WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Instream Flow Studies on Coantag Creek (tributary to Smiths Fork River), a Bonneville Cutthroat Trout (*Oncorhynchus clarki utah*) Stream.

PROJECT: IF-PE96-07-9401

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ABSTRACT

Instream flow data were collected in 1994 and 1995 on Coantag Creek to determine flows needed to maintain or improve Bonneville cutthroat trout (BRC) habitat and populations. Studies were designed to complement ongoing monitoring of BRC index streams (Remmick et al. 1994).

Physical Habitat Simulation (PHABSIM), the Habitat Quality Index (HQI), and the Habitat Retention Method were used to derive instream flow recommendations. Recommendations are: October 1 - April 30 = 7.2 cfs, May 1 - June 30 = 24.0 cfs, and July 1 - September 30 = 21.0 cfs.

INTRODUCTION

Wyoming Bonneville cutthroat trout (*Oncorhynchus clarki utah*) populations occur primarily in the Smiths Fork and Thomas Fork watersheds. Physical, chemical, and biological characteristics were inventoried between 1966 and 1977 (Miller 1977). Binns (1981) reviewed the distribution, genetic purity, and habitat conditions for Bonneville cutthroat trout populations. Recent population and habitat survey results are in Remmick (1981, 1987) and Remmick et al. (1994). In general, populations are limited by seasonally low flows, lack of riparian cover, thermal pollution arising in conjunction with low flows and reduced riparian vegetation, and silt pollution (Binns 1981).

Bonneville Cutthroat trout were recently petitioned for listing under the Endangered Species Act but are not listed at this time. Status review was initiated in response to concerns expressed by the Idaho Fish and Game Department, the Desert Fishes Council and the Utah Wilderness Association. This species is considered "rare" by the Wyoming Game and Fish Department (WGFD 1977).

A 5-year management plan for Wyoming, developed by the Wyoming Game and Fish Department (WGFD) in coordination with the U.S. Forest Service (USFS) and U.S. Bureau of Land Management (BLM), outlines management goals and provides criteria for listing Bonneville cutthroat trout as threatened (Remmick et al. 1994). The plan's purpose is to outline management practices to prevent listing by moving toward wider distribution and higher populations. The plan recommends that status decisions be made after five-years of population and habitat monitoring. Habitat protection by acquiring instream flow water rights will not directly achieve the plan's goals but rather serve to prevent additional population declines.

Fish and other resource management practices could be significantly affected by listing Bonneville cutthroat trout as Threatened or Endangered. Instream flow water right identification and acquisition on Bonneville cutthroat trout streams is important to help avoid listing. Therefore, the WGFD filed for water rights on Huff Creek, Coal (Howland) Creek, Hobble Creek, Porcupine Creek, Smiths Fork River, and Raymond Creek in 1993 and 1994. Studies in 1995 focused on Coantag Creek, Giraffe Creek, Coal Creek, Water Canyon Creek, and Salt Creek.

Study objectives were to 1) investigate the relationship between discharge and physical habitat quantity and quality for Bonneville cutthroat trout and, 2) determine an instream flow necessary to maintain or improve Bonneville cutthroat trout populations.

METHODS

Study Area

Coantag Creek is a tributary to Hobble Creek (Fig. 1). The basin is managed by the Bridger-Teton National Forest (BTNF) and livestock grazing occurs throughout the watershed. The riparian zone consists of various forbs, grass and willow with mixed aspen and conifers at higher elevations and hillside valleys. Willow are common in the riparian zone and beaver are active in the drainage. Overall stream gradient is moderate (<2.5 %) and the channel type was rated as C3 (Rosgen 1985) near the confluence with Hobble Creek. This rating indicates a moderately entrenched channel that is slightly confined by its valley and has bed material composed mostly of gravel with some cobble and sand.

Fisheries

Trout populations, particularly in small mountain streams, normally fluctuate widely. It is not unusual for pristine streams to contain different trout numbers among consecutive years. 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 m^2 and density of age 1 cutthroat trout (juveniles, 4-4.5 inches) ranged from 16 to 34 per 100 m^2 (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.

