Assessment and Inventory of Hydromodified Bank Structures in the Skagit River and Floodplain

Final report submitted to the
Skagit Watershed Council
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Prepared by
The Upper Skagit Indian Tribe
Natural Resources Division

Introduction

The Skagit Watershed Council (SWC) received a Salmon Recovery Funding Board (SRFB) grant to support efforts of a scientifically based approach for identifying and prioritizing opportunities to restore and protect floodplain functions for salmonids in the middle Skagit River. The effort is titled “The Middle Skagit River Project Development” and is being administered by staff from SWC. A data work group was created to procure existing information and to design and/or collect additional data for the project to achieve its objective. This work group identified updating the 10 year old assessment of hydromodified bank structures along the mainstem Skagit River as a priority in developing a scientific approach for habitat protection and restoration activities.

The Upper Skagit Indian Tribe received a contract award from the SWC to conduct the hydromodified bank assessment. The assessment covered all mainstem and secondary river channels of the Skagit River and Chinook bearing tributaries within the Skagit floodplain from the confluence of the Sauk River downstream to the Highway 9 Bridge in Sedro-Woolley. The inventory surveyed areas adjacent and water ward of active mainstem and secondary channels in their current configuration. The scope of work did not include surveying the entire floodplain for structures that could have impacts to a free flow functioning floodplain. To conduct that type of assessment would require substantially different approaches, methods, and budget. This assessment is part of a larger process examining salmon habitat productivity limitations in a developed floodplain of a large river system. Therefore only those hydromodifications immediately adjacent or within the mainstem, secondary channels, and Chinook bearing tributaries were inventoried. The focus of the assessment was to inventory structures visually identifiable that are currently impacting edge habitat. This reach level assessment collected preliminary screening data to be incorporated into additional modeling to determine the areas of greatest habitat potential. Please see Figure 1 for area surveyed, red lines indicate the channel, both banks were screened visually for impairment.

The mainstem and secondary channel surveys were conducted from the water in a jet boat and tributary and or low flow secondary channel surveys were conducted by walking the channels. Surveyors moved downstream looking for anthropogenic bank hardening or flow modifying structures along the water’s edge. The surveyors looked for hydromodified bank structures (i.e. angled rock, concrete slabs, debris, pilings, or disturbed natural banks), to identify areas for rapid assessment mapping using Global Positioning System (GPS) technology. Attributes for these structures were assessed and recorded by their unique site ID which is based on floodplain reach breaks. The floodplain reach breaks and nomenclature are those referenced in the Skagit Chinook Recovery Plan (2005).

Methods

An earlier assessment was conducted in 1998, although no report describing methods were produced, one can determine what and how was collected reviewing the metadata associated with the GIS data.

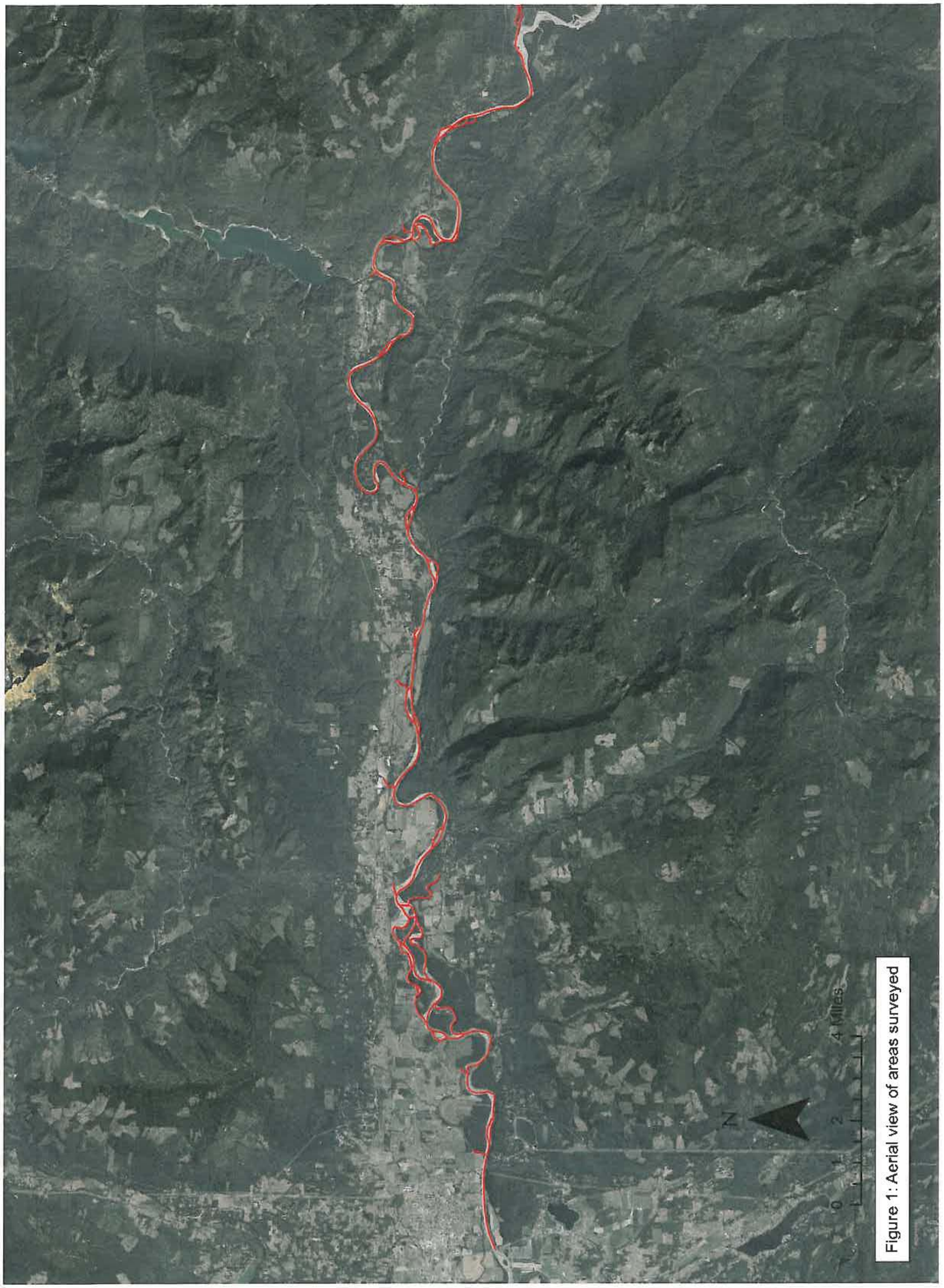


Figure 1: Aerial view of areas surveyed

The current assessment replicated some of the attributes from the previous inventory. The current survey utilized newer software and technologies to enhance the spatial accuracy of inventoried structures. The nomenclature system for each unique feature was replicated from the previous survey. Other metrics collected in the current assessment that were also collected in the original survey include; reach delineation, location in channel, type of hydromodification, size classes of material within structure, association of levee, riparian buffer type and width, what the structure was protecting, and length of the structure. The new attributes collected in this assessment include; vegetation coverage and type of vegetation cover within the structure, height of the structure in relationship to water levels at time of survey, difference in natural bank height vs. hydromodification height, photographs of each structure, slope of hydromodification, a distinction if this was a new feature compared to last survey, and if maintenance was needed or recently conducted on feature. In addition to the line features surveyed (hydromodifications) the current survey also inventoried sub-modifications – relatively short non natural visual hard points or flow modifying structures in or adjacent to water channels. Examples of sub-hydromods include; piers, stairs, abandoned vehicles, fishing huts, or other dwellings. All channels surveyed for this inventory were accessed by a jet boat or by walking. No attempt was made to survey the entire floodplain for flow altering or manmade infrastructure that could alter a free flowing river through a floodplain, only areas adjacent or water ward of current channel configurations were surveyed. The survey only used visual observations to inventory structures in or adjacent to channels.

