5.0 INSTREAM FLOWS

5.1 INSTREAM FLOW INVESTIGATIONS

As stated in Chapter 1, Section 1.2.1, watershed planning units have the option of collaborating with the Washington Department of Ecology (WDOE) to develop and recommend minimum instream flows under the Watershed Planning Act (see sections 040, 060, 080 of Chapter 90.82 RCW). In 1998 the initiating governments and the EWPU decided to include the development of minimum instream flow recommendations as part of the Entiat WRIA planning process.

The term "minimum instream flow" refers to an instream stream flow regime that has been put into rule, or codified, and used for two main water management purposes:

- determining the availability of water for new out-of-stream uses and regulating those new uses; and
- defining stream flows that are needed to protect and preserve instream resources and values.

The instream flow regime recommended by the Planning Unit for codification as a "minimum instream flow" in Chapter 173-546 WAC will be used by the WDOE to help determine the availability of water for issuance of *new* water rights. In essence, a minimum instream flow regime becomes a legal water right for the river to protect the instream resources and beneficial uses/values it supports. A minimum instream flow is "junior" to all existing valid (senior) water rights, and therefore has *no effect* on these water rights and out-of-stream uses; however, the minimum instream flows will be "senior" to all water rights issued after they are codified. Essentially, minimum instream flows say that water is available for new beneficial uses only if a certain flow is present in the river.

The first step in setting minimum instream flows is to identify and assess the stream flow needs for a given watershed, and then to identify which of the instream resources and environmental values are required by existing state law to be protected by those flows within the watershed. Adequate instream flows are important not only for fish, but for irrigation, wildlife, recreation, aesthetics, navigation, stock watering, and water quality needs. Data, such as information relating to the biology (specifically fish and aquatic habitat), hydrology, water quality, and geomorphology of the watershed are gathered.

The planning unit must use a collaborative process to develop minimum instream flow recommendations. Data must be summarized, analyzed, and reviewed by all interested parties. An instream flow regime must consider the temporal and geographic range of stream flows needed to protect and preserve instream resources and environmental values. It includes a set of specific stream flow numbers (usually set as cubic feet per second (cfs)) for a given time-step (week, month, etc.), and time period (spring, summer, fall, winter) tied to a certain location that is needed to assure that enough water is available to protect and preserve the aforementioned resources. The last step of the process involves proceeding with a formal review and codification of the recommendations as "minimum instream flows" in the Washington Administrative Code (WAC).

For more information on instream flows please review the publication, "*A Guide for Instream Flow Setting in Washington State"* (WDOE and WDFW 2003). The full report may be accessed by clicking the following link: http://www.ecy.wa.gov/pubs/0311007.pdf. Information is also available from the following web-site: http://www.ecy.wa.gov/programs/wr/instream-flows/isfhm.html

5.1.1 Previous Instream Flow Work in WRIA 46

In 1992 the WDOE and WDFW collected instream flow data as part of a statewide watershed assessment process. They established transects within representative reaches of the lower and mid-Entiat River (RM 1.0 and 16.2, respectively) and the lower Mad River (RM 0.2). Data on four key measurable elements of fish habitat (depth, velocity, substrate and cover) were collected at each transect for use in a Physical Habitat Simulation (PHABSIM) analysis (Caldwell 1995). PHABSIM analysis is a nationally approved tool for estimating habitat available in a river for different species and different life stages of fish at various stages of flow, and is the most commonly used analysis tool for instream flows in Washington State.

Estimates of spawning and juvenile fish habitat availability for Chinook, steelhead and bull trout were generated by the PHABSIM computer model and calibrated based on several stages of flow at the two study locations in the Entiat. A full analysis of the Mad River data was deferred. A report entitled, "Entiat and Mad Rivers Fish Habitat Analysis Using the Instream Flow Incremental Methodology" (Caldwell 1995) contains the results of the PHABSIM assessment (see the 1995 assessment in the Reports folder on the CD). The title of the report is somewhat misleading as PHABSIM is only a component of the full Instream Flow Incremental Methodology (IFIM) decision-making framework (see Section 5.2).

Instream flows recommended by WDOE and WDFW were presented to the Entiat community on March 23, 1995. During this meeting, the WDOE presented findings from the Initial Watershed Assessment, Entiat River Watershed (Kirk et al. 1995). The minimum instream flow recommendations presented were generated without utilization of a full collaborative decision-making process like IFIM to identify issues, develop and implement a study plan, generate alternatives, and solicit input from multiple stakeholders. As a result, the recommendations were not well understood or received, and not codified. Members of the Entiat CRMP Technical Advisory Committee reviewed the information and concluded that the habitat estimates reasonably approximated the relationship between habitat and flow levels for the study segments. However, the EWPU identified data gaps in the assessment; thus they chose to utilize a more collaborative approach to developing instream flow recommendations and took on the optional instream flow component as part of its collaborative watershed planning effort.

5.2 INSTREAM FLOW INCREMENTAL METHODOLOGY (IFIM)

The Instream Flow Incremental Methodology was developed in the 1980s by an interdisciplinary team of scientists from various federal and state agencies and academia under the leadership of the USFWS (Bovee 1998). Notably, IFIM is a *process* designed to help solve multiple-use water resource allocation issues, such as setting instream flows. It is a decision-support system designed to help determine the benefits and consequences of different water management alternatives within a given river and/or watershed. IFIM is made up of a combination of problem solving tools and integrated computer models, such as PHABSIM, as well as steps intended to involve all stakeholders. It consists of four interrelated phases:

- Phase I: Problem identification and diagnosis,
- Phase II: Study planning,
- Phase III: Study implementation, and
- Phase IV: Alternatives analysis/problem resolution.

The Planning Unit decided to use the IFIM process to develop minimum instream flow recommendations for the Entiat and Mad Rivers for a number of reasons. First, the IFIM framework complemented the collaborative problem solving process already established via the group's past use of the NRCS' Coordinated Resource Management Plan framework, and current Planning Unit structure. Second, since IFIM based studies are considered "flexible" and can be tailored to fit the individual needs of a watershed, use of IFIM enabled the specific goals of the EWPU to be included in the process to develop instream flow recommendations. Finally, IFIM was selected because its framework allows consideration of how given water management alternatives may affect human resources. By employing IFIM, the Planning Unit was able to choose what methods, models, and public involvement procedures were best suited to solving instream flow issues within the Entiat subbasin. For more information regarding the IFIM, please refer to the following links:
http://www.fort.usgs.gov/products/software/ifim/5phases.asp
http://www.fort.usgs.gov/products/publications/3910/3910.asp

5.3 EWPU APPLICATION OF IFIM

In preparation for developing minimum instream flow recommendations, the Planning Unit and WDOE sponsored a three-day IFIM training in March 2000 to educate interested parties on the IFIM process and instream flow setting in Washington State. Subsequently, at their June 2000 meeting, the EWPU agreed to use a robust application of IFIM as their approach to addressing instream flow issues. The group also agreed to apply for FY 2001 Salmon Recovery Funding Board (SRFB) money to help fund the EWPU IFIM process. The Planning Unit successfully obtained SRFB funding, and the consulting firm ENTRIX, Inc. (ENTRIX) was hired in September 2001 to work with the EWPU and the instream flow subcommittee on this issue.

