

Distribution, movements, and life history characteristics of genetically pure westslope cutthroat trout *Oncorhynchus clarki lewisi* in the Fan Creek drainage, Yellowstone National Park

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Introduction

Westslope cutthroat trout *Oncorhynchus clarki lewisi* historically inhabited streams of the upper Missouri River Basin, including the Gallatin River and Madison River drainages in Yellowstone National Park. Westslope cutthroat trout were abundant in the Firehole River below Firehole Falls and the Gibbon River below Gibbon Falls during early surveys of fishes of the Park. Westslope cutthroat trout were also present in tributaries to these rivers, including Canyon Creek and Grayling Creek. Fluvial and resident forms of westslope cutthroat trout were thought to inhabit the Gallatin River and its tributaries, with early accounts indicating that Fan Creek contained "large numbers of trout."

Westslope cutthroat trout occupy only a small percentage of their historical range in the upper Missouri drainage. Competition with introduced trout species has contributed to this decline, but the mechanisms responsible for displacement are not well understood. Loss of genetic integrity through hybridization is a major problem where westslope cutthroat trout and rainbow trout *O. mykiss* occur sympatrically. Loss of diversity from genetic drift and catastrophic losses of populations are also potential risks, particularly among isolated headwater populations.

Genetic surveys of populations in streams of the Gallatin and Madison River drainages in Yellowstone National Park completed in the early 1990s indicated that genetic introgression had occurred to some degree in each sampled population. However, not all of the streams occurring within the historical range of westslope cutthroat trout were sampled, and sampling was usually limited to no more than a few locations within each stream. The Aquatic Resources Center, Yellowstone National Park, has been working to restore westslope cutthroat trout to headwater tributaries of Yellowstone National Park in the upper Missouri River drainage since 1997. Goals of the program include gathering information on the genetics, biology, abundances, life history, and status of westslope cutthroat trout, preparing a stream for restoration, and developing techniques for removing non-native species. As part of this effort, Aquatic Resources Center staff collected genetic samples from putative westslope cutthroat trout in streams of the Gallatin River and

Madison River drainages in the northwest region of Yellowstone National Park. Only one reach, the North Fork of Fan Creek, was found to contain a genetically pure population. Four cutthroat trout sampled in Fan Creek near the confluence of the Gallatin River were also found to be pure. Introgression was present among fish collected in the East Fork. The genetic purity of the North Fork population was surprising, considering that the site is not isolated by a physical barrier from invasion by non-native fishes from downstream. This suggests that the population is reproductively isolated by either temporal or spatial reproductive isolation. That is, the westslope cutthroat trout in the North Fork population either spawn in different places or at different times than rainbow trout and hybrids in this system.

The goal of this study, conducted by the Montana Cooperative Fishery Research Unit in collaboration with the Aquatic Resources Center, was to characterize the seasonal movements and life history characteristics of the genetically pure westslope cutthroat trout in the North Fork of Fan Creek and to compare these parameters with nearby hybridized populations in the mainstem of Fan Creek. This information could help managers make management decisions about the utility and placement of a physical barrier in the system, stream reclamation actions, and the suitability of this population for use as a source stock to reintroduce westslope cutthroat trout elsewhere in Yellowstone National Park in the native range of the subspecies.

Methods

Our primary technique for assessing seasonal movements was radio telemetry. In 2001, we attempted to implant 2.1-g radio transmitters (ca. 90-day battery life) in both hybrid and westslope cutthroat trout throughout the mainstem of Fan Creek and in the North Fork during May and June, at a time when we hoped that the fish had not yet begun their spawning migrations. We were unsuccessful in capturing any fish of a suitable size for telemetrization throughout the middle mainstem of Fan Creek. Six hybrids and one westslope cutthroat trout were telemetered in the lower mainstem and 22 westslope cutthroat trout were telemetered in the North Fork (Table 1, Figure 1). A PIT tag was implanted in each telemetered fish also. The fish were relocated at 1 or 2-week intervals until 01 August 2001.

We were concerned that implanting radios in May and June may have affected spawning behavior and migration of the telemetered fish, and that the movements of fish that inhabited the upper mainstem later in the year were not assessed. Therefore, we tagged fish with 3.6-g radio tags in fall 2001 to determine winter habitat use and spring 2002 spawning migrations (Table 2, Figure 2). The larger tags had 300-day battery life expectancies, which would allow tracking into summer 2002. Westslope cutthroat trout were tagged at four locations in fall 2001. These were the mainstem of Fan Creek at WC2 (1 fish), the mainstem at WC3 (7), at the confluence of the East and North forks (14; 7 in the upper mainstem and 7 in the lower North Fork), and in the upper North Fork (2). Four hybrids were tagged at WC2

and a single rainbow trout was tagged in the lower mainstem.

