LOWER CLARK FORK RIVER FISHERY ASSESSMENT

Project Completion Report

Idaho Tributary Habitat Acquisition and Enhancement Program

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ABSTRACT

A new minimum flow in the Clark Fork River below Cabinet Gorge Dam in Idaho was negotiated in 1999 as part of Avista Corporation's relicensing agreement for Cabinet Gorge Dam. Minimum instream flow was increased from 84.9 cms to 141.5 cms. Increased minimum flows were hypothesized to increase the availability of rearing habitat for fish and improve foraging conditions by providing more stable habitat conditions for aquatic invertebrates. Subsequent effects of these changes were expected to include increased abundance of target fish, increased proportion of younger age classes of target species, and improved condition of all age classes. To describe the effects of increased minimum flows, fish populations were monitored between 1999 and 2008 in a 6.6 km reach of the lower Clark Fork River. Targeted species in the monitoring program included brown trout *Salmo trutta*, mountain whitefish *Prosopium williamsoni*, rainbow trout *Oncorhynchus mykiss*, and westslope cutthroat trout *O. clarkii lewisi*. Assessment focused on monitoring changes in abundance, size structure, and condition of fish populations in the affected area. Abundance of target species was estimated during annual monitoring efforts using mark recapture techniques. Relative abundance (catch per unit effort (CPUE)) of all species was estimated during fall sampling events. Size structure of sampled target species was compared by sample year using structural indices including proportional stock density and quality stock density. Physical condition of target species was evaluated by estimating mean relative weights. Estimated abundance of mountain whitefish ranged from 3,717 to 9,029 over the study period. Brown trout, rainbow trout (includes rainbow trout hybrids), and westslope cutthroat trout abundance estimates ranged from 76 to 356 fish per species, in the study area over the ten year period. No significant changes or trends in relative abundance were detected for any of the target species. Native non-game fishes including northern pikeminnow *Ptychocheilus oregonensis*, redside shiner *Richardsonius balteatus*, peamouth *Mylocheilus caurinus*, and largescale sucker *Catostomus macrocheilus* were the most common fishes sampled. Trends in structural indices were generally positive except brown trout quality stock density. Significant trends were only observed in mountain whitefish proportional stock densities and rainbow trout quality stock densities. Mean relative weights of westslope cutthroat trout, rainbow trout, and mountain whitefish were consistently above 80 while brown trout were consistently near or below 80. No significant linear relationships were observed between year and relative weight. Results suggested abundance, size structure, and condition of fish populations in the lower Clark Fork River were largely unchanged following increases in minimum flow below Cabinet Gorge Dam.

INTRODUCTION

An agreement reached with Idaho Department of Fish and Game (IDFG) in 1973 provided for a 3,000 cfs minimum flow below Cabinet Gorge Dam. That agreement was based on field assessments of the river at varying flows, electrical generating requirements, a review of historic low-flow records, and the earlier recommendation for a minimum flow of the same amount made by the U.S. Fish and Wildlife Service (Service). However, minimum flow in the Clark Fork River below Cabinet Gorge Dam was still one issue of concern to the local stakeholders involved in a collaborative relicensing process conducted by Avista Corporation (Avista; formerly Washington Water Power (WWP)) for Cabinet Gorge and Noxon Rapids dams. Avista relicensed these two hydroelectric facilities on the Clark Fork River in Idaho and Montana in 1999 and the Clark Fork Settlement Agreement (CFSA) was the product of the collaborative relicensing process (Avista 1999). Cabinet Gorge Dam is located just inside the Idaho border and Noxon Rapids Dam is located approximately 32 km upstream in Montana (Figure 1). A new minimum flow was negotiated for Cabinet Gorge Dam as part of the relicensing agreement, which increased the base flow from 84.9 cms (3,000 cfs) to 141.5 cms (5,000 cfs) (Avista 1999, see Appendix T). The objective of the increased minimum flow was to increase the amount of permanently wetted river habitat to benefit the aquatic resources of the Clark Fork River. More specifically, the objectives were to reduce the range of depth and velocity fluctuations in the river, and reduce varial zone and bar dewatering to increase stability of shoreline rearing areas for fish and enhance microinvertebrate production. Photo documentation was used to estimate the minimum flow needed to provide a meaningful increase in permanently wetted perimeter of the Clark Fork River (Beak 1997). Cabinet Gorge Dam is operated as a load following facility, with daily flow fluctuations ranging from 84.9 cms (3,000 cfs) to 1,010.3 cms (35,700 cfs) prior to the increased minimum discharge. Following the increase of minimum flow, generation capabilities were increased and daily flow fluctuations ranged from 141.5 cms (5,000 cfs) to 1076 cms (38,000 cfs).

In addition to increasing minimum flows in the Clark Fork River, Avista and IDFG completed a restoration project in 2001 to provide perennial flow through the approximately 2 km-long Foster Bar side-channel to enhance fish habitat. This involved lowering several hydraulic control points within the side-channel so that water would flow through the side-channel over the range of discharges from Cabinet Gorge Dam. Prior to relicensing, when discharge from Cabinet Gorge Dam dropped below approximately 311.3 cms (11,000 cfs), the side-channel would become a series of un-connected pools. This reconnection was anticipated to provide valuable off-channel spawning and rearing habitat for salmonids, which is in limited supply in the Idaho reach of the Clark Fork River.

To assess the effectiveness of changes in minimum flow and channel alteration, a ten-year monitoring program was conducted from 1999 through 2008. Increasing minimum flows from 84.9 cms to 141.5 cms was hypothesized to increase the availability of rearing habitat for fish and improve foraging conditions by providing more stable conditions for aquatic invertebrates. In addition, consistent flow and channel improvements in the Foster side-channel were expected to provide additional spawning and rearing habitat for salmonids. Subsequent impacts of these changes were hypothesized to increase abundance of target fish, increase the proportion of younger age classes of target species, and improve condition of all age classes. Assessment of these two possible actions focused on monitoring changes in abundance, size structure, and condition of fish populations in the affected area.

