How did Ecology create the Skagit River Basin Water Management Rule and its amendment?

A Chronologic History Prepared by Ecology's Water Resources Program, Fall 2014

Executive Summary

Ecology is required to set minimum instream flows as per RCW 90.22 Minimum Water Flows and Levels, and RCW 90.54.020(a) of the Water Resources Act of 1971. As such, Ecology establishes instream flow rules for the major river basins of the state. The purpose of these flows is to protect instream resources including fish and wildlife habitat and water quality.

In April of 2001, Ecology adopted the Skagit River Basin Water Management Rule (AKA the Skagit Rule or The Rule). This rule was amended in May of 2006, but the Washington State Supreme Court overturned this amendment in October of 2013 and reverted to the 2001 rule language.

The creation of the Rule was not a hasty process, nor was the research that served as the basis for minimum instream flows. In fact, research began in the Cultus Mountain Tributaries in 1994.

Much of this work was originally funded by Skagit Public Utility District Number 1 (PUD) because they had an interest in ensuring their future water supply and understanding how any changes they made to their consumptive water use could impact the environment. Understanding what instream flows were needed to adequately protect salmonids, and setting instream flows in tributaries on the Mainstem of Skagit River is one tool that was used—and is still used—to protect the environment.

Ecology wasn't the only organization in this public process. This was a multi-organization effort. Skagit PUD, the Washington Department of Fish and Wildlife (DFW), the Washington Department of Ecology (Ecology), The City of Anacortes (Anacortes), the Swinomish Indian Tribal Community (The Swinomish) and The Sauk-Suiattle Indian Tribe (The Sauk-Suiattle), known collectively as the Skagit System Cooperative (SSC), and the Upper Skagit Indian Tribe (The Upper Skagit) were all involved in this process. Additionally, it is important to note that the environmental consultants contracted to perform the major research in these studies are the same, but their business name changed from Cascades Environmental Services, Inc. (CES), to Duke Engineering Services, Inc. (Duke).

Additionally, the public was involved in this process. On September 22, 1999, a workshop sponsored by the Committee was held at the Skagit PUD. Another Workshop sponsored by Ecology was held at Skagit Valley Community College on October 12, 2000. Finally, Ecology held a Public Hearing was held at Skagit Valley Community College on November 29, 2000. Both Ecology sponsored events were announced via mass mailings, internet postings, and press releases in local newspapers.

The comment period was between November 1, 2000 through December 8, 2000.

In March of 2001, Ecology published a Responsiveness Summary and Concise Explanatory Statement on the proposed rule. The Rule was adopted on April 14, 2001.

References are on the last page of this document.

Part 1: A Chronologic Summary of Information that is Key to Understanding the Skagit River Basin Water Management Rule

Report 1: Physical Habitat Surveys of Cultus Mountain Streams, Gilligan, Salmon, Janicki, Turner, and Mundt Creeks, CES, Completed December 14, 1994.

Why is this report important?

This report is the first of 3 studies commissioned by the PUD.

Page 1 of this report best summarizes the work performed by CES in this study (agency and business abbreviations added):

> "CES was contracted by the PUD to investigate five streams in the Judy Reservoir system to determine of any may be suitable for expanded water supply. Associated with this task were physical habitat surveys to assess stream morphology and fish habitat availability in each stream. CES surveyed Gilligan, Salmon, Janicki, Turner, and Mundt Creeks. Gilligan, Turner, and Mundt Creeks are confirmed salmon streams. Salmon Creek is likely used by anadromous fish. Perched culverts at the mouth of Janicki creek are a barrier to anadromous fish. Hydrologic records from 1954 to 1967 imply that Mundt Creek can provide more water than is presently diverted. No records were found for Gilligan Creek. However, the Gilligan Creek watershed above the diversion could likely provide more water than is presently diverted. CES recommends that a synthesized flow record be calculated for each of the streams to estimate the volume of water which may be available in each stream. If synthesized flows suggest additional water is available in any of the streams, then IFIM studies of those streams are recommended. Since water rights *[held by the PUD]* for Mundt Creek do not require minimum flows, CES recommends an IFIM study to establish a minimum flow regime to provide adequate water for resident and anadromous fish in Mundt Creek."

These were the three listed study objectives on page 2:

> "1. to characterize and quantify the morphology of the stream channel and associated habitat types between the diversion structures and the confluence of the creeks with the Skagit River on the EF Nookachamps Creek;
> 2. determine the distribution and relative quantity and quality of spawning gravels available for resident and anadromous fish; and
> 3. determine, if possible, upstream barriers to anadromous salmon."

On the following page is a summary of CES' findings.

Summary of Physical Habitat Stuides Of Cultus Mountain Streams, Cascade Environmental Sciences, December 15, 1994

