3km area (area 3), (Figure 1). Additionally, bull trout were collected in Dworshak Reservoir between Cranberry Creek (rkm 30.1) and Grandad Bridge (rkm 64.4) (area 4) by boat electrofishing and hook-and-line. To tag post-spawn bull trout returning to the reservoir and to increase the number of radio tagged bull trout in the reservoir during the winter, sampling was conducted in areas 2 and 3 on 17, 18 and 23 October 2001.

All bull trout were anesthetized in a 60-80 mg/1 solution of MS222. Fish were weighed and measured, and checked for previous Passive Integrated Transponder (PIT) tags. If bull trout were not previously PIT tagged a fin clip was removed for genetic sampling and a PIT tag inserted. Scales were collected from all bull trout to determine age. Bull trout weighing greater than 200 g were candidates for surgical radio transmitter implantation. The surgical procedure is an adaptation of the shielded-needle technique as described by Schill et

al. (1994). All individuals were allowed to recover in fresh water for approximately 15 minutes and then released.

We utilized three types of radio tags, NTC-6 (NANO), MCFT-3EM (MICRO) and CART14-1 (Lotek Engineering). NANO-tags are radio transmitters that are relatively small in size, weighing 3.8 g. Use of NANO-tags allowed for tagging of bull trout weighing a minimum of 190 g and maintain a maximum 2% tag to body weight ratio. The limitation of this tag, and all radio transmitters, is that it cannot be detected below a depth of approximately 10 m because suspended particles in the water scatter the signal. Bull trout likely occupy cooler water in the hypolimnion of Dworshak Reservoir during summer stratification. Habitation at these depths prohibits detection of radio tags. Currently this is the only tag available that is this small and still provides nearly a year of tag life (318 d).

MICRO-tags are larger radio transmitters weighing 8.9 g. Larger tag size allows for longer tag life and a stronger signal to be transmitted compared to the NANO-tag. Stronger signal strength increases the range of detection but does not increase detection of the tag in deeper water. CART-tags are combined acoustic-radio tags that alternate between transmitting an acoustic and radio signal. The acoustic transmitter allows for detection below 10 m while the radio transmitter allows for detection at shallower depths, such as riverine habitat. CART-tags were used to monitor bull trout in deeper water in Dworshak Reservoir during the year. The limitations of the CART-tags are its short battery life (90 d) and heavy weight (19.8 g), allowing it only to be inserted in bull trout weighing a minimum of 990 g. To increase the probability that the CART-tagged bull trout would remain within the reservoir throughout the summer we implanted CART-tags into large bull trout caught within the reservoir below Grandad Bridge (rkm 64.4).

Biweekly mobile radio tracking was accomplished by boat, automobile and fixed-wing aircraft throughout the study area. In addition to mobile tracking we established three stationary radio-receiving sites. The NFCR fixed site was located at rkm 96.6, approximately 4.8 km upstream of Dworshak Reservoir (at full pool). The LNF fixed site was located 10.0 km from the confluence of the LNF and NFCR. The Breakfast Creek (BFC) fixed site was located at the confluence of Breakfast and Floodwood creeks. These sites were approximately 1.0 km and 1.1 km upstream of Dworshak Reservoir (at full pool),

respectively. Bull trout were classified as leaving or entering the reservoir when first recorded on either the NCFR, LNF or BFC receivers on its upstream or downstream migration.

Redd surveys were conducted from the last week of August until the end of September. Tributaries to be surveyed were selected based on the occurrence of radio tagged bull trout either in the tributary or in the mainstem near a tributary mouth. Observers walked stream reaches and identified redds and recorded their physical attributes and their GPS coordinates. Occurrence of bull trout on the redd or in the stream was also recorded.

RESULTS

Tagging

From 9 April to 6 June 2001, 1.13 bull trout were captured within Dworshak Reservoir (Appendix A). An additional 18 bull trout were collected from 17 to 23 October 2001. Total length of all captured bull trout in 2001 ranged from 240 mm to 620 mm (Figure 2) and weight ranged from 100 to 2,250 g (Figure 3). Radio transmitters were implanted in 98 bull trout, 83 in the spring, and 15 in the fall.

Eighty-two percent (107) of the bull trout were captured by hook-and-line sampling in the slack water interfaces in the NFCR and LNF arms of Dworshak Reservoir; the remaining 18% (24) were captured at large within the reservoir. Sixty-four bull trout were radio tagged with MICRO-tags, seventeen with NANO- tags, and two with CART-tags (Table 1).

Table 1. Number of radio transmitters implanted in bull trout in 2001 by tag type and tagging group.

	Tag Type				
		MICRO			
Tagging Group	NANO	Spring Tagging	Fall Tagging	CART	Total
BFC (Area 3)	4	14	3		21
DWOR (Area 4)	5	7		2	14
LNF (Area 2)	1	14	12		27
NFC (Area 1)	7	29			36
Total	17	64	15	2	98

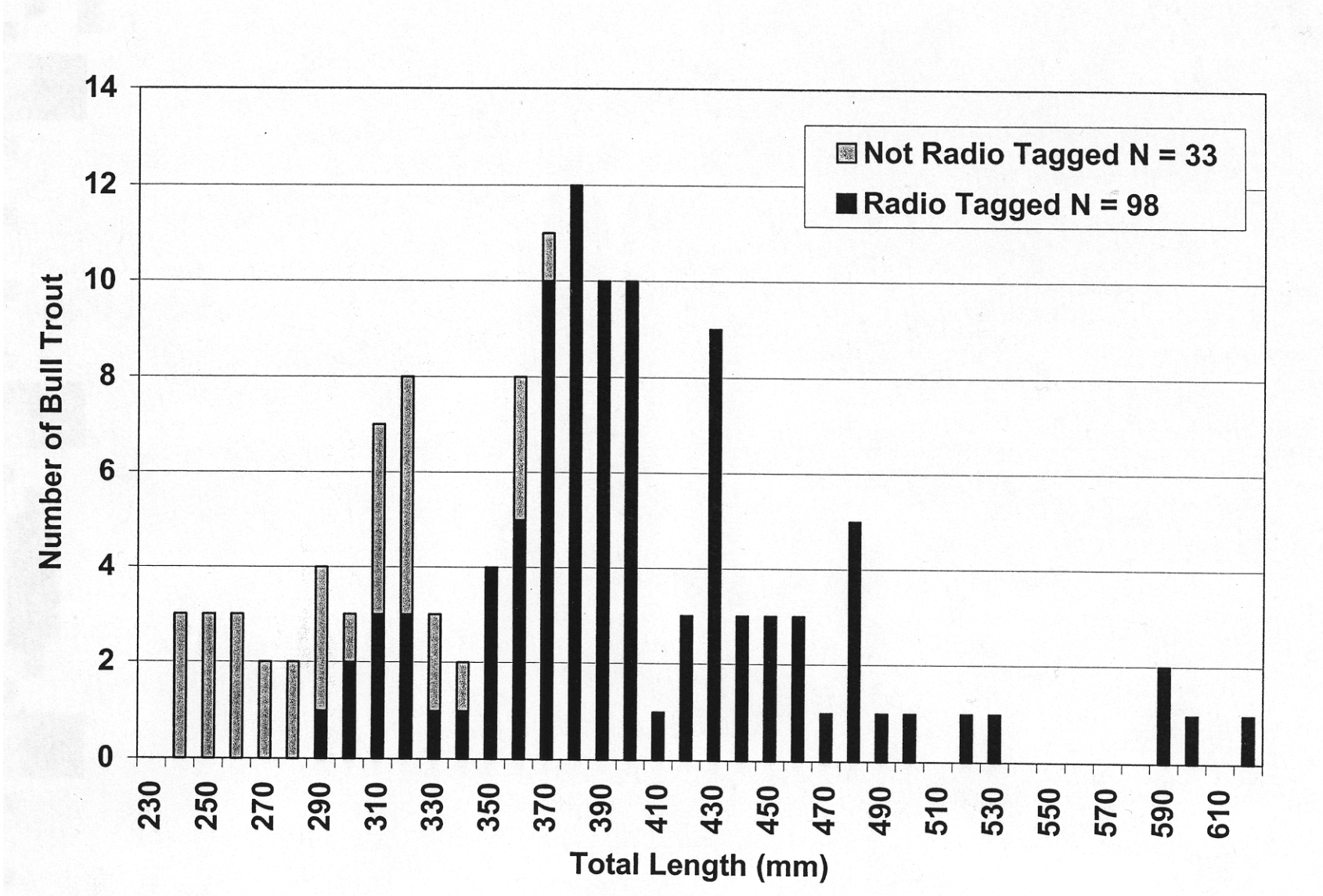

Figure 2. Length distribution of bull trout captured in Dworshak Reservoir, 2001.