Limited quantitative information existed relative to the fishery resources of the Clark Fork River in Idaho prior to this study and prior to influences of hydropower facilities on the lower Clark Fork River. Several studies have investigated river use by adfluvial fish from Lake Pend Oreille (LPO), as well as the fish community composition (Heimer 1965, Anderson 1978, WWP 1995 and 1996). Avista, in preparation for their hydropower license renewal, conducted investigations into relative abundance of fish species present in the Clark Fork River in Idaho (WWP 1995 and 1996). The information contained in these Avista reports adds to our baseline knowledge of fish populations in the Clark Fork River. In combination, the earlier Avista work and the first several years of this investigation formed the baseline from which the effects of the increased minimum flow were judged.

Required monitoring of the impacts of increased minimum flow below Cabinet Gorge Dam on native fishes was also included in the new operating license for the Clark Fork Project (FERC 2000, License Article 429). Also, term and condition (b) of reasonable and prudent measure #4 within the incidental take statement filed by Service on August 23, 1999, included in the new project license, indicated the benefit of increased minimum flow to bull trout and other species should be evaluated for a ten year period at which time or earlier a recommendation to the Service should be made for continuation or change of the minimum flow (McMaster 1999). The completion of this report was intended to provide a summary of monitoring results and recommendations from this required monitoring therefore satisfying these two license requirements.

STUDY AREA

The Clark Fork River is the largest tributary to LPO, contributing an estimated 92% of the annual inflow (Frenzel 1991) and draining approximately 59,324 km^2 of western Montana (Lee and Lunetta 1990). Four tributaries enter the Clark Fork River downstream of Cabinet Gorge Dam: Twin, Mosquito, Lightning, and Johnson creeks (Figure 1). Peak flows in the Clark Fork River typically occur as a result of snow melt in May or June (PBTAT 1998).

The study area encompasses approximately 6.6 km of river habitat from the USGS gauging station below Cabinet Gorge Dam downstream to the inlet of Foster Bar side-channel (approximately river km 234 – 241, Figure 1). There is approximately 17 km of river habitat between Cabinet Gorge Dam and LPO during winter lake draw downs. Approximately 6 km of the lower river is impacted by elevated LPO water levels during late spring through early fall. Physical habitat in the Clark Fork River below Cabinet Gorge Dam can be characterized as primarily low gradient laminar flow, with three major riffles and several deep pools (to 23 m in depth) (WWP 1995). Riffles are located near the mouths of Twin and Lightning creeks, as well as at Foster Bar side-channel. Substrate composition in the river has been described as gravel (26.3%), fines (22.2%), boulder (17.9%) and cobble (16.2%) (WWP 1995).