PIT tags were implanted in additional fish throughout the study, particularly in those that were too small for radio tags. A directional PIT-tag reading weir was installed in the lower North Fork during both 2001 and 2002. We thereby hoped to gather additional movement information. However, the PIT-tag data set is at present unrefined and the weir was programmed incorrectly during 2001. We were therefore able to recover only weir-passage information in 2002 and only on telemetered fish, as well as information on numbers of PIT-tagged fish moving through the weir seasonally in both 2001 and 2002. The student's thesis, if completed, will include a comprehensive analysis of the PIT-tag data.

Results

Telemetered fish, Spring 2001

Six hybrids, all relatively large, were tagged in the lower mainstem of Fan Creek in early June 2001. Three of these (30-011, 30-031, 30-230) moved downstream after tagging into the Gallatin River and were last located there on 12 July 2001. Hybrid 30-040-2 was located several hundred meters downstream from its tagging location 10 days after tagging and then not located again. Hybrid 30-071 moved several hundred meters upstream from its tagging location and then remained stationary through June and July until last located on 01 August 2001. Hybrid 30-080-2 moved downstream about 500 m after tagging and then moved back upstream about 1 km, past its tagging location, and was last located there in mid-July 2001. These results suggest that the tagged hybrids had either entered the lower mainstem of Fan Creek from the Gallatin to spawn and then returned to the Gallatin (hybrids 30-011, 30-031, 30-230) or were residents of the lower mainstem of Fan Creek (hybrids 30-071 and 30-080-2); hybrid 30-040-2 was not tracked long enough to characterize its movement pattern. Overall, we saw no evidence that these hybrids moved very far upstream into the Fan Creek system, and certainly not into the North Fork of Fan Creek.

Five telemetered westslope cutthroat trout tagged in the lower North Fork of Fan Creek during Spring 2001 were never located after tagging (WCT 30-040-1, 30-051, 30-090-2, 30-100, and 30-180). The only westslope cutthroat trout tagged in the lower mainstem of Fan Creek (WCT 30-090-1) apparently died shortly after being tagged on 06 June 2001; its tag was found 10 days later on shore near the Gallatin confluence.

The remaining 17 westslope cutthroat trout tagged during Spring 2001 could be categorized into five movement types. Four fish (30-110, 30-151, 30-190, and 30-260) remained stationary where they were tagged in the lower North Fork. Four fish (30-020, 30-140, 30-160, and 30-220) moved downstream less than 1 km from their tagging location in the lower North Fork and stayed in the lower North Fork. Two others (30-121 and 30-131) stayed in the vicinity of the confluence of the North and East forks, but moved between the North Fork and the mainstem. Three fish (30-080-1, 30-280, and 30-241) stayed in the upper North Fork. Two of these (30-080-1 and 30-280) moved downstream from their tagging locations 1 to 2 km, whereas the third (30-241) initially

moved downstream about 1.5 km but then moved back to its tagging location.

Four westslope cutthroat trout exhibited long downstream movements from the North Fork to the mainstem. Fish 30-171 moved downstream from its tagging location in the lower North Fork to just below WC3 and stayed there. Fish 30-060 was tagged in the upper North Fork on 23 May 2001 but was not located again until mid-July when it was found below the confluence of the North and East forks; it subsequently moved to below WC3 in late July. Fish 30-200 moved from the upper North Fork to below WC3 where it stayed through early August. Similarly, fish 30-300 moved from the upper North Fork to the lower North Fork and then on to a summering location midway between WC2 and WC3. Fish 30-300 was detected moving upstream on 17 July 2002 by the PIT-tag reader at the weir in the lower North Fork.

In summary, most (11) of the 17 westslope cutthroat trout tagged in the North Fork during Spring 2001 moved little and stayed in the North Fork. Two others also moved only short distances, but moved between the North Fork and the mainstem below the confluence with the East Fork. Four westslope cutthroat trout moved long distances from the North Fork to the middle mainstem between WC2 and WC3. Movements of individual fish tagged in spring 2001 are shown in Appendix A. Date-specific aggregate relocations are presented in Appendix B.

Telemetered fish, Fall 2001

The sole rainbow trout (30-050) tagged in the lower mainstem was never relocated.