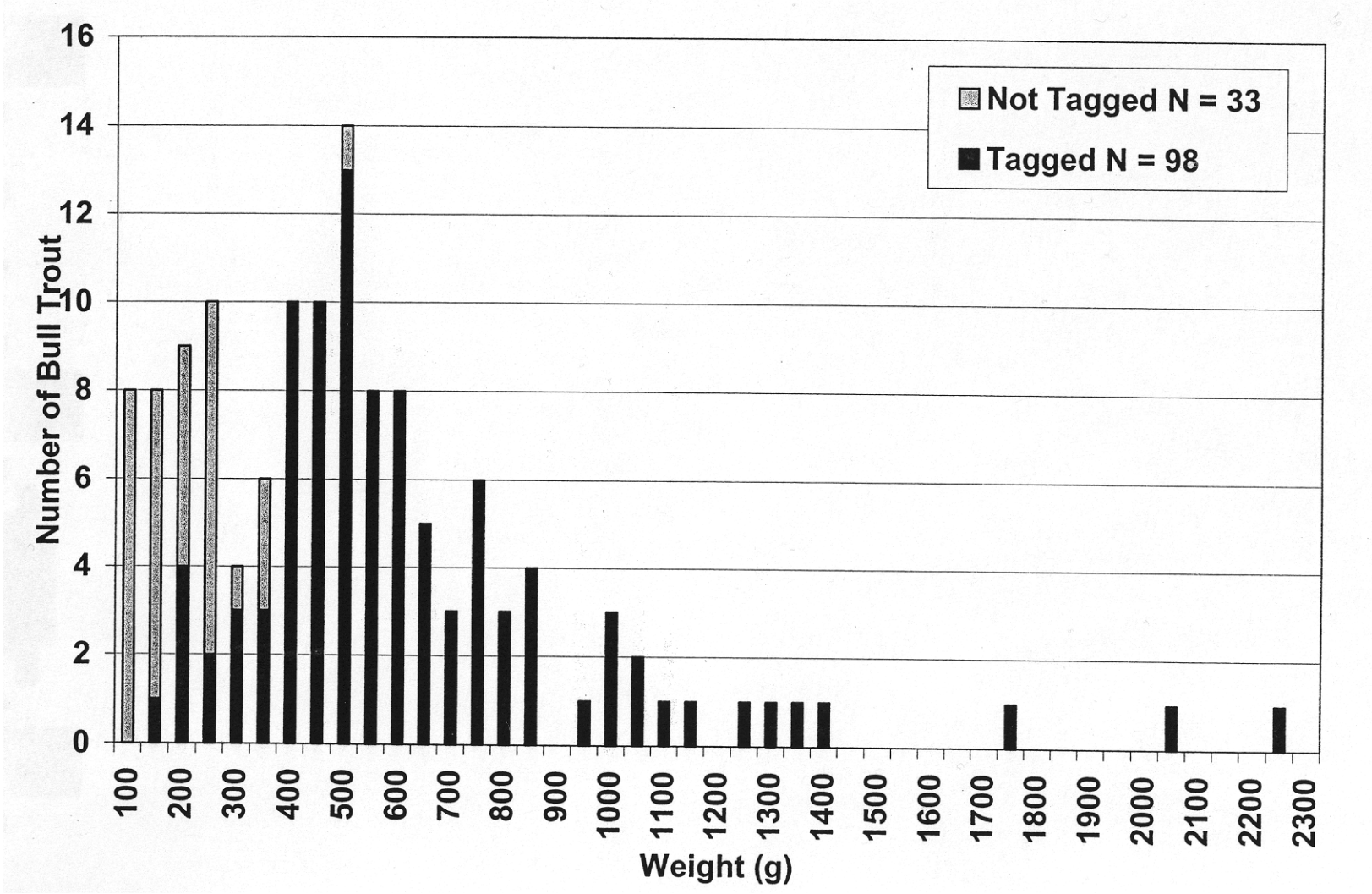

Figure 3. Weight distribution of bull trout captured in Dworshak Reservoir, 2001.

Migration

Migration from the reservoir began on 29 May 2001, when the first radio tagged bull trout was recorded on the NFCR receiver (Table 2). By 14 July 2001, 98% of all bull trout that migrated out of the reservoir had moved above the fixed sites and were within riverine habitat (Figure 4). The last individual to leave the reservoir moved above the LNF fixed site on 7August 2001. Twenty-two radio tagged bull trout were not recorded on a fixed receiver or detected during flight tracking at any time from May to October. All individuals that moved upstream to riverine habitat and were monitored throughout the summer reached their furthest upstream location by 15 August 2001 (Table 2). Bull trout remained in these areas until the last week of August before any individual started migrating downstream.

The first fall migrant, possibly post-spawning, bull trout descended past the LNF receiver on 15 September 2001 (Figure 4, Table 2), 10 days later than in 2000. The fixed sites were removed on 10 October 2001; prior to this 13 bull trout were detected returning to the reservoir (Figure 4, Table 2). Subsequent tracking has detected additional post-spawning bull trout returning to the reservoir, however their exact date of return is unknown.

Three bull trout (770-05, 440-54, and 480-17; Table 2) did not fit the overall migration pattern in the study area. These bull trout initially migrated into the Breakfast Creek drainage on 17, 20, and 24 June 2001, respectively (Table 2) then moved out of that drainage and returned to the reservoir.. They remained in the reservoir for approximately a week before being detected in the LNF drainage (Figure 4, Table 2). Bull trout 440-54 was not detected on the BFC receiver returning to the reservoir, but was detected by the LNF fixed site passing upstream and downstream and during aerial tracking in LNF.

Thirty-six bull trout were tagged in area 1. Of these, 21 (58%) migrated above the fixed site on the NFCR, three (13%) migrated above the LNF fixed site, and six (17%) moved further down in the reservoir where it remained throughout the summer. Six (17%) of these tags (5 NANO, 1 MICRO) were not detected after initial activation and implantation.