To assist in data collection, 11” x 17” laminated aerial photographs of individual reaches were developed to assist in river navigation, data collection, and identification of previously surveyed hydromodified bank features and the associated site ID. If new structures were located the reach maps aided in identifying the proper sequential nomenclature. Please see Table 1 for attributes collected. All field measurements taken such as slope (%), levee height, bank height, hydromod height, and material size are visual estimates in feet. With the exception of riparian width which was estimated in meters. Height of hydromodified structures was a visual estimate from the water’s edge to the top of the structure in feet. Bank height was also a visual estimate from the water’s edge to top of the natural bank in feet. It needs to be understood that this estimate was largely influenced by the river stage height at time of survey. The top of the natural bank was an estimate of what the height of the natural bank would be without a structure. Depending on channel and upland dynamics this could have been a visual estimate of the natural bank next to the structure, or estimating what the natural bank was behind the structure. The difference in bank height and hydromodified height (in feet) was used to depict how much of the natural bank height was converted into artificial or hardened bank, and to document if the hydromodified bank was taller than the natural bank. For instance all the site ID’s that have a negative value for this metric indicate that the hydromodified bank is taller than the natural bank. The levee height metric was a visual estimate of the levee height compared to the surrounding floodplain height. Levee height was estimated by looking from top of levee to the natural floodplain height behind the levee. For features that had a levee adjacent to the hydromodification the bank height was determined by basic surveying methods, looking behind the levee to determine the natural bank height compared to the water’s edge.

All features including both linear segments (Hydromodified Banks) and point segments (Sub Hydromodified Banks) were delineated using a 2008 Trimble GeoXt handheld GPS and projected using the NAD_1983_StatePlane_Washington_North_FIPS_4601 coordinate system. In addition, a pre formatted data dictionary with the approved attribute fields was developed to record all associated data while GPS information was collected for each site. Attributes within the dictionary were designed either as drop down menus, numeric entries, or text entries to both simplify and ensure consistency in data collection between users. All surveyors were given training and field cheat sheets describing each metric for data collection. In addition to collecting spatial, physical and environmental data, a camera was used to take individual photos of each feature. Each photo was then converted to a PDF file and hyperlinked to its corresponding feature within ArcMap.

Post processing of data consisted of downloading field data from the Trimble unit using GPS Pathfinder Office software which enables one to convert data files to GIS shape files. Shape files were then saved along with the pictures under folders labeled with that days date. At this point, pictures were renamed with their corresponding features “Site ID” and saved for later processing and both the line file (hydromod_2010) and the point file (submod_2010) were renamed to reflect the date of collection. When the field portion was complete, all line files and point files were appended into two separate master shape files.

	Description
FID	Internal # automatically assigned by GIS
Shape	Geometry *i.e. line feature*
Reach	Code associated with corresponding floodplain reach identifier.
Site ID	Unique Identifier for each Hydromodified bank. *Example: SK100-1*
Water Type	Main stem, secondary channel, tributary
Location	Right bank or left bank: looking downstream
Mod_Type	Denotes type of Hydromodification. *Example: riprap, groins, bridge abutments, pilings, deflectors, barbs, other*
Sub_Mod_Type	Sub classification of Mod_Type (Other). *Example: Cars, Cement, Large Organic Debris*
LWD	Using TFW (1999) size classes, count logs, root wads and jams in or associated with hydromods
LWD_Origin	natural, constructed, unknown
Slope	Visual Estimate of the degree of slope. *Example: 60˚-90˚, 45˚-60˚, < 45 ˚*
Levee	Denotes whether there is a levee or not. *Example: none, adjacent, or > 60m*
Levee_Height	Estimate of levee height above surrounding floodplain in feet
Bank_Height	Estimate of natural bank height above water's surface in feet
Hydromod_Height	Estimate of hydromod bank height above water's surface in feet
Difference BH-HH	Estimated difference of bank height minus hydromodified bank height in feet.
Largest_Size_Class	Visual estimate of the largest most dominant size of material. *Example: >4', >2'<4' , < 2', NA*
Dom _Size_Class	Estimate of the dominant size class. Example: >4', >2'<4' , < 2', NA
Old/New	Denotes whether surveyed in 1998 or not. *Old = prior survey New = non surveyed*
Maintenance	Visual determination of whether or not recent maintenance has been performed
Veg_Coverage	Indicates presence of vegetation within hydromodified bank structure
Veg_Type	Indicates type of vegetation within hydromodified bank structure
Rip_Type	Riparian stand type. *Example: Includes none, exotic(weeds), shrubs and willows, Immature < 20 "diameter(Deciduous, Coniferous, Mixed), Mature>20" diameter (Deciduous, Coniferous, Mixed)*
Rip_Buffer	Visual estimate of average buffer width in meters
Protecting	Highway, road, houses, farm field, not apparent, and other
Comments	Other information unique to the site, usually landmark related
Hyperlink	Link to PDF photo of each unique site
Length _m	Length of arc in meters, computed by GIS
Length_f	Length of arc in feet, computed by GIS

Table 1. Attribute table describing the metrics collected in the 2009-2010 Hydromification Inventory.

Data Quality Assurance and Quality Control

Besides the spatial data collected with the GPS unit, a list of other physical and environmental metrics was developed and approved by the Middle Skagit Workgroup's data committee. Data associated with each feature was recorded using a pre formatted data dictionary which was loaded onto the Trimble handheld GPS unit. This dictionary was designed with both versatility and simplicity in mind to ensure accurate and consistent record keeping regardless of the user. Each attribute, or field, was created to be a drop down menu, a numeric entry or a text entry. For example, the slope field was broken into three bins, less than 45 degrees, 45 – 60 degrees, or greater than 60 degrees. Some fields such as levee height, bank height, and hydromod height were left as numeric fields in order to provide a more site unique value for each entry.

All measurements recorded within the attribute table, with the exception of length which was calculated by GIS, are visual estimates. A pre survey calibration was performed to standardize the surveyor's estimates as closely as possible. For instance, one would approximate what he/she felt the height or the length of an object was, and then the object was measured with a laser range finder. This practice was done until visual estimates were consistently within 5 feet of measured distances. This practice was sporadically revisited during the assessment to ensure accuracy throughout the duration of the survey.

Quality assurance was met in the post processing environment from multiple angles. The attributes of each point and line feature were individually proofed for completion and accuracy by clicking on the feature within GIS and examining individual records. In addition, the hyperlinked photos and aerial photographs were used to compare data within the attribute table with other visual and spatial data. The riparian buffer size and what the structure was protecting was checked most frequently in this process. Any anomalies or uncertainty observed during this screening was recorded, so that the Site ID and the item in question could undergo post processing ground truthing. In addition to the post processing ground truthing for specific questions, a sub sample of features was resurveyed to ensure accuracy.