Four hybrids were tagged at WC2. Two of these (30-342 and 30-402) essentially remained stationary through July 2002. Hybrid 30-120 remained at its tagging location through January 2002 and was not relocated again until May 2002 when it was found about 0.5 km upstream; it was not relocated thereafter. Hybrid 30-382 moved downstream several km after tagging where it remained until January 2002. It was found about 1 km farther downstream in March 2002 and then moved upstream several km to its last known location in April 2002. Again, we saw no evidence that hybrids entered the North Fork.

Westslope cutthroat trout were tagged at 4 locations in fall 2001. These were the mainstem of Fan Creek at WC2 (1 fish), the mainstem at WC3 (7), at the confluence of the East and North forks (14), and in the upper North Fork (2).

A single westslope cutthroat trout was tagged in the mainstem just upstream from WC2. It moved downstream about 2 km and was relocated in a short reach through January 2002, and then again several hundred meters farther downstream in early June 2002. It moved about 1.5 km upstream to below WC2 in mid-June and remained in about a 0.5 km reach through mid-July.

Seven westslope cutthroat trout were tagged in the mainstem just upstream from WC3. One (30-040) stayed within about a 1-km reach near WC3 through July 2002. Two (30-170 and 30-110) were relocated downstream. Fish 30-170 moved downstream from

WC3 about 1 km, where it stayed through early May 2002. It moved about 2 km farther downstream in mid-May, was not located during June, and was found back upstream near its overwintering location on 05 July 2002. Ten days later it was found about 4 km downstream and was relocated there 3 and 8 days later. Fish 30-110 was relocated at its tagging location in late December 2001 and then not again until June 2002 about 1 km downstream.

Four of the westslope cutthroat trout tagged in the mainstem just upstream from WC3 made upstream movements. Fish 30-311 remained at its tagging location through 21 May 2002. It moved upstream about 1 km between then and late June 2002. Fish 30-220 moved upstream into the North Fork within a month of tagging and stayed near WC4 through late May 2002. Its last relocation was several hundred meters upstream from WC4 on 20 June 2002. Fish 30-271 stayed at its tagging location through December 2001. It was not relocated again until late April 2002 about 1 km upstream. It remained at that location until late June, when it made a brief excursion upstream into the North Fork about 1 km upstream from the East Fork confluence. Two weeks later it returned to its spring location where it remained through its last relocation on 15 July 2002. Fish 30-151 remained at its tagging location through 07 May 2002. One month later (04 June 2002) it was found about 3 km *downstream*, but moved about 7 km upstream through the weir on 20 June 2002 into the lower North Fork and remained there through mid-July.

In summary, the 7 westslope cutthroat trout tagged near WC3 in fall 2001 exhibited highly variable movements. Two moved downstream, one remained stationary, one moved a short distance upstream, and 3 moved upstream into the North Fork. Most major movements occurred in May and June 2002.

Fourteen westslope cutthroat trout were tagged near the confluence of the North and East forks in fall 2001. Fish 30-130 was never relocated. Four fish tagged in the lower North Fork (30-010, 30-261, 30-080, and 30-280) did not move appreciably, although 30-280 was relocated only once, 8 days after tagging. Fish 30-080 was detected moving downstream through the weir by the PIT-tag reader on 12 July 2002. Four fish tagged in the upper mainstem just below the confluence (30-060, 30-090, 30-190, and 30-200) did not move, although 30-090 was relocated only twice, 8 and 14 days after tagging. Fish 30-250 was tagged in the lower North Fork and made only limited movements, but moved several hundred meters downstream into the upper mainstem in late May and early June 2002 before moving back upstream into the lower North Fork in mid-June.

Four of the westslope cutthroat trout tagged near the confluence of the North and East forks in fall 2001 made substantive movements. Fish 30-322 was not relocated after late October 2001 until June 2002 when it was near WC3. Fish 30-180 moved upstream about 1.5 km in the North Fork during November and December 2001 and remained there through July 2002. Fish 30-372 moved up from below the confluence in December 2001 and January 2002 and remained in the lower North Fork through May 2002. It moved downstream through the weir on 27 June 2002 and was back at its tagging location in late July 2002. Fish 30-160 exhibited perhaps the most anomalous

movement observed during this study. It was tagged below the confluence of the East and North Forks and remained there until the end of April 2002 when it moved upstream about 1 km into the *East Fork*. It stayed there for about 1 week and then moved downstream to just upstream from WC3 a week later. It slowly moved downstream about 3 km over the next 2 months.

Nine of the 13 successfully-tracked westslope cutthroat trout tagged near the confluence of the North and East forks in fall 2001 moved very little, whereas the other 4 made highly variable movements; one moved upstream, one downstream, one upstream into the North Fork and back down, and one upstream into the East Fork and then far downstream to the middle mainstem.