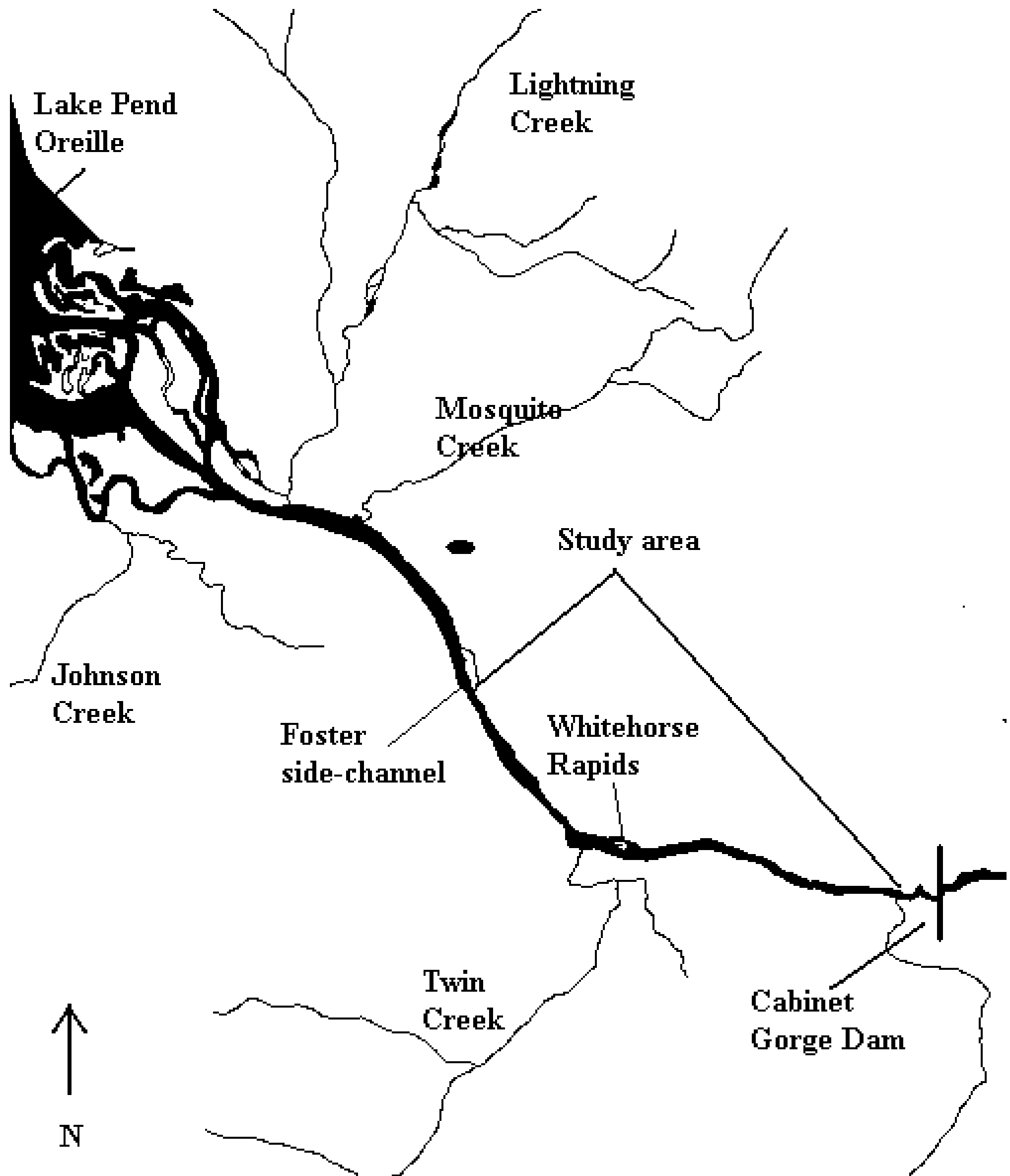

Figure 1. Fishery evaluation study area on the lower Clark Fork River, the major tributary to Lake Pend Oreille, Idaho.

Distances and river kilometers were initially estimated from previous Avista GIS work (Parametrix 2000a). Total surface area of the study reach was estimated at 120.7 ha (Downs and Jakubowski 2003). We validated this estimated area by measuring twenty-five wetted widths along the estimate section, as well as the total length of the section (25 sub-section lengths for a total estimated length of 6.61 km), using a laser range-finder. Using this method, we estimated the surface area at 114.8 ha at approximately 906 cms (32,000 cfs) discharge from Cabinet Gorge Dam. We estimated the surface area at this discharge because it is close to the upper generation limit of the project (approximately 1076 cms (38,000 cfs)), and flows often fluctuated between 141.5 cms and 990.5 cms during these field studies.

Foster Bar side-channel is located approximately 1.9 km downstream of the confluence of Twin Creek with the Clark Fork River (Figure 1). The side-channel is approximately 2.45 km in length. During periods of winter drawdown of LPO, the side-channel functions as a lotic system. During periods of high summer lake levels, about half of the side-channel is influenced by a backwater effect from LPO, and stream flow through the side-channel is greatly slowed.

METHODS

The effects of increasing minimum flows at Cabinet Gorge dam to 141.5 cms and implementation of the Foster side-channel alteration in the lower Clark Fork River on local fish populations were monitored from 1999 to 2008. Monitoring focused on those characteristics of the local fish populations that had potential to benefit from increased wetted channel width and total habitat availability. Monitoring indices included abundance, size structure, and condition of fish populations in the affected area. Targeted species in the assessment included brown trout *Salmo trutta*, mountain whitefish *Prosopium williamsoni*, rainbow trout *Oncorhynchus mykiss*, and westslope cutthroat trout *O. clarkii lewisi*. Alternating sample seasons (spring and fall) were used to avoid spawning migration periods of fish from LPO. Spring sample periods were utilized for fall spawning salmonids and fall sampling periods were used for spring spawning salmonids. Two sample periods, spring and fall, were completed in 2000. In subsequent years, spring and fall sample periods were alternated. Spring samples were consistently collected in even numbered years between March 27 and April 10. Fall sample periods were completed on odd numbered years between October 18 and November 9. Brown trout and mountain whitefish were targeted in the spring while rainbow and westslope cutthroat trout were targeted in the fall. Rainbow x westslope cutthroat trout hybrids were evaluated as rainbow trout for the purpose of this study.

Boat mounted boom-type electrofishing equipment was used to sample fish. Fish sampling was conducted at night, typically using two crews in 6 m-long jet boats. The electrofishing setup in each boat consisted of a Coffelt VVP-15 electroshocker powered by a 5000 watt Honda generator. Smooth DC current was employed to minimize risk of injury to trout (Dalbey et al. 1996). Electrofishing settings were generally set to generate 5 to 8 amps at 200-220 volts. Electrofishing boats floated in fast flow areas, or motored slowly in areas of very slow flow downstream, parallel with the shoreline. While electrofishing, we attempted to keep the anode closest to shore in approximately 0.6 m of water depth. Each boat typically made a single pass down each shoreline, and multiple passes along the shorelines in the Whitehorse Rapids area (to increase sample size in productive areas) each night.

Fish stunned in the electrofishing field were netted and placed into a live well for recovery. Captured fish were anesthetized and checked for fin clips. All target species in the marking runs were measured (TL, mm). Only a subset of target fish caught in the recapture runs were measured (TL, mm). All fish were measured during collections used in estimating catch per unit effort (CPUE). Larger fish were weighed to the nearest 10 g on a top loading spring scale and smaller fish to the nearest 1 g on a digital scale. Target fish were marked with a fin clip, and released. Scales were collected in some years for estimation of age if desired.

Abundance of target fish species greater than or equal to 200 mm total length (TL) was estimated using mark recapture techniques. Typically, the "marking" period was conducted over a three-night period in the first week of sampling and the "recapture" period was conducted over a three-night period the following week. We continued with recapture runs until we captured at least three previously marked fish of each target species to reduce probability of statistical bias in our estimates. Population estimates were calculated using the modified Petersen method for sampling without replacement (any individual was only counted once) (Krebs 1989) as:

$$N = ((M+1)\ (C+1)/(R+1)) - 1$$

Where N = Estimated population

M = Number of individuals marked in the first sample

C = Total number of individuals captured in the second sample

R = Number of individuals in second sample that are previously marked

Confidence intervals (95%) around population estimates were estimated using a Poisson distribution to account for small recapture sample size (Chapman 1948, Seber 1982) and were calculated using tabled values provided in Hayes et al. (2007). Confidence intervals were examined between years to evaluate significant differences between surveyed years.

