

WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Little Gilbert Creek Instream Flow Studies
PROJECT FX-GR-3SF-511
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ABSTRACT

Studies conducted during 1997 determined instream flows necessary for maintaining Colorado River cutthroat trout (CRC) habitat and populations. Physical Habitat Simulation (PHABSIM) and the Habitat Quality Index (HQI) were used in determining instream flow water right recommendations of: October 1 - April 30 = 0.2 cfs, May 1 - June 30 = 3.5, and July 1 - September 30 = 0.2 cfs.

INTRODUCTION

Wyoming's instream flow law (W.S.41-3-1001) defines the Wyoming Game and Fish Department's (WGFD) role in identifying instream flow levels necessary to maintain important fisheries. According to the law, unappropriated flowing water "may be appropriated for instream flows to maintain or improve existing fisheries..." (W.S.41-3-1001(b)). WGFD instream flow recommendations must be for specific stream segments and seasons. These recommendations are incorporated into an instream flow water right application and, as provided by statute, may become an instream flow water right held by the state of Wyoming. This process ensures that adequate stream flow is protected when it is available in priority so that important fisheries will persist.

Since the law was passed in 1986 and through 1997, 76 instream flow water right applications have been filed, 7 approved by the state engineer, and 2 formally adjudicated. Initially, efforts focused on WGFD class 1 and 2 waters, which are highly productive and provide popular recreational opportunities. More recently, efforts have shifted toward small headwater streams supporting native cutthroat trout.

Wyoming has historic ranges for Bonneville cutthroat trout (*Oncorhynchus clarki utah*, sometimes locally referred to as "Bear River" cutthroat trout), Colorado River cutthroat trout (*O.clarki pleuriticus*), and Yellowstone cutthroat trout (*O.clarki bouvieri*). A variant of Yellowstone cutthroat trout, the Snake River cutthroat trout, also occurs in the northwest portion of the state. Since the early 1990s, instream flow studies have been done on many stream segments

throughout the native range of Bonneville and Colorado River cutthroat trout. This report includes results and recommendations from studies on Little Gilbert Creek, a Colorado River cutthroat trout stream.

The historic distribution and conservation status of Colorado River cutthroat trout is reviewed in Young (1996) and Nesler et al. (1999). In Wyoming, historic range includes streams tributary to the Green River: the Little Snake River drainage on the west side of the Sierra Madre mountains, Green River tributaries draining the east face of the Wyoming Range mountains, the Blacks Fork River and its tributaries arising in the Uinta mountains, and a few tributaries that flow directly into the Green River from the east. Prior to 1997, instream flow studies were conducted in the major drainages of the Wyoming Range and Sierra Madre mountains. During 1997, additional studies were performed in remaining streams such as Little Gilbert Creek, a tributary to the Blacks Fork River.

A conservation plan was developed by Wyoming, Colorado, and Utah state wildlife agencies, in coordination with the U.S. Fish and Wildlife Service, to guide conservation efforts in the tri-state area through three primary activities protecting existing and restored ecosystems, restoring degraded ecosystems, and planning (Nesler et al. 1999). The process of acquiring and maintaining suitable instream flows is listed as a strategy for restoration. Obtaining instream flow water rights to be held by the state of Wyoming will provide assurance that available water will be reserved when it is available in priority for providing CRC habitat. Such efforts do not increase habitat from present levels or ensure that adequate habitat is available; instead, they act to avoid future water depletions up to the limits established by instream flow water rights. Instream flow water right acquisition is just one step in a comprehensive process of protecting and conserving native cutthroat trout fisheries.

Study objectives were to 1) investigate the relationship between discharge and physical habitat quantity and quality for Colorado River cutthroat trout in Little Gilbert Creek and, 2) determine an instream flow regime that will help maintain the Little Gilbert Creek Colorado River cutthroat trout fishery.