The two westslope cutthroat trout tagged in the upper North Fork remained largely stationary. Fish 30-240 stayed within about a 300-m reach. Fish 30-392 slowly moved downstream about 1 km from September 2001 to July 2002.

Movements of individual fish tagged in fall 2001 are shown in Appendix C. Date-specific aggregate relocations are presented in Appendix D.

Weir passage

Numbers of PIT-tagged fish moving upstream past the weir in 2001 were highest from late June to late July and declined gradually thereafter (Figure 3). Downstream movement was highest in mid-July and mid-August. Relatively few fish moved through the weir in autumn. In 2002, both upstream and downstream movements were highest in June followed by July (Figure 3).

Discussion

Although we telemetered few hybrids, we saw no evidence that they entered the North Fork of Fan Creek or even the upper portions of the mainstem. Movements of most of the westslope cutthroat trout tagged in the North Fork were limited and most of these fish stayed in the North Fork. Westslope cutthroat trout tagged in the upper mainstem either made short spawning migrations upstream within the mainstem or made longer migrations to the North Fork. Overall these findings suggest that spatial reproductive isolation is responsible for maintaining the genetic purity of westslope cutthroat trout in the North Fork of Fan Creek. Unfortunately, continued isolation cannot be assured, especially considering the presence of introgression in the East Fork. Protection of the North Fork population from introgression can be improved by placement of an artificial barrier on the lower North Fork. Such a barrier would exclude some westslope cutthroat trout from the mainstem from returning to the North Fork to spawn, but relatively few fish make such a migration. The greater danger is from a single hybrid entering the North Fork. An artificial passage barrier would help prevent such an occurrence.

Chemical reclamation of the East Fork and as much of the mainstem as possible would increase the amount of habitat occupied by genetically pure westslope cutthroat trout in

the Fan Creek system and improve the long-term viability and abundance of the population. Stepwise downstream reclamation, in conjunction with temporary barriers, starting with the East Fork tributaries and proceeding sequentially downstream into the upper mainstem below the confluence of the forks, would allow practicable-sized stream segments to be exterminated entirely. These segments could then be restocked with fish from the North Fork or their progeny.

Table 1. Telemetrized fish, Fan Creek, spring 2001, 2.1-g tags.

Tag code	Species	PIT tag number	Total length (mm)	Weight (g)	Date tagged	Location tagged	Number of relocations	Final relocation
30-011	Hybrid	985120005560872	357	435.2	05 JUN 01	Lower mainstem	2	12 JUL 01
30-031	Hybrid	985120005729520	270	205.5	01 JUN 01	Lower mainstem	1	12 JUL 01
30-040-2	Hybrid	985120005748196	309	266.5	06 JUN 01	Lower mainstem	1	16 JUN 01
30-071	Hybrid	985120005747187	279	227.5	01 JUN 01	Lower mainstem	4	01 AUG 01
30-080-2	Hybrid	985120005416332	319	365.0	01 JUN 01	Lower mainstem	3	17 JUL 01
30-230	Hybrid	985120005563832	271	190.6	06 JUN 01	Lower mainstem	2	12 JUL 01
30-020	WCT	985120005410992	229	111.2	16 MAY 01	Lower N. Fork	6	01 AUG 01
30-040-1	WCT	985120005559672	258	157.0	18 MAY 01	Lower N. Fork	0	--
30-051	WCT	985120005551438	182	56.7	28 JUN 01	Lower N. Fork	0	--
30-060	WCT	985120005745875	245	157.9	23 MAY 01	Upper N. Fork	4	01 AUG 01
30-080-1	WCT	985120005741617	204	67.3	17 MAY 01	Upper N. Fork	6	01 AUG 01
30-090-1	WCT	985120005567132	263	166.2	06 JUN 01	Lower mainstem	0	--
30-090-2	WCT	985120011341273	223	137.2	28 JUN 01	Lower N. Fork	0	--
30-100	WCT	985120005085250	208	70.0	16 MAY 01	Lower N. Fork	0	--
30-110	WCT	985120005558369	266	141.3	16 JUN 01	Lower N. Fork	4	01 AUG 01
30-121	WCT	985120005559533	201	64.1	16 MAY 01	Lower N. Fork	6	01 AUG 01
30-131	WCT	985120005084262	194	75.0	15 JUN 01	Lower N. Fork	4	01 AUG 01
30-140	WCT	985120005563596	195	66.0	23 MAY 01	Lower N. Fork	4	01 AUG 01

