State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Mailing Address: PO Box 43200, Olympia, WA 98504-3200 · 360 902-2200 · TDD 360 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street, Olympia, WA

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Dr. Jonathan Yoder
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State of Washington Water Research Center
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Dear Dr. Yoder,

We thank you for the opportunity to contribute to the 2022 Scope of Work for the Join Legislative Task Force on Water Supply and Availability in the Skagit River. Maintaining adequate water to support fish and wildlife in the Skagit is of vital importance. As the largest river in the Puget Sound with the most productive salmonid populations, preserving existing habitat and improving degraded habitat is imperative to support salmonids and the network of species that depend on them.

Below we describe our requests for future research guided by the needs of fish and wildlife, the 2021 Washington Academy of Sciences review of the Duke Study, and the WSU Skagit Water Supply and Demand Synthesis.

1) **What: Develop species and life stage specific habitat suitability indices for fish species occupying the estuary.**

   Why: The WA state Instream Flow Study guidelines (https://apps.ecology.wa.gov/publications/SummaryPages/0411007.html) specify that when instream flows are set for a basin, it is preferable to use river specific Habitat Suitability Indices (HSIs) yet the Duke estuary study did not target individual species. Developing estuary specific HSIs would improve our understanding of how changes in water level, flow, and substrate affect species and life stage specific habitat use. As stated in the 2021 WSAS review of the Duke study "The study does not estimate abundance of habitat in channels or overbank areas, nor does it differentiate between fish species". The WSAS review further suggested that there was a need to "Connect the upstream and estuary study to better understand the watershed as a whole, particularly in the context of fish habitat and life histories".

   How: Development of HSIs by species and life stage for the estuary. See Bovee 1986 (https://www.google.com/books/edition/Development_and_Evaluation_of_Habitat_Su/88pBfPKB-cAC?hl=en&gbpv=0)

   Data: Skagit River specific HSIs for the estuary could be used in an updated IFIM process to better assess and protect the habitat needs of fish.

2) **What: A habitat and flow assessment that includes habitat beyond the lower reaches of the Skagit River basin could provide more current understanding of the system and food web.**

Why: The Skagit River is dynamic, and habitat has likely changed at the sites examined in the Duke report in 1999. An update would provide current data, as recent analyses assume depths and velocity profiles have remained similar. Conditions likely vary across the watershed, so a better understanding of how flow conditions influence spawning and rearing habitat will depend upon better studies of fish, their habitats, and patterns of flow that incorporate spatial variation. Additionally, the WSAS review of the Duke studies suggested that it “Include additional analyses of the interactions between water surface elevations and inundation and flow processes, to understand the effect of inundation processes on estuary food web and species-specific fish habitat”.

How: Apply the IFIM modeling approach used by Duke Engineering (1999) to other reaches with different cross-sectional areas and associated substrate types with updated HSIs for updated portions of the watershed. These should be done for both reference reaches (little impacts to the hydrograph, riparian conditions, and aquatic substrates) as well as places associated with various impacts to flow, temperature, and riparian conditions.

Data:

Surface Water: This could fill a critical gap if it expands the IFIM analysis to tributaries that are critical for fish habitat, rather than only the mainstem. With information about flow levels that are optimum for fish habitat, the DHSVM surface flow modeling and projections could be used to understand the frequency with which these flows are met now and how that would change with climate change. While current DHSVM modeling includes all the tributaries, it is difficult to use this information when it is not known what the optimum flows are for fish in the same locations (note that new HSC curve development described under #1 would support this effort).

Fish Habitat: Although this work predicts the effects of flow on habitat area for the lower Skagit River, much of the higher quality habitat occurs in areas upstream. Better knowledge of habitat extent across the basin will improve our understanding of flow-based constraints on fish populations.