METHODS

Study Area

Little Gilbert Creek is located in southwest Wyoming in Uinta County southwest of Mountain View. The headwaters are located in Utah and the stream flows generally north on Wasatch National Forest land in Wyoming before combining with Gilbert Creek (Figures 1-2). The upper boundary of the proposed instream flow segment is at about elevation 9,155 feet and is the boundary between sections 17 and 20 of Range 115W, Township 12N. This point marks a location where the flow segment is fully formed from its primary springs. The downstream boundary for the creek is fully formed from the confluence with Gilbert Creek in section Range 115W, Township 12N. at an elevation of about 8,715 feet

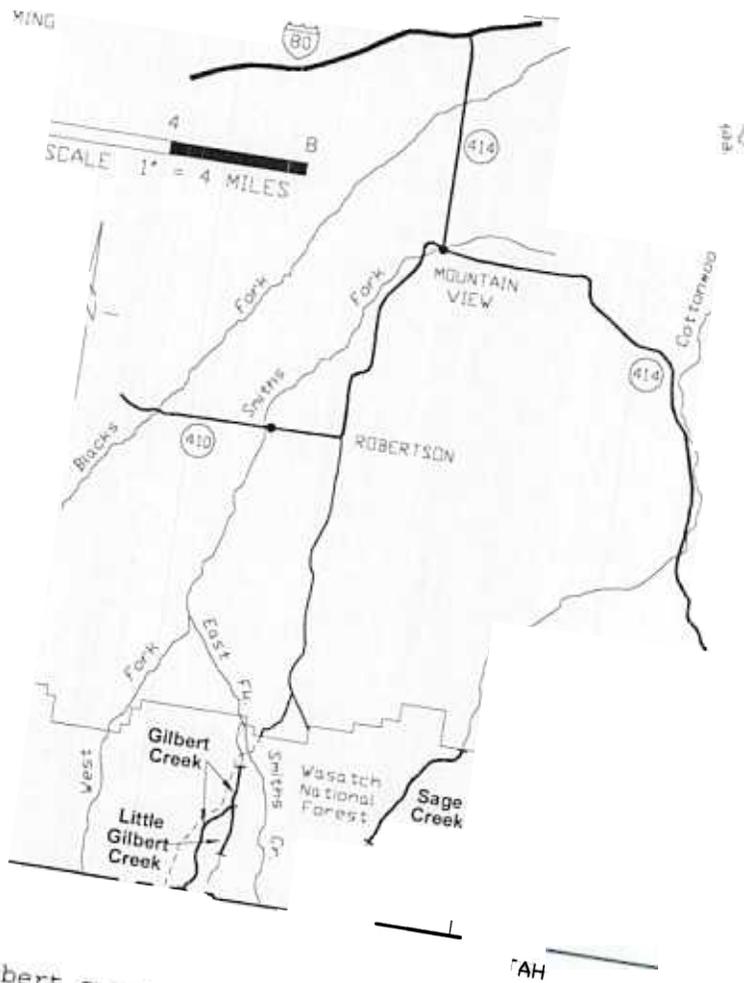


Figure 1. Little Gilbert Creek instream flow segment and general vicinity

Little Gilbert Creek originates from small headwater tributary to Gilbert Creek the Uinta Mountains with elevations over 9,500 feet

in the basin and flows for approximately 3 miles before combining with Gilbert Creek. Watershed climate is montane with 14-16 inches or more of annual precipitation in the headwaters and lesser amounts at lower elevations. Snowmelt run-off typically occurs in May and early June while springs sustain baseflow the rest of the year. Stream aspect is primarily north throughout the proposed instream flow segment. Under Rosgen and Silvey (1998), the channel could be rated as "A3" in some segments and "B3" in other, often downstream segments. Such ratings reflect the relatively high gradient and small size of this stream.