30-151	WCT	985120005553023	223	93.5	16 JUN 01	Lower N. Fork	4	01 AUG 01
30-160	WCT	985120005744847	185	52.0	16 MAY 01	Lower N. Fork	6	01 AUG 01
30-171	WCT	985120005745700	199	72.9	16 JUN 01	Lower N. Fork	4	01 AUG 01
30-180	WCT	985120005750420	230	106.9	16 MAY 01	Lower N. Fork	0	--
30-190	WCT	985120011308158	252	144.9	28 JUN 01	Lower N. Fork	4	01 AUG 01
30-200	WCT	985120005553626	343	412.1	17 MAY 01	Upper N. Fork	5	01 AUG 01
30-220	WCT	985120005561579	190	52.7	23 MAY 01	Lower N. Fork	3	24 JUL 01
30-241	WCT	985120005552292	183	55.0	23 MAY 01	Upper N. Fork	6	01 AUG 01
30-260	WCT	985120005546689	207	81.5	23 MAY 01	Lower N. Fork	5	01 AUG 01
30-280	WCT	985120005567580	232	113.8	17 MAY 01	Upper N. Fork	6	01 AUG 01
30-300	WCT	985120005747358	345	355.4	17 MAY 01	Upper N. Fork	6	01 AUG 01

Table 2. Telemetrized fish, Fan Creek, fall 2001 to July 2002, 3.6-g tags.

Tag code	Species	PIT tag number	Total length (mm)	Weight (g)	Date tagged	Location tagged	Number of relocations	Final relocation
30-050	RBT	985120011307489	258	287	05 OCT 01	Lower mainstem	0	--
30-120	Hybrid	985120005556700	285	231	16 SEP 01	WC2	7	21 MAY 02
30-342	Hybrid	985120011309295	316	315	05 OCT 01	WC2	16	23 JUL 02
30-382	Hybrid	985120011304680	276	225	05 OCT 01	WC2	5	23 APR 02
30-402	Hybrid	985120011334376	302	324.8	05 OCT 01	WC2	13	23 JUL 02
30-010	WCT	985120011306558	205	82	10 OCT 01	Lower N. Fork	11	07 MAY 02
30-040	WCT	985120011307557	243	150	14 SEP 01	WC3	20	23 JUL 02
30-060	WCT	985120011309430	219	103	10 OCT 01	Upper mainstem	16	18 JUL 02
30-080	WCT	985120011309501	234	120	10 OCT 01	Lower N. Fork	19	23 JUL 02
30-090	WCT	985120011309571	208	84	10 OCT 01	Upper mainstem	2	24 OCT 01
30-110	WCT	985120011330749	325	358	14 SEP 01	WC3	6	26 JUN 02
30-130	WCT	985120011307748	315	> 300	10 OCT 01	Upper mainstem	0	--
30-151	WCT	985120011306398	282	224	14 SEP 01	WC3	9	15 JUL 02
30-160	WCT	985120011334599	216	86	10 OCT 01	Upper mainstem	25	23 JUL 02
30-170	WCT	985120011306903	243	132	14 SEP 01	WC3	14	23 JUL 02
30-180	WCT	985120011309390	244	150	23 JUL 02	Lower N. Fork	16	23 JUL 02
30-190	WCT	985120011307787	236	126	10 OCT 01	Upper mainstem	17	18 JUL 02

30-200	WCT	985120011310333	205	98	10 OCT 01	Upper mainstem	18	23 JUL 02
30-210	WCT	985120011310114	310	284	16 SEP 01	WC2	11	11 JUL 02
30-220	WCT	985120011307636	261	174	14 SEP 01	WC3	11	20 JUN 02
30-240	WCT	985120011307993	214	92	19 SEP 01	Upper N. Fork	11	24 JUN 02
30-250	WCT	--	226	105	10 OCT 01	Lower N. Fork	14	03 JUL 02
30-261	WCT	--	214	92	10 OCT 01	Lower N. Fork	13	16 JUL 02
30-271	WCT	985120011308301	308	280	14 SEP 01	WC3	15	15 JUL 02
30-280	WCT	985120011307337	200	88	10 OCT 01	Lower N. Fork	1	18 OCT 01
30-311	WCT	985120011310018	278	208	14 SEP 01	WC3	9	26 JUN 02
30-322	WCT	985120011395608	263	171	10 OCT 01	Lower N. Fork	3	11 JUN 02
30-372	WCT	985120011366928	216	90	10 OCT 01	Upper mainstem	11	23 JUL 02
30-392	WCT	985120011337610	206	96	19 SEP 01	Upper N. Fork	13	18 JUL 02