Relative abundance (CPUE) of all species was estimated only during fall sampling events by netting all fish encountered on one complete pass down each bank of the river during the recapture run. Fall sampling periods reflected the highest overall catch rates and greatest variety of fish species. Trends in relative abundance were used primarily to determine if significant changes ($\alpha \leq 0.05$) in abundance or proportion of non-target species resulted from increased minimum flows. CPUE was estimated as fish captured per minute of electrofishing. Trends in relative abundance were evaluated using linear regression analysis. CPUE data from 1994 (WWP 1996) was included in the evaluation to provide pre-treatment perspective.

Size structure of sampled target species was compared by sample year using structural indices including proportional stock density (PSD) and quality stock density (QSD) (Anderson and Neumann 1996). PSD was defined as the proportion of fish sampled ≥ 305 mm relative to all sampled fish stock length (200 mm, TL) or greater (Schill 1991). QSD were defined as the proportion of fish sampled ≥ 406 mm relative to all sampled fish stock length (200 mm, TL) or greater (Schill 1991). Linear regression was used to evaluate the presence, direction, and significance of trends in structural indices. Evaluation of trends in structural indices included only sample years during which a given species was targeted.

Relative weight (*Wr*) was calculated to assess the condition of target species (Anderson and Neumann 1996). Mean relative weights and associated 95% confidence intervals were calculated by species to evaluate differences between sample years. Linear regression analysis was used to determine if significant trends in fish condition were present ($\alpha \leq 0.05$). Trend analysis included an evaluation of mean relative weights by year.

A post hoc evaluation of mountain whitefish growth rate was completed to further evaluate observed trends in size structure of the sampled population. Whitefish were the most abundant species captured and arguably the most likely to maintain residency in the lower river. Changes in growth were evaluated by comparing mean total length at age four. Age four was selected because it corresponded to the approximate size at which mountain whitefish appeared to be fully recruited to the sampling gear and sufficient scale samples were available in three sample years for comparison. Length at age comparisons included data from years 2000, 2003, and 2007. Scales were collected in fall samples. Scale samples were pressed to acetate slides and viewed on a microfiche. No back calculations were applied to age estimates. Change in length at age between years was evaluated using one-way analysis of variance (ANOVA, $\alpha \leq 0.05$).

RESULTS

Abundance of targeted fishes described by population estimates was dominated by mountain whitefish with brown trout, rainbow trout, and westslope cutthroat trout present in considerably lower proportions (Table 1). Estimated abundance of mountain whitefish ranged from 3,717 to 9,029 fish within the study area. Brown trout and rainbow trout (includes rainbow trout hybrids) abundance estimates ranged from 113 to 282 fish and 76 to 356 fish, respectively. Westslope cutthroat trout cumulatively were the least abundant target species, with abundance estimates ranging from 89 to 170 fish. Rainbow trout x westslope cutthroat trout hybrids were included in rainbow trout abundance estimates to increase sample sizes and specifically recapture events for valid abundance estimates.

No trends in abundance were identified in any target species during the study period. Estimated abundances of target species did not vary considerably among most years for either spring or fall sample periods (Figure 2). Examination of confidence intervals provided no strong evidence that significant changes in abundance occurred during the study period for any target species. Observed shifts in estimated abundance of mountain whitefish between 2000 and 2001 were the most dramatic noted, although overlapping confidence intervals suggested abundance likely did not differ significantly. Whitefish abundance was estimated from only three recaptures in 2000 suggesting variability in that estimate may have been high. Recaptures in subsequent years ranged from eight to 47. Observations from sampling crews indicated their effectiveness of finding and sampling more and larger whitefish increased following early sampling effort, due to the discovery of a mid-river concentration of fish. Resulting abundance estimates and population indices likely demonstrated variation resulting from this inconsistency in sampling protocol.
A variety of target and non-target species were collected in efforts to describe relative

abundances of all fishes (Table 2). Species collected also included some of those exhibiting fall spawning behaviors. A total of 15 fish species were collected during fall sampling periods: bull trout *Salvelinus confluentus*, brown bullhead *Ictalurus nebulosus*, brown trout, kokanee *Oncorhynchus nerka*, northern pikeminnow *Ptychocheilus oregonensis*, lake whitefish *Coregonus clupeaformis*, largemouth bass *Micropterus salmoides*, largescale sucker *Catostomus macrocheilus*, longnose sucker *Catostomus catostomus*, mountain whitefish, pumpkinseed *Lepomis gibbosus*, peamouth *Mylocheilus caurinus*, rainbow trout, redside shiner *Richardsonius balteatus*, smallmouth bass *Micropterus dolomieui*, tench *Tinca tinca*, walleye *Sander vitreus*, westslope cutthroat trout, yellow perch *Perca flavescenes*, and rainbow x westslope cutthroat trout hybrids. Native non-game fishes including northern pikeminnow, redside shiner, peamouth, and largescale sucker were the most common fishes sampled on a regular basis. Kokanee also demonstrated a high CPUE and were abundant in fall sampling efforts in some years, but were absent in three of six sample years.

No significant correlation was identified between year and CPUE for any species sampled in fall CPUE evaluations (Table 2; WWP 1996, Downs and Jakubowski 2006, Downs and Jakubowski 2005a, Downs et al. 2003). Annual variation explained less than 30% of the variability in CPUE in the majority of species sampled. Trends in CPUE by year were weakly present ($\alpha \leq 0.10$) in bull trout, longnose sucker, northern pikeminnow, and pumpkinseed, suggesting some shift in population density in these species may have occurred since 1994. Of those species indicating weak trends in relative abundance, most demonstrated positive trends and overall low abundance with the exception of northern pikeminnow, which demonstrated a negative trend and high abundance.

Table 1. Population estimates by year and species including rainbow trout and hybrids (RBT/HYB), westslope cutthroat trout (WCT), brown trout (BRN), and mountain whitefish (MWF) from the approximately 6.6 km study area in the lower Clark Fork River, Idaho. Sample sizes for marked (M), captured (C), and recaptured (R) groups as well as associated 95% confidence intervals were included.