5.3.1 Instream Flow Work Plan (IFWP) Development

An EWPU instream flow technical subcommittee field trip and a Landowner Steering Committee (LSC) meeting were held in September and October 2001, respectively, to initiate instream flow issue scoping (Phase one of IFIM: Problem Identification). These sessions, combined with input received from the EWPU habitat subcommittee and subsequent landowner meetings, provided stakeholder input for the development of the IFWP (Phase II of IFIM: Study Planning). As stated in the IFWP, the goals of the EWPU were to:

1. **Develop instream flow recommendations for the Entiat and Mad Rivers** (with contingency planning) for the purpose of: (a) addressing future water right decision-making and (b) addressing flows necessary for protection and restoration of habitat for threatened and endangered salmonids and other species of interest within the context of existing water use. The flow recommendations will be associated with key life stages of target fish species (Chinook salmon, steelhead and bull trout) within distinct stream segments of the Entiat and Mad Rivers.
2. **Establish the micro and macrohabitat data platform necessary to conduct status and trend monitoring** of key reaches in the Entiat River watershed for the purpose of evaluating the success of habitat restoration efforts associated with listed species.
3. **Conduct a simultaneous application of the Instream Flow Incremental Methodology and the Ecosystem Diagnosis and Treatment** (EDT) process on a relatively small-scale, data-rich watershed for the purpose of demonstrating the degree of compatibility of the two procedures in facilitating the development, implementation and monitoring of a comprehensive watershed restoration strategy.
4. **Conduct a robust application of the IFIM as a demonstration of a problem solving process**, directed at the local level, that utilizes an efficient combination of both existing data (e.g., 1995 PHABSIM analyses) and new information (e.g., site-specific assessment of passage conditions) to develop instream flow recommendations under the guidance of the Washington State Watershed Planning Act.

5.3.2 IFIM Study Scope and Data Inputs

The EWPU instream flow and habitat subcommittees worked with ENTRIX to define segments of the Entiat and Mad Rivers with similar characteristics for the purpose of identifying where field data should be collected (see Figure 5-1 on page 5-5). Stream flow, land ownership, channel condition, habitat composition, and aquatic habitat utilization data, as well as data from the EDT effort and WDOE/WDFW PHABSIM report (Caldwell 1995), were used to delineate instream flow study segments. The EWPU technical subcommittee determined how new study sites would compliment the previous PHABSIM assessment transects, and how data from both analyses would be used to craft instream flow recommendations. Field reconnaissance was performed on July 31, 2002, by ENTRIX, EWPU instream flow subcommittee members, and WDFW staff involved with the 1995 PHABSIM study in order to discuss the utility of data collection sites and transects proposed in the IFWP, and assure there was no duplication of effort between the 1995 study and ENTRIX's data collection efforts.

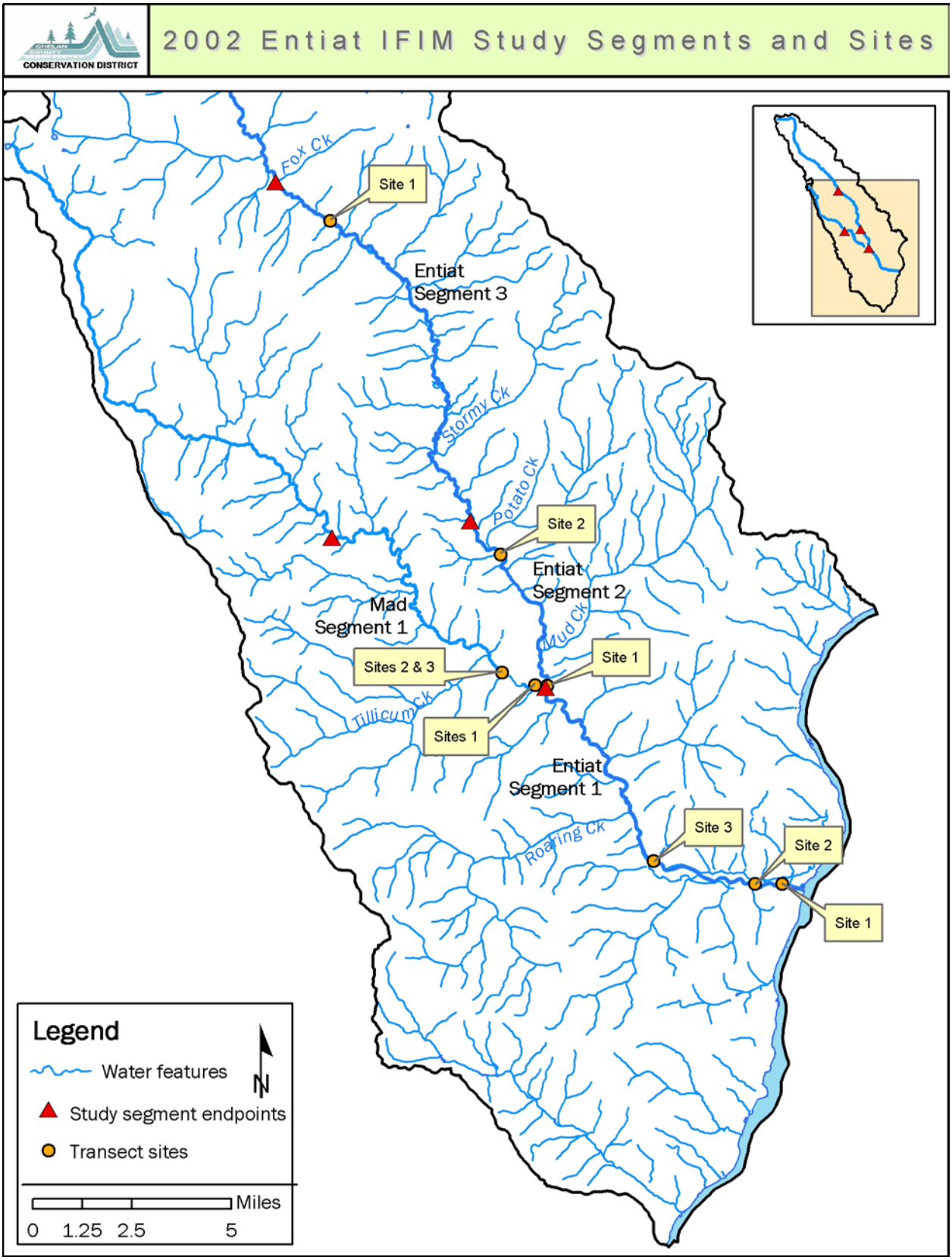


Figure 5-1. Entiat 2002-2003 IFIM study segments and transect sites.

ENTRIX's field data collection focused within three segments of the Entiat River and the lower Mad River in order to balance total study cost against the utility of results from reach-specific instream flow studies. Only segments downstream of RM 28.5 (Fox Creek) were studied in detail due to cost considerations and the very limited potential for future out of stream water use above the Forest Service boundary at RM 26.3. Stream flow measurements for Segments 1 and 2 were correlated to the Keystone gage (USGS gage 12452990); stream flow measurements for Segment 3 were indexed to the Stormy gage (USGS gage 12452800). The Mad River was evaluated as a single study segment with the primary focus being the lower two miles. Mad River stream flow measurements were correlated to USGS gage 12452890 near the mouth of the Mad.