Figure 1. Spring 2001, 2.1-g tags

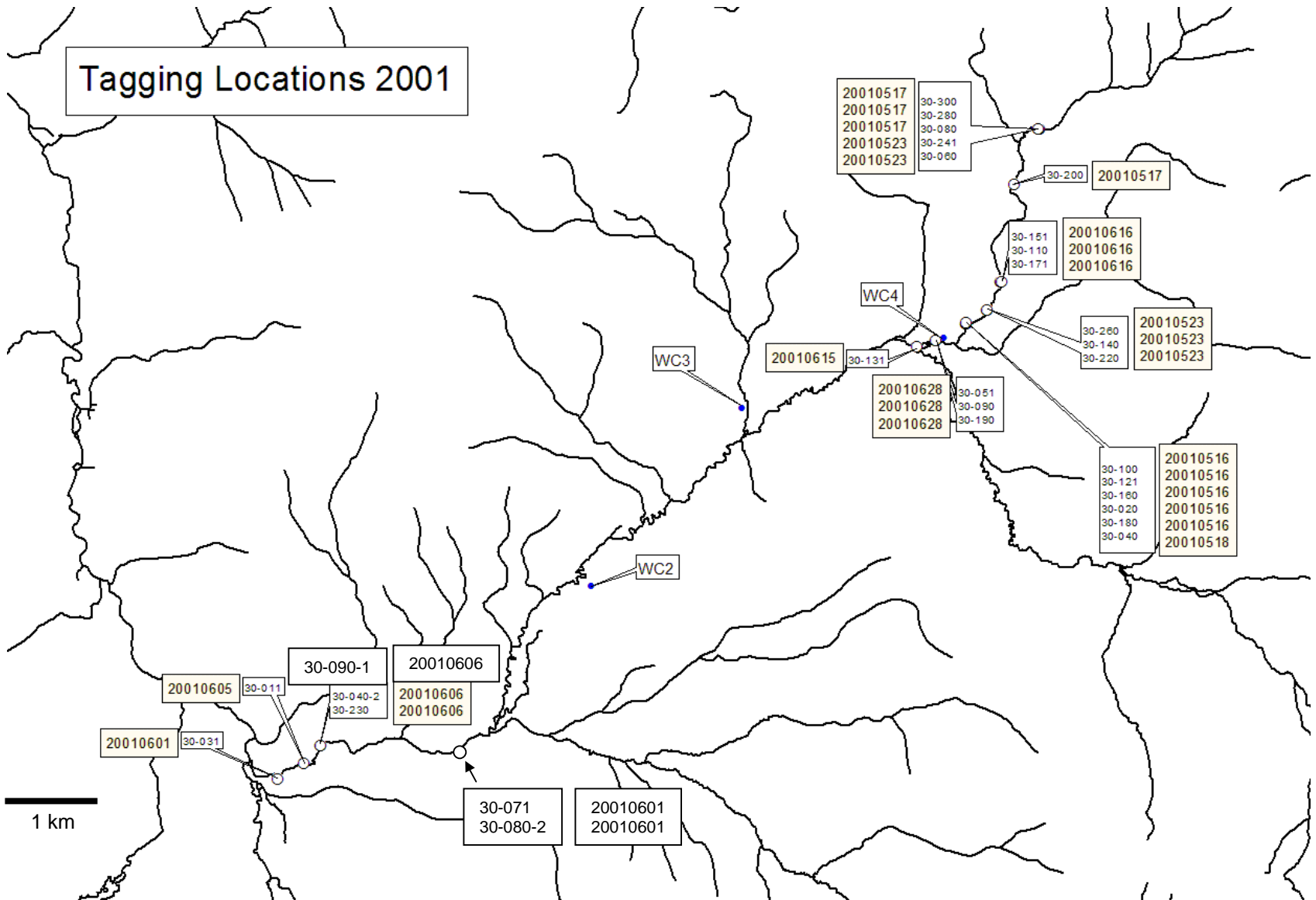
