DISCUSSION ON BIOLOGICALLY BASED FLOWS FOR THE PURPOSE OF DETERMINATION OF AVERAGE WATER YEAR INSTREAM FLOW DEMAND FOR THE YAKIMA RIVER BASIN STUDY

Introduction

The information presented in this paper was based on work conducted under the Yakima River Basin Water Storage Feasibility Study (Storage Study). In that study an important criterion was to establish monthly target flows that resembled the unregulated (normative) flow regime.

This paper presents monthly median flow targets for an average water year (TWSA is ≥2.5 to ≤3.25 million acre feet) for the Easton, Ellensburg, Wapato and lower Naches floodplains, and the Cle Elum River below the dam, which are further organized by season- spring (March-June), summer (July-October) and winter (November-February). Within each reach and season category information is presented on salmonid life history, biological flow objectives, current flow deficiency, flow targets and action items. The salmonid life history information will provide the reader with a brief understanding of the species and life stage(s) present in that reach for a specific season. The biological flow objectives highlight the importance of the desired flow regime for salmonids and/or for other ecological benefits. Current flow deficiency highlights key elements in the seasonal flow regime that are currently considered to be detrimental to fishes and/or river ecology.

Flow data presented in this paper were from the Riverware model generated for unregulated and No Action alternatives.

Salmonid flow-to-habitat information generated by Bovee et al. (2008) for several species and life stages for the Easton, Ellensburg, Wapato and lower Naches reaches are provided in Appendix A.

Monthly flow demand (+/-) was estimated by subtracting the No Action monthly flow value from the monthly flow target, multiplied by the factor of 59.5 to convert the differential in cubic feet per second to water volume expressed in acre feet.

Purpose

For the Basin Study reach specific monthly median flow targets can be considered to, 1) measure the performance of each alternative and 2) quantify in general terms instream flow demand and 3) provide guidance to craft alternative(s) that best address instream flow deficiencies.

Summary Tables

Tables 1 and 2 provide the reader with a quick summary of seasonal instream flow demand and priority by stream reach.

Table 1 summarizes the amount (acre feet) of additional flow volume (±) that would be needed to meet the monthly median flows he flow targets identified in the Storage Study. This same information is presented in more detail in the main body of the document that follows. Table 2 summarizes for selected stream reaches the key instream flow priorities for dry, average and wet water year types.

Table 1. Summary of seasonal water demand (acre-feet) needed to meet flow targets.

Reach	Spring	Summer	Winter
	(Mar-Jun)	(Jul-Oct)	(Nov-Feb)
Easton	118,700	27,400	38,400
Cle Elum River	51,764	-267,750	48,800
Ellensburg	51,157	-303,777	0
Lower Naches	0	-73,184	0
Wapato	271,581	149,665	0

Easton Reach

Spring Season (March-June)

Salmonid Life History

Spring Chinook is the most abundant anadromous salmonid species residing in the Easton reach during the spring season. Spring Chinook fry emergence occurs late March through late May. Juvenile spring Chinook that overwinter in the Easton out migrate as smolts from mid March through mid May.

There is currently a low abundance of coho residing within the Easton reach. They were extirpated in the early 1980s, however the Yakama Nation is actively reestablishing coho throughout the upper Yakima subbasin through the Yakima/Klickitat Fisheries Project. Coho fry emergence and smolt outmigration timing are similar to that for spring Chinook.

There appears to be nominal steelhead spawning and rearing in the Easton reach (Karp et al. 2009). Steelhead spawn in the upper Yakima May through June, and fry emergence occurs May through July.

Biological Flow Objectives

- To provide a flow regime of sufficient magnitude, duration, and rise/fall events that will be benefical for smolt outmigration.
- To provide a flow regime that provides suitable salmonid rearing habitat for emergent fry and parr along channel margins, in side channels and in backwater channels.

Current Flow Deficiency

- There is a general decrease in spring flows from March through May, with an increase in flow in June.
- The flow regime lacks variability in terms of the number of rise/fall events that is an important physical cue to prompt smolt outmigration.

Target Flows

The unregulated monthly median flows range from 840 cfs in March to 915 cfs in June, with a peak flow of 1630 cfs in May (Figure 1).

Monthly spring flow targets were based on the unregulated median March-June flow of 1165 cfs. This flow value was selected as the basis for determining the monthly flow targets because it represents the unregulated spring flow condition. The unregulated median March-June flow value was assigned to represent the peak seasonal flow which occurs in May under unregulated

flow conditions. Monthly flow targets for March, April and June were based on the ratio of the unregulated median flow for each respective month relative to May (i.e. March, 52%; April, 83%; and June, 56% of the median flow in May). Monthly flow targets based on this approach were: March, 600 cfs; April, 970 cfs; May, 1165 cfs; and June, 665 cfs. Flows in the range of 1165 cfs provide suitable side channel habitat for emergent salmonid fry and parr, and provide higher flows for smolt outmigration (see Appendix A).

Flow Demand

The amount of additional spring flow volume needed to meet the monthly flow targets ranged from approximately 10700 to 56200 acre-feet (Figure 2).

Action Items

- Reevaluate the appropriateness of determining monthly flow targets on the basis of the median March-June flow of 1165.

Summer Season (July-October)

Salmonid Life History

During the summer season juvenile spring Chinook is the most abundant anadromous salmonid species rearing in the Easton reach. Spring Chinook parr rear throughout the summer, though a unknown portion of the population moves downstream to rear in lower reaches of the upper Yakima subbasin, which is typical of all spring Chinook populations in the Yakima basin.

There is low abundance of juvenile coho and steelhead in the Easton reach due to the limited amount of coho and steelhead spawning presently occurring in this reach.

Biological Flow Objectives

- To provide a flow regime that continues to decline in flow between the late snowmelt period in July to base low flow in October.

- To provide a flow regime with a natural range in flow variability typical for the summer season that provides stable rearing habitat for juvenile salmonids in the main channel and side channels.

Current Flow Deficiency

- Discuss with subgroup.

Target Flows

The unregulated monthly median flows decline from a high of 350 cfs in July to a low base flow of 150 cfs in September, and then increased to 250 cfs in October with the onset of fall precipitation (Figure 1).

Summer flow targets were set to mimic the unregulated flow regime, which is characterized by early summer snow melt in July producing relatively high flows that rapidly decrease to base flows in September. The monthly flow targets were set higher than the unregulated flow for all months. The July flow target was set at 450 cfs which is 43% lower than the June target flow, and provides more than the minimal amount of spring Chinook parr rearing habitat (Figure 1). The flow target was set at 375 cfs for August, September and October, which provides a small increase in the amount of suitable rearing habitat for salmonid parr than at 450 cfs.

Flow Demand

To meet the July, September and October flow targets an additional flow volume of 8000 to 13700 acre feet is needed; and in August a flow volume reduction of 3600 acre-feet is needed (Figure 2).

Action Items

- Reassess the adequacy of the existing summer flow regime when compared to the unregulated summer flow regime.

Winter (November-February)

Salmonid Life History

Overwintering juvenile spring Chinook are likely the most abundant anadromous salmonid species in the Easton reach in the winter. However, a large (but unknown) portion of the population moves downstream into the middle Yakima River to overwinter beginning in late September and continues through December. The fall/winter downstream movement is typical for all spring Chinook populations in the Yakima basin.

Because coho and steelhead spawning is minimal in the Easton reach, coupled with the potential for fall/winter downstream movement, it is likely there is low abundance of overwintering juvenile coho and steelhead in the Easton reach.

Target Flows

The unregulated monthly median flows during the winter season are between 540 cfs to 665 cfs (Figure 1) and the seasonal median flow was 580 cfs.

The November flow target was set at 425 cfs and was increased to 450 cfs for December, January and February. Winter flow targets were set slightly higher than summer flow targets to reflect the unregulated winter flow regime.

Flow Demand

The amount of additional winter flow volume needed to meet the monthly flow targets ranged from approximately 8000 to 11300 acre-feet (Figure 2).