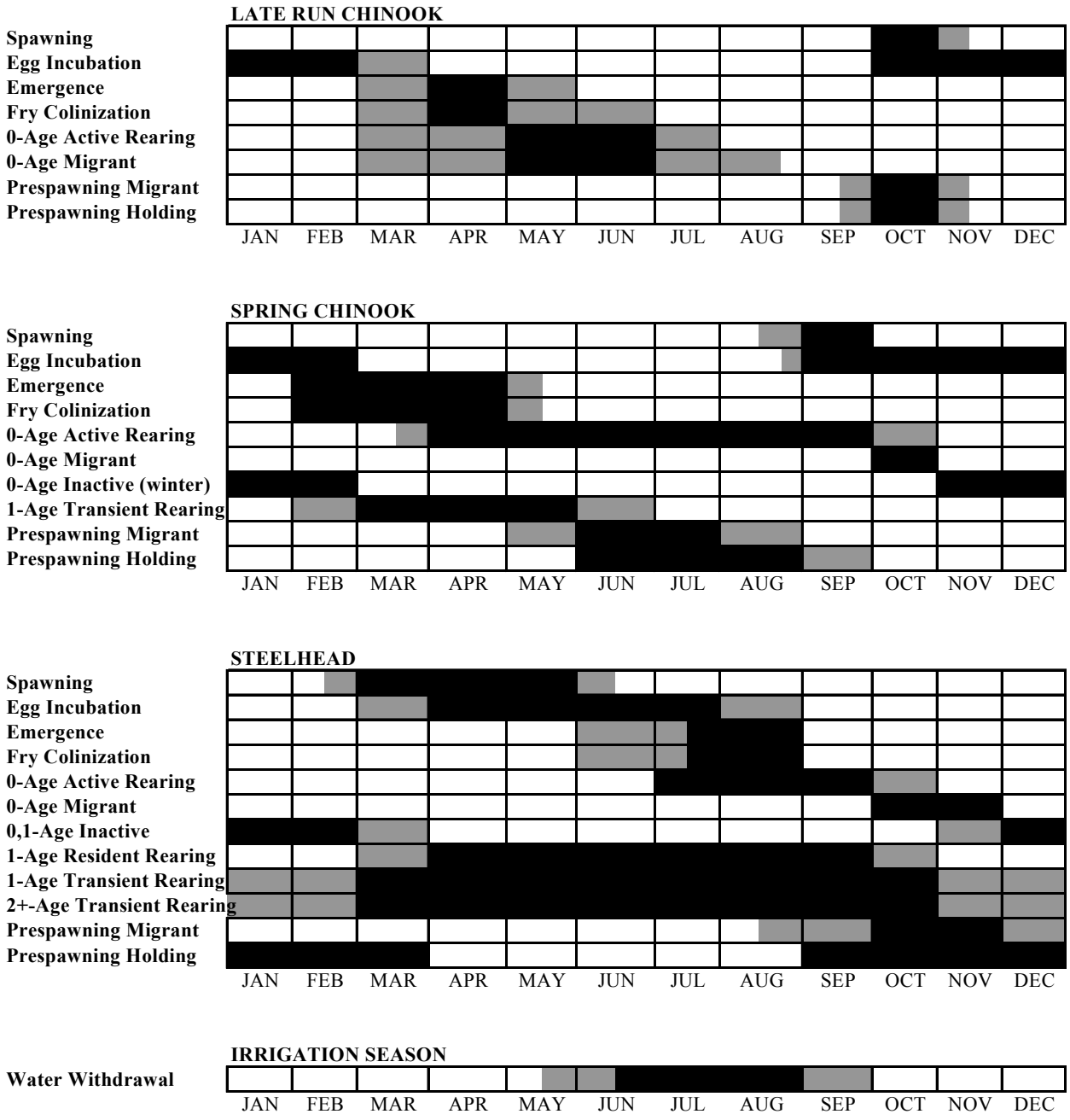
Table 5-1. Summary of 2002-2003 Entiat IFIM segment, sites, transects and selection rationale.

Segment	Site/R.M.	Transect	Purpose	Description	Field Observations 8/02, 9/02, 10/02
Entiat Segment 1	R.M. 0.8 Site 1	1	Spawning	1 chosen for Chinook spawning. 2&3 chosen for steelhead spawning; "no Chinook". Transects are located on right bank channels	Active spawning 10/02.
		2	Spawning /Passage		No passage into side channel at lower flows.
		3	Spawning		
		4	Flow	In combination with the average of 2&3, provides total flow measurement.	Spawning activity observed downstream 10/02.
	R.M. 1.3 Keystone		Spawning /Passage	Chosen because of spawning in previous years and potential passage issues at low flow	Spawning 9/02 and 10/02.
	R.M. 4.5 Dinkleman		Passage	Concern expressed that cross vane may create potential passage issues at low flow.	Adults holding in scour pool downstream of cross vane, all 3 visits. No passage problems.
Mad River	R.M. 0.2	1	Passage	The transect captures a potential passage issue; however, a more likely passage issue is located just upstream of the transect on private property. No permission to enter.	
	R.M. 1.2	2	Spawning	Spawning in previous years.	Chinook redd in 9/02.
	R.M. 1.3	2	Spawning	Spawning in previous years.	Steelhead redds in 7/02. Chinook redd on transect in 9/02.
Entiat Segment 2	R.M. 10.6	Lower	Passage/ Aesthetic	Chosen for potential passage issues and aesthetics viewpoint.	
	R.M. 14.9	Upper	Passage/ Aesthetic	Chosen for potential passage issues and aesthetics viewpoint.	
Entiat Segment 3	R.M. 25.8	1	Spawning	Chosen because of spawning in previous years. Segment 3 typically has the most spawning of the studies segments.	
		2	Spawning		Good cover along right bank.
		3	Spawning		Redd on right bank.

The EWPU habitat subcommittee worked with ENTRIX to document the phenology of Chinook and steelhead within the Entiat and Mad River watersheds in order to determine when field data should be collected. The landowner steering committee provided information about quantity and timing of irrigation water use to help define which months are critical with respect to water demand. Although steelhead, spring Chinook and late run Chinook utilize different segments of the Entiat and the Mad Rivers to different degrees, no difference was observed in the timing of a particular species' life history activity across stream segments. Thus, the timing of life history activities presented in Figure 5-2 on page 5-8 was deemed applicable to all stream segments addressed by the Entiat IFIM.

ENTRIX collected data at transects within each study segment during August, September and October 2002 in order to assess Chinook and steelhead spawning and passage stream flow requirements. Additional steelhead spawning flow data were collected at the upper two transects in the Mad River by USFS Entiat RD fish biologists on April 8, 2003 to record flows during a known steelhead spawning event. Weighted Usable Area (WUA) curves for Chinook, steelhead and bull trout habitat produced by WDOE/WDFW as part of their previous PHABSIM work were also utilized in the development of instream flow recommendations. Habitat Time Series analysis was done combining WUA and Flow Time Series data to examine bull trout habitat in the Mad River and upper Entiat River. ENTRIX paid particular attention to the juvenile habitat WUA curves, as they were only contracted to collect new data on spawning and passage flow issues as part of the Entiat IFIM process. Planning Unit thermograph data and winter habitat condition information in the lower Entiat River were used in conjunction with data from a study on summer/fall Chinook salmon incubation and survival success (BioAnalysts, Inc. 2002a) to guide development of instream flow recommendations for the winter months. For more information on winter habitat conditions and effects on fish, see Chapter 7, Habitat.

As mentioned in Chapter 4, Water Quantity, the Planning Unit and consultant Gran Rhodus compiled and review all historic and current USGS and USFS stream flow records for the Entiat and Mad Rivers (Rhodus and Edwards 2002). Continuous gage records from the three main USGS gages were used, and appropriate correlation analyses were performed to estimate stream flow data and fill the gaps in these records as needed. In order to expand the daily stream flow record at each gage, composite stream flow records were created to tie together both measured and synthesized stream flow data (refer to Chapter 4, Section 4.2).



Stream Use Key:
Black Areas = Periods of Heaviest Use
Grey Areas = Periods of Moderate Use
Blank Areas = Periods of Little or No Use

Note: Light irrigation water use occurs mid-April through mid-May and during the first half of October.

Figure 5-2. Phenology chart for Chinook salmon and steelhead in the Entiat subbasin.

ENTRIX used the composite stream flow records[1] to prepare representative hydrographs for Entiat Segments 1 through 3 and the Mad River to depict the time of year stream flows are the highest and lowest. Four sets of annual and monthly stream flow duration curves were also generated to illustrate the likelihood of a particular magnitude stream flow occurring during a particular month of interest. Composite flow values generated for the Stormy, Keystone, and the Mad River at Ardenvoir gages were plotted by month using their exceedence value. An "exceedence value" represents the probability that a particular flow will be met or exceeded a specific percentage of time during a month. For example, at the Keystone gage a flow of 608 cfs during the month of July has an exceedence value of 50%, meaning that a stream flow of 608 cfs in the lower Entiat River in July is likely to be met or exceeded 50% of the time, or roughly one out of every two years. It is important to note that a 50% exceedence value does not guarantee that this flow will be met or exceeded in July at that gage every one out of two years; it only represents the probability that a flow of at least this magnitude will occur. Exceedence flow values were used to describe water availability (stream flow magnitude) on a monthly basis because these statistics provide a more reliable indication of the amount of water that typically exists in the system during a particular time period.

5.4 INSTREAM FLOWS

Between February and October 2003, six professionally facilitated meetings were held to bring stakeholders together to craft instream flow recommendations for the Entiat and Mad Rivers. Significant effort was made to ensure that interested stakeholders not participating as regular Planning Unit members were either present at the table or informed of the EWPU's efforts.