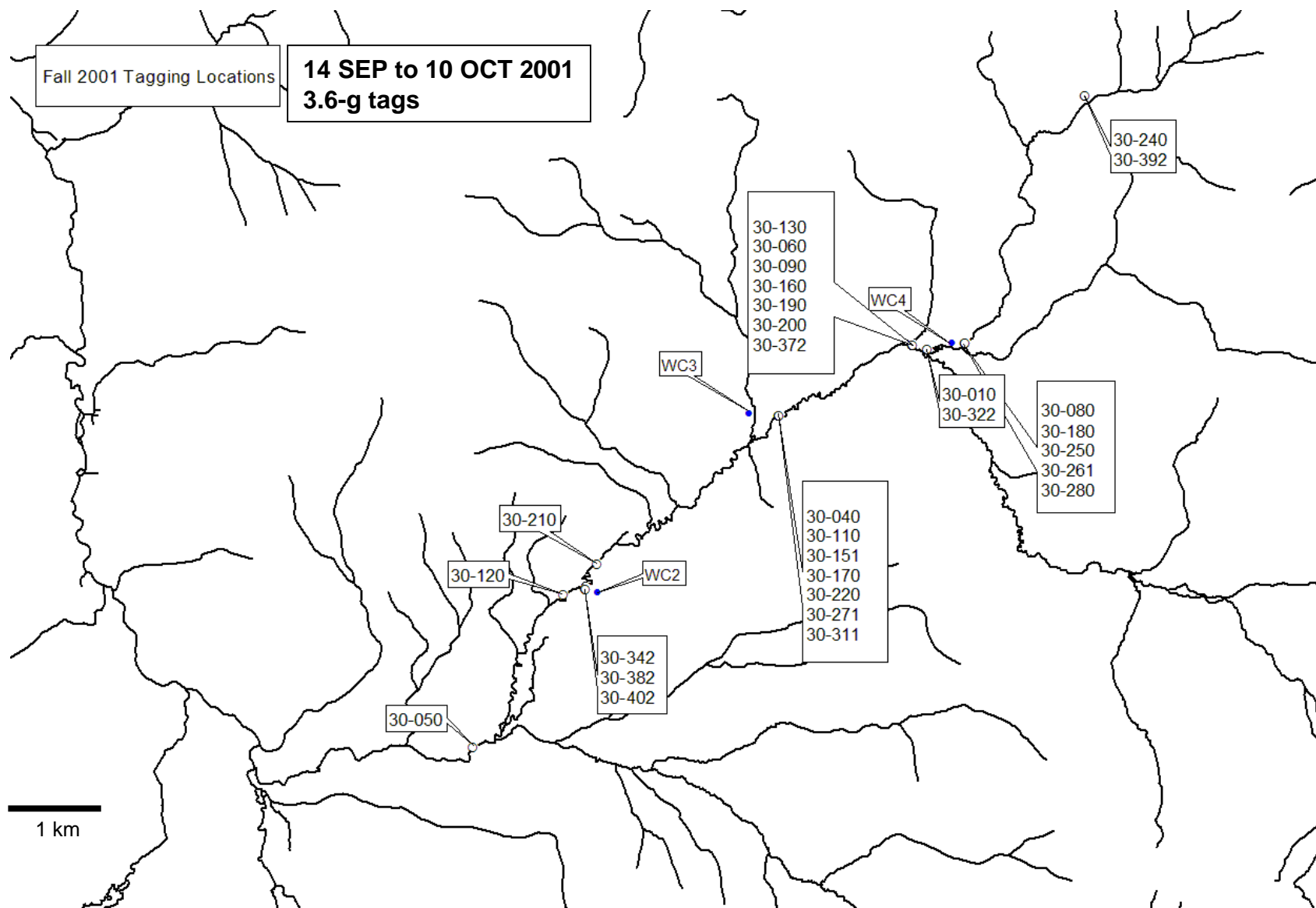