Biological Flow Objectives

- To provide adequate flows to protect spring Chinook and coho redds during the incubation period.

- To provide increased winter flows for the benefit of overwintering juvenile salmonids. Current winter flows are set to protect spring Chinook redds during the winter incubation period.

Current Flow Deficiency

- The adequacy of winter flows for overwintering salmonids has been a point of discussion in the past by the local fisheries biologist.

Action Items

- Reconsider the monthly flow targets in view of the juvenile overwinter spring Chinook flow-to-habitat relationship.

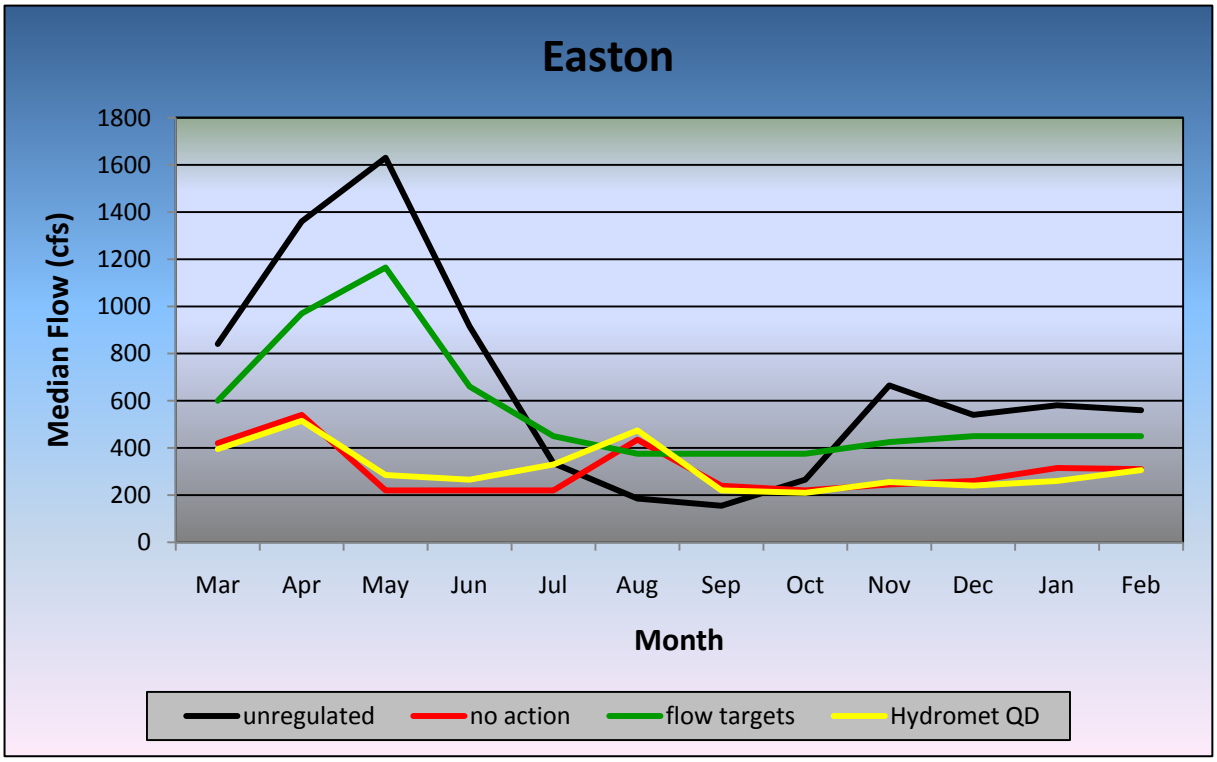
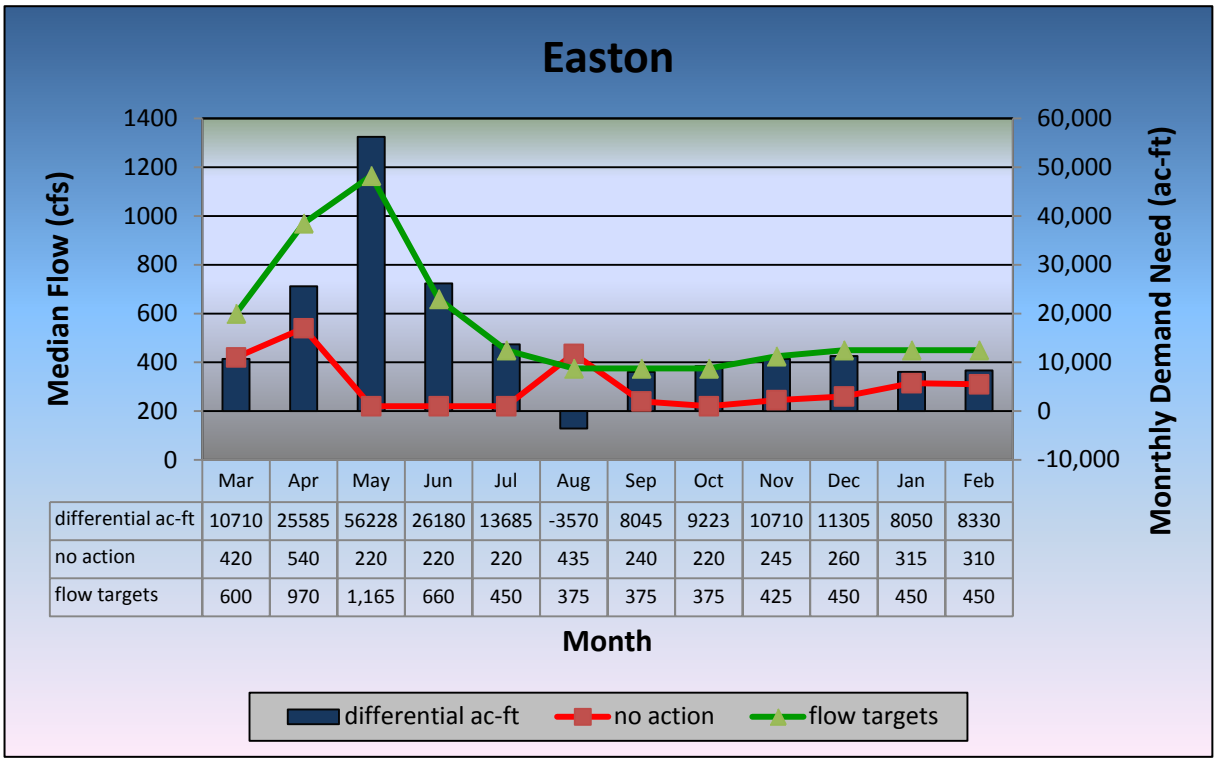


Figure 1. Easton hydrograph based on water years 1981-2005.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
differential ac-ft	10710	25585	56228	26180	13685	-3570	8045	9223	10710	11305	8050	8330
no action	420	540	220	220	220	435	240	220	245	260	315	310
flow targets	600	970	1,165	660	450	375	375	375	425	450	450	450

Figure 2. Easton monthly flow volume differential (ac-ft), based on water years 1981-2005.

Cle Elum River

Spring Season (March-June)

Salmonid Life History

Spring Chinook is the most abundant anadromous salmonid species residing in the Cle Elum River downstream of the dam. Similar to the Easton reach spring Chinook fry emergence occurs late March through late May. Juvenile spring Chinook that overwinter in the Cle Elum River out migrate as smolts from mid March through April.

There may be some steelhead that spawn and rear in the lowermost 2-3 miles of the river based on a recent radio telemetry study (Karp et al. 2009).

It is unlikely that coho inhabit the Cle Elum River in any appreciable numbers. Over the past 10-15 years hatchery pre-smolts have been acclimated and released from various sites in the upper Yakima subbasin; however these sites were not in close proximity to the Cle Elum River. Also the spawning and rearing habitat in the Cle Elum River is generally not conducive for coho.