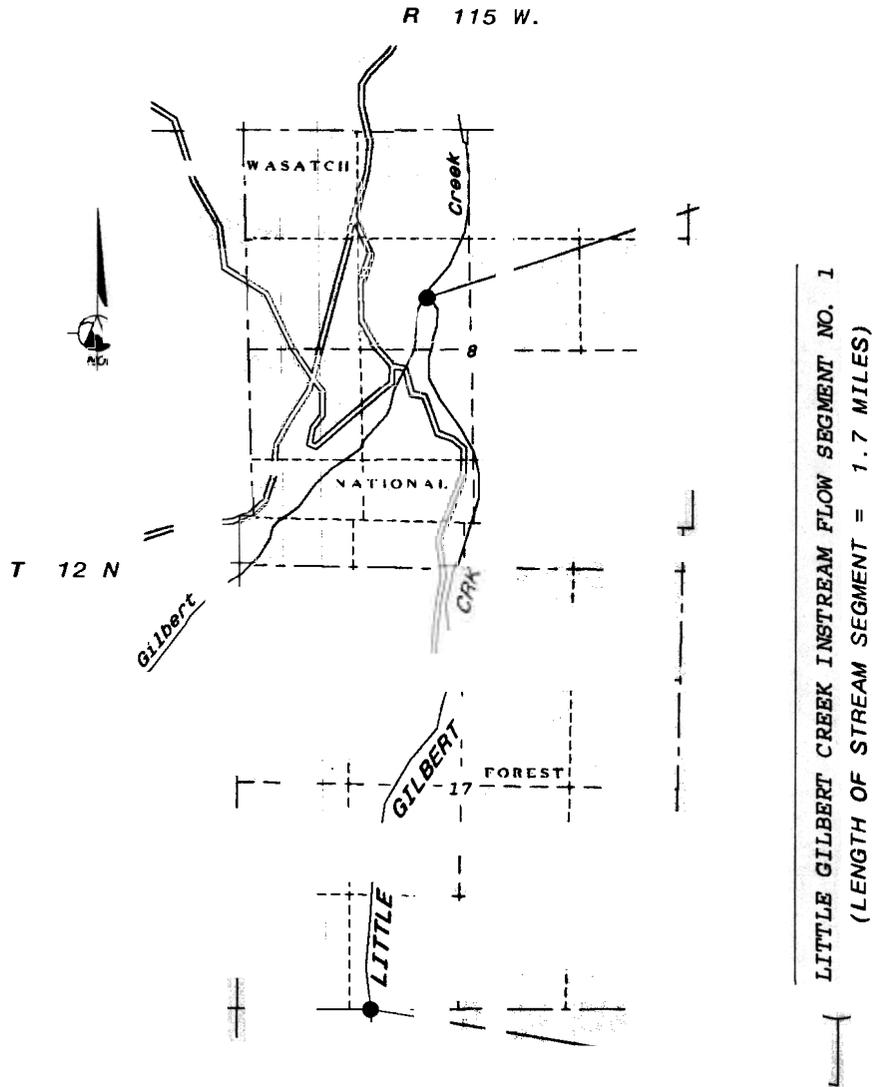


Figure 2 Detailed schematic of the instream flow segment and land ownership.

Upland vegetation consists of mixed conifers including primarily lodgepole pine (*Pinus contorta*) along with subalpine fir (*Abies lasiocarpa*), douglas fir (*Pseudotsuga menziesii*) and spruce (*Picea engelmannii*). Aspen (*Tremuloides spp.*) occur in scattered pockets and sagebrush (*Artemisia spp.*) occur along open side hills. Willow (*Salix spp.*) are the primary woody riparian species while

herbaceous sedges (*Carix spp.*) and grasses (*Poa spp.*) are common near the study site.

Watershed management activities include cattle grazing and timber harvest along with significant outdoor recreation. Beaver are often important for maintaining watershed integrity and function in streams and Little Gilbert Creek is likely no exception. For trout fisheries, beaver presence in a drainage provides benefits such as stabilized banks, reduced sediment sources from banks, and deep pools for overwintering trout. Beaver dams are common in the drainage and there appears to be enough willow to continue to sustain beaver colonies.