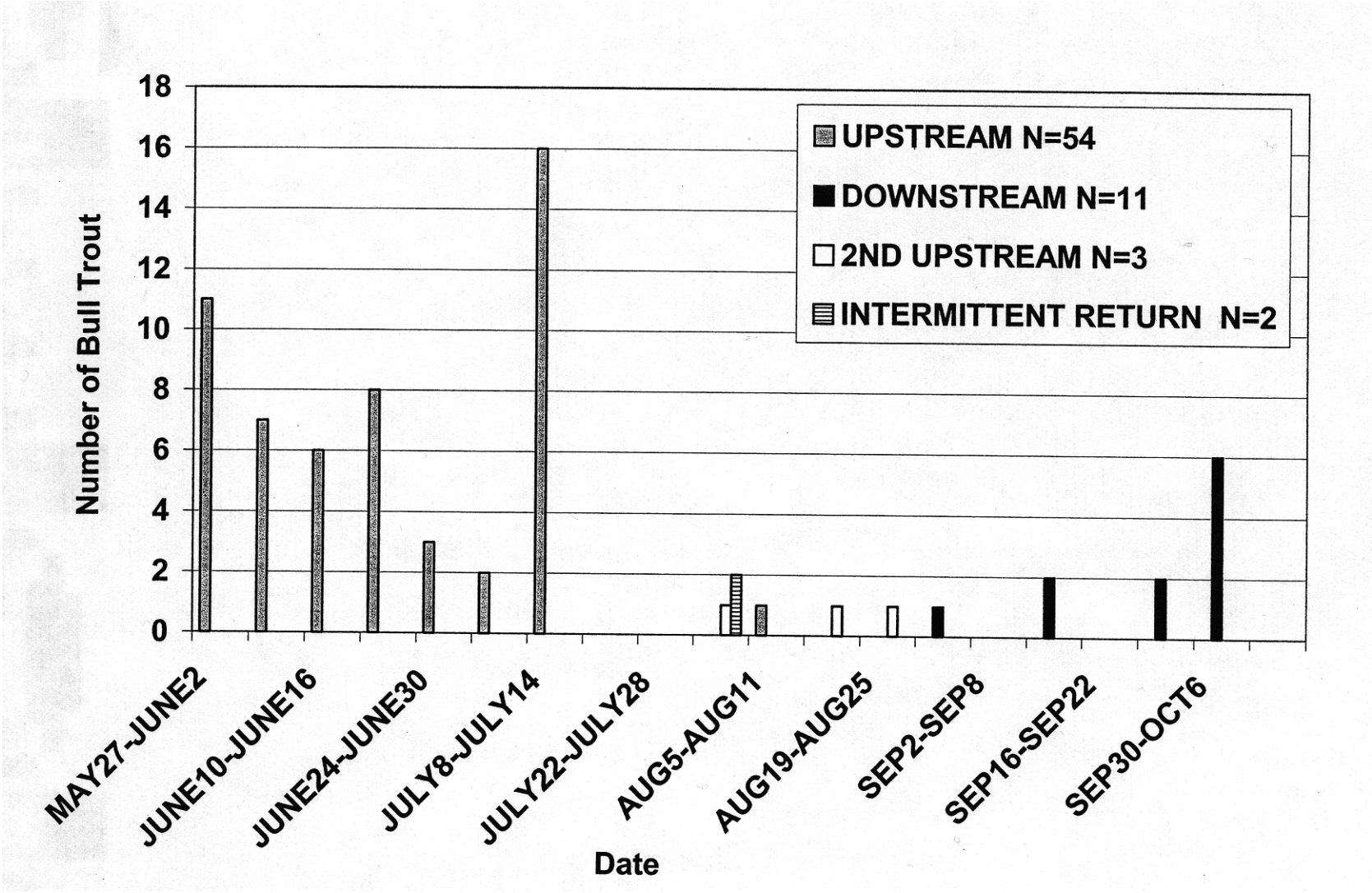

Figure 4. Weekly groupings for radio tagged bull trout based on when they were first detected on a fixed site leaving or entering Dworshak Reservoir, 2001. The intermittent return is two bull trout that were detected returning to the reservoir and then proceeded to migrate into a second drainage, which is classified as second upstream migration.

Table 2. Radio tagged bull trout distribution in the North Fork Clearwater River, 2001.

Bull Trout Radio Number (Frequency-Code)	Tagging Subgroup	Watershed Group	Date past fixed site upstream	Date located at maximum migration point[2]	Date past fixed site downstream	Migration distance from tagging location (km)[1]
930-11	NFCR	Beaver Creek		10-Jul-01		9.0
010-10	NFCR	Collins Creek	09-Jul-01	30-Jul-01		46.5
930-33	DWOR	Larson Creek		14-Aug-01		78.5
930-22	BFC	Long Creek		14-Aug-01		117.5
480-10	DWOR	Long Creek	9-Jul-01	08-Aug-01		101.6
480-04	NFCR	Long Creek	9-Jul-01	30-Jul-01		116.1
480-07	NFCR	Long Creek	09-Jul-01	08-Aug-01		89.8
480-22	NFCR	Long Creek	09-Jul-01	14-Aug-01		69.1
930-16	NFCR	Long Creek		30-Jul-01		98.5
930-32	NFCR	Long Creek		14-Aug-01		91.4
910-29	DWOR	Lost Pete Creek		08-Aug-01		46.6
480-03	NFCR	Lost Pete Creek		08-Jun-01		13.0
930-27	DWOR	Osier Creek		10-Jul-01		133.7
480-01	NFCR	Osier Creek	09-Jul-01	30-Jul-01	15-Sep-01	105.5
480-02	NFCR	Quartz Creek	09-Jul-01	30-Jul-01	15-Sep-01	28.6
930-36	NFCR	Quartz Creek		14-Aug-01		9.4
010-07	NFCR	Schofield Creek	29-May-01	31-Jul-01		64.1
930-34	NFCR	Schofield Creek		10-Jul-01		67.3
010-04	NFCR	Headwaters NFC	14-Jun-01	14-Aug-01		124.1
010-05	NFCR	Headwaters NFC	09-Jul-01	14-Aug-01		126.9
480-11	NFCR	Headwaters NFC	09-Jul-01	23-Jul-01		90.8
480-20	NFCR	Headwaters NFC	09-Jul-01	14-Aug-01		117.3
910-33	NFCR	Headwaters NFC	21-Jun-01	30-Jul-01		125.7
930-14	NFCR	Headwaters NFC		10-Jut-01		121.3
010-02	NFCR	Weitas Creek	9-Jul-01	14-Aug-01		81.1

[1] A negative number indicates that the bull trout moved downstream from its tagging location.
[2] Date located at maximum number migration is within 15 days of actual date due to flight schedule.
* Mortality or shed tag within riverine habitat. Tag recovered.
** Tag not collected but believed shed or mortality.
[A] **Data pertains to bull trout that ascended two different tributaries in 2001.**
[B] **Bull trout that were tagged in 2000 and tracked during 2001.**

Table 2. Continued.

Bull Trout Radio Number (Frequency-Code)	Tagging Subgroup	Watershed Group	Date past fixed site upstream	Date located at maximum migration point[2]	Date past fixed site downstream	Migration distance from tagging location (km)[1]
440-49	BFC	Canyon Creek	31-May-01	15-Aug-01		39.7
480-26	BFC	Canyon Creek	30-May-01	05-Aug-01		37.0
480-12	NFCR	Canyon Creek	17-Jun-01	15-Aug-01		60.4
480-25	BFC	Stony Creek	21-Jun-01	11-Jul-01		13.5
480-15	BFC	Stony Creek	22-Jun-01	31-Jul-01	09-Oct-01	7.1
770-03	BFC	Stony Creek	10-Jun-01	11-Jul-01	04-Oct-01	8.8
440-54	BFC	Stony Creek	20-Jun-01	31-Jul-01		9.1
440-54[A]		Mid-LNF		20-Sep-01	03-Oct-01	13.0
480-17	BFC	Stony Creek	24-Jun-01	31-Jul-01	08-Aug-01	18.4
480-17[A]		Mid-LNF		20-Oct-01	6-Oct-01	8.8
770-05	BFC	Stony Creek	17-Jun-01	10-Jun-01	1-Aug-01	15.6
770-05[A]		Mid-LNF		11-Jul-01		13.7
480-05	BFC	Mid LNF	23-Jun-01	25-Jun-01	**	1.8
770-06	LNF	Mid LNF		08-Jun-01	**	10.6
440-50	BFC	Mid LNF		08-Jun-01		10.8
770-09	LNF	Mid LNF		02-Jul-01	**	-2.5
010-03	LNF	Mid LNF	7-Aug-01	7-Aug-01		24.0
				.		
770-01	BFC	Upper LNF	30-May-01	31-Jul-01	15-Sep-01	49.1
770-11	BFC	Upper LNF		15-Aug-01		64.1
770-12	BFC	Upper LNF		31-Jul-01		57.5
770-13	BFC	Upper LNF		23-Aug-01	*	51.7
930-28	DWOR	Upper LNF	16-Jun-01	31-Jul-01		62.9
930-38	DWOR	Upper LNF	10-Jun-01	15-Aug-01		52.9
010-06	LNF	Upper LNF	06-Jun-01	15-Aug-01	05-Oct-01	56.2
010-08	LNF	Upper LNF	18-Jun-01	15-Aug-01		33.2
010-09	LNF	Upper LNF	29-May-01	23-Aug-01	*	47.5
480-08	LNF	Upper LNF	04-Jun-01	15-Aug-01	04-Oct-01	43.0
480-09	LNF	Upper LNF	31-May-01	11-Jul-01	29-Sep-01	51.2
480-23	LNF	Upper LNF	15-Jun-01	31-Jul-01		48.4
770-04	LNF	Upper LNF		31-Jul-01	03-Oct-01	57.7

[1] A negative number indicates that the bull trout moved downstream from its tagging location.
[2] Date located at maximum number migration is within 15 days of actual date due to flight schedule.
* Mortality or shed tag within riverine habitat. Tag recovered.
** Tag not collected but believed shed or mortality.
[A] Data pertains to bull trout that ascended two different tributaries in 2001.
[B] Bull trout that were tagged in 2000 and tracked during 2001.

Table 2. Continued.

Bull Trout Radio Number (Frequency-Code)	Tagging Subgroup	Watershed Group	Date past fixed site upstream	Date located at maximum migration point[2]	Date past fixed site downstream	Migration distance from tagging location (km)[1]
770-07	LNF	Upper LNF	07-Jun-01	11-Jul-01		53.0
770-08	LNF	Upper LNF	07-Jun-01	15-Aug-01		43.0
770-10	LNF	Upper LNF		31-Jul-01	04-Oct-01	42.4
770-14	LNF	Upper LNF		31-Jul-01		47.9
480-06	NFCR	Upper LNF		31-Jul-01		48.1
480-24	NFCR	Upper LNF	09-Jul-01	14-Aug-01		43.0
010-01	NFCR	NFCR		25-Jun-01	**	10.8
440-57	NFCR	NFCR		10-Jul-01		-6.2
480-13	NFCR	NFCR		10-Jul-01	*	8,1
480-14	NFCR	NFCR		10-Jul-01	**	6.9
480-18	NFCR	NFCR		08-Jun-01		6.5
480-21	NFCR	NFCR	09-Jul-01	02-Aug-01	**	8.2
910-12	NFCR	NFCR				11.8
910-25	NFCR	NFCR		13-Jun-01	**	-1.1
930-30	NFCR	NFCR		30-Jul-01		6.3
770-02	BFC	NFCR		09-Jul-01	*	16.5
420-06	NFCR	Lower NFC		27-Jun-01	**	-14.2
480-16	BFC	Upper Dworshak		27-Jun-01		-27.2
930-35	BFC	Upper Dworshak		02-Jul-01	**	13.3
420-10	DWOR	Upper Dworshak		13-Jun-01		-4.7
930-37	DWOR	Upper Dworshak		25-Jun-01		18.4
480-19	NFCR	Upper Dworshak		21-Jul-01		-31.9
930-19	NFCR	Upper Dworshak				-46.6
010-09	BFC					
440-52	BFC					
910-13	BFC					
420-12	DWOR					
420-14	DWOR					
420-19	DWOR		30-May-01			
420-64	DWOR					
420-07	DWOR					

A negative number indicates that the bull trout moved downstream from its tagging location.
Date located at maximum number migration is within 15 days of actual date due to flight schedule.
* Mortality or shed tag within riverine habitat. Tag recovered.
** Tag not collected but believed shed or mortality.
Data pertains to bull trout that ascended two different tributaries in 2001.
Bull trout that were tagged in 2000 and tracked during 2001.