During facilitated sessions, the EWPU determined that it should develop non-regulatory biological/management flows in addition to instream flows for codification in Chapter 173-546 WAC. This was done to help meet the vision and goals of the group, which include optimizing the quantity and quality of water to achieve a balance between natural resources and human use both current and projected, gaining certainty under the Endangered Species Act through habitat conservation planning under Section 10(A)(1)(b) of the ESA and providing habitat sufficient to eventually provide harvestable and sustainable populations of fishes and other aquatic resources.

During the third and fourth facilitated sessions, the EWPU determined that the terms ***Planning Unit Instream Flows*** and ***Administrative Instream Flows*** should be used to describe the two instream flow regimes during subsequent discussions and the development of instream flow work products. This was done to differentiate between the two, provide clarity regarding their purpose and legal standing, and to avoid confusion often associated with the phrase "Minimum Instream Flow".

[1] During instream flow work negotiations, the WDFW, WDOE, and EWPU instream flow subcommittee determined that the composite records adequately represented the flow regimes of the Entiat and Mad Rivers.

The EWPU agreed that:

1) Approved Planning Unit Instream Flows will serve as non-regulatory management tool for:
   - monitoring the effectiveness of future water conservation efforts;
   - monitoring the effectiveness of channel restoration efforts;
   - guiding the Upper Columbia Salmon Recovery Board's efforts to develop a salmon recovery plan;
   - supporting Wenatchee National Forest Plan revisions; and
   - measuring progress towards compliance with the Clean Water Act.

2) Approved Administrative Instream Flow recommendations will be codified in Chapter 173-546 WAC as legal minimum instream flows, and used by WDOE to help manage future water right appropriations within the Entiat and Mad River watersheds. Instream flows on National Forest system lands require a Forest Plan amendment and line officer decision. The Forest Service will use the analyses completed by the Planning Unit when determining instream flows for National Forest System streams.

5.4.1 Planning Unit Instream Flows

As mentioned earlier, the Planning Unit and ENTRIX developed three biologically-based Planning Unit flow regimes for subbasin management and monitoring purposes. Planning Unit flows were developed for the lower Entiat River (RM 0-16.2; Segments 1 and 2), upper Entiat River (RM 16.2-25.8; Segment 3), and the Mad River (RM 0-4) (see Figure 5-1). Planning Unit flow regimes were developed to identify monthly flow needs for Chinook and steelhead, given existing water and land use, and provide benchmarks for monitoring the effects of future water use, water conservation, stream channel restoration or salmon/steelhead recovery efforts in the Entiat subbasin.

- The primary species and life history concerns identified for Entiat Segments 1 and 2 were summer Chinook spawning and incubation (Oct-Dec), as well as steelhead and spring Chinook rearing (Jul-Sept).
- The primary concerns in Entiat Segment 3 were spring Chinook spawning and incubation (Sept-March), steelhead spawning and incubation (April-June), and steelhead juvenile rearing (July and August).
- The primary concerns in the Mad River were steelhead passage (March), spawning (April and May), incubation (June and July), juvenile rearing (August), and fall/winter base flows.

Each flow regime was indexed to an established USGS stream gage and applies to a specific life history phase of the priority fish species utilizing that segment of the Entiat or Mad Rivers. Refer to Table 5-2, Table 5-3, and Table 5-4 for proposed lower Entiat, upper Entiat and Mad River Planning Unit instream flow regimes, respectively.

ENTRIX (2003) noted that several other species of fish and much of the upper portion of the Mad and Entiat Rivers may or may not benefit from these suggested flow regimes, and

suggested that additional focused studies would be required to determine what benefit might exist or whether modification of the suggested flow regimes would be necessary in order to benefit these other fish species. ENTRIX felt that significance should be assigned to accommodating the general magnitude of the suggested monthly instream flow rather than on replicating specific monthly values. ENTRIX reported that a 5 or 10 cfs departure from a suggested monthly flow value would result in little measurable difference to instream hydraulics or fish habitat conditions in a river as large as the Entiat (ENTRIX, Inc. 2003).

Aesthetic flow recommendations were provided for Entiat River Segment 2 (ENTRIX, Inc. 2003; see Table 5-2 on page 5-13). These flows were defined for May through September, which coincides with the period of highest recreational use and includes the major summer holidays. Aesthetic values were incorporated to reflect local desires for a visually pleasing stream, recreation benefits and the economic benefits of tourism. Recommended aesthetic flows ranged between the 50th and the 70th percentile of flow exceedence for the months of interest (ENTRIX, Inc. 2003).

The average annual peak flows required for channel maintenance were not defined by ENTRIX as part of the Planning Unit Instream Flow regime. They reported that although the dynamic nature of year to year snowmelt floods in erodible stream channels (such as Entiat's stillwater reach) is of paramount importance to maintaining their character and condition, and associated riparian vegetation, high streamflows can also cause low rates of incubation success and fish recruitment.

The relationship between high streamflows, channel condition and fish production in the Entiat subbasin has not been fully investigated and explained; however, snowmelt runoff is, for the most part, unaltered and channel condition in Entiat Segment 3 and further upstream is quite natural. As such, ENTRIX recommended maintaining the current high degree of natural variability in streamflow patterns during the snowmelt season by restricting new streamflow withdrawals from the Entiat River during this time to between 75 to 100 cfs, until further study demonstrated that additional diversions would not impair the long-term quality or productivity of off-channel and main channel habitats in Entiat River Segment 3 (ENTRIX, Inc. 2003).

High flow relationships with habitat and channel conditions have not been studied in the Mad River either. However, it is known that naturally occurring peak flows in the Mad River are, for the most part, unaltered; that steelhead production is "good" in the lower 4 or 5 miles; and that bull trout production is "good" above River Mile 12. ENTRIX (2003) reported that there appears to be a positive relationship between high streamflow, channel condition, and fish production in the Mad River, although this relationship has not been studied in detail. Thus, they advised that new water diversions from the Mad River during May and June should be restricted to 20 or 30 cfs until further study demonstrates that additional water could be withdrawn without adversely affecting current channel conditions or levels of fish production.

Although each of the suggested Planning Unit flow regimes was based upon the best hydrologic, biologic, and water use data available, professional judgment was a primary component of considerable portions of the suggested flow regimes. None of the suggested

Planning Unit flow regimes were recommended by ENTRIX for inclusion in a habitat conservation plan (HCP), as additional study, re-evaluation and modification of the flow regimes would be required for such an effort. Instead, the suggested regimes should serve well as an initial benchmark by which to begin monitoring the success of future salmon recovery efforts. These regimes also provide a sound starting point for the discussion of Chinook and steelhead biological flow requirements when habitat conservation planning is initiated for the Entiat WRIA. The "Rationale" column in each of the following tables provides a brief statement and/or reference related to each flow recommendation. Detailed explanation of the analysis process and the associated professional judgment is provided in the Entiat Watershed Planning Unit Flow Study Report (ENTRIX 2003) and associated appendices.

Table 5-2. Proposed Planning Unit Instream Flows for Entiat Segment 1 (RM 0.0-10.6) and Segment 2 (RM 10.6-16.2), to be monitored at the Keystone gage (USGS gage #12452800, Entiat near Entiat).

Month	Species / Life History Stage of Concern	Fish Flow Range (cfs)	Percent exceedence for fish flow	Segment 2 Aesthetics flow (cfs)	Percent exceedence aesthetic flow	Rationale for Planning Unit flow regime
January	Summer Chinook incubation and juvenile Chinook /steelhead overwintering	**130** (130-145)	56-46	Not defined[2]	---	130 = 80% of spawning flow 145 = approx. winter base flow
February		**130** (130-145)	65-52	Not defined	---	
March		**130** (130-145)	84-72	Not defined	---	
April	Chinook fry dispersal	**250** (260-290)	73-68	Not defined	---	Twice the incubation flow for fry dispersal.
May	Chinook outmigration	**474**[3]	90	815	70	The Planning Unit selected this number to correspond to recommended Admin. Flow
June		**540** (520-580)	97-95	1156	70	Twice the fry dispersal flow for outmigration.
July	Chinook and steelhead rearing	**165**	99	426	70	Figure 4-8 and 4-10 in ENTRIX flow study report. 91% Chinook and steelhead rearing WUA (1995 WDOE report).
August		**165**	89	198	70	
September		**165**	42	140	70	
October	Summer Chinook spawning	**165** (150-185)	27	Not defined	---	Summer Chinook and redd count scattergrams, Figure 5-6 and 5-6 in ENTRIX flow study report.
November	Summer Chinook rearing and juvenile Chinook/steelhead overwintering	**130** (130-145)	73-56	Not defined	---	130 = 80% of spawning flow 145 = approx. winter base flow
December		**130** (130-145)	59-42	Not defined	---	

NOTES: ENTRIX did not identify high flows for channel maintenance.

