A Summary of the 1999 Duke Final Technical Report – *the basis for the 2001 Skagit River Instream Flow Rule*

(tables, charts, and excerpts of key ideas from this report are included in a separate document)

Introduction

The Skagit River Instream Flow rule was based on scientific studies conducted by third party consultants, and then peer reviewed by an additional third party consultant for validity and appropriateness. In June 1999, Duke Engineering and Services, Inc. concluded its *Technical report: Lower Skagit River Instream Flow Studies* (The 1999 Duke Report). This report was reviewed by Hardin-Davis, Inc. in March of 2005. The 1999 Duke Report is the basis for the Skagit Instream Flow Rule (WAC 173-503).

The 1999 Duke Report used an established method for determining base flows for non-estuarine river systems. The Instream Flow Incremental Methodology (IFIM) was developed in the 1970's by the US Fish and Wildlife Service and is the best and most rigorous available method for determining the relationship between stream flows and habitat. The IFIM is a series of computer-based models based on data collected in the field by scientists.

What are the instream Flow Numbers Established in that 2001 Skagit River Basin Instream Flow Rule?

The Skagit Mainstem instream flow numbers established in the 2001 Skagit Basin instream flow 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 the 1999 Duke Final Technical Report? What is the story? 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. These studies were commissioned by Skagit PUD and the City of Anacortes.

Skagit PUD and the City of Anacortes were required to pay for these studies as part of an agreement known as the *Memorandum of Agreement Regarding Utilization of Skagit River Basin Water Resources of Instream and Out of Stream Purposes, 1996* (The '96 MOA).

Additionally, there were other participants in the '96 MOA. Other members included Skagit County, The Washington State Department of Ecology, The Washington State Department of Fish and Wildlife, and the Skagit System Cooperative (Consisting of The Swinomish Tribe, the Upper Skagit Tribe, and the Sauk-Suiattle Tribe).

Skagit County PUD and the City of Anacortes had water right applications filed with Ecology. Due to the contentious nature of water use in the Skagit River Basin, the participants in the '96 MOA agreed to help expedite the water right decision process while also setting instream flows to protect critical salmonid habitat.

The participants in the '96 MOA, along with their consultants, formed "The Committee", an entity that is referred to in the Duke Report. The Committee ultimately made instream flow recommendations (shown on the last page of the Duke Report, page 138) to Ecology, that were adopted by Ecology in the 2001 instream Flow Rule.

Why were these numbers recommended?

After Duke Engineering concluded their IFIM study in the Skagit River Mainstem, their Estuary study, and their hydrology study, their findings were reviewed by The Committee.

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

Based on the IFIM study, 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.*
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> *[…]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.*
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> *[…] 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.*
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> *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).*
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> *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.*
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> *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 was this "IFIM Study", really? 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 Methodolodgy (IFIM)

The Duke report succinctly summarizes IFIM:

> *"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;*
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> *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,*
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> *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).

In short, the Skagit Instream Flow Rule adopted by Ecology was a direct result of the conclusions made by the Committee, a diverse group of entities representing many interests in the Skagit River Basin, after their careful review of 3 river and estuary studies performed by Duke Engineering in the late 1990s.

References

Allen, J. D. (1995). *Stream Ecology: Structure and Function of Running Waters*. Chapman & Hall, New York.

Congleton, J. L., Davis, S. K., & Foley, S.R. (1982). Distribution, Abundance, and Outmigration timing of Chum and Chinook Fry in the Skagit Salt Marsh. *Proceedings of Salmon and Trout Migratory Behavior Symposium, June 3-5, 1981*. Edited by E. L. Brannon and E. O. Salo, 153.163. School of Fisheries: University of Washington, Seattle, WA.

Duke Engineering & Services, Inc . (1999). *Final Technical Report: Lower Skagit River Instream Flow Studies* Prepared for Public Utility District No. 1 of Skagit County and City of Anacortes. Bellingham, WA.

Hayman, R. A., Beamer, E. M., & McClure, R. E. (1996). *FY95 Skagit River Chinook Restoration Research.* Skagit System Cooperative. Chinook Restoration Research Project Report No. 1. Final Project Performance Report in Compliance in Part with NWIFC contract No. 33115 for FY95.

Healy, M.C. (1982). "Juvenile Pacific Salmon in Estuaries: The Life Support System*". Estuarine Comparisons*, edited by V.S. Kennedy, 315-341. New York Academic Press.

Hill, M. T., Platts, W.S. & Beschta, R. L. (1991). Ecological and geomorphological concepts for instream and out-channel flow requirements*. Rivers,* 2, 198-210.

Mason, J.C. (1974). Behavioral ecology of chum salmon fry *(Oncorhynchus keta)* in a small estuary. *Journal of Fishery Research Board of Canada*, 31:83:92.

Thom, R.M. (1987). *The biological importance of Pacific Northwest estuaries.* College of Ocean and Fisheries Sciences, University of Washington, Seattle, WA.

Thompson, R.E. (1981). *Oceanography of the British Columbia coast*. Canadian Special Publication of Fisheries and Aquatic Sciences. 56:291 p.