Results

Reach	Site ID	Mainstem	Secondary	Tributary	Total
SK050	Hydromodified Bank	2138.5	0	0	2138.5
	Sub Hydromodified Bank	21	0	0	21
SK060A	Hydromodified Bank	7347.8	3072.4	353.8	10774
	Sub Hydromodified Bank	11	5	0	16
SK060B	Hydromodified Bank	4751.5	309.5	0	5061
	Sub Hydromodified Bank	11	4	0	15
SK070A	Hydromodified Bank	154.3	123.3	0	277.6
	Sub Hydromodified Bank	0	0	0	0
SK070B	Hydromodified Bank	781.2	0	0	781.2
	Sub Hydromodified Bank	2	0	0	2
SK080A	Hydromodified Bank	450.9	0	0	450.9
	Sub Hydromodified Bank	12	0	0	12
SK080C	Hydromodified Bank	1265.1	0	0	1265.1
	Sub Hydromodified Bank	5	0	0	5
SK080B	Hydromodified Bank	953.3	984.2	0	1937.5
	Sub Hydromodified Bank	5	4	0	9
SK090	Hydromodified Bank	485.7	107.8	0	593.5
	Sub Hydromodified Bank	2	1	0	3
SK100	Hydromodified Bank	412.4	182.6	0	595
	Sub Hydromodified Bank	5	0	0	5
SK100A	Hydromodified Bank	58	0	0	58
	Sub Hydromodified Bank	0	0	0	0
Totals	Hydromodified Bank	**18798.7**	**4779.8**	**353.8**	**23932.3**
	Sub Hydromodified Bank	**74**	**14**	**0**	**88**

*Table 2. *Hydromodifid Bank lengths have been calculated in both feet and meters and are captured in the data sets attribute table. All hydromodified bank measurements within this table have been expressed in meters and rounded to the nearest tenth. Sub hydromodified bank values are expressed in quantity per reach/water type.*

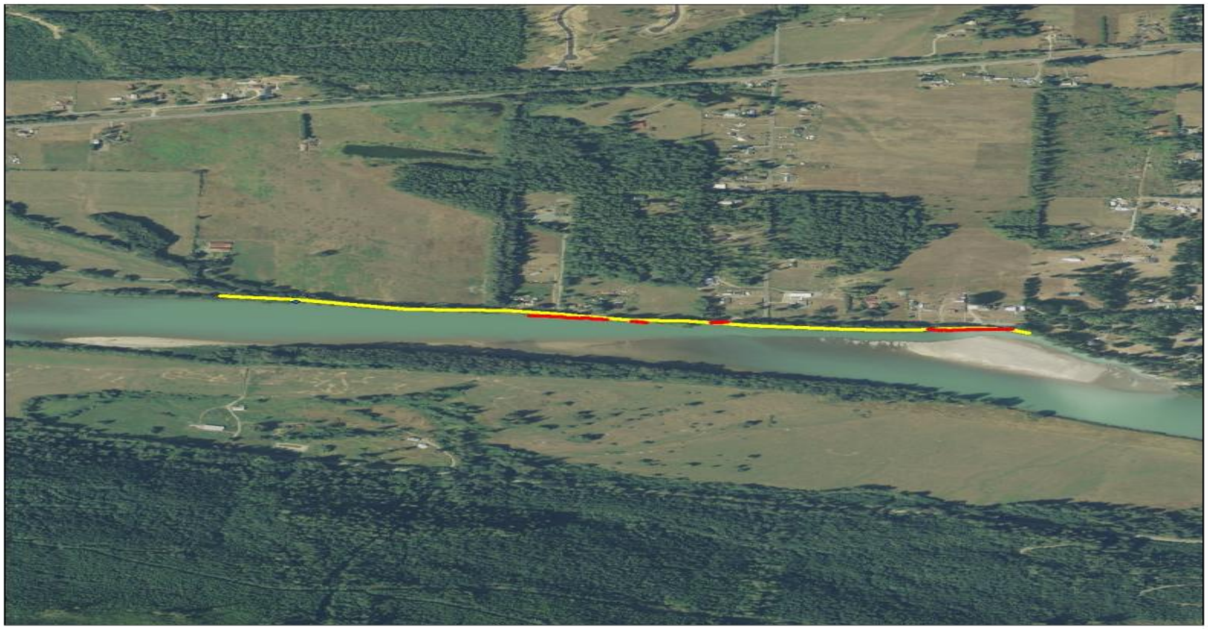
The results of the assessment are summarized in Table 2, and the distinct reaches are identified in the Appendix.

Discussion

The assessment was started in late September 2009 and was completed in February 2010. Weather and flow conditions largely dictated when the surveys could be conducted. Early attempts in September and October were abandoned due to extreme low flows that restricted boat mobility. Fall weather and flows also restricted the surveys when the river was near or at flood flows much of November and December. The majority of the assessment was conducted from December through February. This was the ideal time for conducting this work, because flow levels were low and stable. Water clarity was high and little vegetation obscured bank structures. Conducting any surveys under high turbid flows would limit the accuracy of the data, and was the primary reason for extending the timeframe for this assessment. For instance site SK060B-4 was called out by reviewers under concern that the feature was on the older inventory but not the current inventory. On the final ground truthing less than one foot of rock was exposed above the water's surface, during earlier surveys the river stage height was higher making it impossible to see and inventory that structure. The assessment was limited to visual surveys for hydromodified bank structures and no attempt was made to query historical and current permits for locations and types of hydromodifications, nor were any soil probes or areas cleared to determine if old bank hardening structures were buried under flood sediments and/or vegetation.

It is also important to note the limitations of the data set based on the intentions of the survey. The intent of this inventory was to conduct a reach level assessment to aid in the process of prioritizing large restoration projects to improve salmonid habitat productivity. The rapid field assessment was an inventory to gain spatially explicit information about floodplain and edge habitat impacts to aid in the identification of site specific locations for future detailed studies or scoping. The majority of the attributes in this data set were visual estimates and if site specific actions are being proposed a more detailed assessment needs to be conducted. The height estimates for Hydromodifications, banks, and levees were all dependent on the water surface elevations at the time of survey and no attempt was made to calibrate these estimates to one river stage height.

There may be a tendency to compare the results from this survey with that of the original survey back in 1998. Caution should be used on such occasion. The intent and methods of these two surveys were different making comparative analysis or trend assumptions difficult. The original survey used cartography to map structures, and the newer assessment used highly sophisticated software technology to map structures. The resolution differences in these methods may account for some discrepancies between the results in the two data sets. In addition to technology differences much time has elapsed with several large floods happening after the last inventory. These floods have had the power to move the river away from hardened banks and points, and in some instances dislodged old rip rap from a bank protection location in or downstream in the river. It could also be the case that these flood events have moved large sediment loads over existing rip rap so that it would be impossible to detect with our visual surveys. Given the time elapsed between surveys vegetation growing in the hydromodification may have also hid structures from the visual surveys. These circumstances may explain some of the discrepancies, but the following example helps illustrate the fundamental difference in the two data sets.   See the picture below in reach SK070A with the yellow line representing old 1998 data and the red line depicting 2010 data.