Biological Flow Objectives

- To provide a flow regime of sufficient magnitude, duration and rise/fall events that will be benefical for smolt outmigration.
- To provide a flow regime that provides suitable rearing habitat for emergent fry and parr along channel margins and in the side channels.

Current Flow Deficiency

- Unseasonal low, stable flows with some short duration operational spills are not conducive for smolt outmigrants.

Target Flows

The unregulated monthly median flows ranged from 635 cfs in March to 1610 cfs in June, with a peak flow of 1855 cfs in May (Figure 3).

Monthly spring flow targets were based on the unregulated median March-June flow of 1260 cfs. This flow value was selected as the basis for determining the monthly flow targets because it represents the unregulated spring flow condition. The unregulated median March-June flow value was assigned to represent the peak seasonal flow which occurs in May under unregulated flow conditions. Monthly flow targets for March, April and June were based on the ratio of the unregulated median flow for each respective month relative to the month of May (i.e. March, 34%; April, 64%; and June, 87% of the median flow in May). Based on this approach the

monthly flow targets were: March, 430 cfs; April, 805 cfs; May, 1265 cfs; and June, 1095 cfs. Flows in this range will provide necessary flows for smolt outmigrants, as well as for salmonid emergent fry and parr that rear along the channel margins and in the side channels.

Flow Demand

To meet March through May flow targets an additional flow volume of 12500 to 52700 acre feet is needed, and in June a flow volume reduction of 800 acre-feet is needed (Figure 4).

Action Items

- None.

Summer Season (July-October)

Salmonid Life History

During the summer juvenile spring Chinook is the most abundant anadromous salmonid species rearing in the Cle Elum River. Spring Chinook parr reside in the Cle Elum River throughout the summer period, and an unknown portion of the population moves downstream to rear in upper Yakima River subbasin, similar to what is observed in the Easton reach.

Because there is minimal to no steelhead or coho spawning occurring in the Cle Elum River downstream of the dam, it is likely that little summer rearing of juvenile steelhead and coho is occurring in the river.

Target Flows

The unregulated monthly median flows decrease from a high of 730 cfs in July to a base flow of 160 cfs in September, then increase to 220 cfs in October with the onset of fall precipitation (Figure 2).

The July flow target was based on the ratio of the unregulated flow in July relative to the month of May which was 41% and resulted in a target flow of 495 cfs. The flow target for August, September and October was set at 400 cfs which is 100 cfs higher than the summer seasonal median flow of 300 cfs. Since there is no Cle Elum River habitat-to-flow information, determination of adequate flow targets was based on the expert opinion of local fisheries biologists.

Flow Demand

To meet the July and August flow targets a flow reduction of 2200 to 2600 cfs is needed, and in October and November an additional flow volume of 175-180 acre feet is needed (Figure 4).

Biological Flow Objectives

- To provide lower flows that are more suitable for juvenile rearing salmonids in both the main channel and in the side channels.

Current Flow Deficiency

- Excessive high summer flows washout summer rearing habitat for juvenile salmonids (e.g. loss of pool habitat and slow water edge habitat along stream margins.

Action Items

- Re-evaluate the adequacy of the current monthly target flows. For this assessment consider the biological needs for spring Chinook juvenile rearing, adult holding, and spawning life stages.

Winter (November-December)

Salmonid Life History

Juvenile spring Chinook is likely the most abundant anadromous salmonid species in the Cle Elum River during the winter. However, the population abundance is probably much less than in the Easton reach. Similar to what is observed in the Easton reach juvenile spring Chinook exhibit a fall/winter downstream movement into the upper and middle Yakima River subbasin where they overwinter.

Because coho and steelhead spawning is minimal in the Cle Elum reach, coupled with the potential for fall/winter downstream movement, it is likely there is few overwintering juvenile coho and steelhead in the Cle Elum River.

Target Flows

The unregulated monthly median flows during the winter season are November, 525 cfs; December, 415 cfs; January, 405 cfs; and February, 420 cfs.

The winter seasonal target flow is set at 425 cfs, which with the exception of November is close to the unregulated flows. Determinations of suitable flows are based on expert opinion with the focus on provision suitable flows for juvenile salmonid overwinter habitat.

Flow Demand

The amount of additional winter flow volume needed to meet the monthly flow targets is 12200 acre-feet per month (Figure 4).

Biological Flow Objectives

- To provide winter flows suitable for juvenile salmonids overwintering habitat in the side channels and backwater areas.

Current Flow Deficiency

- The winter flow regime has a constant flow that lacks flow variability, and may under utilizes the amount of suitable overwintering habitat for juvenile salmonids.

Action Items

- Reevaluate appropriate winter flows in the Cle Elum River to provide suitable juvenile salmonid overwintering habitat.

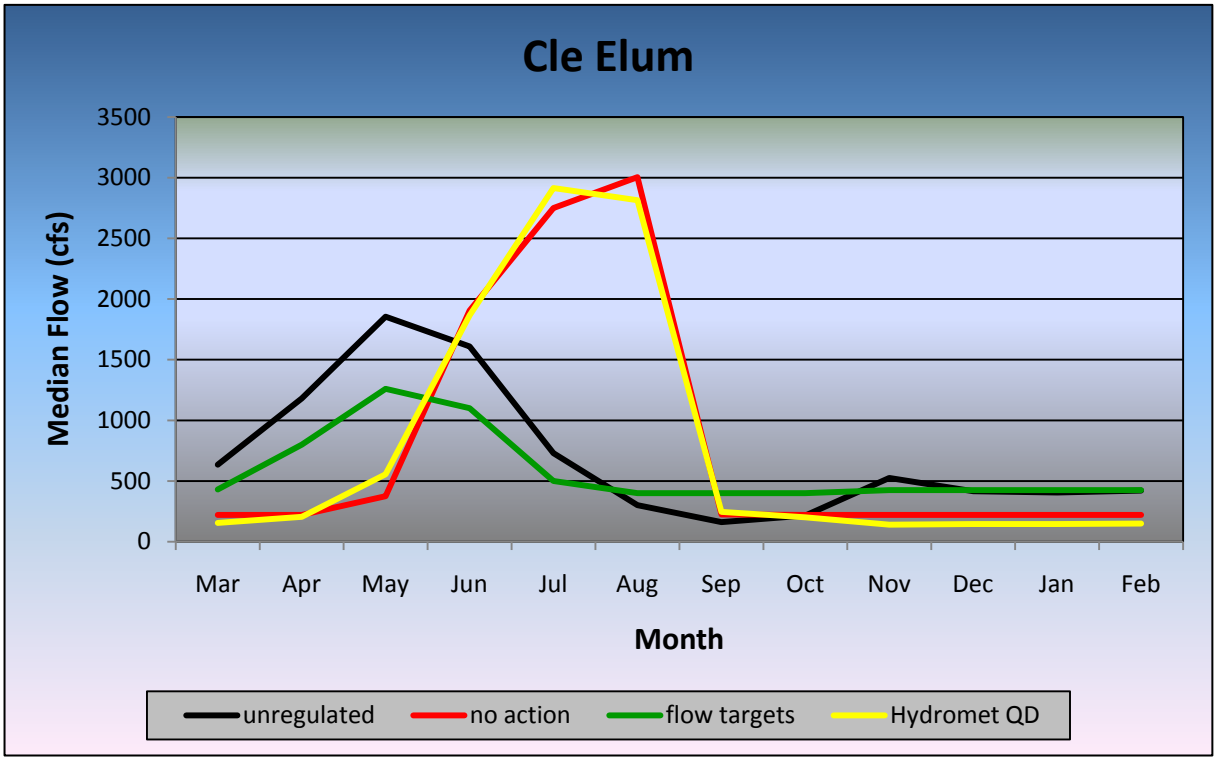
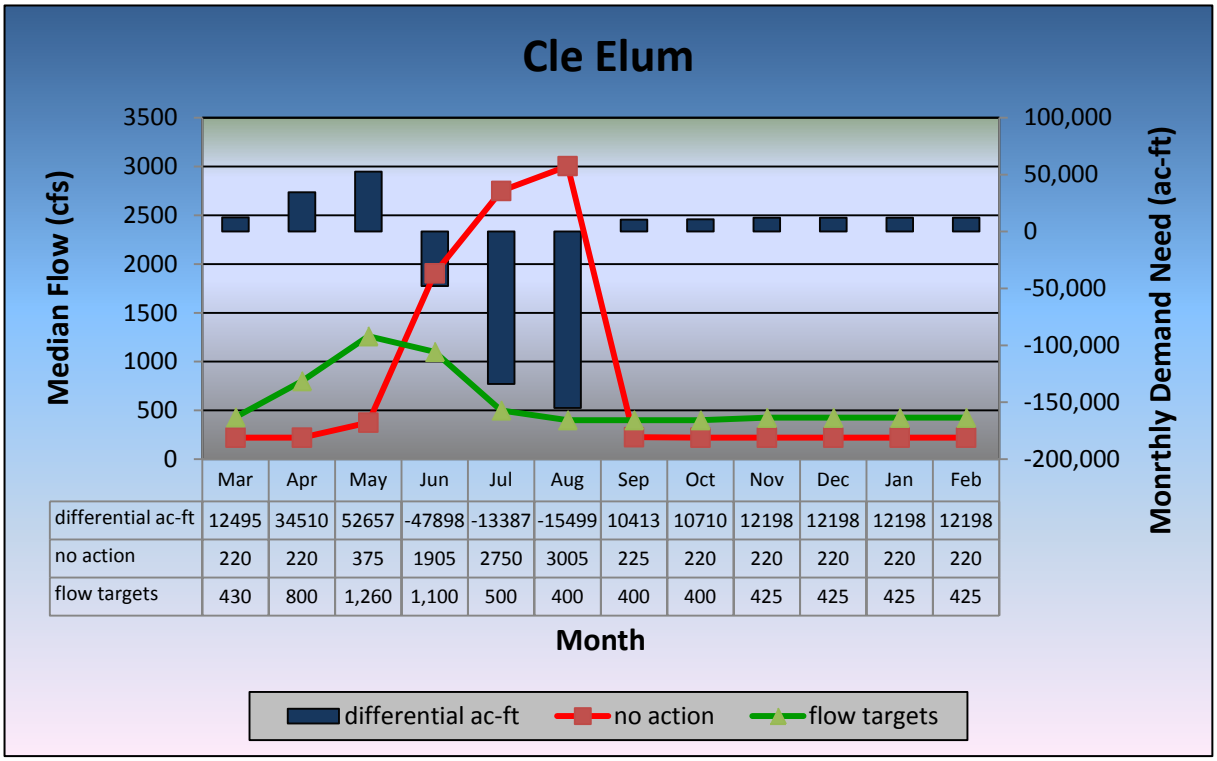