Figure 2. Fall 2001, 3.6-g tags



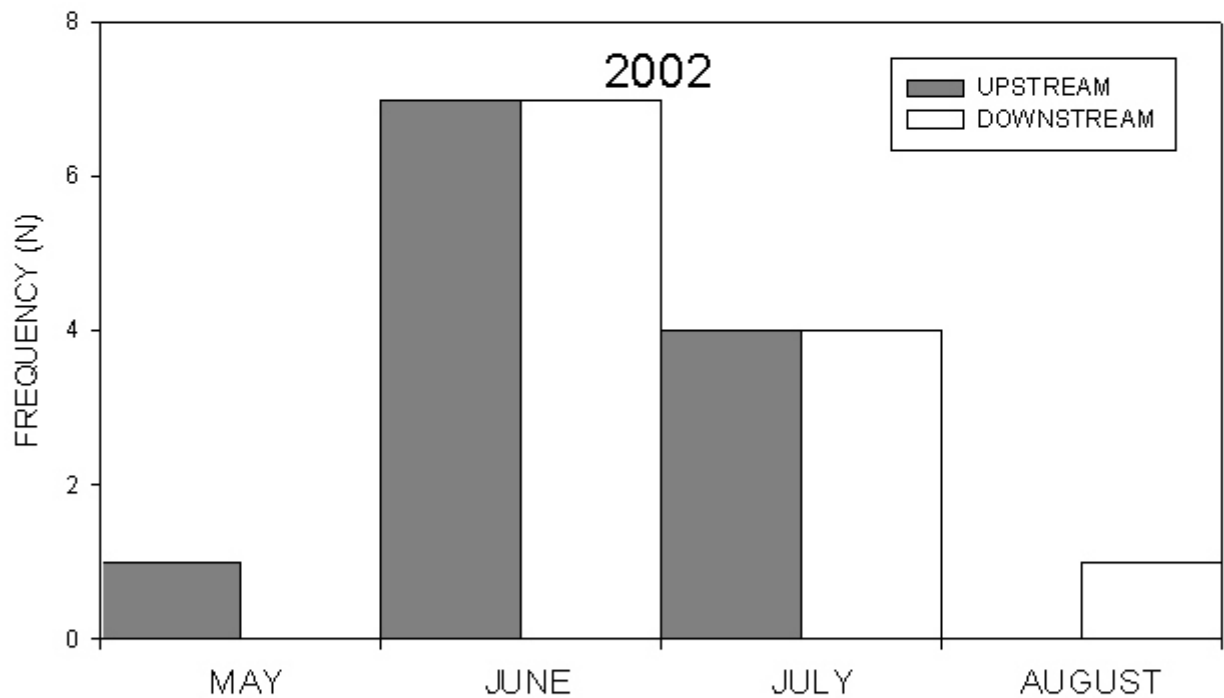
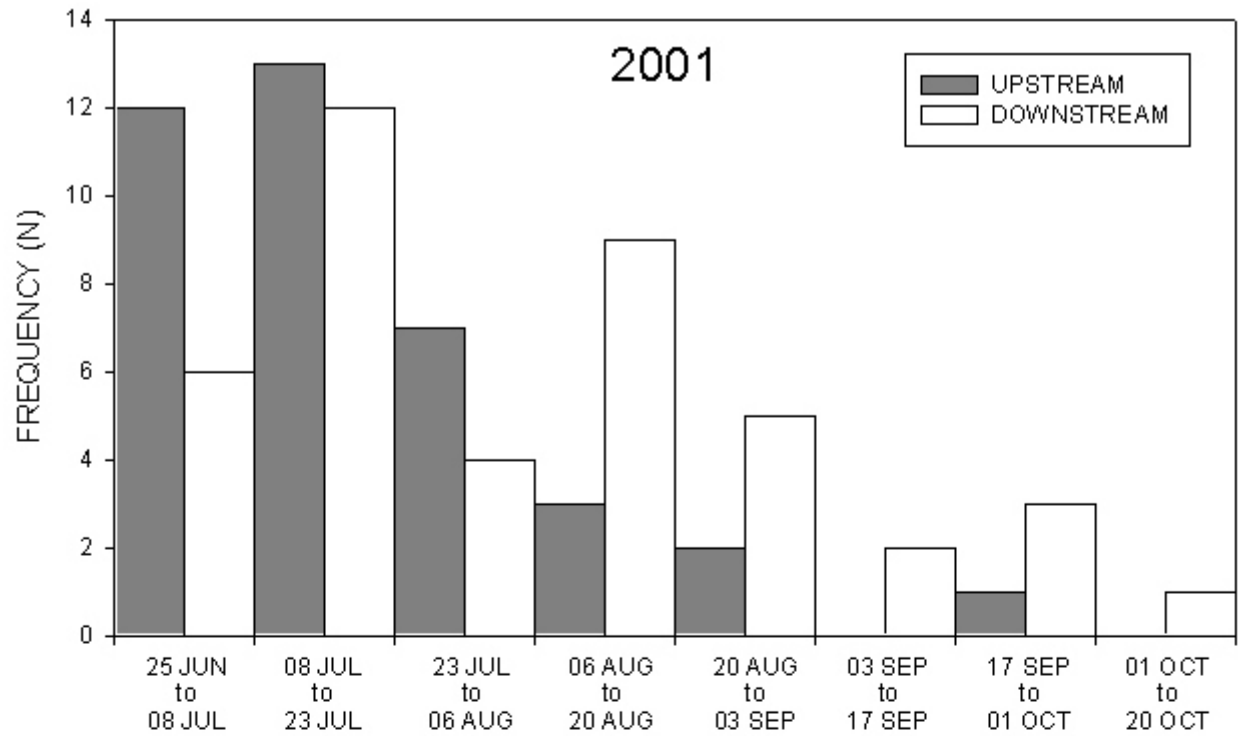


Figure 3. Numbers of PIT-tagged fish moving past the weir in the lower North Fork of Fan Creek.