Year	Species	M	C	R	Estimate	Lower 95% CI	Upper 95% CI
1999	RBT/HYB	46	37	4	356	117	1,256
2000	RBT/HYB	86	38	16	199	114	333
2001	RBT/HYB	17	29	6	76	30	191
2003	RBT/HYB	36	13	5	85	30	240
2005	RBT/HYB	37	36	7	175	75	412
2007	RBT/HYB	33	26	5	152	55	440
1999	WCT	18	20	3	99	26	443
2000	WCT	29	13	3	104	28	464
2001	WCT	18	18	3	89	24	399
2003	WCT	25	25	4	134	43	461
2005	WCT	30	21	3	170	46	775
2007	WCT	29	18	3	142	38	642
2000	BRN	30	25	4	160	52	554

Table 1. Continued

Year	Species	M	C	R	Estimate	Lower 95% CI	Upper 95% CI
2002	BRN	58	30	15	113	64	193
2004	BRN	128	73	38	244	172	336
2006	BRN	75	44	22	148	93	227
2008	BRN	133	60	28	281	187	412
2000	MWF	142	103	3	3,717	1,076	17,990
2002	MWF	757	547	45	9,029	6,650	12,282
2004	MWF	610	644	47	8,209	6,089	11,086
2006	MWF	653	322	24	8,449	5,534	13,036
2008	MWF	261	219	8	6,404	3,007	14,633

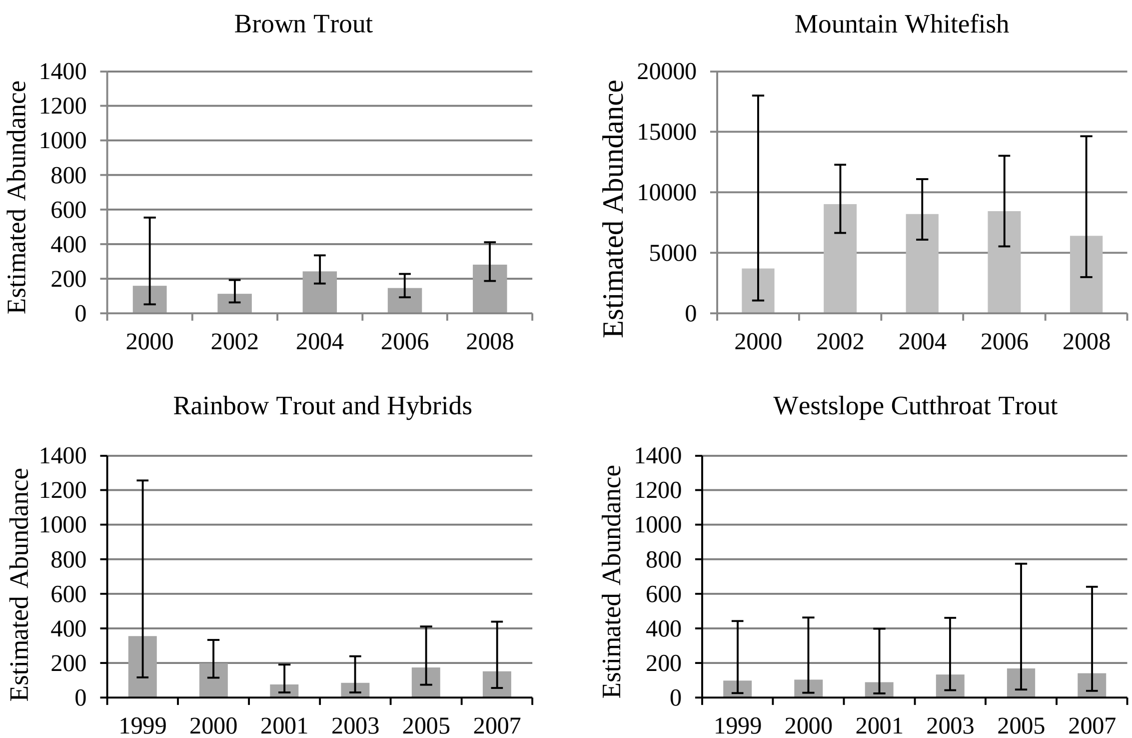

Figure 2. Estimated abundance of target species >200 mm by study year captured in the 6.6 km study reach of the lower Clark Fork River, Idaho. Error bars represent 95% confidence intervals. Note difference in scale for that portion of the figure representing mountain whitefish.

Collected fish samples generally represented age classes of two years and greater as estimated from lengths of sampled fish. Minimum total lengths of all target species were skewed toward lengths greater than 150mm (Table 3). Sampled rainbow trout and westslope cutthroat trout were primarily longer than 200mm. Mean total length of all fish species among all years was greater than 300mm indicating samples were skewed toward larger fish.

Table 2. Results of regression analysis between year (1994, 1999, 2001, 2003, 2005, and 2007) and CPUE for fish species collected in the lower Clark Fork River, Idaho including; Average CPUE, the square of Pearson's correlation coefficient (r2), slope of regression line through the data, and the P-value indicating significance of the relationship.