Figure 3. Cle Elum hydrograph based on water years 1981-2005.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
differential ac-ft	12495	34510	52657	-47898	-13387	-15499	10413	10710	12198	12198	12198	12198
no action	220	220	375	1905	2750	3005	225	220	220	220	220	220
flow targets	430	800	1,260	1,100	500	400	400	400	425	425	425	425

Figure 4. Cle Elum monthly flow volume differential (ac-ft), based on water years 1981-2005.

Ellensburg Reach

Spring Season (March-June)

Salmonid Life History

The Ellensburg reach functions as both a migration corridor for salmonid smolts and as a rearing area for juvenile resident rainbow trout, steelhead, and spring Chinook and coho fry. During the spring this reach has an abundance of hatchery and wild spring Chinook and coho smolts that migrate through this reach on their way to the Columbia River. Peak smolt outmigration occurs April through mid-May. Spring Chinook and coho fry emergence occurs late March through late May.

Resident rainbow trout and steelhead fry emergence begins the latter half of June and continues into the summer season. There is a strong resident rainbow trout population that resides in this reach on a year round basis. During the spring some portion of the rainbow trout spawning population migrates into the local tributaries to spawn.

There is limited steelhead spawning that occurs throughout this reach in low numbers in May-June.

Target Flows

The unregulated monthly median flows increase from 2810 cfs in March to a peak flow of 5260 cfs in May, then declines to 3675 cfs in June (Figure 5).

The March and April flow targets used the No Action median monthly flow values of 1980 cfs and 2425 cfs, respectively. A peak flow of 3700 cfs was set as the May target flow, which is 53% and 43% higher, respectively, than for April and June flow targets. For comparison the percent change in the unregulated April and June flows relative to May was 20% and 43%, respectively.

For juvenile salmonid fry there is a 6% to 10% increase in suitable habitat in the Ellensburg reach for flows in the range of 2300 cfs to 6500 cfs. For the same flow range suitable habitat for spring Chinook parr and resident rainbow yearlings varied less than 10 percent, and coho parr habitat increased approximately 30% from 2300 cfs to 6500 cfs (see Appendix A).

A note- There are several tributaries with unregulated flow that contribute towards providing this mainstem reach with good flow variability in the spring.

Flow Demand

To meet the May flow target an additional flow volume of 79100 acre feet is needed, and a reduction in flow volume 28000 acre-feet in June (Figure 6).

Biological Flow Objectives

- To reestablish the unregulated spring runoff flow regime, where flows increase from March through April and peak in May, then decline in June. A more unregulated spring flow regime is especially important for smolt outmigration.

Current Flow Deficiency

- Peak spring flow occurs in June instead of May under the existing spring flow regime.

Action Items

- Discuss the May flow target of 3700 cfs.

Summer Season (July-October)

Salmonid Life History

Juvenile spring Chinook, coho, steelhead and resident rainbow trout reside in the Ellensburg reach during the summer. The majority of Spring Chinook spawn upstream from Swauk Creek. However, shortly after emergence a portion of the fry/parr population moves downstream continuously throughout the summer and rears to some extent in the Ellensburg Reach (and further downstream into the Yakima Canyon).

Naturally produced juvenile coho now inhabit the Ellensburg reach as a result of the Yakama Nation's reintroduction efforts in the last 10 years. Coho spawning is concentrated in the Ellensburg area in association with the Holmes smolt acclimation site (RM 157.8). Juvenile coho rear throughout the summer in this reach.

Both steelhead and resident rainbow trout of several age classes reside in this reach during the summer. Juvenile steelhead that reside in this reach during the summer includes- fry, parr and age-1, age-2 and age-3 juveniles; and for resident rainbow trout it includes- fry, parr, and multiple age classes over age-1.

Target Flows

The unregulated monthly median flows decrease from a high of 1455 cfs in July to a base flow of 775 cfs in October (Figure 5).

Monthly flow targets for the summer season were based on the juvenile salmonid flow-to-habitat relationships, with the object to mimic the unregulated flow regime with higher flows in July and

base flows in October (see Appendix A). The greatest decrease (63%) in unregulated flows occurs from July to August. The amount of suitable juvenile salmonid rearing habitat begins to increase at flows less than 2300 cfs, which was the basis for setting the July target flow at 2000 cfs. For August, September and October the target flow was set at 1000 cfs, which provides a further increase in suitable habitat (more concentrated in the main channel) that follows the unregulated progression of decreasing flows throughout the summer.

Flow Demand

To meet the July through October flow targets a reduction in flow volume from 3000 to 176100 acre-feet is needed (Figure 6).

Biological Flow Objectives

- To provide a summer flow regime that more closely resembles the unregulated flow condition, which results in creation of more suitable pool, riffle and side channel rearing habitat for juvenile salmonids. Greatly reduce or eliminate the flip flop operation which is an unnatural disturbance to residing fishes, aquatic insects, and the riparian vegetation (e.g. cottonwoods).

Current Flow Deficiency

- The current flow regime is dominated by fast water glide habitat in the main channel.
- The late summer flip flop operation.

Action Items

- Re-assess the August and September 1,000 cfs base flow.