	Gilligan Cr			Salmon Cr				Janicki Cr		Turner Cr				Mundt Cr		
Date(s) of Survey	10/18/94			10/14/94; 10/27/94; 10/31/94				10/27/94		10/31/94; 11/02/94				11/04/94		
Measured streamflow (CFS)	1.08			0.29 (10/14/94); 1.19 (10/27/94); 2.72 (10/31/94)				3.05		11 (est, 11/02/94); 10.01 (10/31/94)				4.39 (low flow of 0.3 measured above diversion on 9/29/94)		
PUD Water Rights for stream at Time of Survey?	Skagit PUD held WR to divert 8.89 CFS, w/ a min. bypass flow req. of 0.75 cfs. App. for 23.4 cfs.			Skagit PUD held WR to divert 1.8CFS, & an app. for 4 cfs with a w/ a min. bypass flow of 0.056 cfs				Skagit PUD did not have WR.		Skagit PUD held WR to divert 6.2 cfs w/ a minimum bypass flow of 0.6 cfs.				Skagit PUD held WR to divert 8 cfs, no min bypass.		
Location of survey	Diversion to confluence w/ Skagit River.			Diversion to confluence w/ Skagit River.				Outlet of Judy Reservoir to Confluence w/ Skagit River.		Diversion to confluence w/ EF Nookachamps.				Diversion to confluence w/ EF Nookachamps.		
Total length of survey (ft)	8,085			4,700				3,675		18,865				12,300		
Elevation range (ft)	40 (confluence) - 800 (diversion)			40 (confluence, pg. 13) - 660 (diversion)				40 (confluence) - 440 (outlet of Judy Reservoir)		35 (confluence) -820 (diversion)				50(confluence) - 1,000 (diversion)		
Stream Gradient	9.4%			Not provided.				Not provided.		Not provided.				7.8%		
Salmon Presence?	Yes, Confirmed. Coho, chum & pink. (WDF 1975)			Likely. "Though Salmon Creek is not listed in the Catalog of Washington streams & Salmon Utilization, Reach 1 is accessible to the Skagit River & is likely to be used by anadromous fish." (pg 23)				Not mentioned. Most likely no due to confirmed barrier at confluence w/ Skagit River.		Yes, Confirmed. Coho & chum. (WDF 1975)				Yes, Confirmed. Coho & chum. (WDF 1975). Fish remnants observed 11/04/94		
Further Notes from Cascades Environmental Services, INC. (CES)	The watershed above diversion could likely provide more water than diverted at time of study. Discharge measured was 40% above minimum flow.			Salmon Cr. did not provided a substantial enough volume of water to recommend an IFIM study. Measurements taken 9/29/94 show a low flow of 0.05 cfs below diversion. Historic flow data ranged from .004 cfs to 4.14 cfs.				Historic flows ranged from .01 cfs to 16.84 cfs. There may be water quality issues (high lead) when flows are low. Confirmed anadromous barried at confluence.		Historic flows ranged from .02 - 18.96 cfs. Habitat observed in all reaches, spawning substrate in reaches 2 & 3.				Since water rights for Mundt cr did not require minimum flows, CES recommended IFIM study so that minimum flows could be established to provide adequate water for fish. Historic flows ranged from 0.01 - 40.83 cfs. Habitat observed in reaches 1 & 2 suitable for rearing & spawning of anadromous & resident fish.		
Reach Number	Reach 1	Reach 2	Reach 3	Reach 1	Reach 2	Reach 3	Reach 4	Reach 1	Reach 2	Reach 1	Reach 2	Reach 3	Reach 4	Reach 1	Reach 2	Reach 3
Date of Survey	10/18/94			10/27/94	10/14/94		10/31/94	10/27/94		10/31/94	11/02/94			11/04/94		
Reach Description Notes				Artificial, ditched channel		Upper reach ends at culvert under Old Day Cr Rd.				Ditched channel, pond @ end of upstream reach						
Reach Length (ft)	4,350	500	3,235	4,700	1,700	650	1,050	1,000	2,775	9,650	1,050	5,715	2,450	5,650	4,150	2,500
Reach elev. range (ft)	40 - 200	200 - 240	240 - 800	40 - 80 (pg 13)	80 - 320	320 - 520	520 - 660	40 - 240	240 -440	35 - 60	60 - 80	80 - 640	640 - 820	35 - 280	280 - 520	520 - 1,000
Stream Gradient	3.7%	8.0%	17.3%	<1%	14.1%	30.8%	13.3%	21.0%	7.3%	0.2%	3.8%	9.8%	7.3%	4.3%	5.8%	19.2%
Barriers to Fish Passage or notes specifically mentioned?	No, noted that this reach is accessible to anadromous fish.	No, noted that this reach is accessible to anadromous fish.	"A number of" unconfirmed barriers to anadromous fish.	No, noted that this reach is accessible to anadromous fish.	Shallow water & cascades may restrict anadromous fish.	2 unverified barriers to anadromous fish.		Yes, confirmed anadromous barrier @ confl. w/ Skagit River (perched culvert 10 ft above Skagit River).			No. "Accessible to anadromous fish".	"A number of" log jams & cascades may impede migration.		Unconfirmed anadromous barrier observed @ upstream end of reach. Log jams, chutes, & cascades.	Continuance of unconfirmed barrier observed in Reach 1.	
Other Observations	Riffles dominate habitat, consisted primarily of med gravel & cobble substrate. this reach is accessible to anadromous fish	Riffles dominate w/ boulder & lg. gravel substrate. accessible to anadromous fish.	cascades, riffles, & pools w/ boulders & cobble substrate.	Beaver dam, unlikely to impede fish passage. Suitable habitat for rearing salmon & resident fish. Silt & detritius substrate	Riffles, pools, glides, & cascades w/ gravel & s& substrate.	Bedrock & Gravel substrate. Substrate eroded to bedrock in chutes with gravel found primarily in pools.	Habitat consisted mostly of riffles. Bedrock & cobble substrate observed in chutes & riffles.	Riffles dominate w/ bounder & gravel substrate. Very little spawning substrate available.	Riffles, cascades & pools. Predominate susbtrate gravel & cobbles.	Weir structures built to improve fish habitat above & below pond at upstream reach. Homogenous habitat. Reed canary grass & blackberry present along channel. Predominate substrate of silt & detritius.	Riffles dominate, consisting of cobble & gravel substrate.	Riffles dominate, substrate mostly boulders & cobbles.	Riffles dominate with cobble & gravel substrate.	River otters observed in reach. Riffles dominant with cobble & gravel substrate. Anadromous remains likely observed (observed fish guts, bones, eggs)	Riffles & pools dominate with boulder & cobble substrate. It is unlikely anadroumous firsh can use reach due to passage barrier in reach 1 & at downstream area of this reach.	Cascades dominate habitat with boulder & cobble substrate. Unlikely that anadromous fish can pass barrier in reaches 1 & 2.
Spawning Substrate Present?	Marginal to fair spawning habitat	Less abundant than reach 1	Yes, generally found in pools	"Very little spawning substrate observed".	"Good spawning habitat for anadromous & resident fish".	"Generally unavailable".	"Very little spawning habitat available".		"Marginal for resident trout".	"Very little available".	"Fair".	"Marginal".	"Poor".	"Marginal".	Poor availability.	Very little available.
%Spawning Substrate (none:marg:fair:good)	25:45:30:0	57:14:14:0	65:0:35:0	90:10:0:0	27:27:23:23	85:8:0:8	91:9:0:0	90:10:0:0	73:23:4:0	93:7:0:0	60:20:0:0	44:36:16:3	48:40:8:4	61:30:7:2	56:36:7:4	80:15:5:0
Major Conclusions	Based on their research, Cascades Environmental Sciences recommended that a synthesized flow record be calculated for each stream. If additional water appeared to be available, an IFIM study would be recommended (with the exception of Salmon Creek). CES also recommended an IFIM study of Mundt Creek so that minimum flows could be established in order to provide adequate water for fish. All streams have habitat available for rearing & spawning anadromous firsh & resident trout.															

Report 2: Synthesized Hydrology and Toe-Width Surveys of Cultus Mountain Streams, Salmon, Turner, and Mundt Creeks, CES, Completed March 10, 1995

Why is this report important?

Several months after finishing their first report, CES completed a follow up report for the PUD pertaining to Salmon, Turner, and Mundt Creeks. The introduction includes this language (with abbreviated names):

> "This report briefly describes the methods and results of predictions of : 1) 11 years of synthesized daily flows; 2) instream flow requirements of fish; and 3) flows available for diversion by the PUD in Salmon, Turner, and Mundt creeks. Daily discharge flows were synthesized with a comparison to the E.F. Nookachamps Creek near Big Lake USGS gage # 12199800. Instream flow requirements for fish were calculated using the "toe width method". The amount of water available for diversion was estimated by subtracting instream flow requirements from synthesized flows. This information is presented to the PUD to provide information for evaluating options of water withdrawal from Salmon, Turner, and Mundt Creeks."

What's a synthesized daily flow? Why did it need to be calculated? Why couldn't the scientists just go out and see how much water was in these creeks?

As of 1995, there weren't long term historic daily flow records for these study streams. This isn't unusual, but CES had to find a way to calculate the average daily flows, by month, without this historic data. They called the resulting calculations the synthesized daily flow.