Table 2. Continued.

Bull Trout Radio Number (Frequency-Code)	Tagging Subgroup	Watershed Group	Date past fixed site upstream	Date located at maximum migration point2	Date past fixed site downstream	Migration distance from tagging location (km)[1]
420-11	DWOR					
440-60	LNF		31-May-01	08-Jun-01		3.4
440-62	LNF					
440-66	LNF					
440-68	LNF					
440-70	LNF					
440-71	LNF					
770-13	LNF					
910-32	LNF					
910-34	LNF					
910-37	LNF					
930-31	LNF					
440-53	NFC					
440-55	NFCR					
440-56	NFCR					
440-58	NFCR					
440-59	NFCR					
910-11	NFCR					-19.5
910-19[B]	NFCR		05-Jun-01			
910-26[B]	NFCR					
910-32[B]	NFCR					
930-15[B]	NFCR		26-Jun-01			

[1] A negative number indicates that the bull trout moved downstream from its tagging location.
[2] Date located at maximum number migration is within 15 days of actual date due to flight schedule.
* Mortality or shed tag within riverine habitat. Tag recovered.
** Tag not collected but believed shed or mortality.
[A] **Data pertains to bull trout that ascended two different tributaries in 2001.**
[B] **Bull trout that were tagged in 2000 and tracked during 2001.**

Fifteen bull trout were radio tagged in area 2. Of these, fourteen (86%) migrated upstream of the LNF fixed site, one fish migrated from this tagging area and migrated into the NFCR drainage. All fish tagged within this area migrated into a tributary where they remained throughout the summer. The majority of bull trout tagged in the NFCR and LNF (areas 1 and 2) tagging areas migrated upstream into the tributary associated with that tagging area.

Eighteen bull trout were tagged in area 3. Of these, six (33%) migrated into the BFC drainage, eight (44%) migrated into the LNF drainage, four (22%) moved into Dworshak Reservoir where they remained throughout the summer, and one (6%) migrated into the NFCR. There was one (6%) NANO-tagged fish that was not detected after initial tag activation and implantation. This is the only tagging area where more fish migrate to alternative locations than ascended the associated tributary.

Fourteen bull trout were tagged in area 4. Of these, two (14%) of the bull trout tagged remained within the reservoir throughout the summer; seven (50%) bull trout migrated into tributaries, four (29%) into the NFC drainage and three (21%) into the LNF drainage. This tagging group had four NANO-tags (29%) and one CART-tag (7%) not detected after initial activation and implantation.

An additional 15 bull trout were tagged in October in areas 2 and 3. As of the date of this report their migration has not been documented. All radio tagged fish will continue to be monitored throughout the winter months in the reservoir and river environments.

Distribution

We separated bull trout into watershed groups based on their furthest upstream location. Each watershed group can be described by the boundaries of a 5th field Hydrologic Unit Code (HUC) described by the USGS (Figure 5). Radio tagged bull trout were distributed in seventeen 5th field HUCs throughout the study area (Table 3). The watershed groups within the NFCR subbasin were; Headwaters NFCR and Beaver, Collins, Larson, Long, Lost Pete, Osier, Quartz, Schofield, and Upper Weitas creeks (Table 3, Figure 6). Bull trout within Larson, Lost Pete and Schofield watershed groups were comprised of bull trout that remained in the mainstem NFCR and were never detected in a tributary (Table 3,

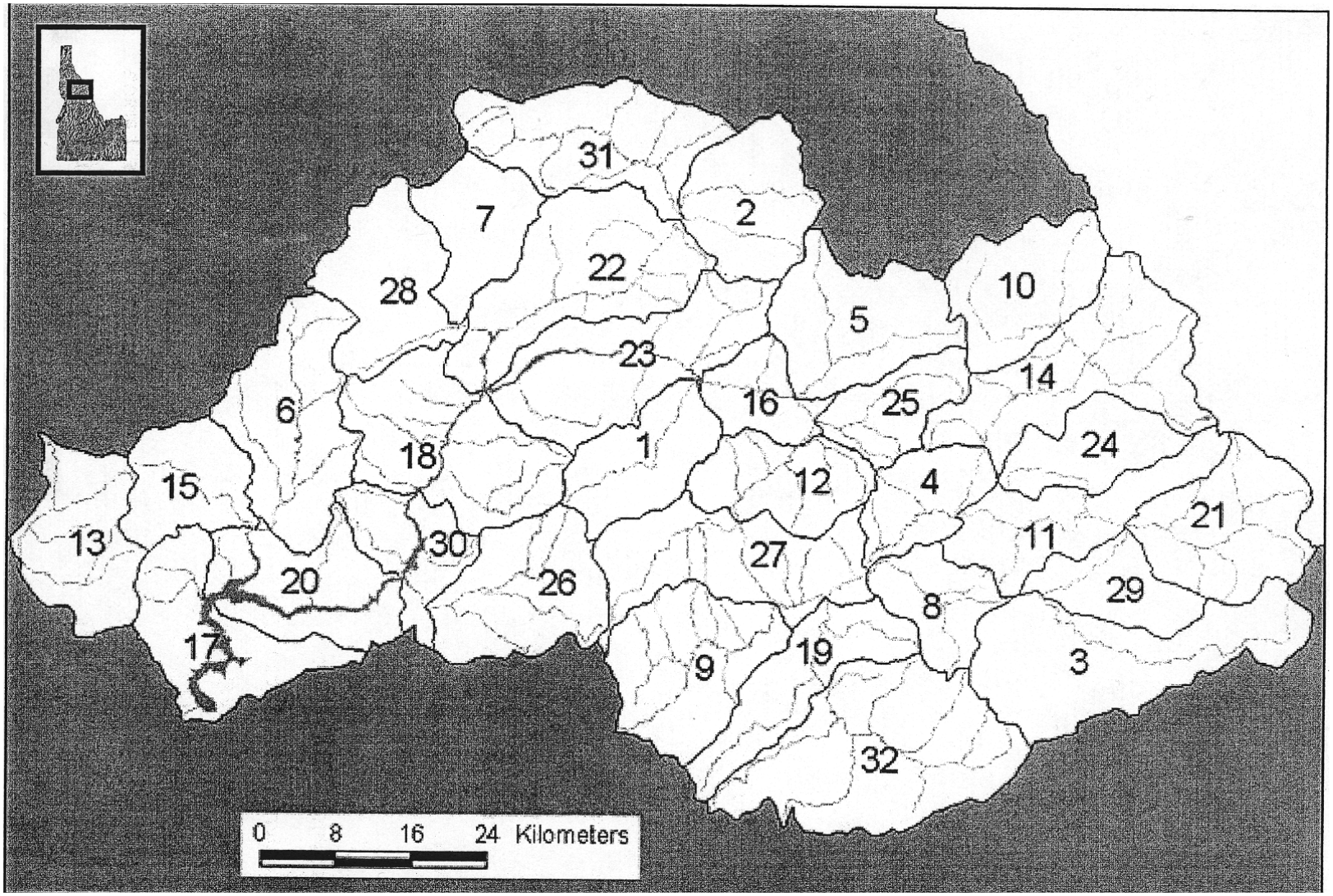

Figure 5. North Fork Clearwater River subbasin HUC 5 delineations. Name of each HUC 5: 1) Beaver Creek, 2) Canyon Creek, 3) Cayuse Creek,4) Cold Springs Creek, 5) Collins Creek, 6) Elk Creek Reservoir, 7) Floodwood Creek, 8) Forth of July Creek, 9) French Creek, 10) Headwaters North Fork Clearwater River, 11) Kelly Creek, 12) Larson Creek, 13) Linden, 14) Long Creek, 15) Long Meadow Creek, 16) Lost Pete Creek, 17) Lower Dworshak Reservoir, 18) Lower North Fork Clearwater River, 19) Lower Weitas Creek, 20) Middle Dworshak Reservoir, 21) Middle Fork Kelly Creek, 22) Middle Little North Fork Clearwater River, 23) North Fork Clearwater River, 24) Osier Creek, 25) Quartz Creek, 26) Reeds Creek, 27) Schofield Creek, 28) Stony Creek, 29) Toboggan Creek, 30) Upper Dworshak Reservoir, 31) Upper Little North Fork Clearwater River, 32) Upper Weitas Creek.