Species	Average CPUE	r^2	Slope	*P-value*
Northern Pikeminnow	0.89	0.60	-0.06	0.07
Redside Shiner	0.56	0.42	-0.10	0.16
Kokanee	0.54	0.32	-0.11	0.24
Peamouth	0.45	0.00	< 0.01	0.94
Largescale sucker	0.43	0.09	-0.02	0.57
Mountain whitefish	0.18	0.04	0.01	0.72
Brown Trout	0.07	0.45	0.01	0.15
Rainbow trout and Hybrids	0.05	0.14	< 0.01	0.47
Lake whitefish	0.04	0.31	0.01	0.26
Westslope Cutthroat Trout	0.03	0.09	< 0.01	0.57
Yellow Perch	0.01	0.39	< 0.01	0.18
Largemouth bass	0.01	0.13	< 0.01	0.48
Smallmouth bass	< 0.01	0.16	< 0.01	0.44
Pumpkinseed	< 0.01	0.61	< 0.01	0.07
Bull Trout	< 0.01	0.53	< 0.01	0.10
Longnose Sucker	< 0.01	0.61	< 0.01	0.07
Walleye	< 0.01	0.03	< 0.01	0.76
Tench	< 0.01	0.03	< 0.01	0.76
Brown bullhead	< 0.01	0.03	< 0.01	0.76

Table 3. Number sampled (n) and minimum, maximum, mean, and standard deviation of total length for target species collected in the lower Clark Fork River, Idaho during mark recapture surveys between 1999 and 2008.

Year	Species	n	Min TL	Max TL	Mean TL	STD
2000	Brown trout	52	205	705	387	107
2002	Brown trout	70	260	592	387	71
2004	Brown trout	167	127	700	359	85
2006	Brown trout	100	109	780	384	97
2008	Brown trout	171	150	560	356	58
2000	Mountain whitefish	296	148	428	316	50
2002	Mountain whitefish	177	215	466	329	41
2004	Mountain whitefish	1,245	128	470	330	45
2006	Mountain whitefish	907	157	454	340	39
2008	Mountain whitefish	477	141	436	348	35
1999	Rainbow trout	79	146	575	339	70

Table 3. Continued

Year	Species	n	Min TL	Max TL	Mean TL	STD
2000	Rainbow trout	108	221	785	354	67
2001	Rainbow trout	37	241	470	364	58
2003	Rainbow trout	44	255	482	350	45
2005	Rainbow trout	65	223	746	349	96
2007	Rainbow trout	53	224	590	373	81
1999	Westslope cutthroat	36	258	375	319	30
2000	Westslope cutthroat	31	259	411	308	41
2001	Westslope cutthroat	26	255	387	322	42
2003	Westslope cutthroat	46	255	421	319	40
2005	Westslope cutthroat	49	247	412	327	37
2007	Westslope cutthroat	48	266	427	327	42
1999	Rainbow Hybrids	7	248	432	341	59
2000	Rainbow Hybrids	0				
2001	Rainbow Hybrids	0				
2003	Rainbow Hybrids	0				
2005	Rainbow Hybrids	16	187	473	323	63
2007	Rainbow Hybrids	6	281	408	333	48

Structural indices demonstrated variability across the ten-year study period in all target species. Observed PSD values for all target species ranged between 61 and 89 except in 2000 in which the proportion of sampled westslope cutthroat trout greater than 305 mm was considerably less as represented by a PSD of 29 (Figure 3). Observed QSD values for all target species ranged from 0 to 43 and were more variable by species. Proportionally, few mountain whitefish or westslope cutthroat trout over 406 mm were sampled in contrast to catches of rainbow trout and brown trout (Figure 3). Trends in structural indices by year were generally positive except brown trout QSD (Table 4). However significant trends were only observed in mountain whitefish (PSD) and rainbow trout (QSD) populations. PSD values for mountain whitefish increased from 67 to 89 and QSD values for rainbow trout increased from 10 to 32. Shifts in size structure associated with these significant trends represented proportional increases in catch of mountain whitefish between 305 mm to 406 mm and in catch of rainbow trout ≥ 406 mm.

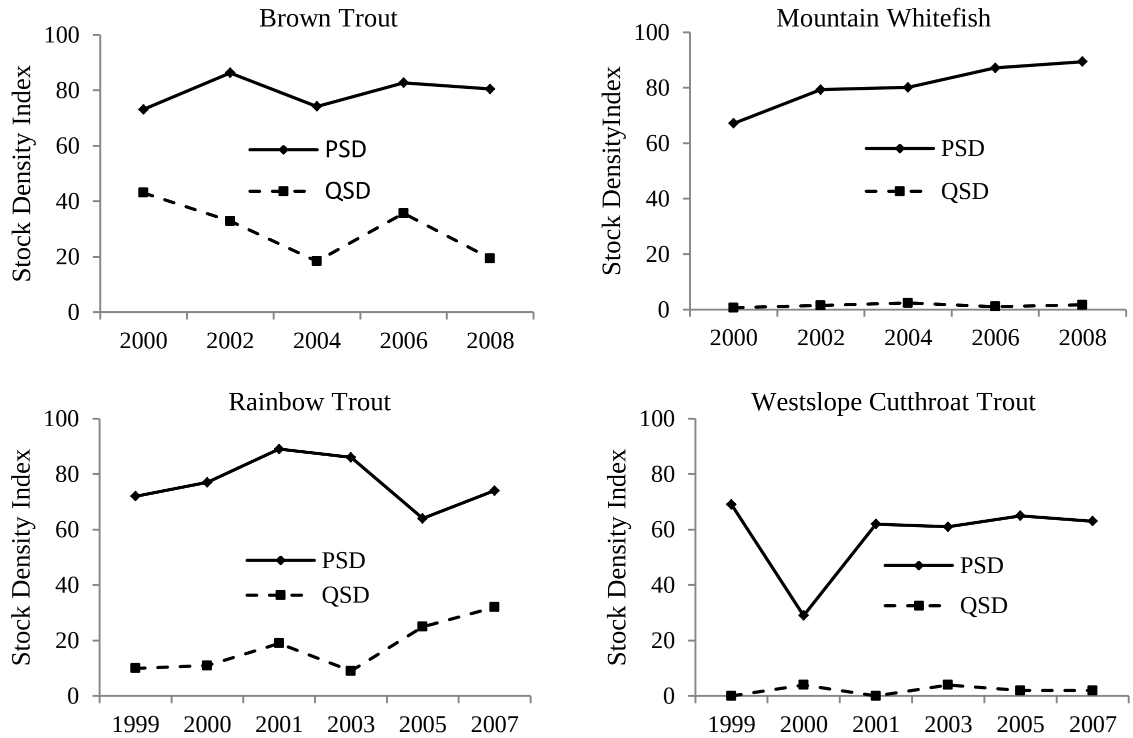

Figure 3. Stock density indices including proportional stock density and quality stock density by year for target species sampled in the lower Clark Fork River, Idaho from 1999 to 2008.