From December of 1961 to August of 1972, the USGS installed and operated a stream flow monitoring gage on the EF Nookachamps Creek (EF Nookachamps). The watershed has similar weather conditions and elevations as the study creeks, and the gage was at roughly the same elevation as the diversion points in the study creeks. Therefore, this data was used to simulate the flow conditions found in the study watersheds.

The major difference was the acreage of these study watersheds from the EF Nookachamps watershed. Using the records from the EF Nookachamps gage, CES calculated the average daily instantaneous flow for each month for the EF Nookachamps. Then, because CES had the acreage of each Watershed, they adjusted these values proportionally by size. For example, if one of these watersheds was ¼ in acreage of the EF Nookachamps, the values for that watershed would be a ¼ of the EF Nookachamps values.

The scientists couldn't just take one flow measurement at each of these study creeks to make this calculation. How would they know if the flow they measured was relatively high or low for that time of year? How would they know how these flows typically varied throughout the year? They needed a long period of records in order to capture historic high and low flows. The EF Nookachamps data was chosen as the best substitute for this data.

What are these toe-width surveys? How were they used with synthesized daily flow numbers to create synthesized hydrology?

Page 2 of this report gives a concise summary:

> "The toe width methodology was developed by C. H. Swift III (1976 and 1979) to determine the stream discharges which salmon and steelhead utilize. *[These studies were specific to Washington, citation follows]*This work compared relationships of 84 study reaches on 28 streams and rivers for salmon and 54 study reaches on 18 streams and rivers for steelhead. Linear regression formulas were calculated to compare the toe-of-bank channel width to the stream discharge which was observed to be preferred by salmon and steelhead. The standard errors of estimate for these relationships are 40% for spawning Chinook, pink, and chum salmon, and 48% for sockeye and coho salmon. Salmon rearing discharge formulas had standard errors of 57%. Standard errors for steelhead spawning and rearing discharges ranged from 28% to 56%.
>
> A field survey of the streambed profiles of Salmon, Tuner, and Mundt creeks was conducted. Using an autolevel transit, stadia rod, and measuring tape., the following data was determined:
>
> Bank Elevation
> Toe-of-Bank Elevation
> Edge of water elevation
> Midchannel and thalweg elevation
> Wetted Channel Width
> Toe-of-bank channel width (TW)
> Top-of-bank channel width"

Using the Toe-of-bank channel width, CES used formulas developed by C.H. Swift III (1976 and 1979) to:

1. derive the stream discharges preferred by spawning and rearing Chinook, Pink, Chum, Sockeye, Coho, and Steelhead salmonids;
2. calculate the sustainable discharge at which the percentage rate of reduction of stream flow equals the percentage of rate of reduction in maximum spawnable habitat for steelhead; and

3. calculate the stream discharge that provides water covering the greatest streambed area with velocities preferred by spawning steelhead.

These surveys and calculations were used to derive the synthesized hydrology for each study watershed. In this study, the synthesized hydrology is a set of numbers that characterized:

1. the average daily flow, by month, at PUD diversion on a study creek;
2. the instream flow requirement for fish below this diversion, based on the toe-width calculations and based on when salmonids at various life stages might utilize the stream;
3. the average daily flow available at the PUD diversion;
4. the average number of days water is available for diversion; and
5. The average amount of flow available for diversion on the days when additional flow is available.

The results of the calculations are on pages 9, 10, and 11 of this report.

So this sounds like a report that Ecology could use to set minimum instream flows. Why wasn't a toe-width study like this ultimately used to determine the instream flow numbers for the Cultus Mountain Tributaries in the Skagit Rule?

According to Ecology's records, Toe-width studies like this one have been used by Ecology to as the basis for instream flow rules. In fact, most instream flow rules in the state were based on toe-width studies. (You can learn more about the methods Ecology uses in our publication: Focus on Instream Flow Studies: Instream Flow Methods Used in Washington State, July 2009, Publication number 09-11-019)

However, it's not the best available science for determining minimum instream flows that can support salmonid habitat. CES included these comments in the discussion on page 7:

> "Past experience of CES has found that instream flow requirements calculated from toe width methodology generally are higher than flows calculated using Instream Flow Incremental Methodology. The toe width method assumes that spawning substrate is uniform across the stream section. Consequently, higher flows which define the toe-of-bank width would suggest and increase in spawning habitat. During our surveys we observed that spawning substrate is found in pockets in the streams, not uniformly across the streams. Therefore, *[emphasis added]* **higher flows** *[derived from toe-width surveys]* **would not necessarily yield an increase in spawning habitat.**
>
> IFIM studies investigate several hydraulic and biological variables in a stream which are integrated into a model to develop an instream flow analysis tool. Where the toe width gives a single number for optimal discharge, the IFIM can evaluate the incremental impacts of different flows on all life history stages of fish (i.e. spawning, incubation and rearing, etc.).
>
> The discharge flows calculated using the toe-width formulas for chum salmon exceeded flows calculated for steelhead trout *[…]*. We believe that these flows are excessive and though chum salmon have been observed in Turner and Mundt creeks, the flows calculated for sustainable spawning area for steelhead would be acceptable for this report."

So what is Instream Flow Incremental Methodology? We'll discuss this further in the next report, but it's the another type of method Ecology uses as a basis to set instream flows, and what part of what Ecology used in setting the Skagit Instream flow rule.

Additionally, March 15, 1995 letters to Larry Wasserman of the SSC and Stephen Hirschey of Ecology from Bradley Spangler of the PUD, emphasized that these "surveys were not intended to replace an IFIM, but rather to determine the rough potential for Cultus Mountain streams as a continued sources for the district. *[…]* Based on surveys and future demand projections, the District's Commission has authorized final IFIM studies on Gilligan, Salmon, Turner, and Mundt Creeks."

Report 3: Draft Report: Skagit County Water Supply IFIM and Fisheries Study, CES, Completed August 19, 1996.

Why is this report important?

This is the report that provided the information that was the basis for the instream flow numbers set for the Cultus Mountain Tributaries in the Skagit Rule. By now, multiple agencies and entities were involved in the instream flow rule making process, and this study was what their experts used as a beginning point for making instream flow rule recommendations. For more information on these discussions please see the summaries of Hal Beecher's (DFW) March 27, 1997 letter, Pete Ritttmueller's (CES) January 9, 1998 letter.

During the fall and winter of 1995-1996, CES performed fisheries and is-stream field work for this report. CES then calculated synthesized stream flow on Gilligan, Salmon, Turner, and Mundt Creeks, and then conducted IFIM studies on each of these creeks. They prepared this report for the PUD, however, the introduction makes it clear that there were multiple interested parties, including the DFW, DOE, the Skagit System Cooperative (representing the Swinomish and the Sauk-Suiattle), and federal agencies. The report was prepared for the express intent to evaluate the effects of alternative flow regimes on salmonid fisheries in Gilligan, Salmon, Turner, and Mundt Creeks.

What's an alternative flow regime?