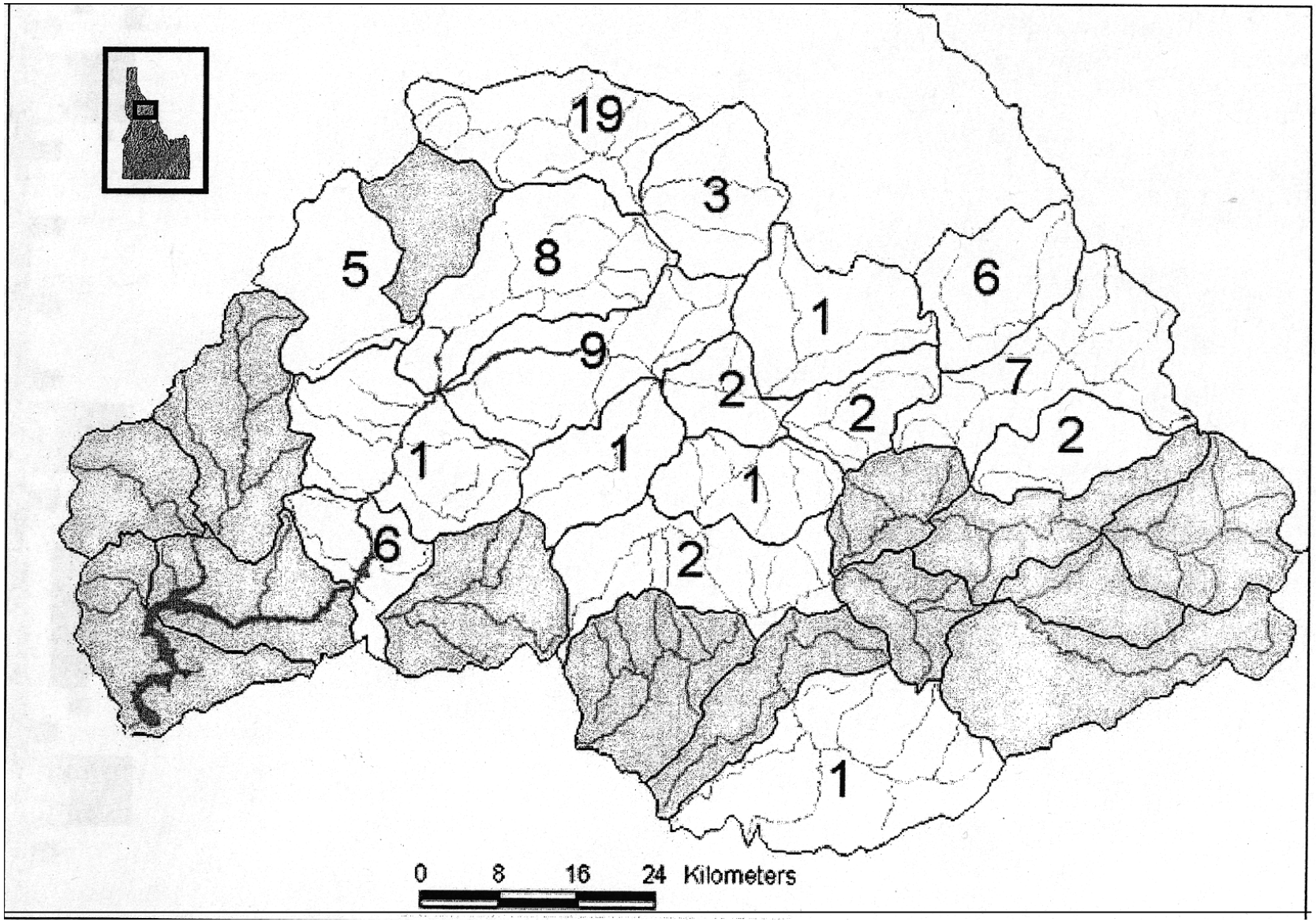

Figure 6. Bull trout distribution in the North Fork Clearwater River Drainage, July-August 2001. Number represents the number of radio tagged bull trout located in each HUC 5. HUCs that are shaded gray did not have bull trout distributed within them.

Table 3. Number of radio tagged bull trout within each watershed group. The average migration distance is the distance that radio tagged bull trout traveled from tagging location to maximum migration distance averaged for the bull trout detected in the HUC. The unknown bull trout are those that were not detected after initial tagging or only detected on a fixed site.

Subbasin	5th Field HUC Watershed Group	Number of Bull Trout	Average migration distance from tagging location (km)
NFCR	Beaver Creek	1	9.0
	Collins Creek	1	46.5
	Larson Creek	1	78.5
	Long Creek	7	93.0
	Lost Pete Creek	2	29.8
	Osier Creek	2	119.6
	Quartz Creek	2	19
	Schofield Creek	2	65.7
	Headwaters NFCR	6	117.7
	Upper Weitas Creek	1	81.1
LNF	Canyon Creek	3	45.7
	Stony Creek	5	11.4
	Middle LNF	7	8.7
	Upper LNF	19	50.1
Dworshak	NFCR	10	9.7
	Lower NFCR	1	14.2
	Upper Dworshak Reservoir	6	23.7
Unknown Location		29	

Figure 6). This is comparable to the study in 2000, where all bull trout that remained in the mainstem NFCR were classified together as the lower NFCR mainstem group (Cochnauer et al. 2001). The watershed groups Headwaters NFCR and Beaver, Collins, Osier, Quartz, and Upper Weitas creeks, were comprised of bull trout that entered tributaries. The Long Creek watershed group was composed of seven bull trout that remained in the Black Canyon section of mainstem NFCR; one individual from that group did immigrate into a tributary. Bull trout immigrated into three additional watersheds not documented in the 2000 study (Cochnauer, et al. 2000), Beaver, Collins, and Quartz creeks.

The watershed groups within the LNF subbasin were: Middle LNF and Upper LNF and Canyon and Stony creeks (Table 2). The Canyon Creek watershed group was comprised of three bull trout in Canyon Creek (Table 3, Figure 6). The Stony Creek (Breakfast Creek) watershed group consisted of five bull trout in July, but in mid-August three of these bull trout moved from this area into the Middle LNF. These are the only three bull trout to move into two different tributaries after initial immigration into a tributary over the course of this study. The Middle LNF watershed group consisted of seven bull trout, including the two from the Stony Creek watershed, that were detected in the mainstem and were not associated with a tributary (Table 3, Figure 6). Nineteen bull trout immigrated into the Upper LNF; this was the largest number of radio tagged bull trout to be located within a watershed (Table 3, Figure 6). The LNF drainage was not surveyed in 2000.

Bull trout remaining in Dworshak Reservoir were separated into three watershed groups: NFCR, Lower NFCR and Upper Dworshak. The Lower NFCR and NFCR watershed groups consisted of one and ten bull trout, respectively, (Table 3) distributed between rkm 52.0 and rkm 93.4. There were six bull trout in the Upper Dworshak watershed group distributed between rkm 41.2 and rkm 52. This watershed group is comparable to the Dworshak subgroup in the 2000 study (Cochnauer et al. 2001).

Life History Information

Scale samples, collected from all 113-bull trout captured in Dworshak Reservoir, were pressed and are being analyzed. Scale interpretations will be used to determine growth rates and generate an age structure of the population. Adipose fin samples were collected for genetics analysis. The length-weight relationship for these bull trout is described by the

equation: log weight = 3.3027 log total length - 5,8485 (Figure 7). This is similar to the value obtained by Hyatt and Hubert 2000 (log weight = 3.115 log total length - 5.327).

No radio tagged bull trout less than 350 mm were detected migrating above a fixed site. Therefore, we classified bull trout less than 350 mm as subadults and those greater than 350 mm as adults (Figure 8). All radio tagged subadults (<350 mm) remained in the reservoir throughout the year. Seventy-four percent (58/78) of the radio tagged adult sized bull trout (>350 mm) were detected ascending tributaries past fixed sites. In Dworshak Reservoir 23% of the bull trout radio tagged in 2001 that were greater than 350 mm did not migrate above a fixed site.