In western Wyoming, Binns (1981) noted significant trout number declines in several Bonneville cutthroat trout streams following drought in 1977. Few BRC population estimates have been conducted on Coantag Creek. In August 1973, 507 fish per mile (including mountain whitefish, brown trout and snake river cutthroat trout along with bonneville cutthroat trout) were measured at a station about 1 mile upstream of the Hobble Creek confluence. Electrofishing on September 14, 1995 in a station downstream from the USFS bridge yielded low BRC numbers, likely related to relatively high flows that occured during summer 1995. Coantag Creek angling in 1994 yielded several BRC's.

Long-term trout population maintenance in small streams depends on periodic strong year classes produced in good flow years. Without benefit of periodic favorable flows, populations in some streams would decline or disappear. The WGFD instream flow strategy recognizes the inherent variability of trout populations as documented in Coantag Creek and other streams (House 1995) 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

After visually surveying the stream from its confluence with Hobble Creek upstream approximately 1.0 mile, a study site was located on USFS land between the confluence and a USFS bridge in Township 28N, Range 117.5W, Section 36, SW1/4 (Figure 1). Two representative sites, separated by about 120 feet, were established. The lower site consisted of three transects modeling a control riffle, a run and a pool. The upper site, which also included the HQI station, had six transects modeling riffle, run and pool habitat (Appendix 1).

Site reconnaisance occurred in 1993 and data was collected in 1994 and 1995 (Table 1). Access to the study site was limited by inclement weather in 1994 making it necessary to return in 1995 for low flow data. However, 1995 was a relatively high water year so a real low discharge data set was not collected. In addition, high 1995 spring flows caused channel changes. Therefore, PHABSIM modeling efforts relied on 1994 data from 48 and 75 cfs.

Instream flow filing recommendations derived from the study site were applied to 4.9 mile segment of Coantag Creek extending downstream from the confluence of North and South Forks Coantag Creek at the northern border of section 4 in T27N, R117W to the confluence with Hobble Creek in section 36 of T28N, R117 1/2W. The land through which the proposed segment passes is under Bridger-Teton National Forest administration.

Table 1 Dates and discharges Coantag Creek instream flow data were collected in 1994 and 1995.

Date	Data Collected	Discharge (cfs)
May 27, 1994	PHABSIM, HQI	75.0
June 21, 1994	PHABSIM, HQI	48.0
August 3, 1995	PHABSIM, HQI	63.5
September 14, 1995	HQI, Population	39.0

Determining critical trout life stages (fry, juvenile, adult, etc.) during specific time frames aids in focusing 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 adult and juvenile habitat throughout the remainder of the year. (Table 2)