A full discussion of the flow rationales for fisheries and aesthetics is presented in the EWPU Flow Study Report (ENTRIX, Inc. 2003). The aesthetic assessment was limited to Segment 2 and focused on determining adequate flows to maintain natural appearing views of the river. Aesthetic and recreational values are considered a beneficial use in the watershed and study was required to meet the goals of the EWPU.

[2] Aesthetic flow recommendations for these months were not determined to be relevant by the Planning Unit and ENTRIX.
[3] ENTRIX's recommendation for May was 540 cfs.

Table 5-3. Proposed Planning Unit Instream Flows for Entiat River Segment 3 (RM 16.2-26.5), to be monitored at the Stormy gage (USGS gage #12452990, Entiat near Ardenvoir).

Month	Steelhead life history stage	Steelhead flow range (cfs)	Steelhead rationale	Spring Chinook life history stage	Spring Chinook flow (cfs)	Spring Chinook rationale	Percent exceedence for Chinook flow
January	Juvenile overwintering	120	110-130 cfs = 25%-30% exceedence value	Incubation	**120** (110-130)	Incubation for Chinook should be the same or slightly lower than spawning.	26
February							29
March							48
April	Spawning and incubation	300 (240-325)	240-325 cfs = 80%-90% WUA for steelhead spawning (1995 WDOE report). Figure 4-10 in the ENTRIX flow study report.	Fry dispersal	**240** (240-325)	Twice the incubation flow; 80% WUA for steelhead spawning (1995 WDOE report).	57
May		325 (240-325)		Juvenile outmigration	**375**	Twice the fry dispersal flow. Steelhead spawning WUA is decreasing, but still high.	82
June	Incubation and rearing	260-300	80% of spawning flow in May. Steelhead incubation.		**325**		95
July	Juvenile rearing	275	99% juvenile WUA (1995 WDOE report).	Juvenile rearing	**275**	93% WUA for Chinook rearing (1995 WDOE report).	80
August	Juvenile rearing	180	89% juvenile WUA (1995 WDOE report).	Juvenile rearing	**180**	100% WUA for Chinook rearing (1995 WDOE report).	49
September	Juvenile rearing	125	75% juvenile WUA (1995 WDOE report).	Spawning	**125** (120-135)	Spring Chinook redd count scattergrams, Figures 5-8 and 5-8 in the ENTRIX flow study report.	30
October	Juvenile rearing	120	73% juvenile WUA (1995 WDOE report).	Incubation	**120** (110-130)	Incubation for Chinook should be the same or slightly lower than spawning.	16
November	Overwintering		Arithmetic average of the 25%-30% exceedence flows at Ardenvoir gage.				27
December							26

Flows identified in **BOLD** are suggested flows; flows for spring Chinook were selected because they are listed as endangered and Segment 3 of the Entiat River has been identified as a primary production area in the subbasin for this species.

NOTES: ENTRIX did not identify high flows for channel maintenance

Table 5-4. Proposed Planning Unit Instream Flows for the Mad River (RM 0-4), to be monitored at USGS gage #12452890, Mad at Ardenvoir.

Month	Steelhead Life History Stage of Concern	Fish Flow Range (cfs)	Percent exceedence for fish flow	Rationale for Planning Unit flow regime
January	Steelhead passage	25 (20-30)	56 (93-20)	Winter base flow.
February			68 (94-19)	
March		31 (30-35)	53 (53-46)	Figure 4-7 in the ENTRIX flow study report.
April	Steelhead spawning	70	74	Data collected in April 2003, 93% WUA (1995 WDOE report), and Figure 4-11 in the ENTRIX flow study report.
May		70	97	
June	Steelhead incubation	55	91	80% of spawning flow.
July		55	69	
August	Steelhead juvenile	40	45	To ramp down between July and September flows, the arithmetic average was calculated (55+25/2) = 40. 40 cfs = 80%-90% WUA for juvenile steelhead and Chinook (1995 WDOE report).
September		25 (20-30)	59 (100-24)	Winter base flow.
October		25 (20-30)	45 (94-12)	
November		25 (20-30)	52 (92-23)	
December		25 (20-30)	46 (92-22)	

NOTES: ENTRIX did not identify high flows for channel maintenance.
A full rationale for all flows is available in the full Entiat Flow Study Report (ENTRIX, Inc. 2003).

5.4.2 Administrative Instream Flows

The Planning Unit also developed Administrative Instream Flow recommendations for codification as minimum instream flows in Chapter 173-546 WAC. Three flow regimes were developed and tied to USGS gages:

- lower Entiat River, tied to the Keystone gage (USGS #12452800, Entiat near Entiat);
- upper Entiat River, tied to the Stormy gage (USGS #12452890, Entiat near Ardenvoir;
- Mad River, tied to USGS #12452990, Mad at Ardenvoir.

Under the Watershed Planning Act, minimum instream flows "…set by rule of the department [of ecology] shall have a priority date of two years after funding is first received from the department … unless determined otherwise by a unanimous vote of the members of the planning unit but in no instance may it be later than the effective date of the rule adopting such flow" [Chapter 90.82.080, sub-section 2(a)]. As Entiat Planning Unit first received funds on September 16, 1998, "Administrative" instream flows recommended in this document would receive a priority date of September 16, 2000 "…unless determined otherwise by a unanimous vote of the members of the planning unit".

As the Reserve of water described in Chapter 4, and recommended for implementation in Chapter 9 was intended by the Planning Unit to be a non-interruptible source of water for qualifying new beneficial uses, the Planning Unit recognized the benefit of clarifying the relationship of instream flow and Reserve priority dates. Thus, at the April 13 meeting of the Planning Unit, the group elected to specify, by unanimous vote, that the priority date of proposed instream flows be the date of rule adoption. In this way, instream flows and the Reserve would have the same priority date. As authorized under Chapter 90.82.080 2(a) of the Watershed Planning Act and consistent with instream flow and water resource management programs established under the Water Resources Act of 1971 (Chapter 90.54, RCW) and other state laws, the EWPU voted unanimously on May 17, 2004 to make the priority date of minimum instream flows the date of rule adoption.

Refer to Table 5-5, Table 5-6, and Table 5-7 on the following pages for proposed lower Entiat, upper Entiat and Mad River Administrative instream flow regimes. The priority species and life history stage, biological rationale and flow exceedence value for each period/flow are also presented in the tables. Figure 5-3, Figure 5-4, and Figure 5-5, which are based on the numbers in Tables 5-6, 5-7 and 5-8, respectively, depict the proposed Administrative [minimum] instream flows and compare them to representative 10%, 50%, and 90% flow exceedence hydrographs developed using historic USGS gage #12453000, Entiat at Entiat, data.

Table 5-5. Proposed Administrative Instream Flows for lower Entiat River (RM 0.0-16.2), to be monitored at the Keystone gage (USGS gage #12452800, Entiat near Entiat).