Table 4. Results of regression analysis between year and relative stock density indices (PSD and QSD) for target species sampled in the lower Clark Fork River, Idaho including the square of Pearson's correlation coefficient (r^2), slope of regression line through the data, and the *P-value* indicating significance of the relationship.

Species	Indice	Slope	r^2	*P*-value
Brown trout	PSD	0.56	0.10	0.61
Brown trout	QSD	-2.23	0.43	0.23
Mountain whitefish	PSD	2.62	0.90	0.01
Mountain whitefish	QSD	0.08	0.16	0.51
Westslope cutthroat trout	PSD	1.46	0.10	0.55
Westslope cutthroat trout	QSD	0.13	0.05	0.68
Rainbow trout	PSD	0.88	0.09	0.57
Rainbow trout	QSD	2.53	0.69	0.04

Estimated mean length of mountain whitefish at age four demonstrated a consistent decline across study years. A significant change in estimated mean total length at age four was detected (Age 4, $P > 0.01$). However, detected differences primarily reflected the 2007 estimate (Table 5).

Table 5. Estimated mean total length (TL, mm) of mountain whitefish at ages three, four, and five from fish sampled in the spring of 2000, 2003, and 2007 in the lower Clark Fork River, Idaho. Differing subscripts indicated significant difference in mean total length.

Year	Age	Mean TL	n	Std Dev	±95% CI
2000	4	359 [a]	11	20.8	12
2003	4	345 [a]	18	12.6	6
2007	4	321 [b]	16	16.8	8

No significant linear relationships were observed between year and relative weight (Table 6). Mean relative weights of westslope cutthroat trout, rainbow trout, and mountain whitefish were consistently above 80. Relative weights of brown trout were consistently near or below 80. Measures of mean relative weight demonstrated variation between sample years, but evaluation of confidence intervals supported conclusions from regressions analysis that variations were not significant (Figure 4).

Table 6. Results of regression analysis between year and mean relative weight (*Wr)* of target species sampled in the lower Clark Fork River, Idaho including the square of Pearson's correlation coefficient (r^2), slope of regression line through the data, and the *P-value* indicating significance of the relationship.

Species	r^2	Slope	*P*-value
Brown Trout	0.17	-0.51	0.49
Mountain Whitefish	0.42	0.96	0.24
Westslope Cutthroat Trout	0.00	0.03	0.95
Rainbow Trout	0.44	0.48	0.15

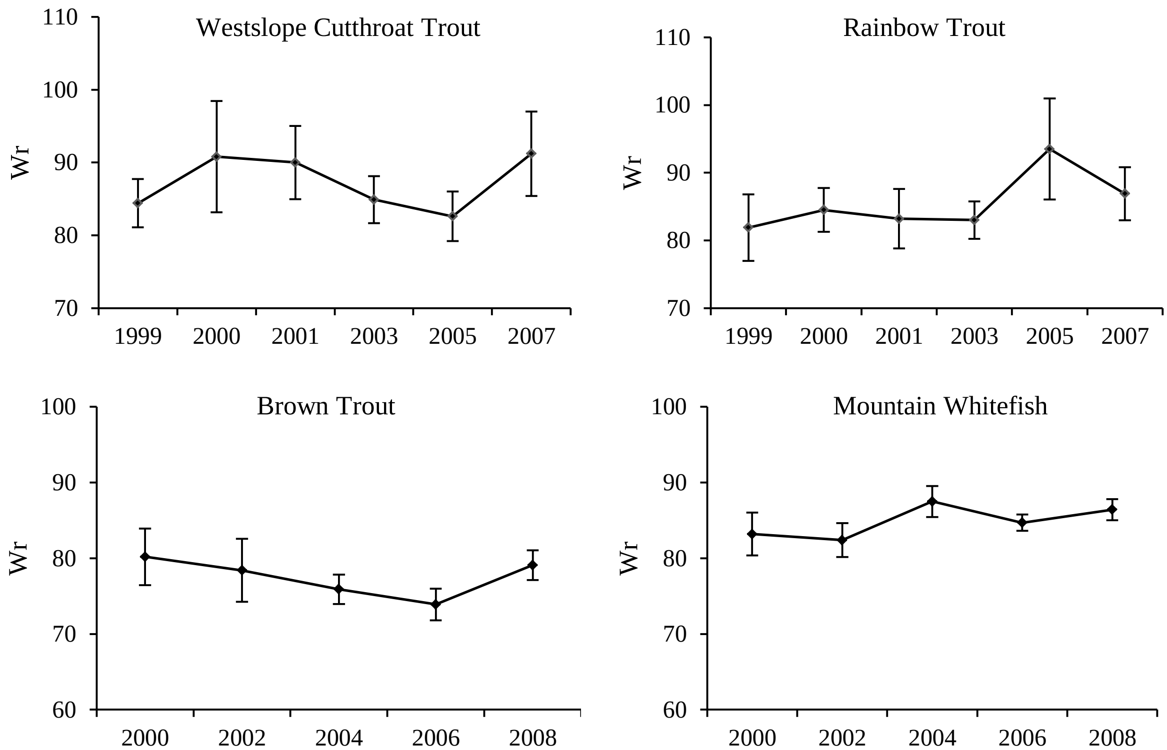

Figure 4. Mean relative weight (*Wr*) by study year estimated for target species captured in the lower Clark Fork River, Idaho. Error bars represent 95% confidence intervals.