Tracking of post spawning adults in 2000-2001 found 40% (6/15) of radio tagged bull trout in NFCR retained their radio tag and survived through spawning to overwinter in downstream locations. Three of these six returned to Dworshak Reservoir and were distributed between rkm 41.2 and 70.4. The other three remained in the mainstem NFCR between rkm 93.4 and 127.7. We documented 50% (3/6) of the surviving bull trout in NFCR spawning areas again in 2001.

Radio tagged bull trout migrated an average upstream distance of 55.5 km (range = 3.4-133.7 km). Migration past fixed sites and into riverine habitat began on 29 May 2001, and continued through June and was mostly complete by the first week of July. The first radio- tagged bull trout was detected in a known spawning tributary on 10 July 2001, with the last bull trout to enter a tributary on 15 August 2001. There may be a portion of this bull trout population that enters a tributary for a few days to spawn, but due to our tracking schedule were not detected in a tributary.

We documented 12% (2/17) of the NANO-tagged bull trot (subadults) emigrating from Dworshak Reservoir. Three percent (2/58) of the riverine migratory bull trout, and 45% (15/33) of the non-migratory bull trout that remained in the reservoir were NANO-tagged. Conversely, we detected 77% (56/78) of the MICRO-tagged bull trout migrating to and from the reservoir on an annual basis. If subadults and adults emigrate from the reservoir at the same frequency we would expect to see the same proportion of NANO and MICRO-tagged bull trout in the reservoir and riverine habitats. However, a higher percent of NANO-tagged

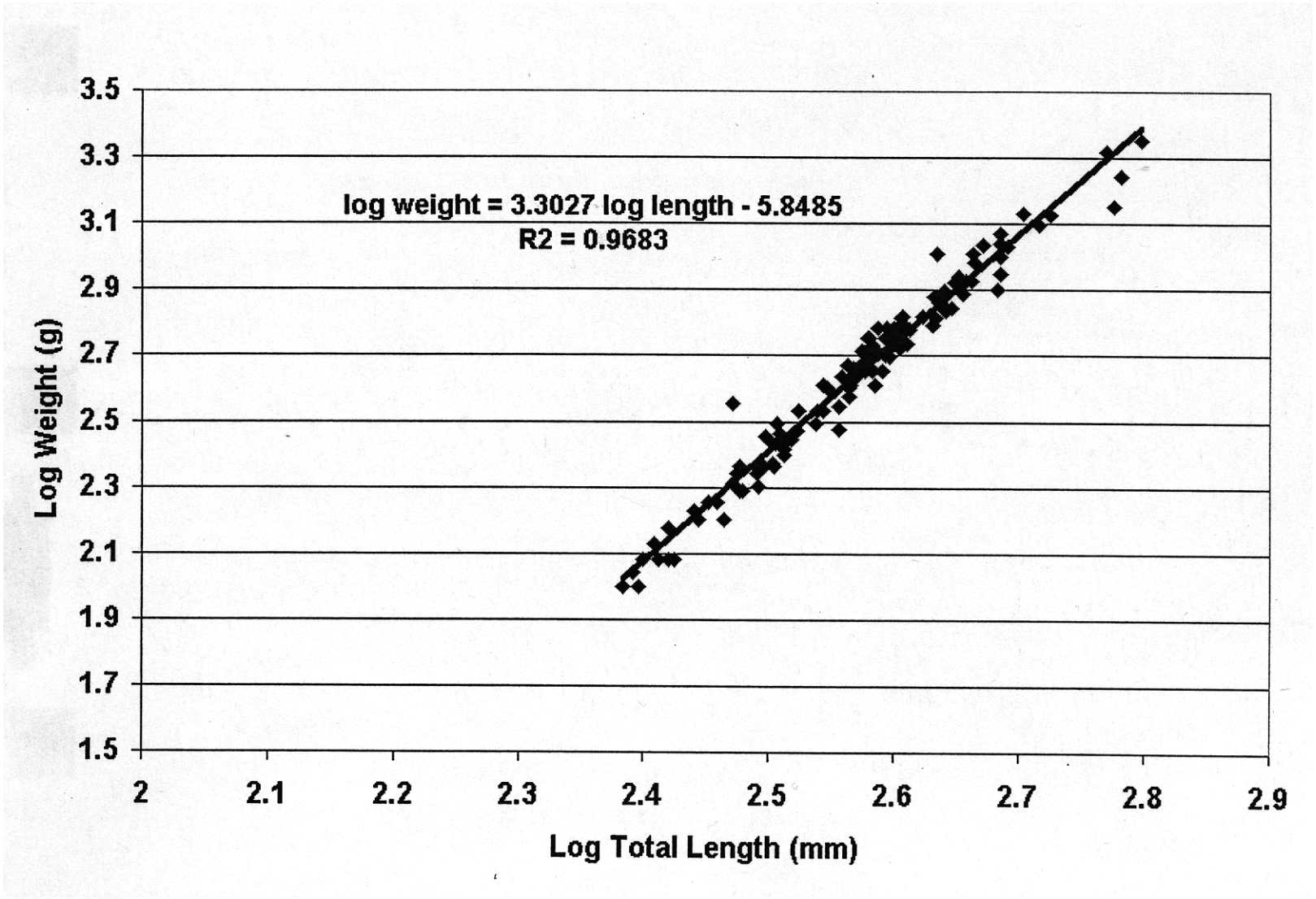

Figure 7. Length-weight relationship for bull trout captured in Dworshak Reservoir, April-October 2001.

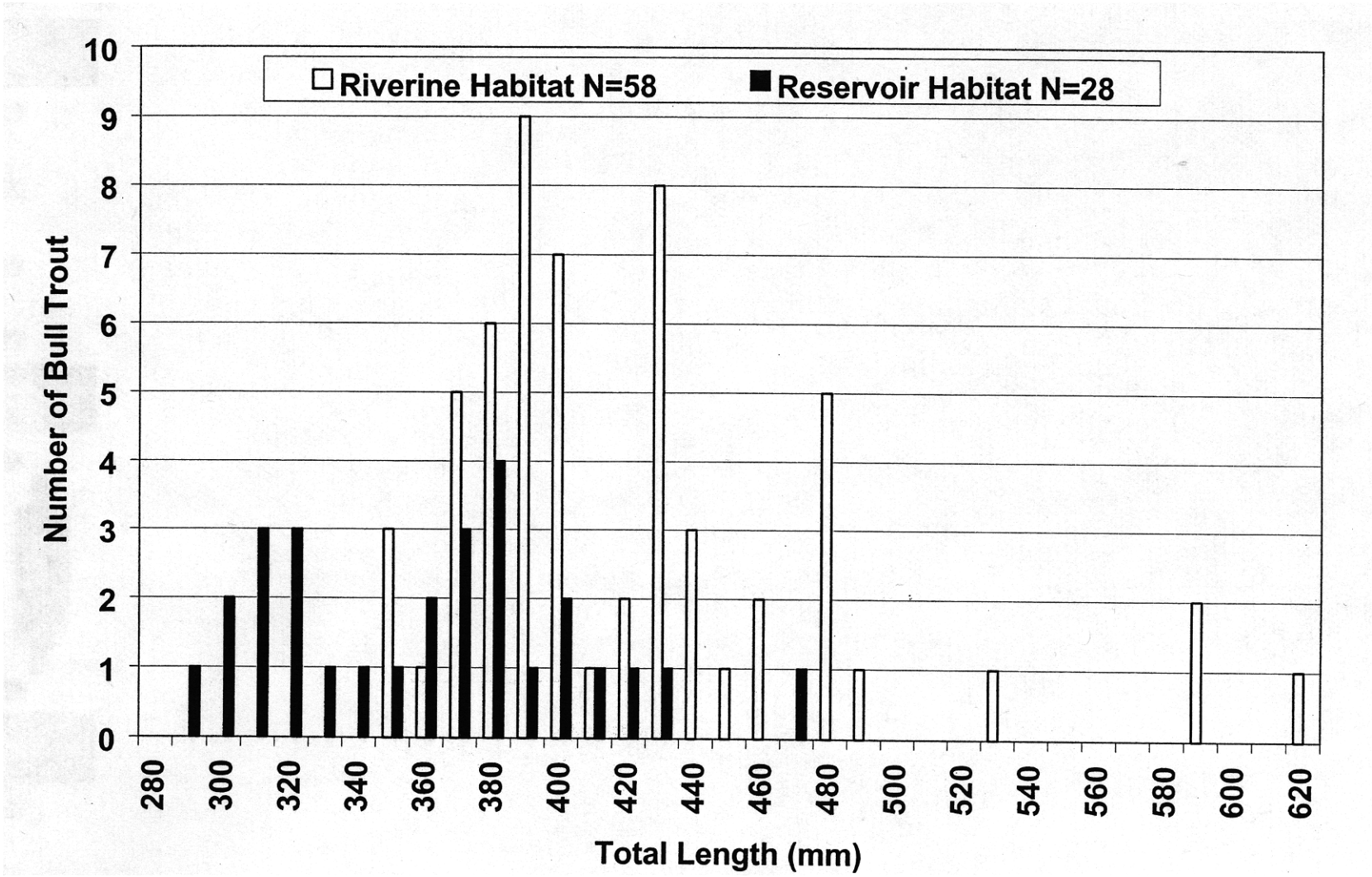

Figure 8. Number of radio tagged bull trout that emigrated from Dworshak Reservoir based on total length (mm) in 2001.

bull trout remained in the reservoir and a lower percent of NANO-tagged fish in riverine habitat. This indicates that subadult bull trout use the reservoir during the summer months when adult spawners are in streams. Since the NANO-tagged bull trout were handled in the same manner as MICRO-tagged fish, we would not expect their mortality/tag loss to be significantly different. We estimated prespawn mortality/tag loss for MICRO-tagged bull trout at 6%, by collecting four tags out of 64 MICRO-tagged bull trout. Therefore, we do not suspect mortality/tag loss to be the cause of this discrepancy.