Fisheries

In addition to CRC, mottled sculpin (*Cottus bairdi*) and mountain sucker (*Catostomus platyrhynchus*) are native to the Little Gilbert Creek drainage. The stocking history for Little Gilbert Creek includes brook trout (*Salvelinus fontinalis*), which were last stocked in 1961. Through 1995 no brook trout were collected at 9,000 feet during routine sampling. High flows in 1996 breached a natural barrier near the mouth and brook trout from Gilbert Creek invaded the downstream-most reaches (Keith 1997). Cutthroat trout genetic purity was rated "C" by Dr. Robert Behnke based on 17 fish collected in 1989. Meristic features indicated pure CRC but lack of basibranchial teeth in a portion of sampled fish resulted in downgrading.

Population data collected in 1988 by the Green River fish management crew from a site at elevation 9,000 feet indicated a healthy population of 501 CRC per mile (Keith 1997). Population estimates conducted at the instream flow study site near the mouth in 1996 and 1997 showed CRC densities of 197 and 259 CRC per mile, respectively. These trout ranged between 1.7 and 8.5 inches in length. Brook trout densities at the instream flow study site (below the natural movement barrier) were 1448 and 932 per mile for 1996 and 1997, respectively. Average length in both years was less than 4 inches.

In a western Oregon stream studied for 11 years, density of age 0 cutthroat trout (fry, <2 inches) varied from 8 to 38 per 100 m² and density of age 1 cutthroat trout (juveniles, 4-4.5 inches) ranged from 16 to 34 per 100 m² (House 1995). In this example, population fluctuations occurred despite the fact that habitat conditions were not degraded and appeared to be relatively stable. The author suggested that small changes in peak winter flows between years would have accounted for shifts in overwinter survival between age-classes. Similar population fluctuations occur in Sand Creek, a Crook County, Wyoming stream that experiences relatively little discharge variation (Mueller 1987). Sand Creek brown trout population density ranged from 646 trout/mile to 4,060 trout/mile in a three-year period. Biomass estimates for the same period ranged between 48 and 142 pounds per acre.

These two examples illustrate that trout populations, particularly in small mountain streams, are expected to fluctuate. Long-term trout population maintenance depends on periodic strong year classes produced in good flow years. Without benefit of periodic favorable flows, populations might decline or disappear. The WGFD instream flow strategy recognizes the inherent variability of trout populations and thus defines the "existing fishery" as a dynamic feature. Instream flow recommendations are based on a goal of maintaining habitat

conditions that provide the opportunity for trout numbers to fluctuate within existing natural levels.

Habitat Modeling

A representative study site was located less than 100 yards from the confluence with Gilbert Creek at Township 12N, Range 115W, Section 8, NW1/4 on May 20, 1997 (Figure 1). The site contained trout cover associated with a fairly deep pool and lateral scour pools. Eight transects were distributed among pool, run and riffle habitat types (Appendix 1). Data for calibrating simulations were collected between May 20 and August 27, 1997 (Table 1).

Table 1 Dates and discharges Little Gilbert Creek instream flow data were collected in 1997. An additional flow measurement in August 1996 was collected during site reconnaissance.

Date	Discharge (cfs)
May 20	2.5
June 5	0.7
July 24	0.3
August 27	0.2
August 20, 1996	0.2

Habitat at the study site was subjectively estimated to represent some of the better trout habitat observed during a survey of less than one mile of stream. The site was selected for its relatively good habitat and because it was easily accessible whereas other stream segments offered poor data collection prospects. It also offered clearly definable hydraulic control transects for performing hydraulic retention analyses whereas controls were largely absent in upstream areas. Following data analysis, the recommendation from Habitat Retention (see Dey and Annear 1999 for a description of the methodology) was found to be inappropriate - probably related to the unique low gradient yet narrow channel characteristics of the site. Habitat quality index and PHABSIM (described below) analyses were used to develop instream flow recommendations.

Determining critical trout life stages (fry, juvenile, adult, etc.) for a particular time period is necessary for developing flow recommendations. Critical life stages are those most sensitive to environmental stresses. Annual population integrity is sustained by providing adequate flow for critical life stages. In many cases, trout populations are constrained by spawning and young (fry and juvenile) life stage habitat "bottlenecks" (Nehring and Anderson 1993). Therefore, our general approach includes ensuring that adequate flows are provided to maintain spawning habitat in the spring as well as juvenile and adult habitat throughout the year (Table 2). The headwater nature of the stream and the fact that numerous small trout have been collected over the years indicates that Little Gilbert Creek acts as a CRC recruitment source for the Gilbert Creek watershed. Therefore, it is especially important to maintain spawning habitat during high spring flows and rearing cover through the summer and winter.