An alternative flow regime is a way to describe the difference in how water in a river, creek, or stream could be changed by a) an increase or decrease in the amount of water removed from a water body for out-of-stream uses, or b) a change in when water is removed for out-of-stream uses.

What's a synthesized stream flow? Why did it need to be calculated?

In order to evaluate and compare alternative flow regimes, we need to know the current and historic flow regimes before we change them. How does the river or stream currently behave? When are the high flows and low flows? What are the magnitudes of these flows? How are they related to precipitation?

As of 1996, there weren't long term historic daily flow records for these study streams. This isn't unusual, but CES had to find a way to calculate the distribution of daily flows, by month, without this historic data.

From December of 1961 to August of 1972, the USGS installed and operated a stream flow monitoring gage on the EF Nookachamps Creek. The watershed has similar weather conditions and elevations as the study creeks, and because the gage was at roughly the same elevation as the diversion points, it was decided that this data could be used to simulate the flow conditions found in the study watersheds.

Flow duration curves for the annual and monthly flows, and monthly discharge charts of the 10% and 90% exceedence flow, were made for the EF Nookachamps based on this historic data. From there, CES derived this information for each of the study watersheds by proportionally adjusting for differences in watershed acreage. The results are in Appendix B of the study.

Spawning Salmon Depth and Velocity

The introduction to the section is concise (abbreviation added):

> "As part of the Skagit Water supply IFIM studies, DFW requested that surveys be conducted to measure the water depth and velocity utilized by salmon that spawned in streams. CES conducted surveys for spawning Coho and Chum salmon in Mundt and Turner Creeks during November and December of 1995."

Why is water depth and velocity important for spawning salmon important for instream flow studies?

Salmonids typically have a range of depths and velocities in which they spawn. Salmonids won't spawn in depths or velocities that are too high or too low. CES needed to evaluate what depths and velocities these Salmonids needed in order to evaluate what flows were needed to adequately protect salmonid habitat.

The second page of Appendix C of this report summarizes their field results.

About IFIM, what is it? Was there anything about specific about how IFIM was used in these studies?

CES used IFIM to model the relationship between surface water discharge and physical habitat for salmonids in the diversion reaches of Gilligan, Turner, and Mundt Creeks.

As of this draft, The Salmon Creek IFIM study wasn't completed. After the habitat surveys in 1994, It was found in 1995 that a pond near Salmon Creek was being excavated, and was increasing the amount of sediment in the creek and changing the stream bed elevation. Without stable conditions, would not be performed at the time.

But what is IFIM? Ecology updated our explanation on IFIM in publication Q-WR-95-104, in 2010. In short:

> "IFIM *[Instream Flow Incremental Methodology]* is a series of computer-based models which calculate how much fish habitat you gain or lose as you increase or decrease stream flow. It is based on the understanding that fish prefer water with a certain depth or velocity. These preferences vary for different species of fish, and for each of their life stages.
>
> IFIM was developed in the late 1970s by the U.S. Fish and Wildlife Services. It involves putting site-specific stream flow and habitat data into a group of modes collectively called PHABSIM (**P**hysical **HAB**itat **SIM**ulation). PHASIM was an is the most commonly used hydraulic modeling program within IFIM to predict depths and velocities in streams.
>
> *[…]* IFIM only uses four variables in hydraulic simulation (depth, velocity, substrate, and cover), which are key measurements for determining instream flow numbers. At certain flows, such as extreme low flows, other variables such as food supply (aquatic insects) and predators (birds, larger fish,etc.) may be of overriding importance to fish survival and production. In addition to the *[PHABSIM model]*, IFIM may include water quality, sediment, temperature, and other variables that affect fish production.

It's worth noting that PHABSIM isn't the only model that is used to simulate habitat, but it is what CES used in these studies. According to the IFIM overview in this report, these are the components CES used in their IFIM studies:

1. "study site and transect selection,
2. transect weighting,
3. field data collection,
4. hydraulic simulation to determine the spatial distribution of combinations of depth sand velocities with respect to substrate and cover under a variety of discharges, and
5. habitat simulation, using habitat suitability criteria, to generate an index of habitat relative to change in discharge."

Finally "the product of the habitat simulation is expressed as Weighted Usable Area (WUA) for a range of simulated stream discharges". These WUAs were integrated with the synthesized stream flows and the spawning salmon depth and velocity studies. Then according final summary on page VI-1, "total WUA for Gilligan, Mundt, and Turner creeks can then be known for any species and life stages for any given discharge at their respective diversions."

This was powerful information to interested parties; these results could then be used to determine the best minimum stream flows for maximizing salmonid habitat. The results of this study were discussed for another year and a half.

On January 9, 1998, Pete Rittmueller of CES sent a letter to DFW, SSC, PUD, and DOE confirming an October 6, 1997 meeting. This meeting was the conclusion of the instream flow discussions for Gilligan, Salmon, Turner, and Mundt Creeks. The instream flow numbers for Gilligan, Turner, and Mundt Creeks were based on IFIM, the instream flow numbers for Salmon Creek was based on the previous toe-width study. **These instream flow numbers agreed upon by the committee are the same as those adopted into the final Skagit Rule.**

Agreement: The 1996 Memorandum of Agreement

Why is this agreement important?

By now, there were 8 stakeholder entities that were interested in the future management of the Skagit River, for multiple reasons. By December of 1996, these following parties had all signed the Memorandum of Agreement: Utilization of Skagit River Water Resources for In-Stream and Out-Of-Stream Purposes:

- The City of Anacortes
- Public Utility District Number 1 of Skagit County
- Skagit County
- The Upper Skagit Indian Tribe
- The Swinomish Indian Tribal Community
- The Sauk-Suiattle Indian Tribe
- The Washington Department of Ecology
- The Washington Department of Fish and Wildlife

In this 17 page document, the parties outline their respective goals and roles in this process. The purpose of this agreement outlines these goals:

"A. To ensure the establishment of instream flows to protect fisheries resources, and the mitigation of any interference with such established flows.

B. To provide a mechanism for the coordinated management of water resources in areas described by the Skagit County Coordinated Water System Plan, Regional Supplement, July 1993 ("CWSP") to meet the out-of-stream needs of the Swinomish Indian Tribal Community, Upper Skagit River, Tribe, and Sauk-Suiattle Indian Tribe (collectively "the Tribes"), local governments, and public water purveyors within Skagit County;

C. To avoid litigation or adjudication or water resources within the Skagit River Basin Between the Parties to this Agreement;

D. To assist in expediting the Department of Ecology's water right decision-making within the CWSP service area;

E. To modify the CWSP to conform to this Agreement and to incorporate this Agreement into the City of Anacortes' and Public Utility District No. 1 of Skagit County's Joint Operating Agreement."

What were the key Skagit Rule Components of the MOA?

Each party agreed to their role in this MOA. Some agreements had language identical to others, some had slightly different language. Some if this language may have addressed the same issues, but may have indicated different intents. Passages in Green have identical language to other portions of the MOA (though they may be summarized here). Passages in purple have language that addresses similar issues, but isn't identical to other portions of the MOA.