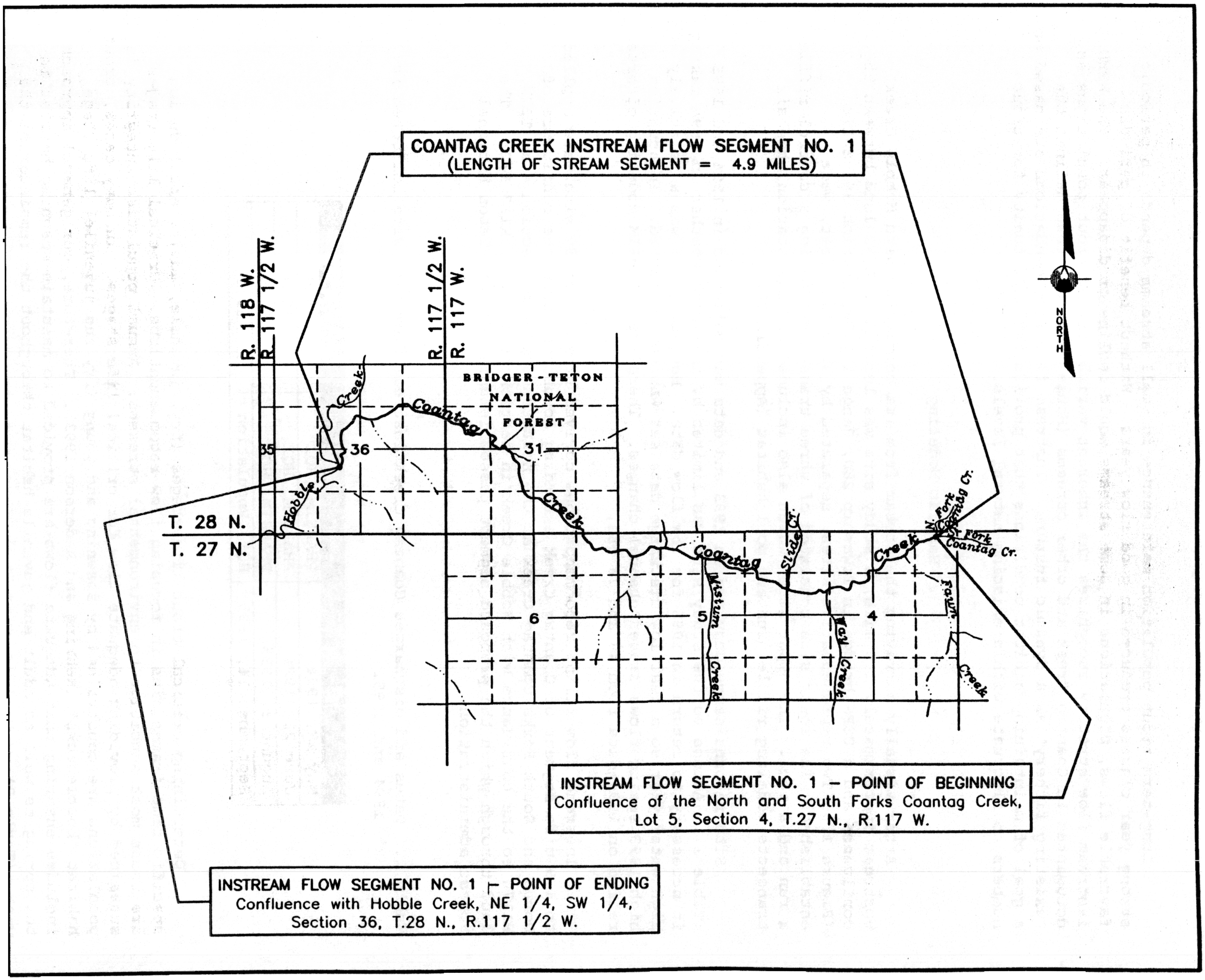
COANTAG CREEK INSTREAM FLOW SEGMENT NO. 1
(LENGTH OF STREAM SEGMENT = 4.9 MILES)
R. 118 W.
R. 117 1/2 W.
R. 117 1/2 W.
R. 117 W.
T. 28 N.
T. 27 N.
BRIDGER - TETON NATIONAL FOREST
NORTH
Coantag Creek
Hobble Creek
Creek
Mistum Creek
Slide Cr.
Way Creek
Fawn Creek
N. Fork Coantag Cr.
S. Fork Coantag Cr.
35
36
31
6
5
4
INSTREAM FLOW SEGMENT NO. 1 – POINT OF BEGINNING
Confluence of the North and South Forks Coantag Creek,
Lot 5, Section 4, T.27 N., R.117 W.
INSTREAM FLOW SEGMENT NO. 1 – POINT OF ENDING
Confluence with Hobble Creek, NE 1/4, SW 1/4,
Section 36, T.28 N., R.117 1/2 W.

Table 2. Bonneville cutthroat trout life stages and months considered in Coantag Creek instream flow recommendations. Numbers indicate method used to determine flow requirements.

LIFE STAGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SPAWNING							1	1	1			
ADULT					2	2						
ALL	3	3	3	3	3	3	3	3	3	3	3	3

1 - Habitat Quality Index
2 - PHABSIM
3 - Habitat Retention

Habitat Retention Method

A Habitat Retention method (Nehring 1979, Annear and Conder 1984) was used to identify a maintenance flow by analyzing data from three riffle transects. A maintenance flow is defined as the continuous flow required to maintain specific hydraulic criteria in stream riffles. Year-round criteria maintenance ensures passage between habitat types for all trout life stages. In addition, the criteria maintain adequate benthic invertebrate survival. A maintenance flow is realized at the discharge for which any two of the three criteria in Table 3 are met for all riffle transects in a study area. The instream flow recommendations from the Habitat Retention method are applicable year round except when higher instream flows are required to meet other fishery management purposes (Table 2).