Winter (November-February)

Salmonid Life History

Coho spawning occurs November through early December and as stated above is concentrated in the Ellensburg area in the general vicinity of the Holmes smolt acclimation site. A few spring Chinook spawn in this reach in mid-September to mid-October.

Both juvenile spring Chinook and coho overwinter in this reach to seek out mainstem and side channel pool or backwater habitat that is protected from high flow events. There is a strong downstream movement of juvenile spring Chinook in the fall presumably seeking out more suitable overwinter habitat, as is observed elsewhere in the Yakima basin. Juvenile steelhead and resident rainbow trout overwinter in protected, deep pools and in large intersticial spaces in the substrate.

Target Flows

The unregulated monthly median flows range from 1535 cfs in October, then decrease to 1405 cfs in November, and then begin to increase in January (1700 cfs) through February (1950 cfs) (Figure 3).

The No Action monthly median flows were used to define the winter target flows. These monthly flow values are November, 980 cfs; December, 1015 cfs; January, 1255 cfs; and February, 1460 cfs. Even though the No Action winter flows are reduced due to upriver reservoir storage at Keechelus, Kachess and Cle Elum dams, there remains much uncontrolled flow from major tributaries such as Teanaway, Swauk, Taneum and Manastash Creeks which provide adequate winter flows in terms of flow magnitude, variability and timing.

Flow Demand

No additional flow is necessary since the No Action monthly median flows represent the monthly target flows (Figure 6).

Current Flow Deficiency

- None.

Action Items

- None.

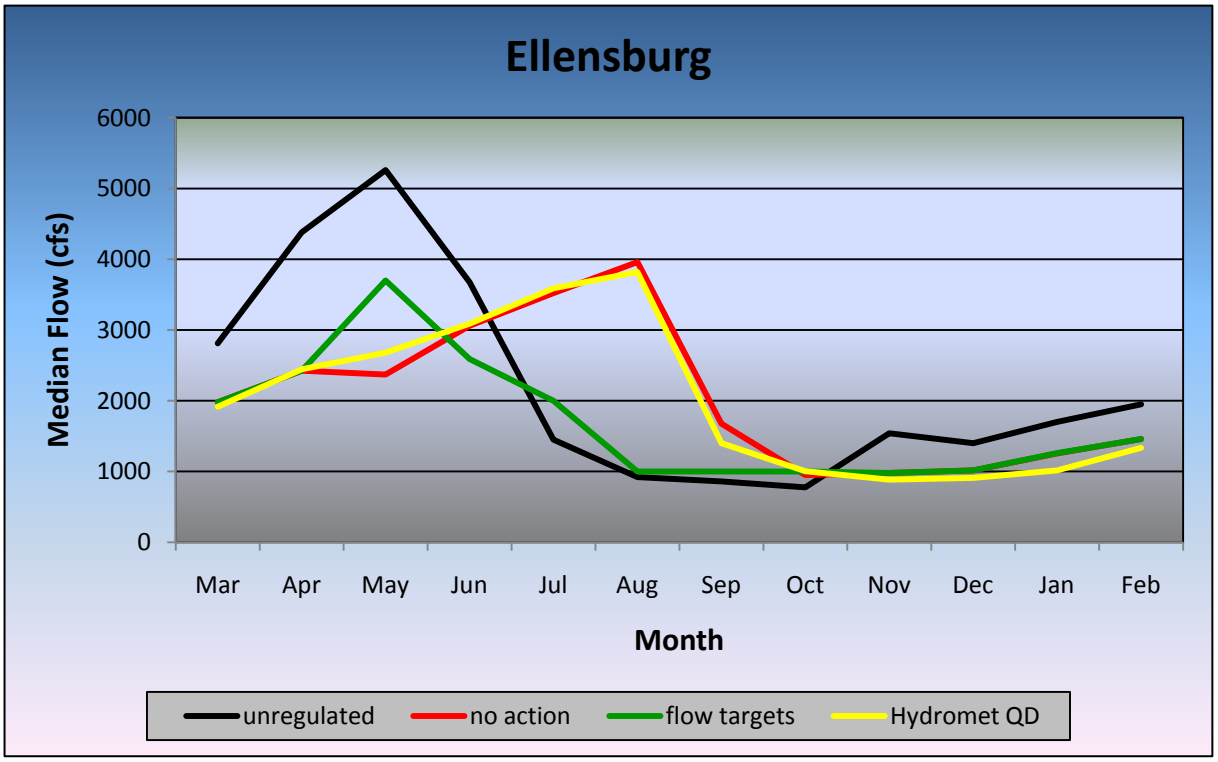
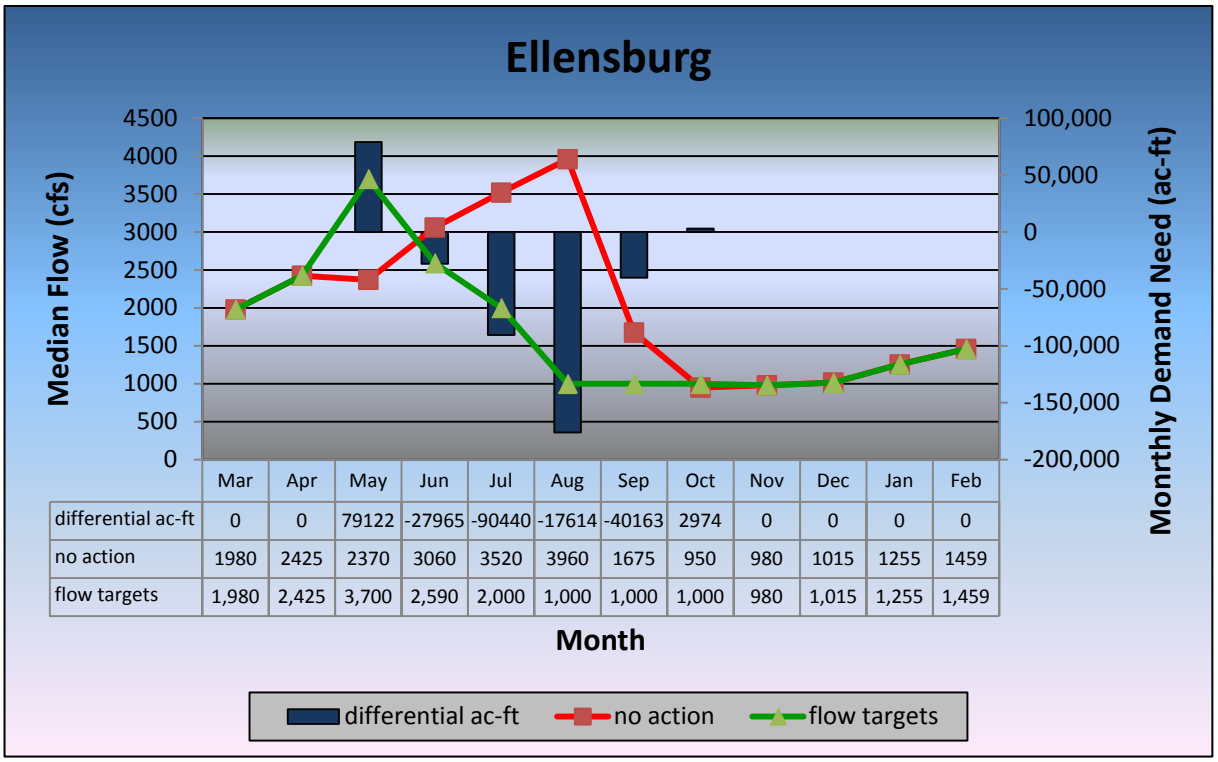


Figure 5. Ellensburg hydrograph, based on water years 1981-2005.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
differential ac-ft	0	0	79122	-27965	-90440	-17614	-40163	2974	0	0	0	0
no action	1980	2425	2370	3060	3520	3960	1675	950	980	1015	1255	1459
flow targets	1,980	2,425	3,700	2,590	2,000	1,000	1,000	1,000	980	1,015	1,255	1,459

Figure 6. Ellensburg monthly flow volume differential (ac-ft), based on water years 1981-2005.