The Swinomish, the Upper Skagit, and the Sauk-Suiattle:

- conditioned their agreement on "other Parties meeting their obligations as outlined in this Agreement, which includes establishing Lower Skagit River Instream Flows as defined in this Agreement";
- agreed not to challenge any water right documents from the Anacortes or the PUD within 50 years of the agreement, as long as these water right documents were consistent with the agreement;
- to work towards establishing satellite systems in the CWSP and improving public water delivery in Skagit County; and
- agreed to work toward improving efficiency and reducing impacts to stream flows, particularly with an emphasis on reducing permit exempt well use.

Anacortes:

- stated that they had pre-existing water rights not subject to future rules, but that they also had 2 water rights subject to future rules;
- agreed to participate in an IFIM study process in the Lower Skagit River, and they would jointly fund it with the PUD while consulting with the 3 tribes;
- agreed that Anacortes, the PUD, and these 3 tribes would jointly recommend these instream flows to Ecology or all submit differing recommendations;
- could negotiate with dam operators in the Upper Skagit Portion of the River to release more water so that flow levels could be met in the Lower Skagit River;
- agreed to guarantee that 2.8 million gallons a day would be available for all residents within the Swinomish Indian Reservation into perpetuity;
- agreed to "actively support and provide input at both a policy and technical level to County officials regarding implementation of Section 63 of the Growth Management Act, such that building permits will only be issued if there is an adequate supply of potable water that can be withdrawn from groundwater without adversely impacting instream flows, other than as agreed herein; and
- agreed to "actively seek amendment of the CWSP and adoption of County ordinances that a)require, in lieu of individual wells, connection of new individual/single family homes to public water systems where the proposed

development is within the designated services are of existing utilities and timely and reasonable service is available; and b) limits the use of the 5,000 gallons a per day exemption in those areas of the County experiencing inadequate Skagit River Basin Instream Flows that may be occurring as a result of groundwater withdrawals."

Skagit PUD:

- like Anacortes, stated that they had some pre-existing water rights not subject to future instream flow rules, but that they also held water rights that would be subject to future in-stream flows;
- would actively manage their Cultus Mountain Sources so that instream flows on those Cultus Mountain streams would be protected while ensuring their water supply;
- agreed to participate in an IFIM study process in the Lower Skagit River, and they would jointly fund it with Anacortes while consulting with the 3 tribes. "The Swinomish, the Upper Skagit, the Sauk-Suiattle, and DFW *[would]* provide fisheries and fisheries habitat management criteria for input into the IFIM Study and recommended Lower Skagit River Instream Flows";
- could negotiate with dam operators in the Upper Skagit portion of the river to release more water so that flow levels could be met in the Lower Skagit;
- agreed to guarantee to the Upper Skagit Tribe that 0.75 million gallons a day would be available for all residents within the Bow Hill Indian Lands and the Upper Skagit Indian Reservation, into perpetuity;
- agreed to assist Ecology in the adoption of Instream Flows in the Lower Skagit River and the Cultus Mountain Streams;
- agreed to "actively support and provide input at both a policy and technical level to County officials regarding implementation of Section 63 of the Growth Management Act, such that building permits will only be issued if there is an adequate supply of potable water that can be withdrawn from groundwater without adversely impacting instream flows, other than as agreed herein"; and
- agreed to "actively seek amendment of the CWSP and adoption of County ordinances that require, in lieu of individual wells, connection of new individual/single family homes to public water systems where the proposed development is within the designated services are of existing utilities and timely and reasonable service is available. Also, to limit the use of the 5,000 gallons a per day exemption in those areas of the County experiencing inadequate Skagit River Basin Instream Flows that may be occurring as a result of groundwater withdrawals."

Skagit County:

- agreed "to implement Section 63 of the Growth Management Act, such that building permits will only be issued if the parcel is served by a public water system or if there is an adequate supply of potable water that can be withdrawn from groundwater without adversely impacting Skagit River Basin Instream Flows, other than as agreed herein";
- agreed to "to actively work with all parties to address the 5000 gallon permit exemption for all public water systems and for all individual water systems in those portions of Skagit County that are impacted by inadequate Skagit River Instream Flows that may be occurring as a result of surface or groundwater diversions. Skagit County reserves the right to allow exempt wells for single family systems in the Skagit River basin above the PUD pipeline Crossing"[1];
- agreed "to seek amendment of the CWSP and related County implementing ordinances to require connection of new individual/single family homes to public water systems to achieve conservation of resources where the proposed development is within the designated service area of exisiting utilities and timely and reasonable service is available";
- agreed to assist Ecology in establishing instream flows in the Lower Skagit River, "with the goal of establishment within four years from the effective date of this Agreement"; and
- agreed "to seek the goals of: (1) providing certainty and stability for water supplies for citizens of Skagit County; (2) to secure adequate streamflow for Ecology designated Low Flow Streams during critical periods to meet fisheries needs; (3) to encourage public water suppliers to provide water from the mainstem of the Skagit River for water users near Ecology Low Flow Streams where withdrawals may have direct impacts on in-stream resources; and (4) to evaluate, jointly with other parties, streams for possible designation by Ecology as Low-Flow Streams.

Ecology:

- *[agreed]* "to process any City or PUD requests for changes identified in this Agreement, and to expressly and clearly condition any document effectuating changes to existing rights to require compliance with this Agreement. Ecology agrees to seek to the extent possible, to enact all necessary rule and water right changes necessary to implement this Agreement";

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[1] If this sentence was legally valid at the time of writing, it is no longer valid due to 2 State Supreme Court Cases. Postema v PCHB (2000) recognized hydraulic continuity between surface water and ground water, stating that "any diminution of surface water, however slight or even de minimus, constitutes an adverse impact if it is measureable". Kittitas v GMHB (2011) ruled that Counties are legally responsible for land use decisions that affect groundwater resources.

- "Until the adoption of Lower Skagit River and Cultus Mountain Instream Flows provides a framework for determining the availability of water for future appropriations, *[will make]* no final decisions will be made on any water right permit applications within that portion of the Skagit River Basin which lies within WRIA 3 which could affect or be affected by those instream flows"; and
- "in signing this Agreement, Ecology is only obligated to take those actions set forth in this section and is not obligated by or agreeing to any other specific provisions of this Memorandum of Agreement."

DFW:

- along with the 3 tribes, would "provide the fisheries and fisheries habitat management criteria for input into the IFIM study and recommended Lower Skagit River Instream flows";
- "make a recommendation regarding the adequacy of the jointly developed recommended instream flow for Lower Skagit River Instream Flows to Ecology. *[DFW's]* recommendation decision will be based upon the jointly developed recommendations consistent with the fisheries and fisheries habitat management criteria;
- in the event that parties could not agree on a recommended instream flow for the Lower Skagit River, DFW would make a recommendation "regarding the differing recommendations for Lower Skagit River Instream Flows to Ecology"; and
- "will provide appropriate technical support for developing recommended instream flows for the Cultus Mountain Streams";
- "is in no way obligated or bound by any other provision of the Memorandum of Agreement, except as outlined in the above four items."