Monthly / semi-monthly period	Administrative instream flow (cfs)	Priority species and life history stages	Biological rationale	Percent flow exceedence
January 1-31	**185**	Chinook egg incubation, steelhead and Chinook juvenile rearing plus adult steelhead adults immigrating.	Incubation – flows at least 2/3 of spawning flows present mid-August thru October (90-300 cfs), Juveniles – best balance of 1995 study habitat flows gives 95% of peak habitat for steelhead and 85% of peak habitat for Chinook. Provide stable flows for juveniles.	25
February 1-28	**185**	Same as above plus Chinook fry emerging.	Same as above.	32
March 1-15	**185**	Same as above.	Same as above.	46
March 16-31	**250**	Steelhead spawning, steelhead and Chinook juveniles rearing and outmigrating, plus steelhead egg incubation.	Juveniles becoming more active and outmigrants need more flow. 1995 study – 93% habitat for steelhead spawning, 98% for steelhead juveniles,	35
April 1-15	**250**	Same as above.	Same as above.	65
April 16-30	**350**	Steelhead spawning peak, steelhead and Chinook juveniles plus steelhead egg incubation.	From 1995 study – 100% habitat for steelhead spawning, 80% habitat for steelhead juveniles, 48% habitat for Chinook juveniles. Plus juvenile outmigration flows should be increased.	72
May 1-15	**474** Plus a 100 cfs limit on total new rights.	Channel maintenance flows and steelhead and Chinook juvenile rearing and outmigration, plus steelhead spawning and egg incubation plus adult Chinook immigration.	To better protect channel maintenance flow and variability of flows, limit the total quantity of new water that can be given away during these periods. *	90
May 16-31	**720** Plus a 100 cfs limit.	Same as above.	Lesser priority is given to spawning since the majority of spawning is in the upper Entiat River reach.	90
June 1-15	**898** Plus a 100 cfs limit.	Same as above.		90
June 16-30	**617** Plus a 100 cfs limit.	Same as above.	Outmigration of juvenile salmonids is a high priority during this high flow time of year.	90
July 1-15	**359** Plus a 67 cfs limit on new water rights.	Channel maintenance, steelhead and chinook juvenile rearing and outmigration, steelhead egg incubation, and adult Chinook immigration.	Another high priority is providing the typical channel forming flows to maintain the shape of the channel, the substrate and woody debris, and connecting the side channels by using at least the 90% exceedence flows.	90
July 16-31	**268**	Same as above.		90

Monthly / semi-monthly period	Administrative instream flow (cfs)	Priority species and life history stages	Biological rationale	Percent flow exceedence
August 1-31	**185**	Steelhead and Chinook juveniles, Chinook spawning and egg incubation.	From 1995 study –95% habitat for steelhead juveniles, 85% habitat for Chinook juveniles and 90% habitat for Chinook spawning.	85
September 1-30	**185**	Same as above.	Same as above.	29
October 1-31	**185**	Chinook spawning and egg incubation, steelhead and Chinook juveniles, steelhead adults immigrating.	From 1995 study – 90% habitat for Chinook spawning, 95% habitat for steelhead juveniles, 85% for Chinook juveniles. Plus incubation is at least 2/3 of spawning flows in August and September.	15
November 1-30	**185**	Chinook egg incubation, steelhead and Chinook juveniles, steelhead adults immigrating.	Same as above but Chinook spawning over.	26
December 1-31	**185**	Same as above.	Same as above.	24

* The instream flow was chosen using the 90% exceedence flow instead of the 250 and 350 cfs IFIM flows needed for steelhead spawning because the lower reach is more important for juvenile outmigration and for juvenile rearing in side channels than for spawning. Additionally, because of uncertainty around the flows needed for fish outmigration, side channel connectivity, and for maintenance of the channel and floodplain, biologists felt that flows around the 100 % exceedence level were too low to protect those functions but that flows around the 90% exceedence level would help reduce that uncertainty when combined with a limit of 100 cfs on the quantity of water available for granting new water rights. This could lower the typical channel maintenance flow of 2500 cfs in May to 2400 cfs; however, biologists felt the channel maintenance flow would still be sufficient.

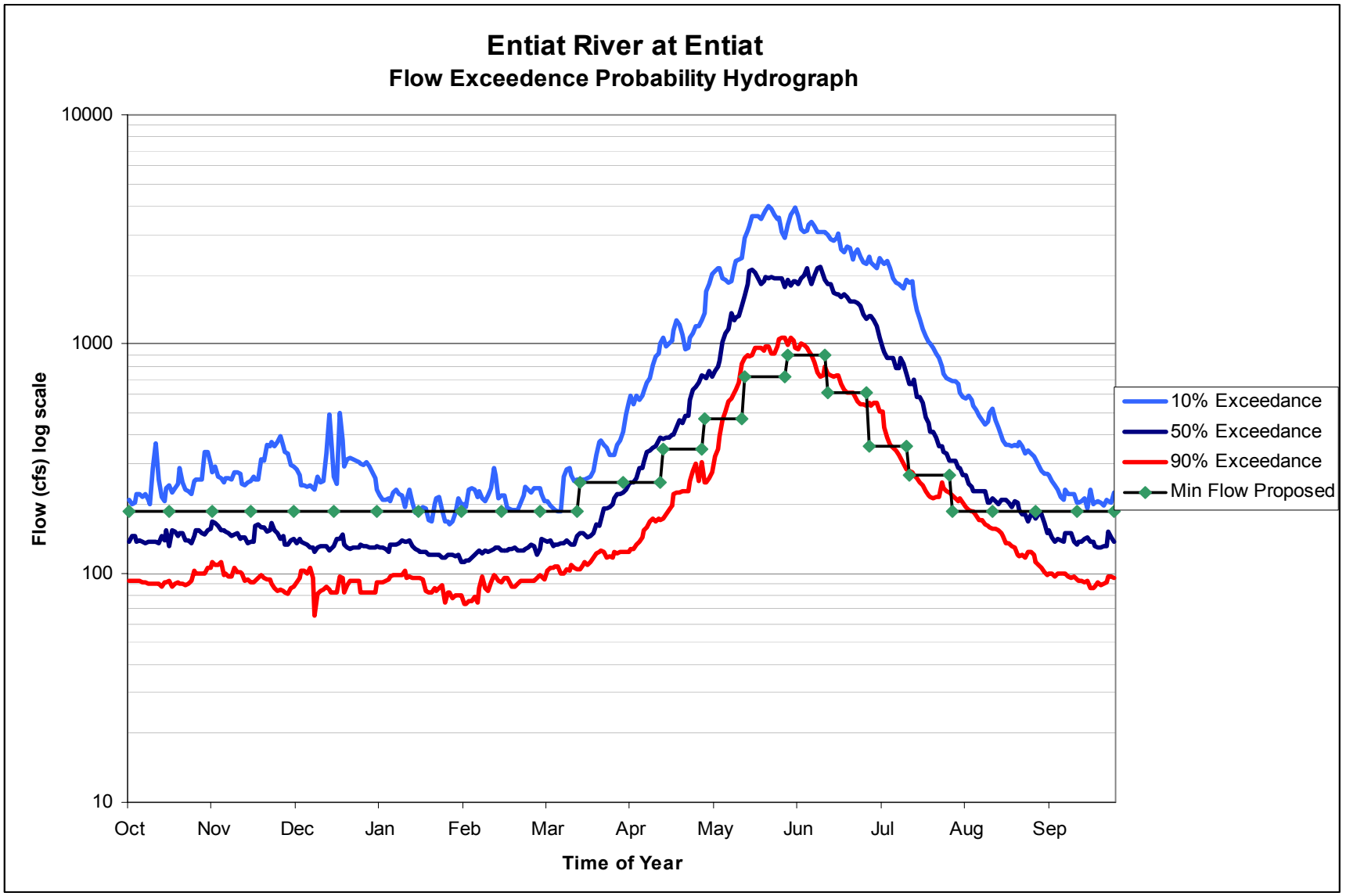


Figure 5-3. Proposed Administrative instream flows for lower Entiat River and 10%, 50% and 90% flow exceedence values recorded at historic USGS gage #12453000, Entiat at Entiat.

Table 5-6. Proposed Administrative Instream Flows for the upper Entiat River (RM 16.2-25.8), to be monitored at the Stormy gage (USGS gage #12452990, Entiat near Ardenvoir).