DISCUSSION

Results suggested abundance, size structure, and condition of fish populations in the lower Clark Fork River were largely unchanged following increases in minimum flow below Cabinet Gorge Dam and in-channel improvements to the Foster Bar side-channel. No significant change in abundance of target and non-target fish species sampled in the study reach was detected. Size structures of brown and westslope cutthroat trout populations remained stable. Mountain whitefish and rainbow trout demonstrated detectable increases in the proportions of larger fish present. However, different segments of the mountain whitefish and rainbow trout populations were affected. Rainbow trout demonstrated increased presence of fish greater than 405 mm, while mountain whitefish demonstrated increases in fish greater than 302 mm. Notably few whitefish greater than or equal to 400 mm were collected. The physical condition of all target species was stable throughout the study period. Although significant shifts in estimated metrics were not observed, high variability within and or between estimates suggested testing power may have been limited and likely reflects the challenges associated with sampling the lower Clark Fork River. This condition was notably evident in abundance estimates and structural indices.

The increase in the proportional size structure of mountain whitefish was likely independent of change in growth rate and occurred in the absence of detectable changes in abundance, suggesting other factors may have contributed to the observed trend. Length at age, the surrogate of growth, for sampled mountain whitefish demonstrated a significant decline across sample years. A reduction in growth contradicted observations of increased proportions of quality size fish sampled over the study period. Growth of mountain whitefish in the lower Clark Fork River based on mean length at age (range 321 to 359 mm at age four) was comparable to other whitefish populations. For example, length at age four of Kootenai River whitefish downstream of Libby Dam immediately post impoundment ranged between 296 and 349 mm in spring samples (Partridge 1983), while modeled length of whitefish at age four from representative sites across Idaho was approximately 314 mm (Meyer et al. 2009). Abundance monitoring failed to detect changes in mountain whitefish abundance, suggesting increased proportions of quality size fish were not representative of increased numbers of larger fish due to increased recruitment or survival. However, analysis of abundance by specified length group was not feasible due to limited recaptures and therefore limited the ability of detecting length specific increases. The majority of recaptured whitefish were between 300 mm and 400 mm, and likely represented largely three to five year old fish. Recaptures were further limited in collections of rainbow trout, precluding their evaluation.

The observed increase in the proportional size structure of sampled rainbow trout and mountain whitefish may have resulted from changes in sampling protocol. As noted, sampling crews indicated the effectiveness of finding and sampling whitefish increased following early sampling efforts, potentially resulting in a collection of more and larger fish. This change was in large part reflective of including a new portion of the river (mid channel) in the sampled area.

Results also suggested foraging conditions were not improved by increased minimum flow as intended. Increased minimum flow was intended to provide additional wetted habitat that would benefit the fish community in part by enhancing habitat for aquatic invertebrate fauna and subsequently promoting foraging conditions. Conditional indices demonstrated stability across target species suggesting no changes in invertebrate fauna occurred. Stable relative weights below 100 suggested less than optimum foraging conditions existed in the Clark Fork River (Anderson and Neumann 1996). However, caution should be used when comparing relative weights against an optimal condition (i.e. 100) as environmental limitations may vary considerably and subsequently impact resulting conclusions (Murphy et al. 1991, Willis et al. 1991). Short term flow alterations similar to those of the lower Clark Fork River have been demonstrated to effect invertebrate fauna density and distribution (Gislason 1985) and may have contributed to the inability to detect changes in fish condition. However, the response of aquatic invertebrates to increased minimum flow is unknown as no monitoring of invertebrate fauna was included in this study.

Fish populations in the lower Clark Fork River in Idaho may be affected regardless of minimum flow increases by low habitat variability in the study reach. Only three main riffle sections exist during low LPO lake levels. Normal summer pool levels in LPO inundate the lower most riffle at the mouth of Lightning Creek and impact the lower end of the Foster Bar side-channel, further limiting habitat complexity. Limited complexity likely includes a lack of in-river spawning habitat. The absence of smaller size classes of all target species sampled suggested spawning and early rearing of target species largely takes place outside of the main river, likely in adjacent tributary streams. Prior to isolation by Cabinet Gorge, Noxon Rapids, and Thompson Falls (located upstream of Noxon Rapids) dams it is likely native fish populations in the lower Clark Fork River, Idaho were influenced to a larger extent by connectivity to abundant spawning and rearing habitats upstream in Montana.

After 10 years of evaluating an increase in minimum flow from 84.9 cms (3,000 cfs) to 141.5 cms (5,000 cfs), no significant trend in fish abundance, size structure, or condition of target species was detectable. A number of factors acting in combination likely continue to regulate salmonid abundance and condition in the lower Clark Fork River below Cabinet Gorge Dam outside of the affects of minimum flows. Limiting factors may have included large daily flow fluctuations, low habitat diversity, availability of spawning and early rearing habitat, high summer water temperatures, and elevated total dissolved gas below Cabinet Gorge Dam (Land and Water Consulting 2001, PBTAT 1998, Parametrics 2000 a, Parametrics 2000b). However, these factors were not included in this study and where appropriate are being studied/mitigated through other CFSA programs.

RECOMMENDATIONS

- Based on this evaluation the 5,000 cfs minimum flow does not appear to be warranted. In accordance with the CSFA Appendix T, and within one year of this report, the MC should review the resource benefits and economic value of power peaking between the minimum flow of 3,000 and 5,000 cfs and if warranted renegotiate the minimum flow below Cabinet Gorge.

- Continue working within the Clark Fork Settlement Agreement to insure facilitation of passage programs for migratory native fish is continued and that decision making relative to minimum flows consider impacts to this program.

- Continue to monitor fish populations in the lower Clark Fork River at a reduced frequency to enable continued long term evaluation of population changes relative to future water management.

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