All parties agreed:

- "that the long term objective is to develop a comprehensive watershed management plan for the Skagit River Basin designed to manage the used of the water resources to meet both instream and out of stream objectives defined by the City, PUD, and Tribes"; and
- the parties recognize that there is a possibility that the *[Anacortes']* 54.94 MGD and the PUD's 57.52 MGD recognized in this agreement as not subject to the Lower Skagit River Instream Flows may reduce Skagit River Flows below the established flows. The attached Water Shortage Response Plan is incorporated by reference into this Agreement, and will be implemented in the event that this occurs".

Report 4: Final Technical Report: Lower Skagit River Instream Flow Studies, Duke (formerly CES), June 1999

The Instream flow numbers for the Skagit Mainstem in the Skagit Rule are primarily based on this final report from Duke. This report was reviewed by Hardin-Davis, Inc. in March of 2005.

Why is this report important?

The Skagit Mainstem instream flow numbers established in the 2001 Skagit Rule are the same as the numbers recommended by the Skagit River Instream Flow Committee in the 1999 Duke Final Technical Report (Page 138). These numbers are based on how much habitat is needed by several salmonids species at different life stages. This is also why the instream flow number varies throughout the year.

What is this report, exactly? Who is "The Committee"?

The 1999 Duke Final Technical Report: Lower Skagit Instream Flow Studies is a summary of several studies conducted by Duke Engineering in the late 1990s (formerly Cascades Environmental Services). These studies were commissioned by Skagit PUD and the City of Anacortes as part of the 1996 MOA.

The participants in the '96 MOA, along with their consultants, formed "The Committee", as they are referred to in this report. The Committee, after extensive discussion, ultimately made instream flow recommendations (shown on the last page of this Report, page 138) to Ecology, which were adopted by Ecology in the Skagit River Basin Water Management Rule.

Why were these numbers recommended?

After Duke Engineering concluded their IFIM work in the Skagit River Mainstem, their Estuary study, and their hydrology study, their findings were reviewed by The Committee. The following 3 ideas are what guided Committee decisions.

Idea 1: Maximize Spawning and Rearing Salmonid Habitat throughout the Year

Based on results from the IFIM models, The committee made these conclusions:

> *"After considering the habitat needs of all the species, the committee determined that the rearing habitat requirements of cutthroat trout, bull trout, and coho salmon would be adequately met with the recommended flows for chinook and steelhead rearing. Therefore, efforts focused on providing optimal instream flows for rearing steelhead trout and Chinook salmon. The Committee also determined that the most equitable means to balance the rearing habitat needs of both target species was to weight the habitat available for each species equally[…]Considering this analysis for the rearing stage of the target species, the Committee agreed that 10,000 CFS be the recommended instream flow for the Chinook salmon and steelhead trout rearing life stage. The recommended rearing flow will be used during the time periods when spawning by steelhead trout, Chinook salmon, or chum salmon is not occurring in the Lower Skagit River. The flow of 10,000 cfs will be in effect for the Months of January, February, March, July, August, September, and the period of December 16-31." (Page 120)*

However, there are other species and life stages to consider during the rest of the year, and the report addresses this:

> *"In the lower Skagit River, steelhead trout spawn in the spring from April through June […] Pink, Chum, and Chinook salmon begin spawning in the Lower Skagit River in October. Pink and Chinook salmon spawn through mid-November while chum spawning can continue through mid-December […] Maximum steelhead spawning habitat occurs at a flow of 12, 000 cfs while the maximum Chinook spawning habitat occurs at a flow of 14,000 cfs and the maxium chum and pink spawning habitat occurs at 11, 000 cfs […] As with the rearing life stage, The Committee chose to combine life stages of two species in the final analysis. Due to the high concern placed on Chinook by its listing under the Endangered Species Act, The Committee chose to weight Chinook spawning habitat by a factor of 70% and weight chum spawning habitat by a factor of 30%. [This process shows that] a flow of 13,000 CFS provides the maximum spawning habitat.*
>
> *[…]The Committee recommended an instream flow of 12,000 cfs for steelhead trout spawning, 13,000 cfs for combined Chinook and chum spawning, and 11,000 cfs for chum spawning in the Lower Skagit River. The instream flow for Steelhead Spawning could occur in April, May and June. The instream flow for combined Chinook and chum spawning would occur from October 1 through November 15. The Instream flow for chum salmon spawning will continue from November 16 through December 15." (Page 126-127)*

Idea 2: Any decrease in stream flows results in a degradation of estuary habitat

Based on the Estuary Study, the Committee made these conclusions:

> *"The results of the [Estuary Study] clearly indicate the relationship between both tide and stream flow as critical factors for determining the duration of inundation in estuarine habitats. […] The average percent reduction in time that the critical 1 foot depth criteria is equaled or exceeded with a 500 cfs incremental reduction in flow between the flows of 10,000 and 25,000 cfs.*

[…] Given the results from the [Estuary Study] it was evident that any reduction in flow would cause some reduction in the duration of inundation for the estuary habitat. The Committee discussed the issue of [future] hydrologic impacts on the ecological function of the Skagit River and decided that significant impacts to the historical hydrologic regime should be avoided. Based on the Professional judgment of the group, the Committee further determined that a 10% maximum threshold was a reasonable level to set for significant impacts.

Based on this analysis, the Committee determined that a 10% reduction threshold was reached at 836 cfs. The Committee recommended that for the months of February through August the maximum allocation of water from the Lower Skagit River be limited to 836 cfs." (Page 134)

This Recommendation was also incorporated into the Skagit River Basin Water Management Rule.

Idea 3: The natural hydrologic fluctuations must be preserved.

The committee also considered the historic and future potential changes in the hydrologic aspects of the Skagit River system. Some of this research was from the Duke Report, some of it was from other studies. Their conclusions are as follows:

"Other ecologically relevant attributes of the river system, such as flushing flows for out migrating fish, habitat diversity biotic diversity, species distribution, ground water movement and nutrient cycling are recognized to be dependent upon the natural hydrologic variations within a river system (Richter et al., 1997). Natural hydrologic fluctuations that occur seasonally and annually are critical factors that shape nearly all function aspects of the river system (Hill et al., 1991).

To retain the valuable functions of the hydrologic fluctuations, it is necessary to retain natural hydrologic variability within the flow regime (Allan, 1995; Hill et al., 1991). Although a portion of the flow in the Lower Skagit study area is regulated by water released from hydroelectric projects, flow from nearly 70% of the watershed is not subject to human control. In addition, size of the impoundments and regulatory restrictions on the projects limit the seasonal impacts to hydrologic variability.

[…] The committee discussed the issue of hydrologic impacts on the ecological function of the Skagit River and decided that significant impacts to the historical hydrologic regime should be avoided. Based on the Professional judgment of the group, the Committee further determined that a 10% maximum threshold was a reasonable level to set for significant impacts.