Monthly / semi - monthly period	Administrative instream flow (cfs)	Priority species and life history stages	Biological rationale	Percent flow exceedence
January 1-31	**175**	Chinook egg incubation, steelhead and Chinook juvenile rearing, steelhead adults immigrating.	Provides a stable juvenile rearing flow and incubation flow. Flows rarely go above 175 cfs and stability is more important in winter for juvenile rearing and egg incubation than changing flows to gain a small amount of habitat.	12
February 1-28	**175**	Same as above plus Chinook fry emerging.		15
March 1-15	**175**	Same as above.		19
March 16-31	**285**	Steelhead spawning starting, steelhead and Chinook juveniles rearing plus juvenile outmigration and Chinook fry emerging	Juveniles becoming more active, flow provides 78% of habitat for steelhead spawning, 94% of habitat for steelhead juveniles. Limited flow to 10% exceedence level.	10
April 1-15	**325**	Steelhead spawning and egg incubation, steelhead and Chinook juveniles rearing plus juvenile outmigration.	Flow provides 91% of habitat for steelhead spawning, and 98% of habitat for steelhead juveniles.	18
April 16-30	**375**	Steelhead spawning peak and egg incubation, steelhead and Chinook juveniles rearing plus juvenile outmigration.	Flow provides 100% of habitat for steelhead spawning, 100% for steelhead juveniles, and 71% for Chinook juveniles.	45
May 1-15	**375** Plus a 100 cfs limit on allocation on total new water rights.	Steelhead spawning and egg incubation, steelhead and Chinook juveniles rearing and outmigrating, plus adult Chinook immigration and channel maintenance.	We decided a 100 cfs limit on the quantity of new water rights would be a better way to protect the channel maintenance flow than using the 1800 cfs, 1.5 year interval bank full flow. Spawning is a higher priority in this reach than downstream so we kept the 325 to 375 1995 numbers for spawning and rearing even though the exceedence values were 90-99%.* Flow provides 91 to 100% of habitat for steelhead spawning, 98 to 100% for steelhead juveniles, and 71 to 80% for Chinook juveniles.	90
May 16-31	**375** Plus a 100 cfs limit on new water rights.	Same as above.		90
June 1-15	**325** Plus a 100 cfs limit on new water rights.	Same as above.		99.5
June 16-30	**325** Plus a 100 cfs limit on new water rights.	Same as above.		99.5

Monthly / semi - monthly period	Administrative instream flow (cfs)	Priority species and life history stages	Biological rationale	Percent flow exceedence
July 1-15	**275** Plus a 67 cfs limit on new rights.	Steelhead egg incubation, steelhead and Chinook juveniles rearing and outmigrating, plus adult Chinook holding in the river and channel maintenance.	We decided the priority would still be incubation and juvenile rearing but use a 67 cfs limit on new rights to protect the channel maintenance flow.*	80
July 16-31	**275**	Steelhead and Chinook juveniles rearing and outmigrating, plus adult chinook holding in the river	Flow provides 92% of habitat for steelhead juveniles and 91% for chinook juveniles.	80
August 1-31	**275**	Chinook spawning and egg incubation, steelhead and chinook juvenile rearing.	Flow provides – 91% of habitat for chinook spawning, 92% of habitat for steelhead juveniles, and 91% of habitat for chinook juveniles.	22
September 1-30	**175**	Chinook spawning and egg incubation, steelhead and chinook juvenile rearing.	Flow above 175 cfs is better for spawning but rarely occurs, so we lowered the flow to 10% exceedence. Incubation flow should about 2/3 of the August spawning flow.	10
October 1-31	**175**	Chinook egg incubation, steelhead and Chinook juvenile rearing, and steelhead adult immigration.	Provides a stable juvenile rearing flow and incubation flow. Flows rarely go above 175 cfs and stability is more important in winter for rearing and incubation than changing flows to gain a small amount of habitat.	5
November 1-30	**175**	Same as above.		15
December 1-31	**175**	Same as above.		16

*This could possibly lower the typical channel maintenance flow of 1800 cfs in May to 1700 cfs, but biologists felt the channel maintenance flow would still be sufficient to do its job. The 100 cfs allocation limit on new rights was proposed for May and June because it was about 10% of the median flow, and 67 cfs was proposed for the first half of July because it was about 10% of the median flow. The numbers were kept the same for allocation in both the upper and lower Entiat for ease of regulating. These numbers are for a cumulative total for upstream and downstream combined, not a separate 100 cfs from each reach.

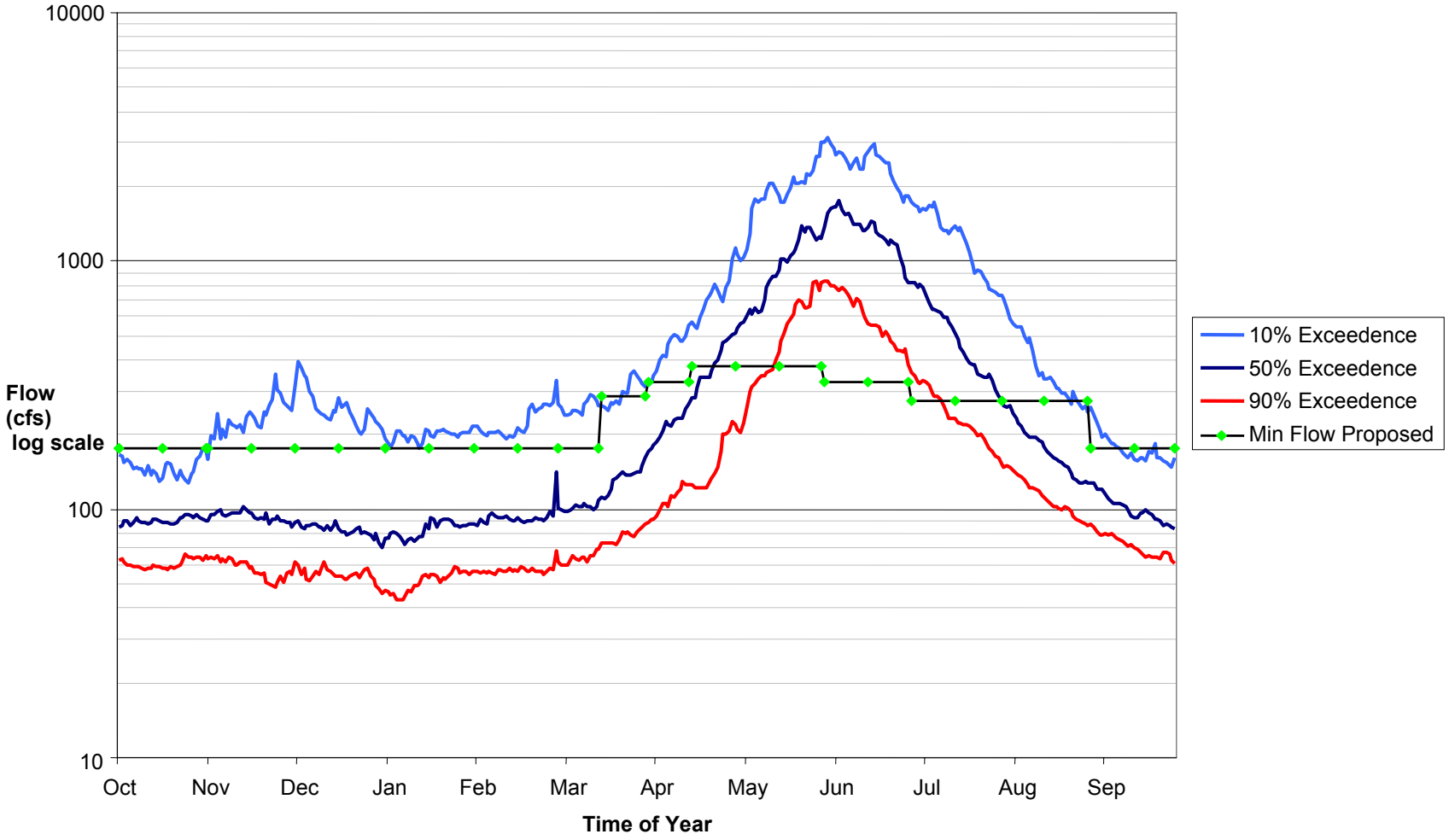


Figure 5-4. Proposed Administrative instream flows for the upper Entiat River and 10%, 50%, and 90% flow exceedence values recorded at the Stormy gage (USGS gage #12452990, Entiat near Ardenvoir).