3) **What: Life cycle models that incorporate spatial variation to account for movements of fish within the watershed.**

Why: Many fishes are highly mobile and move both upstream and downstream to find high quality habitat (e.g., food, refuge, optimal temperatures, or dissolved oxygen). This is especially true for Pacific salmon, which must eventually migrate to the ocean at some point in their life cycle. Movements within a watershed complicate assessment of the effects of flow-related impacts to habitats in portions of the watershed upon the entire population because patchy high-quality habitats may "buffer" impacts of poor-quality habitats, even as they reduce the total amount of habitat in the basin. In addition,

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evaluating flow-related impacts should account for multiple limiting factors or cumulative impacts to habitat at different life stages.

How: Because they incorporate multiple life stages, all life cycle models address multiple possible limiting factors. Many life cycle models have been developed to account for spatial variation and some can accommodate for movements of individuals within basins, and these can readily be adapted for the Skagit River basin.

Data: Because fish are capable of moving and migrating, getting at quantitative impacts of flow management to fish populations requires a spatially informed model, and without this, it's easy to "point fingers" at other impacts affecting fishes.

4) **What: Additional modeling is needed to simulate future water temperatures to determine what flow levels are needed to maintain water temperatures at levels that are consistent with salmon recovery goals.**

Why: A key factor affecting fish – in particular the flow levels needed to maintain healthy habitat conditions for salmon – is water temperatures. Warmer air in the future could lead to inhospitable water temperatures even if instream flow targets are met.

How: Future water temperatures can be estimated with the River Basin Model, which was designed to work with DHSVM flows and provides physically-based water temperature estimates; the model can also be used to simulate the relationship between flow levels and water temperatures at specific times in the future. Modeling results could be confirmed, in part with eDNA monitoring for upstream fish presence.

Data:

Surface Water: Water temperature will likely be a dominant constraint on low flows, given the implications for salmon viability. Could also relate to water quality for municipal and agricultural uses.

Groundwater: Baseflow rates, and the proportion of streamflow composed of baseflow from groundwater, would play a significant role in moderating temperatures.

Fish Habitat: Water temperature plays a huge role in positive (growth) and negative (stress, migration, mortality) fish responses in certain watersheds.

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5) **What: Multivariate analysis of water quality metrics to determine which attributes are tied to poor flow conditions.**

Why: While river flow is often considered a master variable for determining habitat conditions in rivers, extreme flows are just one parameter affecting fish measured in Skagit streams. In addition to stream flow, water quality measurements such as temperature and invertebrates are measured in lowland tributaries, and integrating these can help determine best management practices such as flow management versus other management interventions (e.g., improved shade).

How: Multivariate data analysis of habitat attributes (e.g., velocity, temperature, invertebrates, and estuary/lower main channel salinity) integrating landscape drivers (e.g., land use, shade, water availability).

Data: Fish Habitat: Evaluating multiple dimensions of habitat characteristics and potential impacts (and their spatial variation) can help put flow management in better context of alternative forms of management.

6) **What: The DHSVM hydrologic model used to simulate streamflow in this assessment includes a glacier model that simulates melting glaciers and the contributions of glacier melt water to streamflow, but the glacier model has not been thoroughly validated to ensure it adequately represents glaciers, glacier melt water, and the response of glaciers to warming.**

Why: Glaciers in the upper Skagit basin contribute substantial water to streamflow in late summer, the time of lowest flows and greatest likelihood of scarcity. These glaciers are sensitive to climate change and changes in glacier melt water will affect surface water availability in the basin in the future.

How: Additional model refinement could improve on the glacier simulations, thereby ensuring that future streamflow estimates accurately reflect changes in glacier contributions to flows.

Data:

Surface Water: This would hopefully help to reduce the bias in the streamflow, particularly for summer low flow times when water scarcity is of greatest concern. This would improve flow simulations for the tributaries, an interest expressed by some on the task force.

Fish Habitat: Better understanding of effects of glaciers on summer flows will improve understanding of low flow and summer temperature constraints on cold-water fishes.

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Please contact me if you have any questions regarding our research requests. We thank you for the work your team has and will be putting into the development of a scope of work and look forward to being very engaged in the process.

Sincerely,

Dr. Kiza K. Gates

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