In order to ensure that the historic hydrologic regime is not significantly altered, the committee determined that a limit would be placed on the maximum water allocation from the Skagit River from September through January, when the recommended allocation for estuarine habitat protection is not in effect.

After review of the historical hydrologic data from the gaging station at Skagit River near Mt. Vernon (USGS Sta. #12200500), the Committee decided that the monthly 50% exceedence flow was a reasonable criteria to use as a basis to compute the 10% impact threshold. The historical 50% exceedence flow is determined as the flow that is equaled or exceeded on 50% of the days during a particular month."

The Committee recommended the maximum water allocation from the Skagit River be limited to 10% of the flow that is equaled or exceeded 50% of the time for each month." (Pages 135-136)

But what scientific studies were the basis for these discussions that led to mainstem flow recommendations? How did Duke use IFIM? What was this "Estuary Study"? What was this "Hydrologic Study"?

The Duke Technical Report consisted of 3 components, a Skagit river main stem instream flow study, a study of the Skagit Estuary System, and a hydrology study of the Lower Skagit River.

Study 1: The Instream Flow Incremental Methodology (IFIM)

The Duke report succinctly summarizes how IFIM was used in these studies:

"The instream Flow incremental Methodology (IFIM) is based on the premise that stream-dwelling fishes prefer a certain range of depths, velocities, substrates, and cover types, depending upon the species and life stage, and the availability of these preferred habitat conditions varies with stream flow. The IFIM is designed to quantify potential physical habitat available for each life stage of interest for a target fish species at various levels of stream discharge, using a series of computer programs developed by the US fish and Wildlife Service. Major components of the IFIM method include: (1) study site and transect selection; (2) transect weighting; (3) field collection of hydraulic data; (4) development or verification of habitat suitability criteria; (5) hydraulic simulation to determine the spatial distribution of combinations of depths and velocities with respect to substrate and cover under a variety of discharges, and (6) habitat simulation, using habitat suitability criteria, to generate an index of change in habitat relative to change in discharge. The product of the habitat simulation is expressed as Weighted Usable Area (WUA) for a range of simulated stream discharges." (Page 7)

Study 2: The Skagit River Estuary Study:

The Committee and Duke Engineering recognized that stream flows in the estuary may also be impacted by future water use and instream flows. According to the Duke Report, this is important because:

> *"One of the most important aspects of estuaries is that they act as nutrient traps where river-born organic and inorganic materials collect in concentrated amounts. This makes estuaries biologically active areas that support complex food webs of large assemblages of plants and animals from primary producers (plants) to higher level consumers (mammals). The area in the immediate vicinity of the river mouth is particularly rich with plant and animal life (Thompson 1981; Thom 1987). According to Healy (1982 as cited in Thom 1987) all five species of Pacific salmonids use estuaries of their natal stream. Healy found that Chinook were most dependent upon estuaries as a feeding ground. Sockeye and pink salmon utilize estuaries primarily as an area for acclimatization to higher Salinities. There is considerable variation in the habitats used by each species dues to the food that they eat. For example, chum salmon are able to use freshwater, estuarine, and marine food resources. Chum will spend extended periods of time foraging on invertebrates within marshes (Mason 1974; Congleton et al. 1982 cited by Thom 1987). Besides its importance as a nursery habitat for the early life histories of anadromous salmonids, estuaries are also important foraging habitat for sea-run trout. Studies by the Skagit System Cooperative (SSC) have demonstrated the importance of the Skagit River estuary for rearing of sub-yearling chinook (Hayman et al. 1996). Fish species known to occur in the Skagit River estuary include the 5 Pacific salmon species and the char and trout species Dolly Varden, rainbow, and cutthroat. Whitefish, cottids, suckers, chub, peamouth, perch, smelt, sticklebacks, and flounder also inhabit the estuary (Hayman et al. 1996)." (Page 35)*

However, unlike in riverine areas, there is no universally recognized methodology like IFIM to characterize and quantify potential available habitat. IFIM cannot be used because IFIM studies *"predict the habitat value of depth and velocity in relation to substrate and cover as a function of discharge" (Page 36).* Estuaries like those in the Skagit are tidally influenced, which means that depth of water, velocity, and direction of stream flow are affected not only by surface water runoff and ground water inflow, but also ocean tides. Therefore, Duke Engineering elected to develop a hydrodynamic/habitat model that served as their primary tool in their estuary study.

Duke was asked by the Committee to accomplish these 3 primary objectives in the estuary study:

> *"a) to spatially and temporally isolate the tidal from the non-tidal periods;*
>
> *b) to establish a relationship between freshwater discharge and Water Surface Elevation (WSE) for selected estuary channels and associated tidal marshes during both tidal and non-tidal periods; and,*
>
> *c) using WSE as the link, to model estuary hydrodynamics and potential salmonid habitat availability as a function of river discharge.*
>
> *To accomplish these objectives, [Duke Engineering] chose water survey elevation at each study site as the fundamental tool for measuring and analyzing the effect of alternative instream flows on estuary hydrodynamics."*
>
> *[…] In addition to WSE readings, channel geometry and habitat features such as cover and substrate were surveyed at each study site. With channel geometry and the relationship between channel WSE, river discharge, and tide, the study method provided a tool that would predict the relationship between river discharge and a number of hydrodynamic and physical habitat parameters related to water surface elevation. In addition, this method provided a means of determining the tide level below which WSE is only a function of discharge (non-tidal period)." (Pages 44-45)*

The report best summarizes the end result of this new method:

> *"After thorough review and consideration of the inundation frequency data, the committee elected to focus its analysis on duration and inundation as the key indicator for estuary habitat protection. The two key reason were: a) focusing on duration would preserve the amount of time that overbank habitat is made available and would inherently preserve the natural frequency based on the tide cycle; and 2) peculiarities in combining discharge, WSE, and tide frequencies made the Committee less comfortable with the reliability of the frequency analysis over the duration analysis." (Page 102)*

Study 3: The Hydrologic Study

This portion of the report served to the existing body of knowledge on surface water patterns within the Skagit River Basin. Including this information is important because salmonids have adapted to these patterns, because hydroelectric projects had already altered these patterns, and because increased future use may also impact these patterns. (Summarized from pages 103 and 136)

Part 2: A Summary of the 2006 Department of Ecology Skagit River Basin Water Management Rule Amendment

Report Summary: Ecology's "Rule Making Criteria: Background on the Reservations, Closures and Hydraulic Continuity Report" May 2006.

The reservations established in 2006 as part of the Amendment of WAC 173-503 *Instream Resource Protection Program – Lower and Upper Skagit Water Resource Inventory Area (WRIA) 3 & 4* were composed of 3 separate reservations that would not be subject to the Skagit River Basin Water Management Rule. The purpose of the reservations was to establish an uninterruptable supply of water available for out-of-stream needs in the Skagit River Basin. These reservations were defined as follows:

- A reservation of approximately 14.5 cubic feet per second (cfs) was reserved for domestic, municipal, and commercial/industrial uses. This reservation was divided among 25 separate sub basin areas within the Skagit River basin.
- A reservation of approximately 10 cubic feet/sec (cfs)[1] was reserved for agriculture irrigation purposes.
- A reservation of approximately 0.5 cfs was reserved for stock watering purposes.