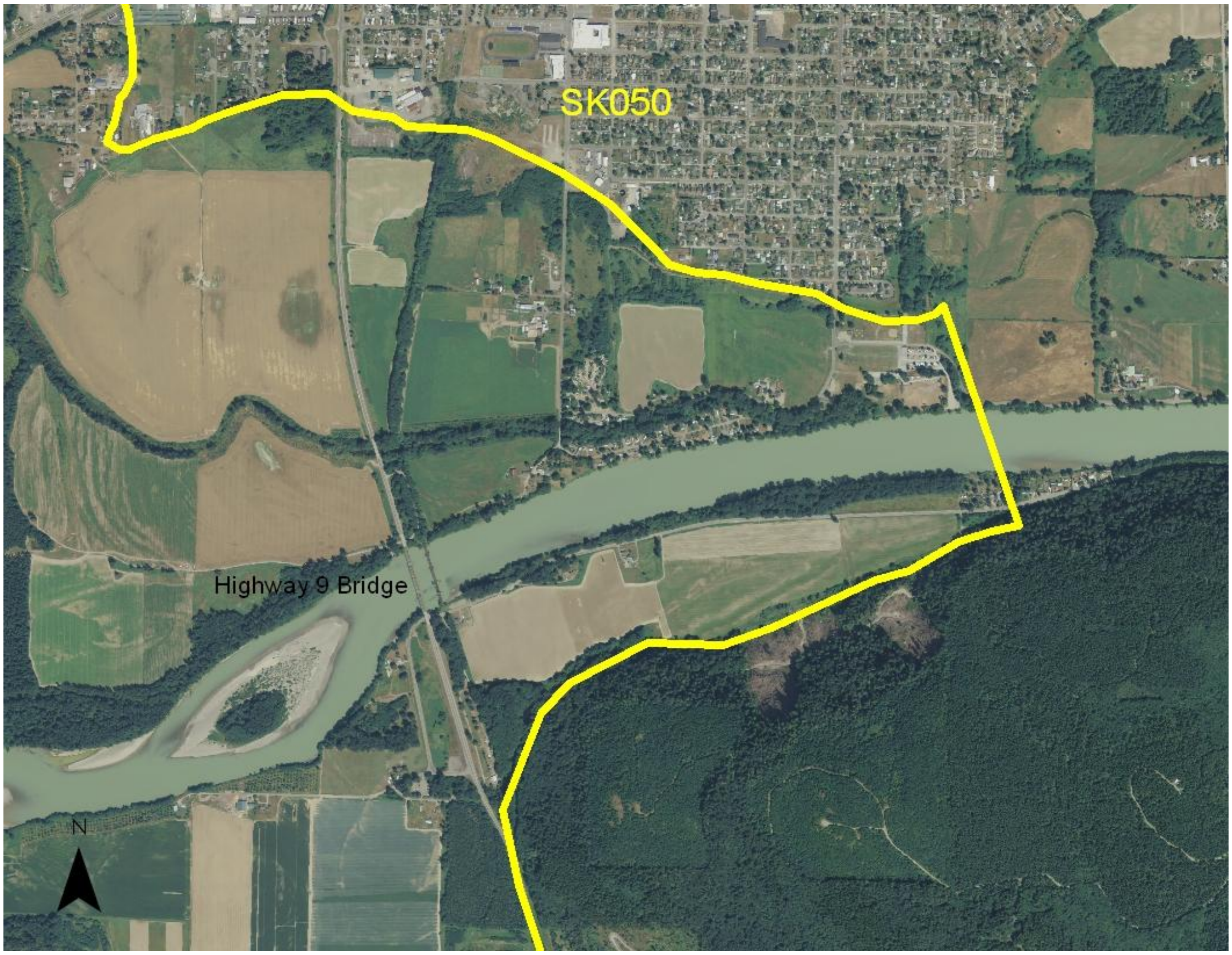


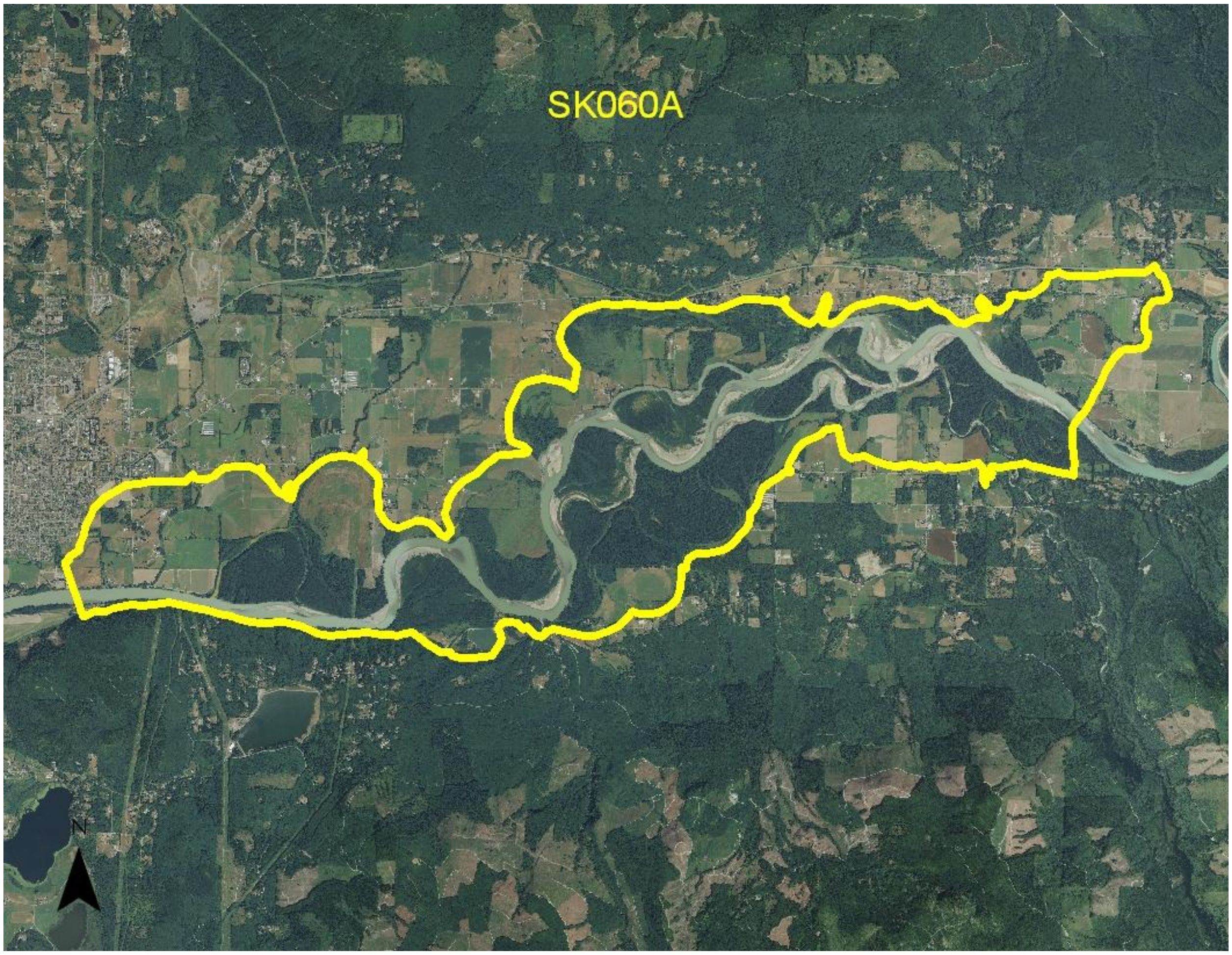
The 1998 data identifies two hydromodified structures (Sk060B-11, and Sk070A-1) totaling 4024 feet, yet the comments state that areas are interspersed with bedrock. The 2010 data identified 4 structures (Sk070A-1, Sk070A-2, Sk070A-3, and Sk070A-4) totaling 909 feet. There is a road running parallel to the river above this entire stretch. The 2010 survey only delineated rip rap where it could be seen from the water's edge and did not map the road bed or any of the natural bedrock. The attached photograph below shows a clear break in hydromodified bank rock and natural bedrock, this picture was taken well within the yellow line and upstream portion of Sk070A-4. The largest difference in the two data sets is exemplified in this example, if a road was adjacent to a channel but no visual rock could be seen the road was not mapped and inventoried. In this example natural bedrock is a buffer from any potential geomorphic impacts to the river; surveyors did not see any placed rock therefore the feature was not mapped.

Authors of this report know this assessment is part of a larger strategic plan to identify restoration actions, yet felt the need to share additional information from the work on this project. This information is relevant for comprehensive restoration strategies. A case should be made that all derelict vehicles should be removed from the river to mitigate habitat impacts and other environmental pollution as a first step in protecting natural resources. Recreational impacts to fishery resources were also observed through the study reach. If the goal of the project is to determine proper protection and restoration strategies there should be an outreach effort to the recreational users in the area. For instance, ATV use in wetted channels, including driving over redds, harming adult and juvenile fish. Channel modifications and impacts from ATV use was observed as well as cutting of LWD out of the channels was also observed.

