

Skagit River Basin Hydrologic Study Reports: The Estuary Study, the Groundwater Study, and the Tributary Study

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*Julie Padowski, Project Manager, State of Washington Water Research Center
Jonathan Yoder, Director, State of Washington Water Research Center*

Thomas Gast & Associates Environmental Consultants
HDR Engineering
NOAA Northwest Fisheries Science Center
Washington State Academy of Sciences

Overview

The Skagit Basin's complex hydrologic system of surface and groundwater supports growing municipalities and rural communities with water for consumption and for energy production, irrigated agriculture, ecosystem services that support salmon and steelhead, recreation, and other uses. The system is fed seasonally by rain and snow, and the Skagit River mainstem flows are regulated in part by reservoir releases and water withdrawals. The dynamics of the Skagit hydrologic system are changing along with changes in climate and demographics. A great deal of research, data, and information about water availability and use in the Skagit Basin has already been generated. However, there remains critical gaps in our understanding as they relate to the basin's estuary, mainstem and tributaries, hydrogeology, fish habitat resources, and water demand. To this end, the Task Force identified and funded three projects aimed at addressing knowledge gaps in these areas, as described below:

1. ***Comprehensive Hydrologic Study of the Skagit Estuary*** aimed to evaluate how water withdrawals from the Skagit River affect estuarine habitats and fish populations in the Skagit River delta and Skagit Bay. This work includes data collection on topography and seasonal inundation of the estuary and analysis of

seasonal variation in habitat, a synthesis of habitat suitability indexes for target species, and hydrodynamic modeling for the estuary and life cycle modeling for target species.

2. **Skagit River Basin Groundwater Study** studied the Skagit River mainstem in the vicinity of Grandy Creek to understand the subsurface geology and aquifer characterization (hydrogeologic framework); groundwater baseflow assessment via hydrograph separation and to characterize groundwater-surface water interactions via seepage run surveys and hydraulic gradients at paired gaging stations.
3. **The Skagit River Tributary Instream Flow Habitat Assessment** was tasked with assessing fish habitat suitability in Grandy Creek under historical and future streamflow alterations as impacted by different climatic and population growth scenarios.

These projects were completed over a two-year period from July 2023 through June 2025. Initial drafts of each report were submitted to the Water Research Center, who contracted with the Washington State Academy of Sciences (WSAS) to conduct an expert technical review of the work completed. WSAS reviews were shared with project teams who had the opportunity to revise their final documents based on the provided suggestions and comments before submitting their final report.

Key Findings

The work included here is meant to fill pressing knowledge gaps in our understanding of how climate, hydrology, and environmental and human needs intersect in the Skagit Basin. To this end, key findings from each report are highlighted below:

Comprehensive Hydrologic Study of the Skagit Estuary

- The modeled efforts provided here improved resolution and accuracy over previous models (i.e., the Duke Study), especially in small tidal channels.
- Overall, juvenile Chinook salmon and other estuarine species were most abundant in low-salinity, low-velocity, and moderate-depth waters.
- The South Fork of the Skagit delta was most affected by increased salinity under high water use scenarios, especially in low-flow years.
- Flows reduced habitat suitability for juvenile Chinook salmon, although this effect was nonlinear, and was dependent on location in the delta and time of the year.
- Under high water use and low-flow conditions, shrub cover declined by up to 27%, replaced by herbaceous species. These changes could reduce habitat quality for species like beavers, which create important rearing habitats for juvenile salmon.

Skagit River Basin Groundwater Study

- Aquifer characterization (Tasks 200 and 500) suggests the area is made up of complex geology. Data and monitoring validate aquifer continuity from the glacial outwash deposits in the eastern portion of the study area recharging Skagit floodplain aquifers and the Skagit River. There may be no truly isolated aquifers in the upland area that would serve as an alternative water supply.
- The evaluation of groundwater/ surface water interactions indicate that both Grandy and Muddy Creeks gain flow from groundwater in their respective watersheds and then discharge flow to the aquifer associated with the Skagit River floodplain during the low-flow period. Both Grandy Creek and Muddy Creek gain flow from groundwater discharge from outwash deposits. Grandy gains more flow. Differences in groundwater gains were due to the presence and thickness of glacial outwash. Both streams lose flow on the Skagit River floodplain because of seepage into the alluvial aquifer.
- Hydrograph separation efforts (Task 300) used 44 gaging stations of streamflow data collected between 1908 and 2021. From these and other data, this work offers a wide set of water balance data, from precipitation to basin runoff, including components partitioned into GW recharge, and streamflow, and the portion of streamflow moving through the GW system and emerging in streams as baseflow. Findings indicate that about 85 percent of the subbasins analyzed have estimated GW discharge rates that are higher than the GW recharge rates derived from the Synthesis Study (Yoder et al. 2021).

The Skagit River Tributary Instream Flow Habitat Assessment

- The hydrologic changes in Grandy Creek from the climate and population growth scenarios only impact the life-stages present during the summer months. Climate change impacts to hydrology suggest a 15-20% reduction in summer streamflow, which would negatively impact salmonids using the stream at this time, including steelhead fry and juveniles, coho juveniles, and Chinook spawning.
- Spawning habitat is more prevalent in the lower reach of Grandy Creek, and is more responsive to flow changes than rearing habitat. Rearing habitat suitability is generally low across all flows due to limited instream cover and pool habitat.
- Restoration of rearing habitat (e.g., increasing pool frequency and instream cover) would be more effective than flow manipulation alone.