Table 2. Colorado River cutthroat trout life stages and months considered in Little Gilbert Creek instream flow

recommendations. Numbers indicate method used to determine flow requirements

Life Stage	J	F	M	A	M	J	J	A	S	O	N	D
	a	e	a	p	a	u	u	u	e	c	o	e
	n	b	r	r	y	n	l	g	p	t	v	c
Adult												
Juvenile	2	2	2	2	2	2				2	2	2
Spawning					2	2						

1 = Habitat Quality Index; 2 = PHABSIM;

Habitat Quality Index

The Habitat Quality Index (HQI; Binns and Eiserman 1979; Binns 1982) was used to determine trout habitat levels over a range of late summer flow conditions. Most of the annual trout production in mountain streams occurs during the late summer, following peak runoff, when longer days and warmer water temperatures stimulate growth at all trophic levels. The HQI was developed by the WGFD to measure trout production in terms of habitat. It has been reliably used in Wyoming for habitat gain or loss assessment associated with instream flow regime changes. The HQI model includes nine attributes addressing biological, chemical, and physical aspects of trout habitat. Results are expressed in trout Habitat Units (HUs), where one HU is defined as the amount of habitat quality that will support about 1 pound of trout. HQI results were used to identify the flow needed to maintain existing levels of Colorado River cutthroat trout production between July 1 and September 30 (Table 2).

In the HQI analysis, habitat attributes measured at various flow events are assumed to be typical of late summer flow conditions. For example, stream widths measured in June under high flow conditions are considered a fair estimate of the stream width that would occur if the same flow level occurred in the month of September. Under this assumption, HU estimates are extrapolated through a range of potential late summer flows (Conder and Annear 1987). Little Gilbert Creek habitat attributes were measured on the same dates PHABSIM data were collected (Table 1). Some attributes were mathematically derived to establish the relationship between discharge and trout habitat at discharges other than those measured.

Average daily flow (ADF; 1.7 cfs) and peak flow (26.1 cfs) estimates for determining critical period stream flow and annual stream flow variation are based on precipitation and basin area (Lowham 1988). Maximum stream temperature was estimated at 69°F based on spot measurements and a max-min thermometer placed in nearby Gilbert Creek during summer 1997.

Physical Habitat Simulation

Physical Habitat Simulation (PHABSIM) methodology was used to quantify physical habitat (depth and velocity) availability for life stages over a range of discharges. The methodology was developed by the Instream Flow Service Group of the U.S. Fish and Wildlife Service (Bovee and Milhous 1978) and is widely used for assessing instream flow relationships between fish and physical habitat (Reiser et al. 1989).

The PHABSIM method uses empirical relationships between physical variables (depth, velocity, and substrate) and suitability for fish to derive weighted usable area (WUA; suitable ft² per 1000 ft of stream length) at various flows. Depth, velocity, and substrate were measured along transects (*sensu* Bovee and Milhous 1978) on the dates in Table 1. Hydraulic calibration techniques and modeling options in Milhous et al. (1984) and Milhous et al. (1989) were employed to incrementally estimate physical habitat between 0.1 and 7.0 cfs.

Spawning area as well as physical habitat for other life stages was modeled for the entire reach covered by the eight transects. The spawning simulations were used in developing instream flow recommendations while the remaining simulations were used to validate the recommendation from the Habitat Retention model and provide incremental analyses of changes in physical habitat with flow for a winter instream flow recommendation.

Curves describing depth, velocity and substrate suitability for trout life stages are an important component of the PHABSIM modeling process. The spawning suitability curves used for deriving instream flow recommendations are from data collected by Thurow and King (1994) and are listed in Appendix 2. Curves for fry are from Bozek and Rahel (1992) while those for adults and juveniles were developed from bank observations of Colorado River cutthroat trout in Dirtyman Creek, tributary to Savery Creek.