Wapato Reach

Spring Season (March-June)

Salmonid Life History

The Wapato reach functions as both a migration corridor for salmonid smolts and as a rearing area for fall Chinook fry/parr/smolts and coho fry. All salmonid smolts migrate through this reach on their way to the Columbia River, which occurs from mid March through June.

Fall Chinook is the primary salmonid species that resides in the Wapato reach. Fry emergence occurs between late March and mid-May. Juvenile fall Chinook spend 1-3 months rearing in the reach before initiating smolt outmigration. A large portion of the juvenile fall Chinook population slowly migrates downstream as they rear within the reach. By mid-June nearly all juvenile fall Chinook have out migrated from the reach into the lower Yakima River or into the Columbia River.

There is some natural production of coho in the upper portion of the Wapato reach from past hatchery smolt acclimation at Roza Wasteway #3 near Wapato in the 1990s by the Yakama Nation. Juvenile coho reside in the off-channel habitat and peak smolt outmigration likely occurs in April.

Biological Flow Objectives

- To reestablish the unregulated spring flow regime, where flows increase from March through April, peak in May, and then decline in June. A more unregulated spring flow regime that has sufficient flow magnitude, timing, and rise/fall events is important for smolt outmigration.

- To provide for a more attenuated decrease in flows past Parker Dam in preparation for going on storage control in late June.

- Modification of the spring flow regime past Parker Dam described for the previous bullet is also important cottonwood regeneration in the Wapato riparian zone.

Current Flow Deficiency

- Depending on the water year type (i.e. wet, average, dry) and the spring runoff pattern, flows can be inadequate to provide flows conducive for smolt outmigrants.

- Going on storage control results in an unnatural decline in flows past Parker Dam that may impact coho fry and parr and other non-salmonid fishes, which may become stranded in side channels and flows decrease. Little information exists to evaluate the stated operational

effect to fishes in the Wapato reach. This river operation also has an impact on the cottonwood regeneration life cycle in this reach.

Target Flows

The unregulated monthly median flows increase from 4580 cfs in March to a peak of 9095 cfs in May, and then decline to 6900 cfs in June (Figure 7).

Determination of appropriate spring seasonal flows focused primarily on providing flows of sufficient magnitude and timing to benefit salmonid smolt outmigration. Previous PIT tag analysis on smolt survival between Prosser and Mc Nary Dams suggest a flow range of 3000-6000 cfs provided the best smolt survival rate from Chandler-to-McNary Dam[1]. Secondarily, habitat suitability fall Chinook and coho fry/parr was considered (see Appendix A). A peak spring flow target of 3500 cfs was set for May. The No Action median flow of 3110 cfs was used to define the target flow in March, which for the most part is dictated by the unregulated flow below the reservoirs. The median flow target for April and June were 2795 cfs and 2655 cfs, respectfully and were based on the ratio of the unregulated flow for April (80%) and June (76%) relative to May.

Flow Demand

The amount of additional April through June flow volume needed to meet the monthly flow targets ranged from approximately 19000 to 138900 acre-feet (Figure 8). The No Action March flow was used to set the March flow target.

Action Items

- Revisit the peak May flow target of 3500 cfs.

Summer Season (July-October)

Salmonid Life History

Juvenile coho is most likely the main salmonid species that resides in the Wapato reach during the summer, as fall Chinook have out migrated as smolts by this time. In the near future, however juvenile summer Chinook are anticipated as the Yakama Nation develops their hatchery program for this species. It is possible that some of juvenile spring Chinook and steelhead may reside in this reach during the summer that have moved downstream from upstream natal areas in the Naches and upper Yakima subbasins.

[1] Note- This is the best available data to evaluate the relationship between flow at Parker Dam and smolt-to-smolt survival through the middle and lower reaches of the Yakima River.

Target Flows

The unregulated monthly median flows decrease from a high of 2730 cfs in July to a base flow of 1580 cfs in October (Figure 7).

The initial target flow was set at 1500 cfs, but subsequently was reduced to 1300 cfs when water imbalance issues in the Riverware model runs for severe water short years. A reduction of 200 cfs in the target flow was a compromise in order to maintain a water balance in the water supply during these water short years. This reduction in target flow decreased the amount of suitable rearing habitat -0.7% (0.7 acres) for fall Chinook parr and -2.5 (1.7 acres) for coho par (See Appendix A).

Flow Demand

The amount of additional spring flow volume needed to meet the monthly summer flow targets ranged from approximately 33000 to 39000 acre-feet (Figure 8).

Biological Flow Objectives

- To provide adequate flows for the upstream migration of adult sockeye and summer Chinook. Reintroduction programs are currently being developed by the Yakama Nation and WDFW.

Current Flow Deficiency

- Expert opinion amongst the local fisheries biologists is that the summer base flows in the Wapato reach (especially the upper half) should be higher to take advantage of the side channel habitat. There has also been an ongoing discussion as to what effect an increase in flow will have on water temperature- is it a benefit or is it detrimental?

Action Items

- Revisit what is a suitable summer flow target flow below Parker Dam. Current summer base flow targets are 1300 cfs for wet and average water years and 1100 cfs for dry water years.
- Discuss the effect of river flow volume on river temperature.

Winter (November-February)

Salmonid Life History

The Wapato reach is an important overwintering area for juvenile spring Chinook, coho and steelhead. Beginning in late September and into the winter season juvenile anadromous salmonids move from upriver reaches to overwinter in this reach, which is best documented for spring Chinook (Fast et al. 1991).

Fall Chinook and coho adults spawn throughout this reach in November and December.

Target Flows

The unregulated monthly median flows during the winter season are November, 2465 cfs; December, 2445 cfs; January, 2855 cfs; and February, 3235 cfs (Figure 7).

The No Action monthly median flows were used to define the winter season monthly target flows. Monthly target flow values are November, 1760 cfs; December, 1855 cfs; January, 2165 cfs; and February, 2460 cfs. Winter flows in the Wapato reach are normative in nature due to the contribution of the Naches River, which is largely unregulated during the winter season.

Flow Demand

No additional flow is necessary since the No Action monthly median flows represent the monthly target flows (Figure 8).

Biological Flow Objectives

- There are no specific flow issues in the winter that require a need to designate specific flow objectives.

Current Flow Deficiency

- None.

Action Items

- None.