Table 3 Hydraulic criteria for determining maintenance flow with the Habitat Retention method.

Category	Criteria
Mean Depth (feet)	Top Width[a] X 0.01
Mean Velocity (feet/second)	1.00
Percent Wetted Perimeter[b]	50

a - At average daily flow. Minimum depth = 0.20.
b - Percent of bank full wetted perimeter

Habitat Quality Index

The Habitat Quality Index (HQI; Binns and Eisermann 1979) was used to estimate trout production over a range of late summer flow conditions. This model was developed by the WGFD and received extensive testing and refinement. It has been reliably used in Wyoming for trout standing stock 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 or improve existing levels of Bonneville 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 mean late summer flow conditions. Under this assumption, HU estimates are extrapolated through a range of potential late summer flows (Conder and Annear 1987). Coantag 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 production at discharges other than those measured. Average daily flow (ADF;23.6 cfs) was estimated from elevation and basin area (Lowham 1976) and average peak flow (171 cfs) was estimated from regression of Coantag flows to Smiths Fork flows at gage 10032000. The SSTEMP (Bartholow 1989, Theurer et al. 1984) model was used to simulate stream temperatures for HQI simulation.

Physical Habitat Simulation

Physical Habitat Simulation (PHABSIM) methodology was used to quantify physical habitat (depth and velocity) availability over a range of discharges. This 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 ft^2 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 1 and 150 cfs. Precision declines outside this range; however, the modeled range accommodates typical Coantag Creek flows.

Curves describing depth, velocity and substrate suitability for trout life stages are a vital component of the PHABSIM modeling process. Suitability curves are listed in Appendix 2.

Estimates by Binns (1981) indicate BRC spawning activity in Coantag Creek (elevation 7200 feet) peaks approximately between May 15 and June 7. Because spawning onset and duration varies between years due to differences in flow quantity and water temperature, spawning recommendations should extend from May 1 to June 30. Even if spawning is completed by June 1, maintaining flows at a selected level throughout June will benefit trout egg incubation by preventing dewatering. The PHABSIM model was used to obtain flow recommendations for maintaining or improving BRC spawning habitat from May 1 to June 30 (Table 2).

RESULTS AND DISCUSSION

Habitat Retention Analysis

Habitat retention analysis indicates that 7.2 cfs is required to maintain hydraulic criteria at all riffles to provide passage between habitats for all trout life stages (Table 4). Maintenance of naturally occurring flows up to this flow is necessary at all times of the year. Higher flows are needed May 1 through June 30 to support critical life stages (Table 2).

Simulated hydraulic criteria for three Coantag Creek riffles. daily flow = 23.6 cfs. Bank full discharge = 153 cfs.

	Mean Depth (ft)	Mean Velocity ft/s)	Wetted Perimeter (ft)	Discharge (cfs)
Riffle 1	1.23	3.78	33.7	153.0
	1.14	3.38	31.7	120.0
	0.93	2.73	29.9	75.0
	0.76	2.25	28.5	48.4
	0.57	1.67	25.2	23.6
	0.39	1.20	21.7	10.0
	0.29	1.00[a]	20.1	5.8
	0.25	0.90	17.7	4.0
	0.21	0.82	16.8[a]	2.9[b]
	0.20[a]	0.74	14.0	2.0
Riffle 2	1.11	3.80	36.9	153.0
	1.25	3.48	28.3	120.0
	1.08	2.84	25.1	75.0
	0.88	2.34	24.1	48.4
	0.63	1.72	22.2	23.6
	0.40	1.23	20.7	10.0
	0.32	1.10	20.3	7.0
	0.26	1.00[a]	19.1	5.0
	0.25	0.97	18.4[a]	4.4[b]
	0.20[a]	0.88	17.4	3.0
Riffle 3	1.18	3.89	34.3	153.0
	1.05	2.87	25.6	75.0
	0.99	2.67	24.7	63.5
	0.96	2.36	22.0	48.4
	0.75	1.69	19.2	23.6
	0.52	1.15	17.3	10.0
	0.48	1.09	17.1[a]	8.8
	0.43	1.00[a]	16.8	7.2[b]
	0.35	0.88	16.3	5.0
	0.20[a]	0.72	14.9	2.1

a - Hydraulic criteria met
b - Discharge at which 2 of 3 hydraulic criteria are met