Observations by WGFD biologists in streams of similar elevation and size suggest spawning activity in Little Gilbert Creek likely peaks in May during most years. Because spawning onset and duration varies between years due to differences in flow quantity and water temperature, spawning flow recommendations should extend from May 1 to June 30. Even if spawning is completed before the end of this period, maintaining flows at a selected level throughout June will benefit trout egg incubation by preventing dewatering. The PHABSIM model was used in making flow recommendations for maintaining spawning habitat from May 1 to June 30 (Table 2).

RESULTS AND DISCUSSION

Habitat Unit Analysis

Article 10, Section d of the Instream Flow Act states that waters used for providing instream flows "shall be the minimum flow necessary to maintain or improve existing fisheries". One way to define "existing fishery" is by the number of habitat units that occur under normal July through September flow conditions. Since there is no stream flow gage on Little Gilbert Creek, an estimate for discharge over the July through September period can be derived from the two flows measured in late summer 1997 (Table 1). A reasonable estimate of late summer flow in Little Gilbert Creek is thus somewhere around 0.2 to 0.3 cfs. This level of flow provides about 61 habitat units (Figure 3). Flows lower than 0.2 cfs provide rapidly decreasing habitat levels while higher flow levels would provide substantially more habitat. To maintain 61 trout habitat units, the simulation shows that a flow of 0.2 cfs is needed. Therefore, the minimum flow to maintain the existing fishery during late summer is 0.2 cfs.

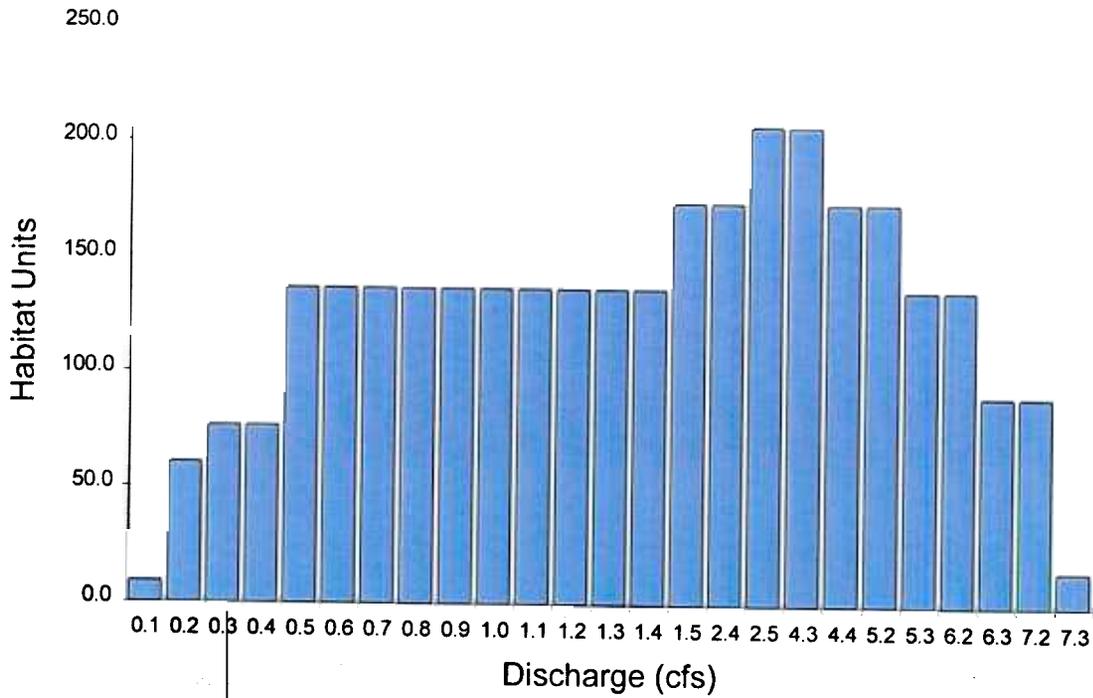


Figure 3. Trout habitat units at several late summer Little Gilbert Creek flow levels. X-axis discharges are not to scale.