Bull trout redd surveys were conducted from the last week of August until the end of September on Vanderbuilt Gulch, Lake, Goose, and Quartz creeks in the NFCR. In the LNF redd surveys were conducted on the mainstem upper LNF and Butte, Canyon, Lund, Lost Lake, Little Lost Lake, Rocky Run, and Spotted Louis creeks. Thirty-six redds were located within the NFCR drainage, with the highest number of redds observed in Vanderbuilt Gulch (Table 4, Appendix B). In the LNF, 38 bull trout redds were observed, with the highest number of redds observed in the mainstem LNF (Table 4). There were no redds observed in Canyon, Lost Lake, Little Lost Lake, Rocky Run, or Spotted Louis creeks. But later redd surveys conducted found a redd in Lost Lake Creek (personal communication Joe Dupont, IDFG).

Table 4. Summary of bull trout redds observed in the North Fork Clearwater river basin, 2001.

Stream	Number of Redds	Average Size (cm2)
Lake Creek	7	5990
Goose Creek	1	10000
Quartz Creek above Wolf Creek	4	2930
Vanderbuilt Gulch	24	9010
Mainstem Upper LNF	28	7300
Butte Creek	5	6040
Lund Creek	5	8060

DISCUSSION

Study results confirm that there is a migratory bull trout population utilizing Dworshak Reservoir. Our data suggests that subadult bull trout are using the reservoir throughout the year. This is supported by the fact that bull trout <350 mm were not detected

migrating from the reservoir and only two NANO- tagged bull trout migrated from the reservoir, both greater than 350 mm. Therefore, environmental and habitat changes that occur during the summer in the reservoir are likely to affect the subadult segment of the population.

Adult bull trout (>350 mm) seem to be using Dworshak Reservoir as an overwintering area and staging area for spawning migrations. In April and May they can be found congregated in the slackwater interfaces of Dworshak Reservoir. They leave the reservoir in late May through early July and return after 15 September. And tributary entry is from early July to mid-August. We believe these are adult fluvial bull trout on a spawning migration, due to the high occurrence of bull trout redds in those areas where radio tagged bull trout were documented. However, we did not document radio-tagged bull trout actively spawning. This migration pattern is different from the adfluvial bull trout population in the Flathead River basin (Shepard et al. 1984). This adfluvial population begins migrating in April and peaks during high water flows in May and June (Shepard et al. 1984) and tributary entry is from late July through September. It is more similar to the fluvial population in Rapid River, Idaho (Schill et al. 1994). This study documented bull trout beginning to run on 30 April, peaking the last week of May and being mostly complete by 7 July.

Alternate- and repeat- year spawning is known to occur in bull trout populations. Allan (1980) found 73% of adult bull trout tagged in Timber Creek, Alberta did not return to spawn the following year. Bull trout in Rapid River, Idaho, showed 66-80% of post-spawning survivors spawned the next year (Elle et al. 1994). In Dworshak Reservoir 23% of the adult bull trout (>350 mm) radio tagged in 2001 did not migrate above a fixed site. This may represent the proportion of adults exhibiting alternate-year spawning behavior. However, this estimate may be bias because tagging areas were known to have concentrations of pre-spawn bull trout.

Post-spawning survival is estimated at 40% (6/15) for radio tagged bull trout in NFCR. This is comparable to 31% post-spawning survival reported for bull trout in Rapid River (Schill et al. 1994). We documented 50% (3/6) of the surviving bull trout in NFCR spawning areas in 2001. Although the sample size was small, this may represent an unbiased estimate of a segment of the adult bull trout population that exhibits alternate year spawning behavior in NFCR drainage.

Our current estimate of the proportion of alternate- year spawning behavior based on those bull trout that did not migrate and the post-spawn survivors that migrated in 2001 is 23-50% of the adult population. Currently, we do not know if there is a portion of the population that spawns less frequently than every other year. Additional data are required to obtain an accurate estimate of the proportion of repeat and alternate year spawners in the adult population and the relationship of sex to post spawning survival and spawning frequency.

To date we have not found radio-tagged bull trout being entrained at Dworshak Dam. In 2001, the furthest downstream bull trout were detected in Dworshak Reservoir was at approximately rkm 30.1, which is 27.0 km above Dworshak Dam. In 2000, a radio-tagged bull trout was located at rkm 9.7, which is 6.5 km above Dworshak Dam (Cochnauer et al. 2000). Spawning bull trout have a low probability of entrainment associated with summer water withdrawal because, they are not utilizing the reservoir during this period of time. Subadult bull trout may have a higher probability of entrainment because subadult radio-tagged bull trout were documented remaining in the reservoir during the summer. In 2001 we could not determine subadult distribution within the reservoir because of the type of tags used and the depth that bull trout are thought to occur during this time. Therefore, further study is recommended to determine if entrainment is occurring. Entrainment related to winter water withdrawal has not yet been assessed; it will be monitored during the winter of 2001-2002.

The second year of this study documented trends in migration patterns and identified riverine habitat areas utilized seasonally by bull trout. Continuation of the study in 2002 will include expansion to include additional tracking of bull trout within the reservoir through the use of acoustic tags implanted in the fall when bull trout are over-wintering in the reservoir. This additional information will help document habitat use in Dworshak Reservoir to ensure protection of critical areas for these bull trout populations, and help to determine risk of entrainment through the project. Additionally, bull trout will be captured in the spillway of Dworshak Dam and radio tagged to determine if these fish attempt a spawning migration out of the NFCR, and if they do which drainage they immigrate into, and if spawning occurs.

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APPENDICES

Appendix A. Bull trout captured in Dworshak Reservoir 2001.

Date	Frequency	Code	Total (mm)	Fork (mm)	Weight (gm)	Group
4/9/01	148.770	2	403	385	610	BFC
4/9/01	148.770	1	461	441	1020	BFC
4/13/01	150.010	3	482	462	800	LNF
4/14/01	150.010	7	380	395	570	NFCR
4/14/01	150.010	1	386	370	520	NFCR
4/17/01	150.010	10	443	424	700	NFCR
4/23/01	148.930	37	302	287	195	DWOR
4/25/01			320	300	230	DWOR
5/1/01	149.420	12	296	290	360	DWOR
5/1/01	149.420	10	322	293	310	DWOR
5/1/01	150.010	6	404	382	560	LNF
5/2/01	148.480	10	350	330	410	DWOR
5/2/01			315	300	285	NFCR
5/2/01	149.420	6	321	305	270	NFCR
5/2/01	148.480	2	353	335	400	NFCR
5/2/01	148.480	4	371	352	450	NFCR
5/2/01	148.480	1	392	372	510	NFCR
5/2/01	148.480	3	405	395	660	NFCR
5/7/01			242	227	100	DWOR
5/7/01			258	244	120	DWOR
5/7/01	149.420	19	431	412	1020	DWOR
5/9/01			263	247	150	BFC
5/9/01			283	267	180	BFC
5/9/01			296	280	205	BFC
5/9/01			334	312	295	BFC
5/9/01			367	350	375	BFC
5/9/01	148.770	3	392	377	505	BFG
5/10/01			249	234	100	BFC
5/10/01			256	237	135	BFC
5/10/01	148.770	5	378	353	450	BFC
5/10/01	148.930	35	381	362	570	BFC
5/10/01			300	286	195	DWOR
5/10/01	148.770	6	395	375	500	LNF
5/11/01	148.770	7	484	460	1100	LNF
5/11/01	148.770	4	531	505	1340	LNF
5/11/01			326	304	250	NFCR
5/11/01			360	342	350	NFCR
5/11/01	150.010	4	381	362	465	NFCR
5/11/01	150.010	2	397	377	570	NFCR
5/11/01	150.010	5	485	464	1180	NFCR
5/12/01	148.770	8	455	432	850	LNF
5/12/01	148.770	10	627	609	2250	LNF
5/16/01			251	239	120	NFCR
5/16/01			379	360	500	NFCR
5/17/01			317	301	280	BFC

Appendix A. Continued.