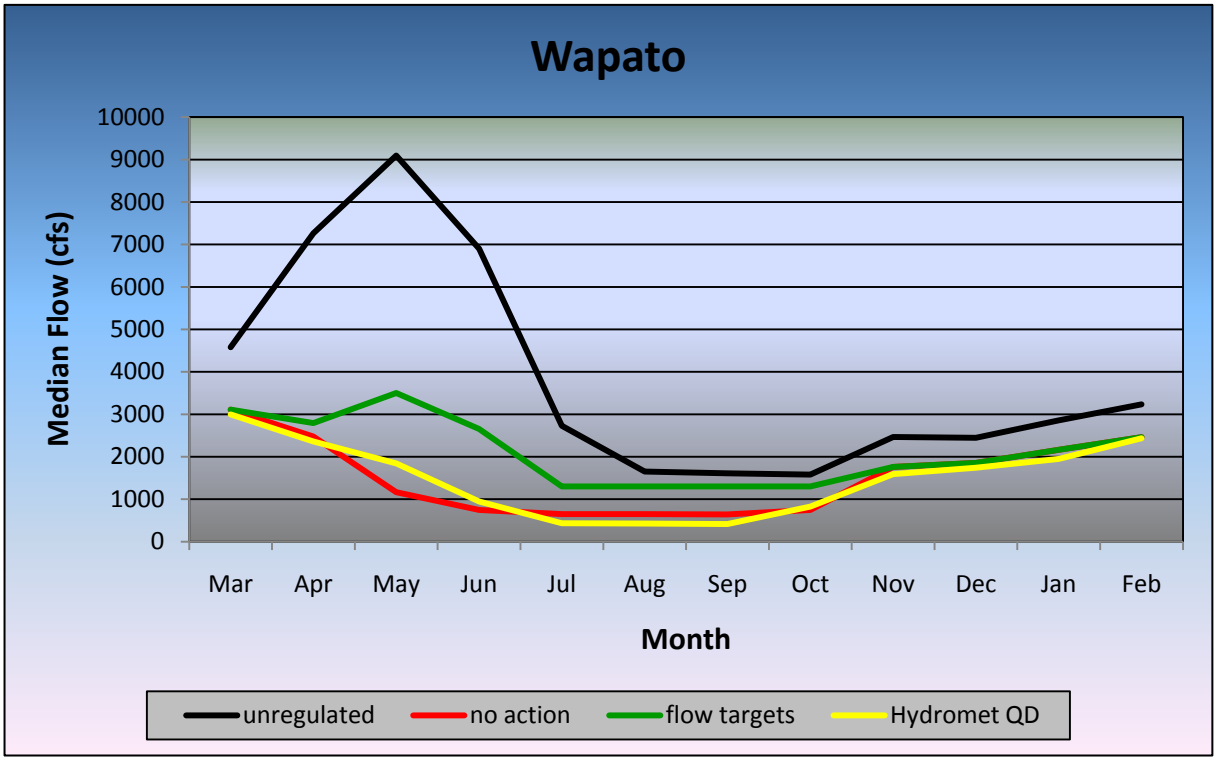
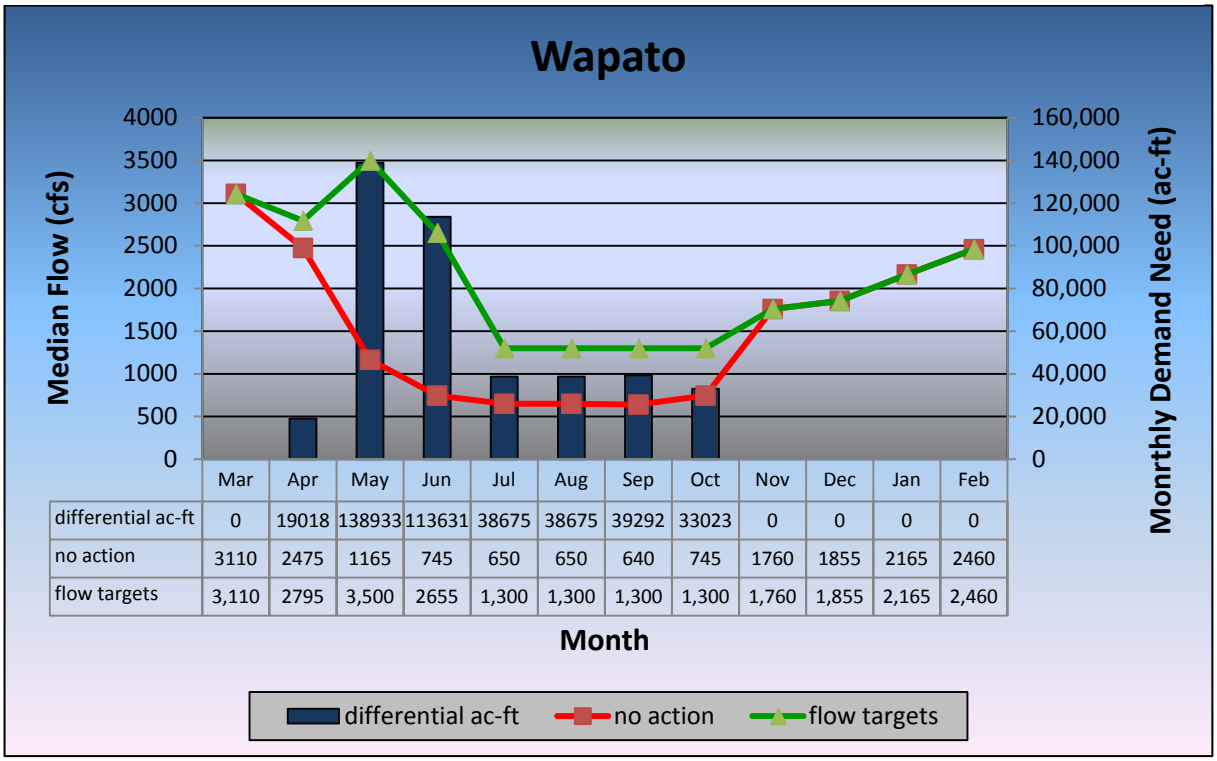


Figure 7. Wapato hydrograph, based on water years 1981-2005.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
differential ac-ft	0	19018	138933	113631	38675	38675	39292	33023	0	0	0	0
no action	3110	2475	1165	745	650	650	640	745	1760	1855	2165	2460
flow targets	3,110	2795	3,500	2655	1,300	1,300	1,300	1,300	1,760	1,855	2,165	2,460

Figure 8. Wapato monthly flow volume differential (ac-ft), based on water years 1981-2005.

Lower Naches Reach

Spring Season (March-June)

Salmonid Life History

During the spring season the lower Naches reach functions as both a migration corridor for upper Naches subbasin salmonid smolt outmigrants and as a rearing area for emergent coho, steelhead and resident rainbow trout fry/parr.

Adult spring Chinook begin migrating through this reach to their natal spawning areas in the upper Naches subbasin in May. Adult steelhead are also migrating through this reach to upriver spawning areas, while some spawn in the lower Naches.

Target Flows

The unregulated monthly median flows range from 1425 cfs in March, to a peak flow of 3375 in May, and then decreases 2880 cfs in June (Figure 9).

Because the ratio of storage capacity (231700 cfs; Rimrock and Bumping reservoirs) to median annual runoff (approximately 950500 acre-feet) is low (approximately 24%) for the Naches subbasin, mainstem flows in the Naches subbasin are the most normative in the Yakima basin. For this reason the unregulated monthly median flows were used to represent the monthly target flows. These monthly flow values are March, 1265 cfs; April, 1800 cfs; May, 2295 cfs; and June, 2290 cfs.

Flow Demand

No additional flow is necessary since the No Action monthly median flows represent the monthly target flows (Figure 10).

Biological Flow Objectives

- There are no specific flow issues in the spring that require a need to designate specific flow objectives.
- Current flow regime is adequate.

Current Flow Deficiency

- None.

Action Items

- None.

Summer Season (July-October)

Salmonid Life History

Juvenile spring Chinook, coho, steelhead and resident rainbow trout are the primary salmonids that reside in the lower Naches reach during the summer. Juvenile spring Chinook continuously move downstream from their natal reaches in the upper Naches subbasin and rear throughout this reach. Juvenile coho and steelhead that were hatched in this reach continue to rear in this reach. For both species there may be a certain fraction of the upper Naches subbasin population that moves downstream like spring Chinook and resides in this reach for part of the summer.

Target Flows

The unregulated monthly median flows decrease from a high of 1065 cfs in July to a base flow of 460 cfs in October (Figure 9).

The No Action median July flow of 990 cfs was used to represent the July flow target. Flow targets for August, September and October were set at 550 cfs, which is comparable (a little higher) to the median monthly August-September unregulated flow.

Flow Demand

For the summer months of August through October a reduction in flow volume from 600 to 59000 acre feet is needed to meet the monthly target flows (Figure 10).

Biological Flow Objectives

- To substantially reduce or eliminate the late summer flip-flop operation. (Figure 9).

Current Flow Deficiency

- The late summer flip flop operation that result in a sharp increase in flow in August followed by a flow reduction in September is spatial and temporal disturbance to residing fishes, aquatic insects, and the riparian vegetation.

Action Items

- Revisit the summer flow target values.