The existing fishery is naturally dynamic as a function of stream flow availability. In years when stream flow is naturally less than 0.2 cfs in late summer the fishery can be expected to decline. Likewise, in years when late summer flow is 0.2 cfs or more, it should expand. Maintaining this existing fishery simply means maintaining existing natural stream flows up to the recommended amount in order to maintain the natural habitat and fish population fluctuations.

PHABSIM Analyses

The spawning life stage was identified as important for maintaining CRC populations in Little Gilbert Creek. The amount of physical area available for spawning in the study site peaked at a flow of 3.5 cfs and declined rapidly at higher flow levels (Figure 4). Therefore, the instream flow recommendation for the spawning period of May 1 to June 30 is 3.5 cfs.

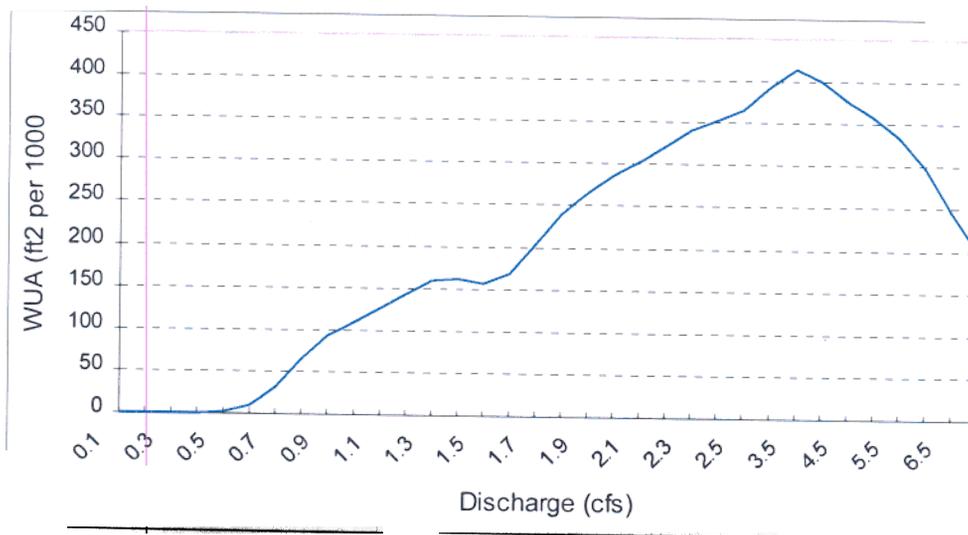


Figure 4 Relationship between stream flow and spawning habitat at a Little Gilbert Creek study site.

Physical habitat levels for adults, juveniles and fry do not change drastically as a function of flow in Little Gilbert Creek (Figure 5). However, it is clear that physical habitat for juveniles rapidly decreases at flows less than 0.2 cfs while fry physical habitat decreases steadily as flows increase until a plateau is reached at about 0.9 cfs. The two curves cross at 0.2 cfs and this appears a convenient flow level that maintains relatively high levels of physical habitat for both life stages. Therefore, the recommended winter flow is 0.2 cfs to maintain fry and juvenile habitat.

Due to its small size, shallow depths, and close proximity to the larger Gilbert Creek, it is unlikely that Little Gilbert Creek normally provides much overwintering adult habitat. Therefore, adult habitat during winter was not considered in developing instream flow recommendations. The recommendation of 0.2 cfs for juveniles, though developed in the summer under ice-free conditions, will ensure that flowing water is maintained through cobble and gravel interstices where younger life stages seek shelter. Any artificial reduction of natural winter stream flows could increase juvenile trout mortality and effectively reduce the number of fish the stream could support.

The 0.2 may not always be present during the winter. Because the existing fishery is adapted to natural flow patterns, occasional shortfalls during the winter do not imply a need for additional storage. Instead, they illustrate the necessity of maintaining all natural winter stream flows, up to 0.2 cfs, to maintain existing trout survival rates.