Clearly enforcement under the hydraulic code could be used as one path, but outreach could also be another path to rectify these impacts. Additional assessments with the new data set should include examining all new features from this survey that were not included in the 1998 survey to determine if the feature was permitted and if mitigation was completed. In addition the sub hydromods need to be assessed for permitting actions. For instance the newer fish shack (Sk060B-15s – please see below) which is clearly the largest impact of all sub hydromods should have County permits and HPA's for bank armoring. If it is determined these activities or developments were not permitted then enforcement actions need to be pursued.

Appendix

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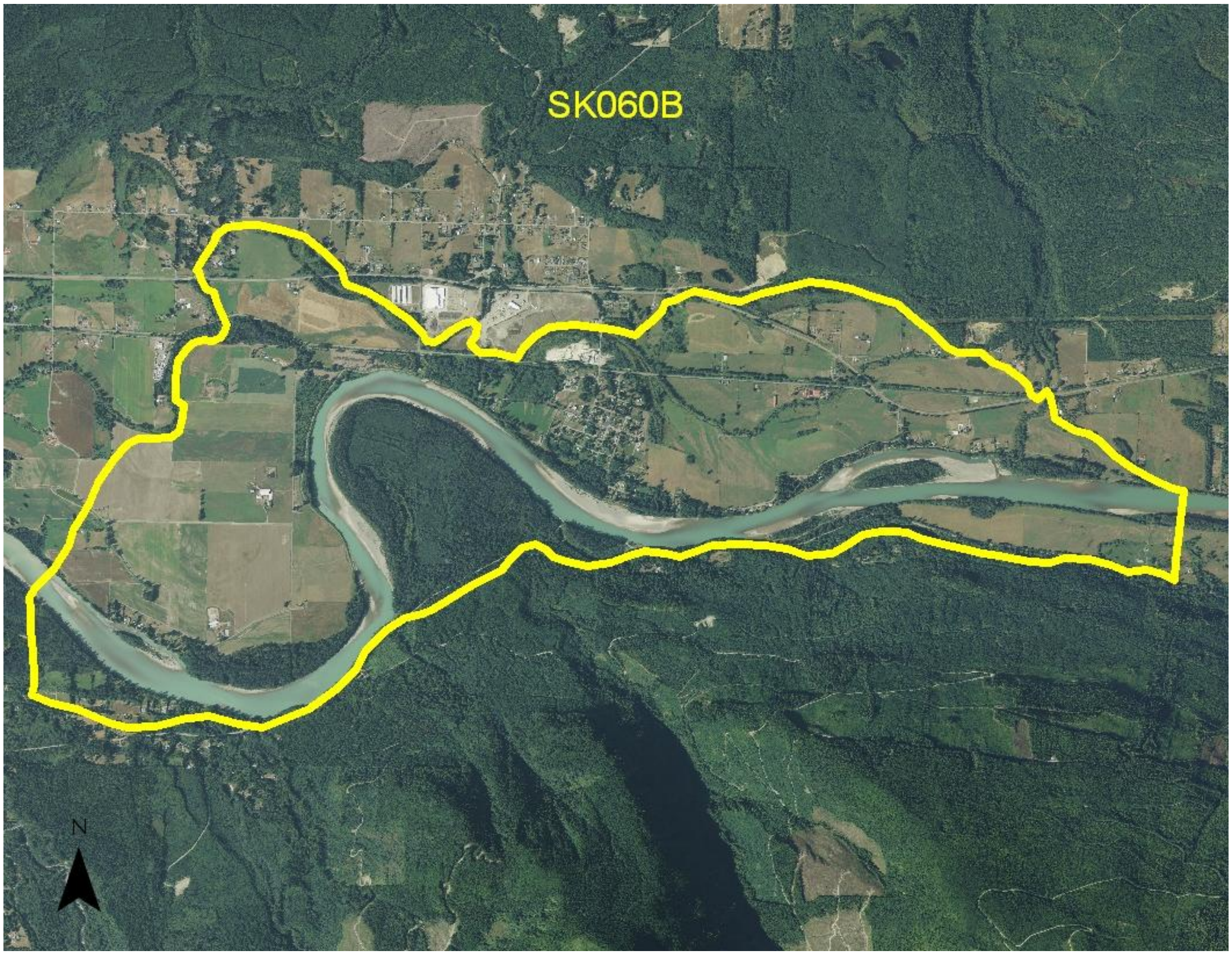
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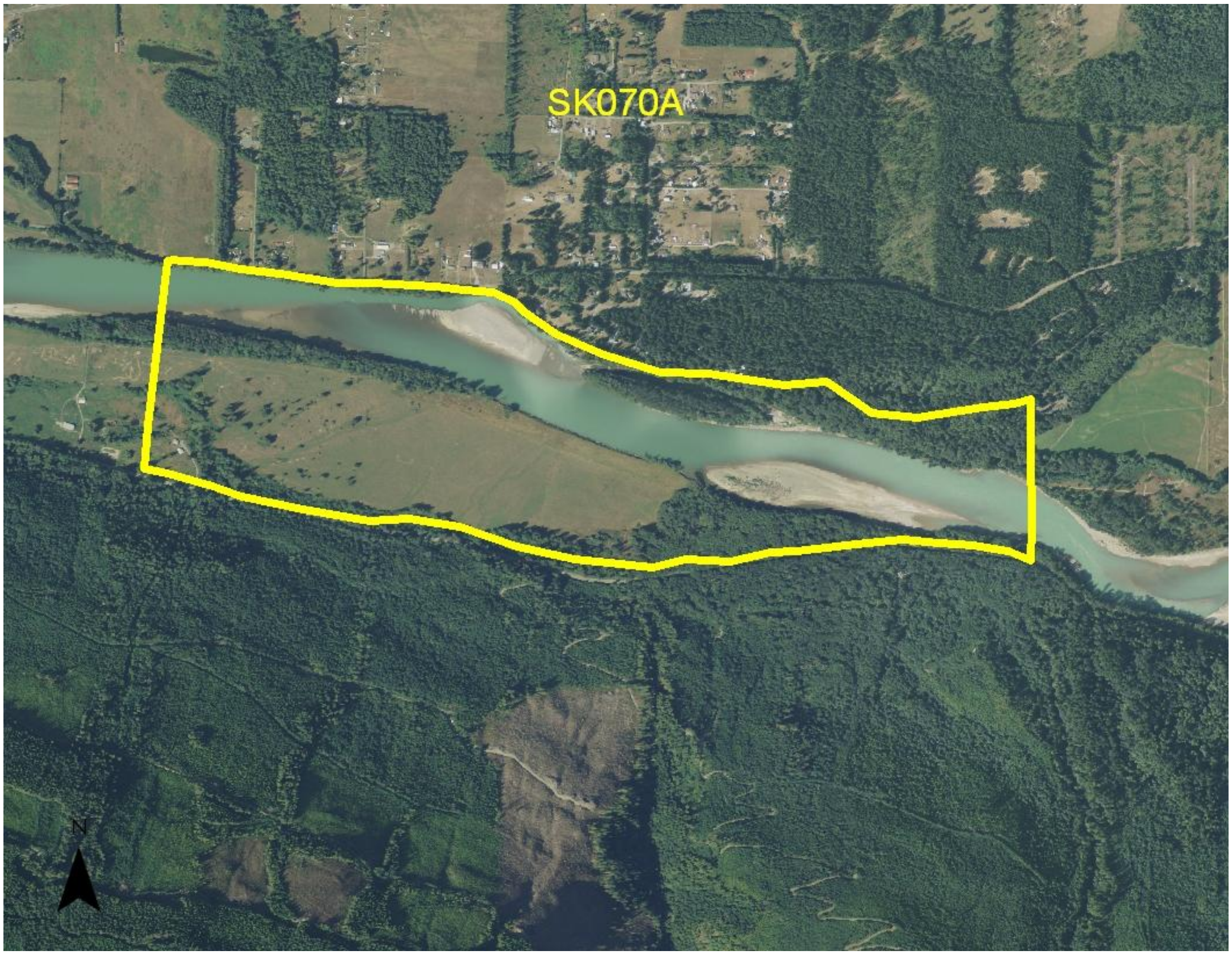
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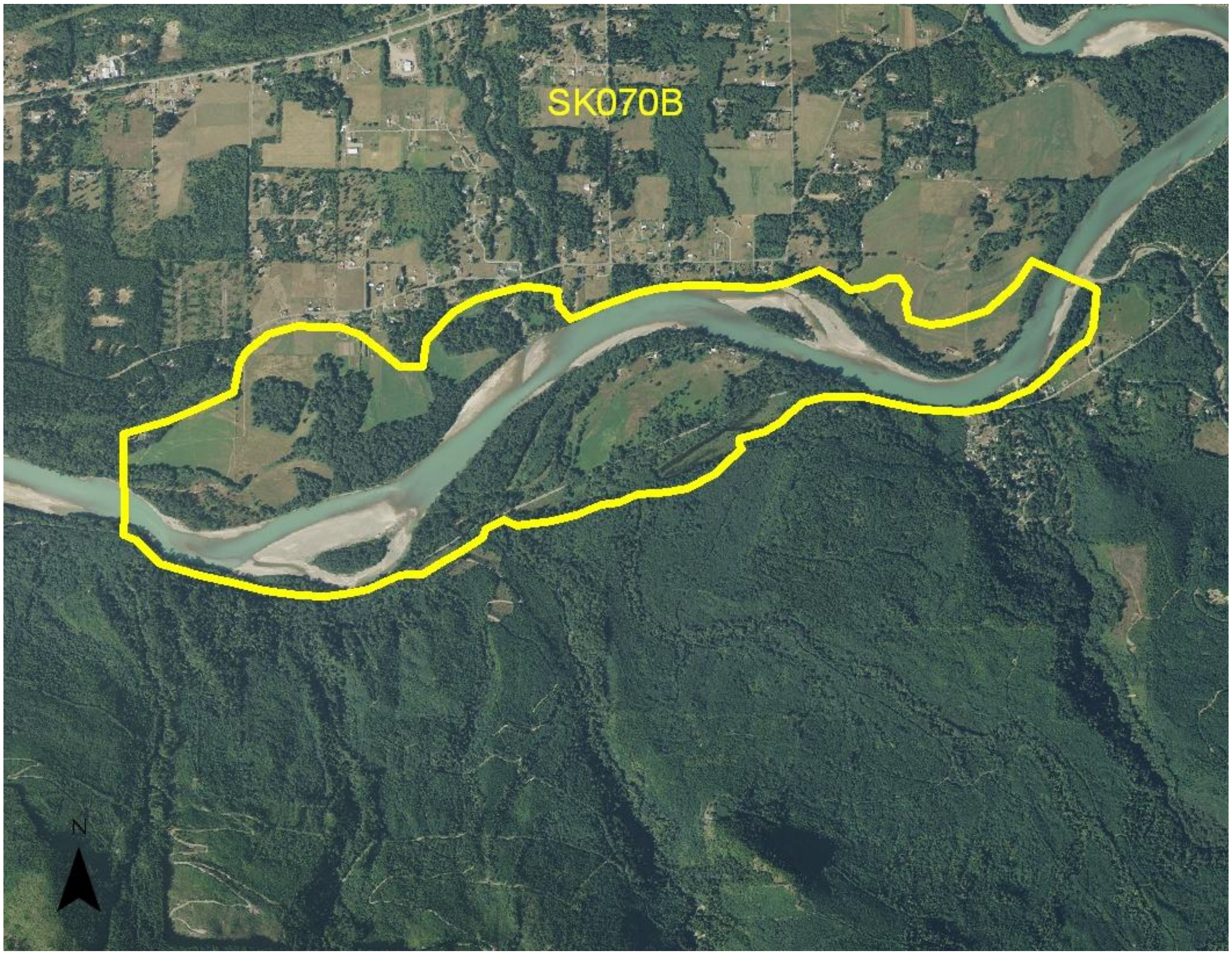
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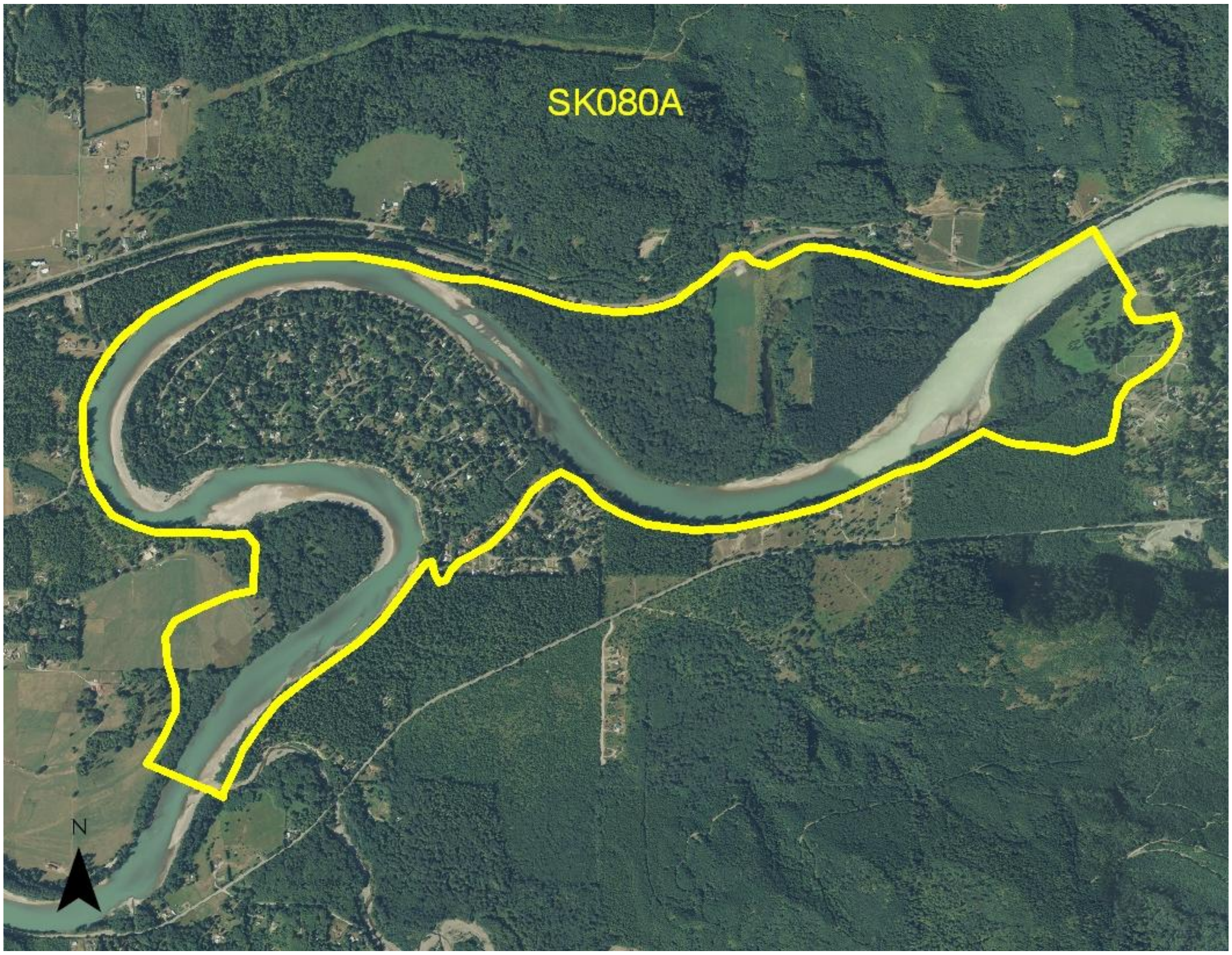