Winter (November-December)

Salmonid Life History

Juvenile spring Chinook, coho, steelhead and resident rainbow trout are the primary salmonids that reside in the lower Naches reach during the winter. There is a pronounced downstream migration of juvenile spring Chinook from the upper Naches subbasin from about mid September through December. A portion of the spring Chinook fall/winter outmigrant

population overwinters in the lower Naches reach, while others continue to move downstream to overwinter elsewhere in the Yakima River.

Juvenile coho and steelhead natal to this reach as well as downstream migrants from the upper Naches also overwinter in the lower Naches reach, and some of these fish may move downstream to overwinter elsewhere in the Yakima River.

Adult coho spawn throughout this reach in November and December.

Target Flows

The unregulated monthly median flows during the winter season are November, 680 cfs; December, 790 cfs; January, 825 cfs; and February, 965 cfs (Figure 9).

The No Action monthly median flows were used to represent the November-February target flows. These monthly flow values are November, 500 cfs; December, 575 cfs; January, 690 cfs; and February, 720 cfs. Since the Naches River is mostly unregulated the existing winter flow regime is considered adequate.

Flow Demand

No additional flow is necessary since the No Action monthly median flows represent the monthly target flows (Figure 10).

Biological Flow Objectives

- There are no specific flow issues in the winter that require a need to designate specific flow objectives.

Current Flow Deficiency

- None.

Action Items

- None.

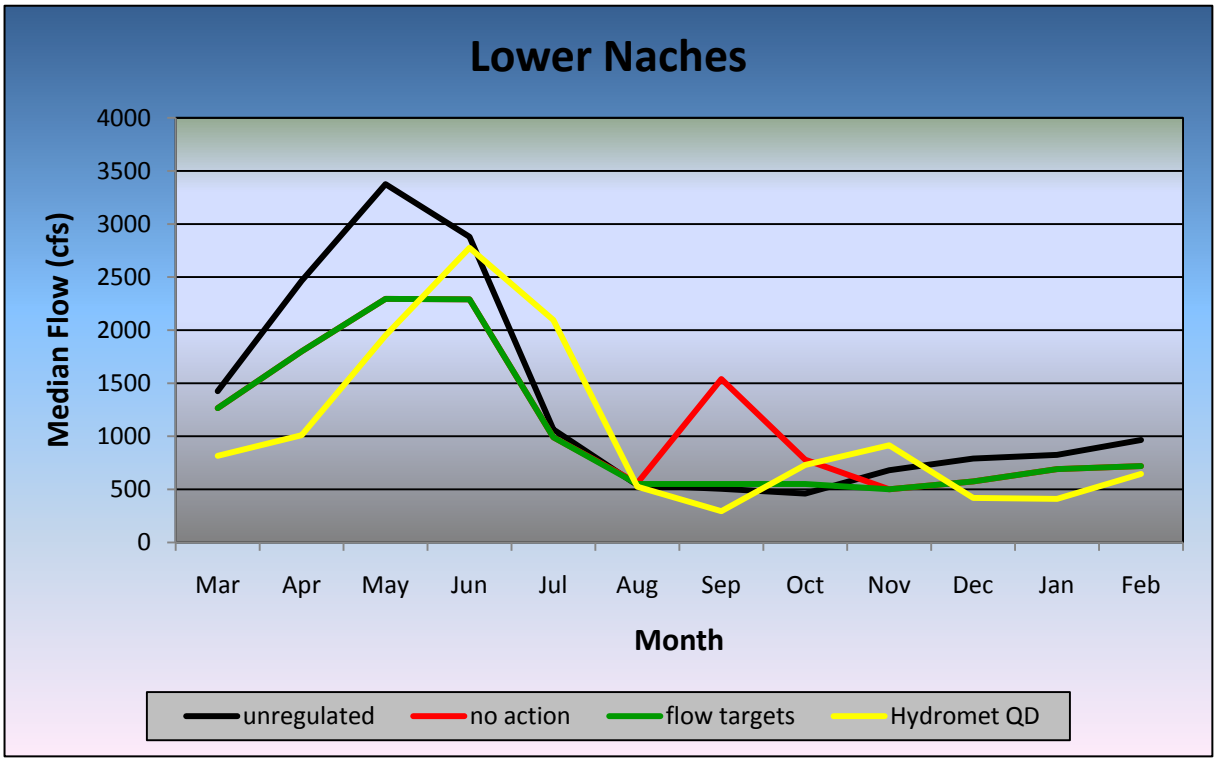
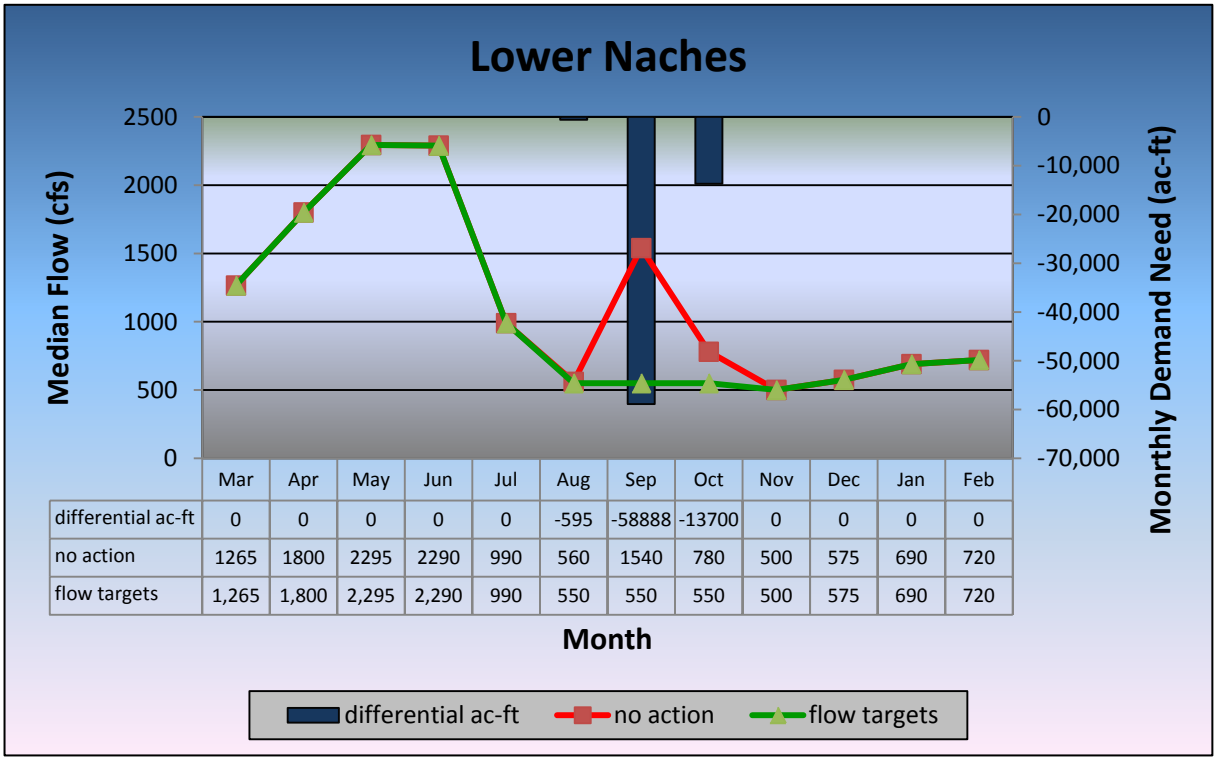


Figure 9. Lower Naches hydrograph, based on water years 1981-2005.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
differential ac-ft	0	0	0	0	0	-595	-58888	-13700	0	0	0	0
no action	1265	1800	2295	2290	990	560	1540	780	500	575	690	720
flow targets	1,265	1,800	2,295	2,290	990	550	550	550	500	575	690	720

Figure 10. Lower Naches monthly flow volume differential (ac-ft), based on water years 1981-2005.

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APPENDIX A

Salmonid Flow-to-Habitat Figures and Tables for the Easton, Ellensburg, Wapato and Lower Naches Floodplain Reaches