(Please Note: the 2006 Amendment was invalidated on Oct 3, 2013 by the Washington State Supreme Court in Swinomish Indian Tribal Community vs. Ecology.)

The importance of base flow and the potential impact of groundwater withdrawals

A significant portion of stream flow in the Skagit Basin is dependent on base flow, or ground water recharge, especially during late summer months in tributary sub-basins. For example, base flow was estimated to represent 80-98% of stream flow in Alder Creek, 41-66% of stream flow in Day Creek, and 55-72% of stream flow in Tank Creek during the months of July-September. This information was based on flow data collected over decades. Therefore, groundwater withdrawals from wells can have a significant potential impact on surface water sources during critical times of the year.

With this in mind, the reservations were designed to have a very small impact to the long term sustainability of the fish population in the Skagit and were considered very protective of fish while providing for out-of-stream needs.

Determining the size of reservations

The size the reservations were limited to amounts that Ecology and Department of Fish and Wildlife (WDFW) fish biologists believed were unlikely to significantly impact the long term sustainability of migratory and resident fish populations. Biologists from Ecology, in consultation with the WDFW, determined that the reservation withdrawals would cause a habitat loss of 0.5% to 2% during a bad case scenario such as during a low flow month like September during a low flow year. This percentage loss would be much smaller during the other months of the year when higher flows exist. These numbers are based on an established high correlation between stream flows, habitat and fish population. Numerous studies since the 1940's have demonstrated that the higher the 30 or 60 day low summer flow (August-September), the higher number of returning adult salmon. The results from one such study done by F. W. Olson in 1983 for the South Fork Skokomish River is shown at left, showing the relationship between the size of the Puget Sound Coho Run and low Summer Flows.

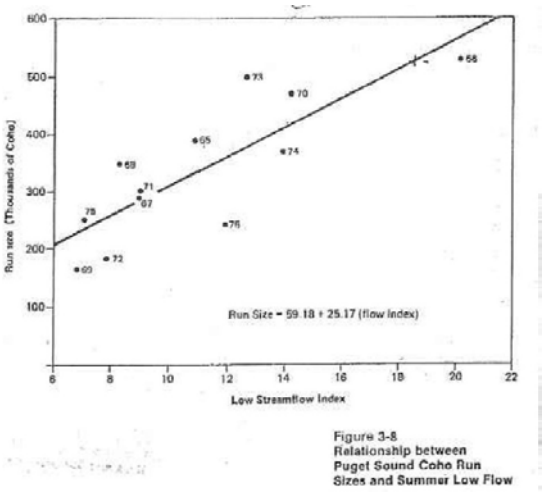

Figure 3-8
Relationship between
Puget Sound Coho Run
Sizes and Summer Low Flow

The impact of reservations on fish habitat

A habitat loss of 1 to 2% was calculated on other streams in Washington State where Instream Flow Incremental Methodology /Physical Habitat Simulation (IFIM/PHABSIM) fish habitat studies were preformed. Ecology biologists found that a 1%-2% loss in habitat closely corresponds with a 1%-2% loss in stream flow during low flow conditions. Therefore, a 1% to 2% loss in stream flow during a low stream flow month such as September can serve as a reasonable surrogate for estimating the 1% to 2% loss in fish habitat in the Skagit River Basin.

7Q10 as a Measure of Low Stream Flow Conditions

Based on the relationship of stream flow to fish habitat, Ecology used a flow statistic known as 7Q10 as representative of low stream flow conditions in the tributary sub basins. 7Q10 is the lowest consecutive seven day stream flow to occur an average of every 10 years (in other words, flow duration at a

[1] 1 cubic foot per second is equal to 448.8 gallons per minute.

particular interval, the longer the interval, the greater likelihood of having lower recorded flows). This is generally comparable to a 90% exceedence flow (a low stream flow that is exceeded 90% of the time over a 10 year interval). The 7Q10 is representative of a significant, longer dry spell than usual which would take months to develop and would have significantly longer-term environmental and economic impacts beyond the low flow duration. Ecology considered 2% of the 7Q10 flows to be the upper limit of an acceptable reservation size when determining the reservation quantities. Since sub-basin specific flow data didn't exist where Ecology intended to implement reservations, Ecology's calculated synthesized flows for each subbasin. Scientists can calculate what an average range of stream flows might be for a watershed by using stream flow data from a similar watershed. This is what is known as a synthesized flow calculation. In Ecology's calculations, the most important criteria for determining correlation between gauged basins and un-gauged basins were similar trends in drainage area and precipitation (mean annual precipitation). The USGS has also used this approach in the statistical regression analysis of high flows for in other parts of Washington State.

Low flows are considered to represent groundwater inflow into the streams (base flow). These base flow conditions occur sometime after the last significant precipitation and surface runoff. Therefore, watershed geology, soil type, land uses, slope, and proximity between basins were also considered when determining the relation of gauged to un-gauged watersheds. In assigning specific quantities of the reservations to each basin based on 2% of the 7Q10, Ecology used a metric called Cubic Feet/second to Square Mile (cfs/square mile) or CSM. This is the total amount of instantaneous flow per total area of the basin.

Notes on the Agricultural Irrigation Reservation

The agricultural irrigation reservation was limited to only the Mainstem sub-basins (Upper, Middle, and Lower Skagit). This reservation was sized to stay below the 1-2% stream depletion threshold, as previously discussed, and was also shaped by assessing future agricultural irrigation demand. Irrigation water rights are typically seasonal rights used during the irrigation growing season. In Western Washington, for crops that are typically grown in this region, the irrigation season is typically defined in water rights for the months of April- October, approximately 180 days. The irrigation season is the authorized period of use for the water, and it is unlikely that an irrigation water right holder would use water throughout this period. The agricultural reservation was 3,564 acre feet per year. This figure was derived by assuming 10 cfs diverted continuously throughout the irrigation season.

The quantities authorized under the water right were based on the physical capacity to withdraw water and the projected irrigation need. According to water demands for typical crops grown in the Skagit Basin, the average water duty for crops grown in the Skagit Basin is approximately 1.5 acre feet per acre. Based on these assumptions the agriculture reservation of 3,564 acre feet per year would cover an additional 2,376 acres.

Conclusion of 2006 Amendment Summary

Please note that this approach for determining reservation quantities is not as rigorous as is currently possible. A more detailed analysis including more sophisticated modeling would improve accuracy. Sub basin instrumentation for precipitation and stream flow would also have provided more definitive flow estimates. However, such data collection and modeling would take significant resources, especially if studies were performed at each sub basin. Also, it is unknown whether the results would significantly differ from the reservation values created by the conclusions of the existing approach.

The above method of determining suitable reservation amounts was independently peer reviewed by Geomatrix Consultants. Additional information and recommendations provided by Geomatrix's review were incorporated in the final report as was deemed appropriate.

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