Based on habitat retention results, an instream flow of 7.2 cfs is recommended for the October 1 to April 30 time period. If approved, this flow level will maintain the existing fishery because it protects existing natural flow patterns up to the identified maintenance level. Trout populations are naturally limited by low flow conditions during the winter months (October through March; Needham et al. 1945, Reimers 1957, Butler 1979, Kurtz 1980, Cunjak 1988). Such factors as snow fall, cold intensity, and duration of cold periods can influence winter trout survival. Fish populations are influenced primarily through the effects of frazil ice including metabolic stress and anchor ice formation which limits habitat and may result in stranding.

ice impacts. Any artificial reduction of natural winter stream flows would increase trout mortality and effectively reduce the number of fish the stream could support. Therefore protection of natural winter stream flows up to the recommended maintenance flow is necessary to maintain existing survival rates of trout populations.

The 7.2 cfs identified by the Habitat Retention Method may not always be present during the winter. Because the existing fishery is adapted to natural flow patterns (see above fisheries discussion), occasional periods of natural shortfall 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 7.2 cfs, to maintain existing trout survival rates.

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". Often, HU's measured during low flow are used to define the existing late summer fisheries. In situations where the goal is to "maintain" existing fisheries, we determine the flow range with the same HU's as measured and the minimum flow in that range becomes the recommendation. At the measured late-summer flow level of 39 cfs there are 248 HU's (Fig. 2). This level of habitat is maintained between 34 and 41 cfs. However, the minimum in the range (34 cfs), should not be the instream flow recommendation.

Average late-summer flow is probably less than the 39 cfs measured in September 1995 because 1995 flow levels were high. In addition, lower flows in the range 21 to 33 cfs provide maximum trout habitat (295 HU's; Fig. 2). Therefore, the minimum flow to *maintain* the fishery during late summer is 21.0 cfs. Maintaining higher or lower late summer flows would decrease habitat.

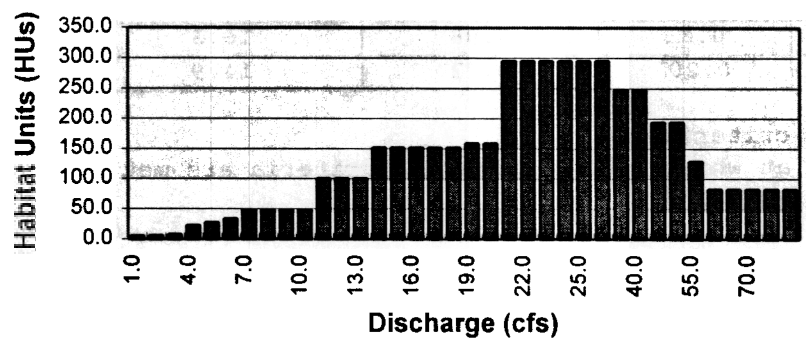

Figure 2. Trout habitat units at several late summer Coantag Creek flow levels. X-axis discharges are not to scale.

Based on HQI analysis and in consideration of the Bonneville cutthroat trout Management Plan's goals (Remmick et al. 1994), an instream flow of 21.0 cfs is recommended to maintain existing trout production between July 1 and September 30. This flow represents the lowest stream flow that will accomplish this objective.

Storage to achieve this flow solely for instream flow purposes is likely not in the State's best interest.

PHABSIM Analyses

Weighted usable area estimates for Bonneville cutthroat trout are in Figure 3. Adult and juvenile physical habitat peak at about 10.0 and 4.0 cfs, respectively. The HQI-derived 21 cfs late-summer flow will maintain less than 60% of maximum adult and less than 40% of maximum juvenile habitat suggesting that physical habitat rarely approaches maximum levels under natural flow regimes (natural flows likely do not often drop to 10 cfs). Only when HQI attributes such as water temperature, cover, and channel water velocity are considered does the utility of 21 cfs for late-summer become apparent. The winter maintainance flow level of 7.2 cfs will provide close to maximum physical habitat for adults and juveniles.