Table 5-7. Proposed Administrative instream flows for the Mad River (RM 0-4), to be monitored at USGS gage #1245890, Mad at Ardenvoir.

Monthly / semi - monthly period	Administrative instream flow (cfs)	Priority species and life history stages	Biological rationale	Percent flow exceedence
January 1-31	32	Chinook egg incubation; steelhead, Chinook, and bull trout juvenile rearing, and steelhead adult immigration.	Provides a stable juvenile rearing flow and incubation flow. Flows above 32 cfs would provide more habitat but flows rarely go above 32 cfs and stability is more important in winter for juvenile rearing and egg incubation than changing flows to gain a small amount of habitat. Provides 74% of habitat for steelhead juveniles and 86% of habitat for Chinook juveniles.	16
February 1-28	32	Same as above plus Chinook fry emerging.		16
March 1-15	32	Same as above.		33
March 16-31	68	Steelhead spawning starting; steelhead, Chinook, and bull trout juveniles rearing plus juvenile outmigration and chinook fry emerging.	More flow needed for juveniles outmigration. Flow provides 93% of habitat for steelhead spawning, 90% for steelhead juveniles, and 99% for chinook juveniles.	33
April 1-15	100	Steelhead spawning and egg incubation; steelhead, Chinook, and bull trout juveniles rearing plus juvenile outmigration.	Flow provides 100% of habitat for steelhead spawning, 100% for steelhead juveniles, and 99% for Chinook juveniles.	46
April 16-30	100 Plus 25 cfs limit on new water rights.	Steelhead spawning peak and egg incubation, steelhead and Chinook juveniles rearing plus juvenile outmigration	Flow provides 100% of habitat for steelhead spawning, 100% for steelhead juveniles, and 99% for Chinook juveniles.	75
May 1-31	100 Plus a 25 cfs limit on new water rights.	Steelhead spawning and egg incubation, steelhead and Chinook juveniles rearing and outmigrating, plus adult Chinook immigration and channel maintenance.	A 25 cfs limit on the quantity of new water rights would protect the channel maintenance flow. 25 cfs is 10% of the median flow in May.	90
June 1-30	100 Plus a 25 cfs limit on new water rights.	Same as above.		99.5

Monthly / semi - monthly period	Administrative instream flow (cfs)	Priority species and life history stages	Biological rationale	Percent flow exceedence
July 1-31	68	Steelhead egg incubation; steelhead, Chinook, and bull trout juveniles rearing and outmigration.	Flow provides 90% of habitat for steelhead juveniles and 99% of habitat for Chinook juveniles. Provides 2/3 of 100 cfs spawning flow for incubation.	80
August 1-15	68	Steelhead, Chinook, and bull trout juvenile rearing.	Flow provides 90% of habitat for steelhead juvenile and 99% for Chinook juveniles.	22
August 16-31	51	Chinook spawning and egg incubation; steelhead, Chinook, and bull trout juvenile rearing.	Would prefer flows over 51 cfs but they rarely occur so we used the 10% exceedence value as an upper limit.	10
September 1-30	32	Same as above.	Would prefer flows over 32 cfs but they rarely occur so we used the 10% exceedence value as an upper limit. Provides a stable juvenile rearing flow and incubation flow. Flows rarely go above 32 cfs and stability is more important in winter for juvenile rearing and egg incubation than changing flows to gain a small amount of habitat.	10
October 1-31	32	Chinook egg incubation; steelhead, Chinook, and bull trout juvenile rearing, and steelhead adult immigration.		5
November 1-30	32	Same as above.		15
December 1-31	32	Same as above.		16

*This could possibly lower the typical channel maintenance flow of 500 cfs in May to 475 cfs, but I feel the channel maintenance flow would still be sufficient to do its job. The 25 cfs allocation limit on new rights was proposed for mid-April through June because it was about 10% of the median flow for May. This allocation number is for a cumulative total for the whole river combined; not a separate 25 or 100 cfs from each reach or tributary of the river.

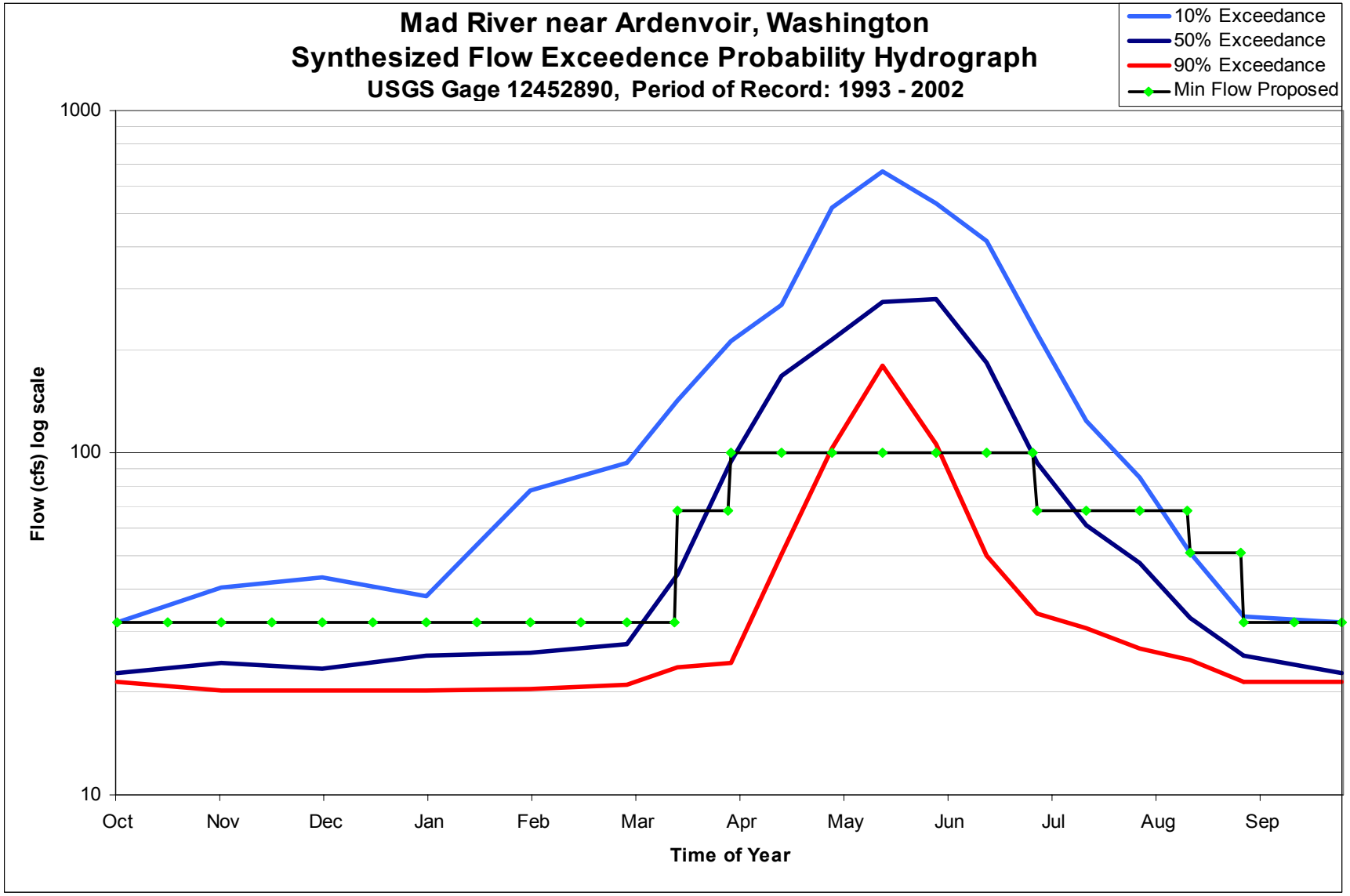


Figure 5-5. Proposed Administrative instream flows for the Mad River and 10%, 50%, and 90% exceedence values recorded at the USGS gage #12452890, Mad at Ardenvoir.