Date	Frequency	Code	Total (mm)	Fork (mm)	Weight (gm)	Group
5/17/01	149.440	49	350	330	340	BFC
5/17/01	149.440	50	356	337	390	BFC
5/17/01	148.770	12	383	362	540	BFC
5/17/01	148.770	13	401	381	605	BFC
5/17/01	148.770	11	491	466	1080	BFC
5/17/01	148.770	9	405	385	630	LNF
5/18/01			276	264	170	DWOR
5/18/01	148.930	27	404	392	650	DWOR
5/18/01	148.930	38	408	385	545	DWOR
5/18/01	149.440	60	368	351	410	LNF
5/18/01	148.770	14	382	365	500	LNF
5/18/01	150.010	8	438	414	685	LNF
5/19/01	148.480	5	377	359	480	BFC
5/19/01	150.010	9	406	385	590	LNF
5/19/01			246	232	110	NFCR
5/19/01			299	283	220	NFCR
5/19/01			319	304	235	NFCR
5/19/01			324	306	265	NFCR
5/19/01			328	310	280	NFCR
5/19/01	148.480	7	398	377	610	NFCR
5/19/01	148.480	6	449	430	870	NFCR
5/20/01	148.910	29	390	369	450	DWOR
5/20/01			323	304	290	LNF
5/20/01	148.480	23	434	404	750	LNF
5/20/01	148.480	8	590	575	2070	LNF
5/20/01	148.480	9	597	475	1420	LNF
5/21/01			263	248	120	DWOR
5/21/01			266	250	120	DWOR
5/21/01	149.420	7	300	284	230	DWOR
5/21/01	149.420	14	311	292	200	DWOR
5/22/01	149.440	52	345	327	310	BFC
5/22/01	148.480	25	392	372	570	BFC
5/22/01	148.480	26	428	413	620	BFC
5/22/01			314	296	230	DWOR
5/23/01			278	262	160	NFCR
5/23/01	148.480	11	383	360	450	NFCR
5/23/01	148.480	14	387	369	610	NFCR
5/23/01	148.480	12	403	382	530	NFCR
5/23/01	148.480	13	420	405	660	NFCR
5/24/01	149.440	53	310	293	220	NFCR
5/30/01	149.440	54	370	358	450	BFC
5/30/01	148.480	17	387	369	510	BFC
5/30/01	148.480	16	410	385	600	BFC
5/30/01	148.480	15	430	410	650	BFC
5/30/01			292	272	160	DWOR

Appendix A. Continued.

Date	Frequency	Code	Total (mm)	Fork (mm)	Weight (gm)	Group
5/31/01	149.420	64	470	492	1090	DWOR
5/31/01	149.440	56	335	316	340	NFCR
5/31/01			346	326	340	NFCR
5/31/01	149.440	55	367	349	400	NFCR
5/31/01	148.480	19	387	365	510	NFCR
6/5/01			330	311	280	DWOR
6/5/01	148.930	37	435	413	720	DWOR
6/5/01	149.440	59	310	292	230	NFCR
6/5/01	148.910	33	362	345	435	NFCR
6/5/01	149.440	58	372	353	435	NFCR
6/5/01	148.910	26	373	355	440	NFCR
6/5/01	148.480	18	395	375	570	NFCR
6/5/01	148.480	21	430	405	760	NFCR
6/5/01	148.480	20	435	411	770	NFCR
6/5/01	148.930	36	437	415	790	NFCR
6/5/01	148.480	22	445	426	840	NFCR
6/5/01	148.930	32	485	462	1000	NFCR
6/6/01	148.930	33	395	375	530	DWOR
6/6/01	148.930	28	429	408	760	DWOR
6/6/01			288	270	180	NFCR
6/6/01	149.440	57	326	308	260	NFCR
6/6/01	148.910	25	374	356	440	NFCR
6/6/01	148.480	24	376	357	520	NFCR
6/6/01	148.910	32	393	374	610	NFCR
6/6/01	148.930	3	462	442	960	NFCR
10/17/01	148.930	22	370	345	460	BFC
10/17/01	148.910	13	386	365	510	BFC
10/17/01	150.010	9	405	384	550	BFC
10/17/01	148.770	7	605	580	1750	LNF
10/17/01			520	495	1020	LNF
10/18/01	148.480	8	600	580	1700	LNF
10/18/01	148.910	34	366	351	420	LNF
10/18/01	148.910	32	385	362	410	LNF
10/18/01	148.910	37	450	430	810	LNF
10/18/01	149.440	68	452	436	775	LNF
10/18/01	148.930	31	460	435	850	LNF
10/18/01	148.770	13	505	525	1350	LNF
10/18/01	148.480	13	520	502	1250	LNF
10/23/01			360	340	300	LNF
10/23/01	149.440	62	366	351	470	LNF
10/23/01	149.440	70	371	352	450	LNF
10/23/01	149.440	66	432	418	730	LNF
10/23/01	149.440	71	484	465	890	LNF

Appendix B. Bull trout redds observed in the North Fork Clearwater river basin, 2001.

Stream	Survey Date	Redd Number	Size (cm2)
North Fork Clearwater River			
Lake Creek	8/28/01	LCK 01	4000
	8/28/01	LCK 02	3200
	8/28/01	LCK 03	9600
	8/28/01	LCK 04	2400
	8/28/01	LCK 05	16000
	9/20/01	LCK 06	3600
	9/20/01	LCK 07	3150
Goose Creek	9/20/01	GSE 01	10000
Quartz Creek above Wolf Creek	9/19/01	QTZ 01	6000
	9/19/01	QTZ 02	2100
	9/19/01	QTZ 03	1800
	9/19/01	QTZ 04	1800
Vanderbuilt Gulch	8/29/01	VB 01	20000
	8/29/01	VB 02	1500
	8/29/01	VB 03	5200
	9/21/01	VB 04	11200
	9/21/01	VB 05	6600
	9/21/01	VB 06	4800
	9/21/01	VB 07	6000
	9/21/01	VB 08	9600
	9/21/01	VB 09	7800
	9/21/01	VB 10	16000
	9/21/01	VB 11	9100
	9/21/01	VB 12	23200
	9121/01	VB 13	6000
	9/21/01	VB 14	20800
	9/21/01	VB 15	9600
	9/21/01	VB 16	7500
	9/21/01	VB 17	5200
	9/21/01	VB 18	14000
	9/21/01	VB 19	6500
	9/21/01	VB 20	6500
	9/21/01	VB 21	10500
	9/21/01	VB 22	3600
	9/21/01	VB 23	2700
	9/21/01	VB 24	2400

Appendix B. Continued.

Stream	Survey Date	Redd Number	Size (cm2)
Little North Fork Clearwater River			
Mainstem	9/7/01	LNF 01	2100
Upper LNF	9/7/01	LNF 02	10000
	9/7/01	LNF 03	17100
	9/22/01	LNF 04	6000
	9/22/01	LNF 05	9600
	9/22/01	LNF 06	5400
	9/22/01	LNF 07	12000
	9/22/01	LNF 08	13500
	9/22/01	LNF 09	7200
	9/22/01	LNF 10	18000
	9/22/01	LNF 11	9600
	9/22/01	LNF 12	4000
	9/22/01	LNF 13	2800
	9/22/01	LNF 14	6000
	9/22/01	LNF 15	8800
	9/22/01	LNF 16	7200
	9!22/01	LNF 17	3200
	9/22/01	LNF 18	8800
	9/22/01	LNF 19	6000
	9/23/01	LNF 20	7200
	9/23/01	LNF 21	5500
	9/23/01	LNF 22	3600
	9/23/01	LNF 23	3200
	9/8/01	LNF 23	8000
	9/22/01	LNF 24	1600
	9/22/01	LNF 25	6600
	9/22/01	LNF 26	4500
	9/22/01	LNF 27	2400
	9/23/01	LNF 28	4400
Butte Creek	9/23/01	BTC 01	5400
	9/23/01	BTC 02	4400
	9/23/01	BTC 03	6000
	9/23/01	BTC 04	2400
	9/23/01	BTC 05	12000
Lund Creek	9/23/01	LDC 01	4500
	9/23/01	LDC 02	8400
	9/23/01	LDC 03	8800
	9/23/01	LDC 04	3600
	9/23/01	LDC 05	15000