Spawning was identified as a critical life stage. Peak spawning physical habitat in the study site occurs at 24.0 cfs. Normal spring flows are much higher - 75 cfs was measured in June 1994 and spring 1995 flows were undoubtably over 100 cfs since 65 cfs was measured in August (Table 1). Such high flows might limit spawning activity near the study site or cause migration to more favorable (upper) reaches. Though trout can usually find someplace to spawn whenever temperatures are appropriate and flows allow unrestricted movement, maximum physical habitat in the study site occurs at a flow of 24.0 cfs. Therefore, an instream flow of 24.0 cfs is recommended for the period May 1 to June 30.

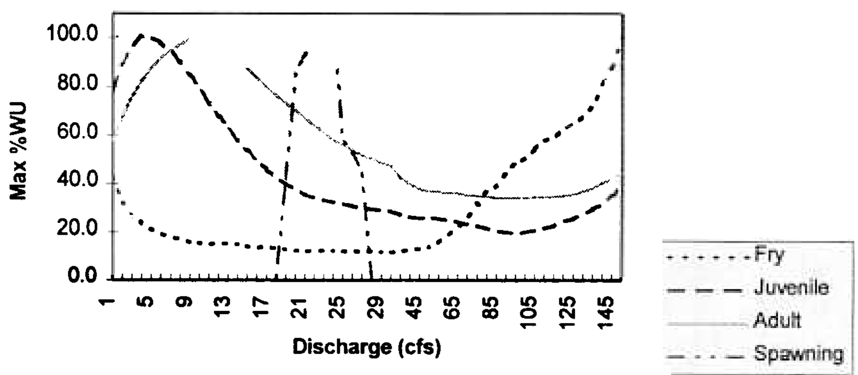

Figure 3. Weighted usable area (percent of maximum) for Bonneville Cutthroat trout life stages in Coantag Creek over a range of discharges.

INSTREAM FLOW RECOMMENDATIONS

Based on the analyses and results outlined above, the instream flow recommendations in Table 5 will maintain the existing Coantag Creek Bonneville cutthroat trout fishery. These recommendations apply to 4.9 mile segment of Coantag Creek extending downstream from the confluence of North and South Forks Coantag Creek at the northern border of section 4 in T27N, R117W to the confluence with Hobble Creek in section 36 of T28N, R117 1/2W. 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.

Table 5. Instream flow recommendations to maintain or improve the existing Coantag Creek trout fishery.

Time Period	Instream Flow Recommendation (cfs)
May 1 to June 30	24.0.8
July 1 to September 30	21.
October 1 to April 14	7.2

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 may be appropriate for establishing channel maintenance flow requirements.

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Appendix 1. Reach weighting used for PHABSIM Analysis.

Transect	Length	Weight	Percent	Habitat Type
0.0	7.0	0.50	26.2	Riffle/Control/IFG1/Spawning
14.0	10.8	0.30	40.5	Run
26.7	8.9	0.50	33.3	Pool
0.0	8.3	0.50	4.7	Riffle/Control/IFG1
16.6	15.0	0.50	8.4	Run
29.9	13.6	0.50	7.6	Run
43.7	12.7	0.10	7.2	Run/Pool
101.7	90.2	0.50	50.8	Riffle
177.7	38.0	0.50	21.4	Riffle/Control/IFG1

Appendix 2. Spawning suitability index data used in PHABSIM analysis. Spawning index data were developed by Idaho Department of Fish and Game.

Spawning	Velocity	Weight		Depth	Weight		Substrate	Weight
	0.00	0.00		0.00	0.00		0.00	0.00
	0.20	0.00		0.30	0.00		4.00	0.00
	0.30	0.10		0.40	0.10		4.20	0.54
	0.40	0.22		0.50	0.30		4.50	0.76
	0.50	0.40		0.60	0.70		5.00	1.00
	0.60	0.68		0.70	0.90		5.20	0.82
	0.75	1.00		0.80	1.00		5.50	0.50
	0.80	0.98		1.00	1.00		5.60	0.30
	0.90	0.58		1.30	0.84		6.00	0.00
	1.20	0.23		1.40	0.52			
	1.40	0.00		1.50	0.35			
	100.00	0.00		1.80	0.13			
				3.60	0.00			
				100.00	0.00			