INSTREAM FLOW RECOMMENDATIONS

Based on the analyses and results outlined above, the instream flow recommendations in Table 3 will maintain the existing Little Gilbert Creek Colorado River cutthroat trout fishery. These recommendations apply to an approximately 1.5 mile segment extending downstream from the boundary between sections 17 and 20 of Range 115W, Township 12N. to the confluence with Gilbert Creek in section 8 of Range 115W, Township 12N. The land through which the

proposed segment passes is under Forest Service administration. Because data were collected from representative habitats and simulated over a wide flow range, additional data collection under different flow conditions would not significantly change these recommendations.

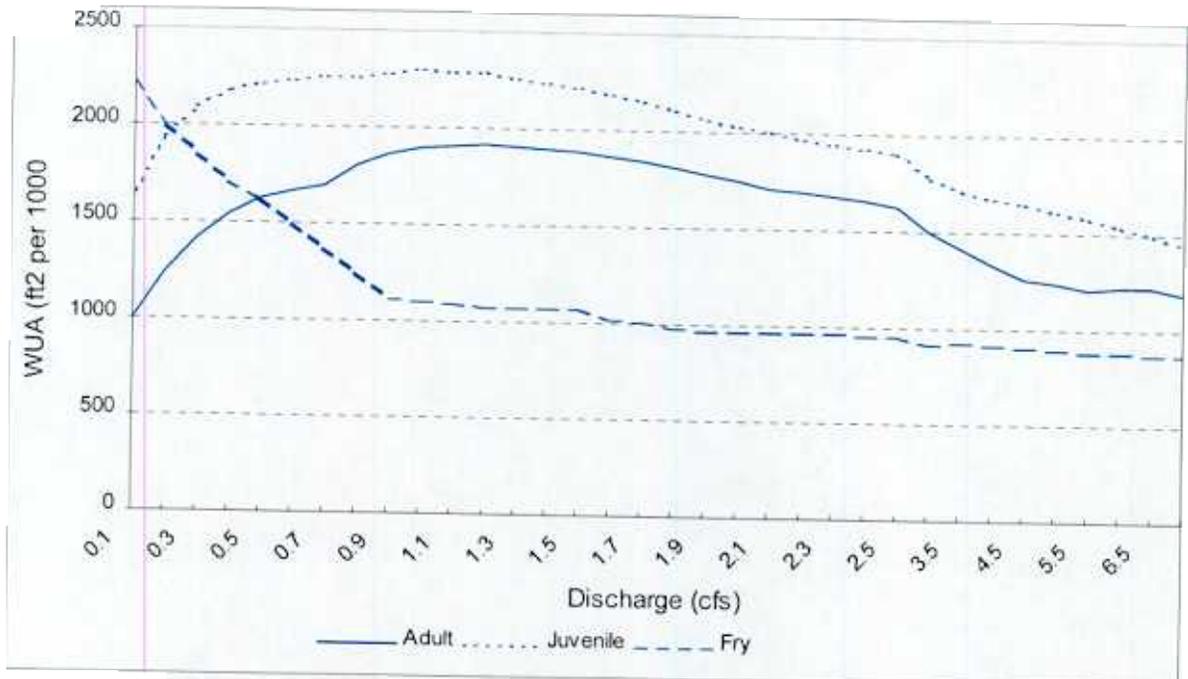


Figure 5. Weighted usable area for Colorado River cutthroat trout in Little Gilbert Creek over a range of discharges. X-axis discharges are not to scale.

Table 3. Instream flow recommendations to maintain the existing Little Gilbert Creek trout fishery.

Time Period	Instream Flow Recommendation (cfs)
October 1 to April 30	0.2
May 1 to June 30	3.5
July 1 to September 30	0.2

This analysis does not consider periodic requirements for channel maintenance flows. Because this stream is unregulated, channel maintenance flow needs are adequately met by natural runoff patterns. If regulated in the future, additional studies and recommendations are needed for establishing channel maintenance flow requirements.

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