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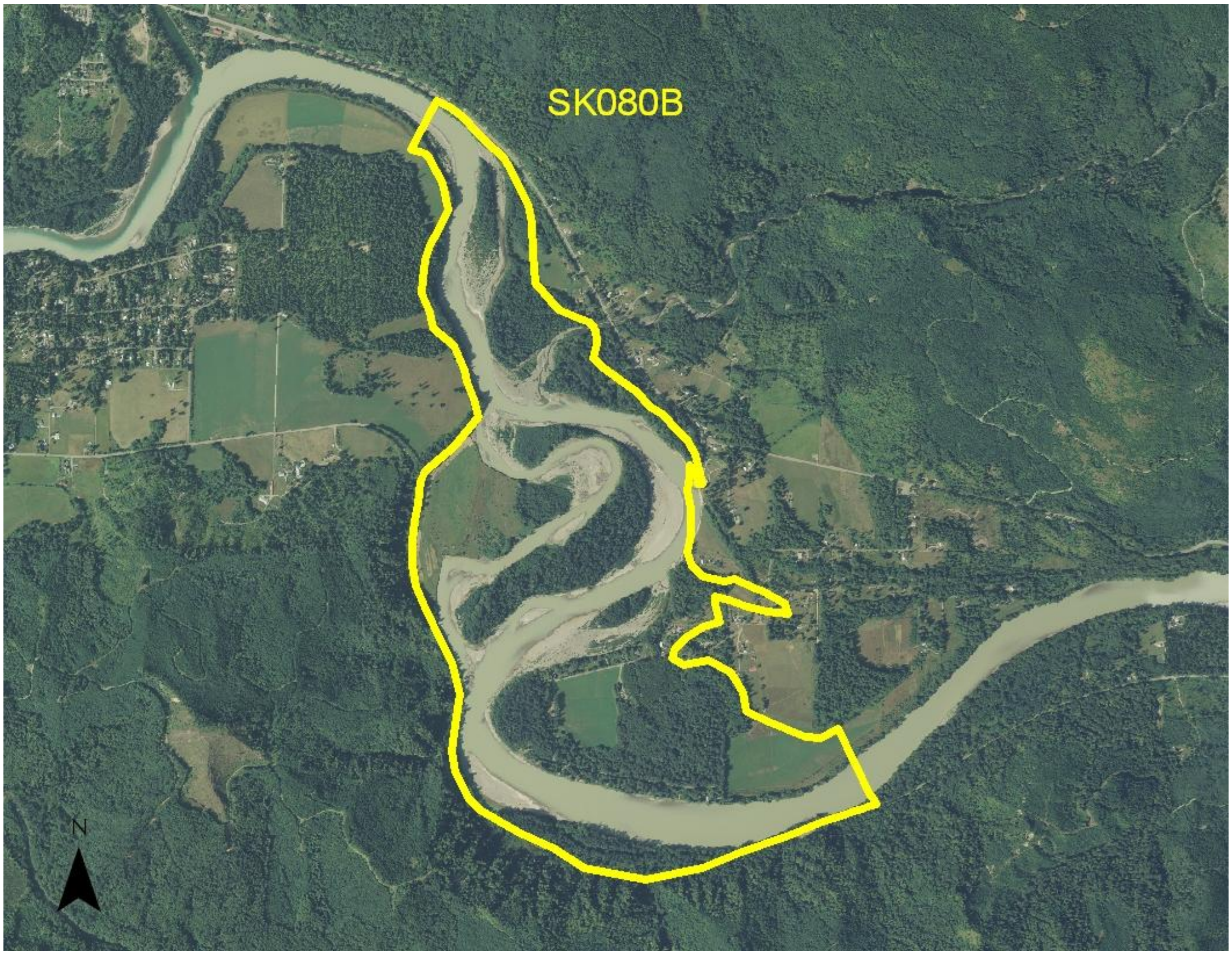
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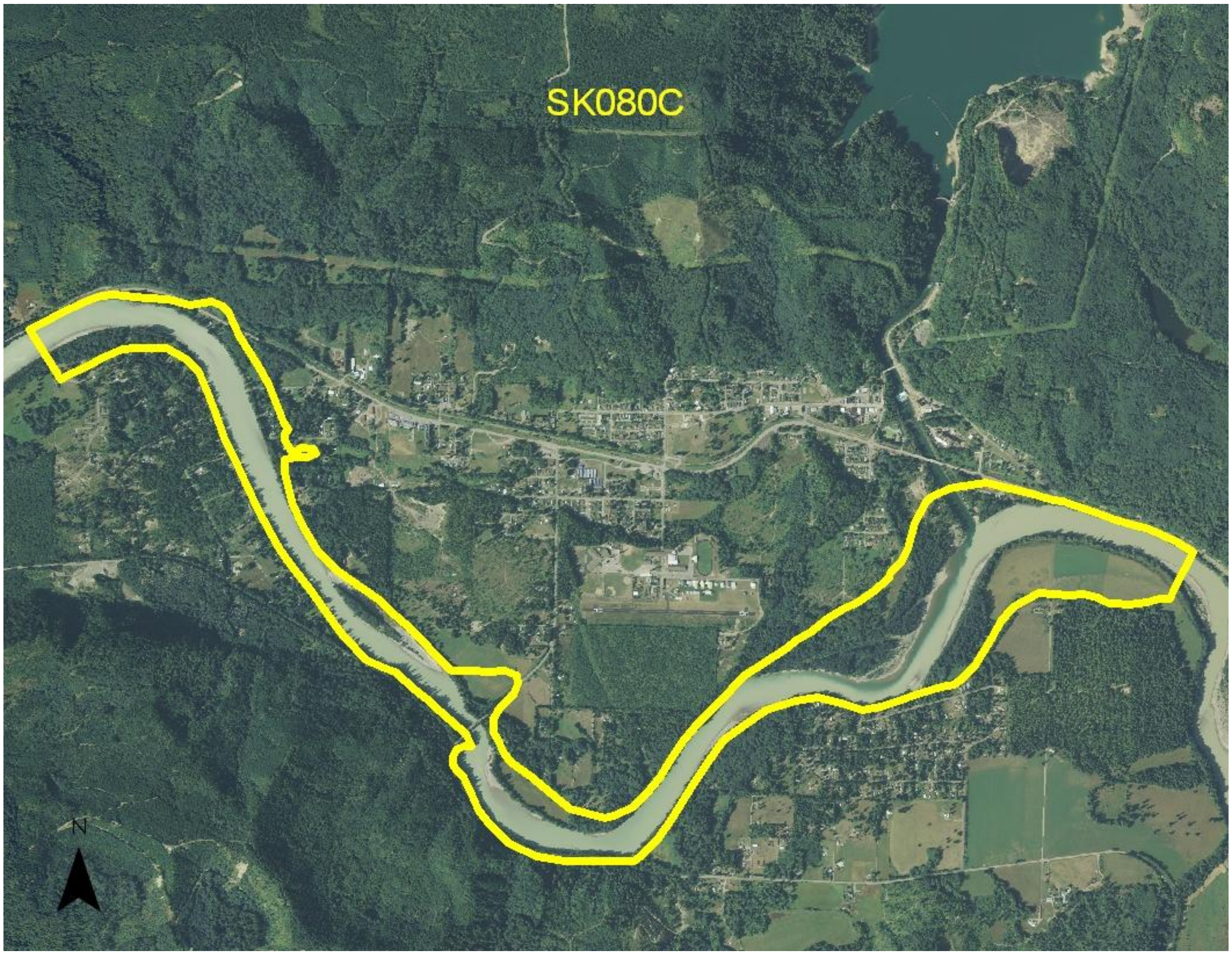
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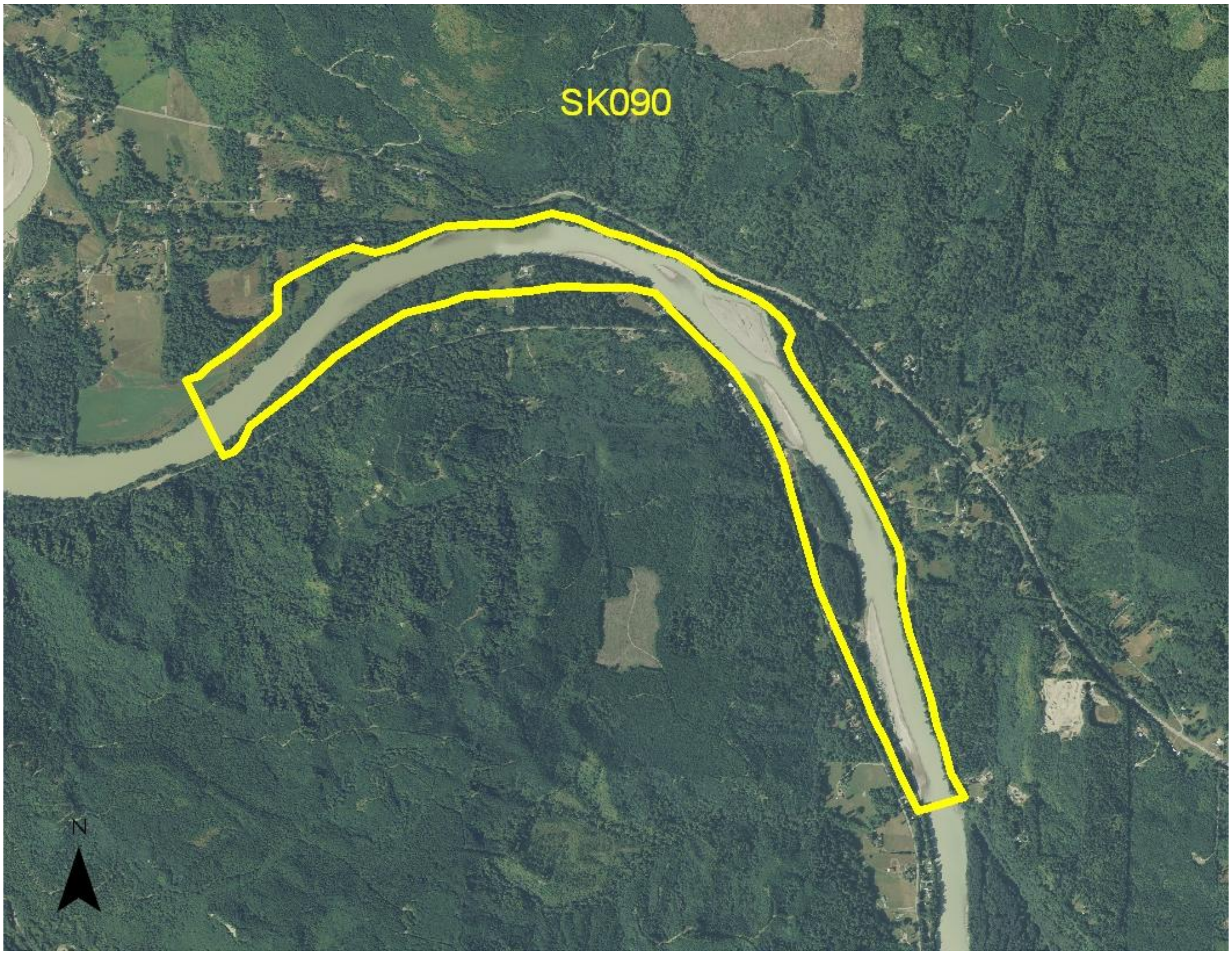
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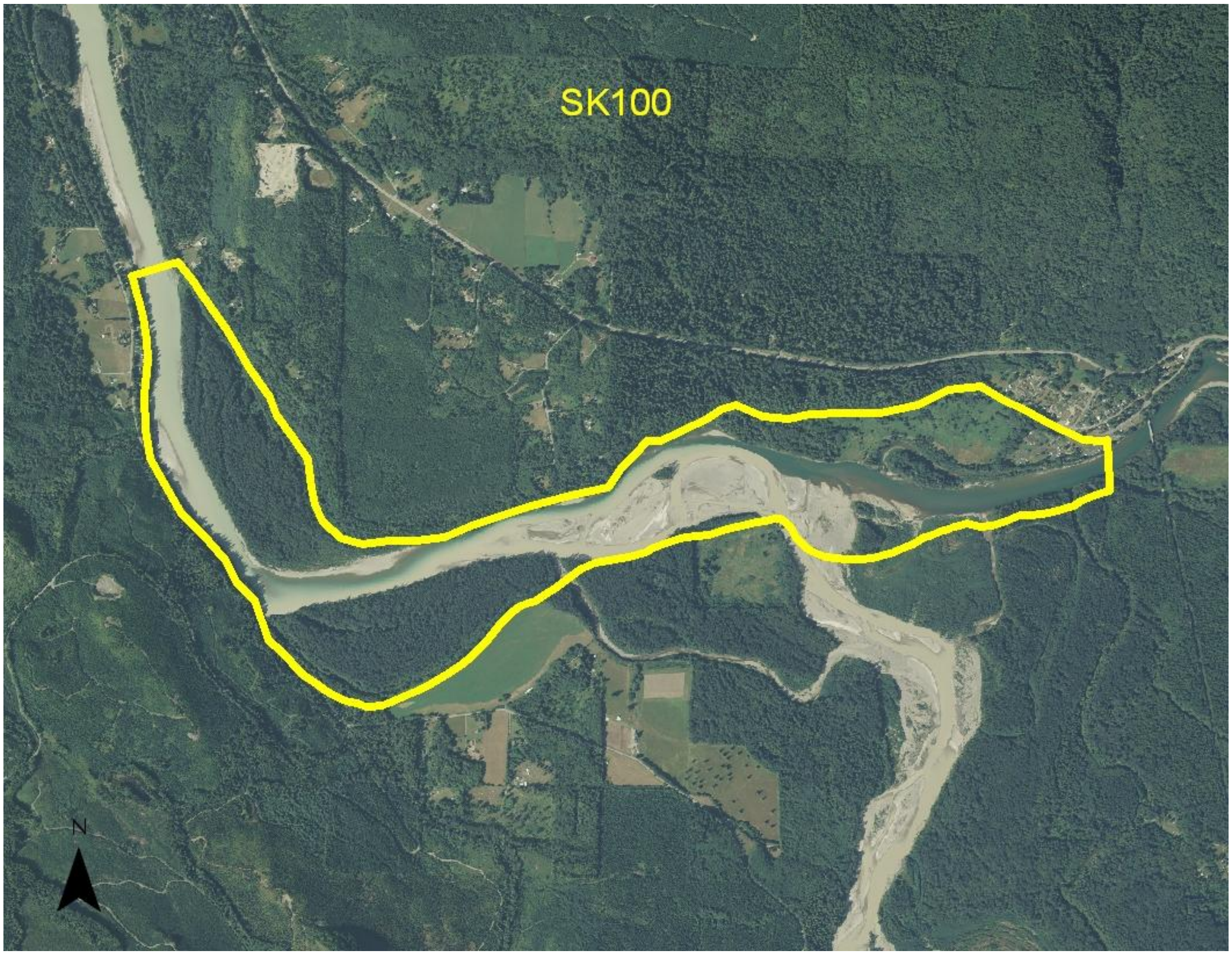
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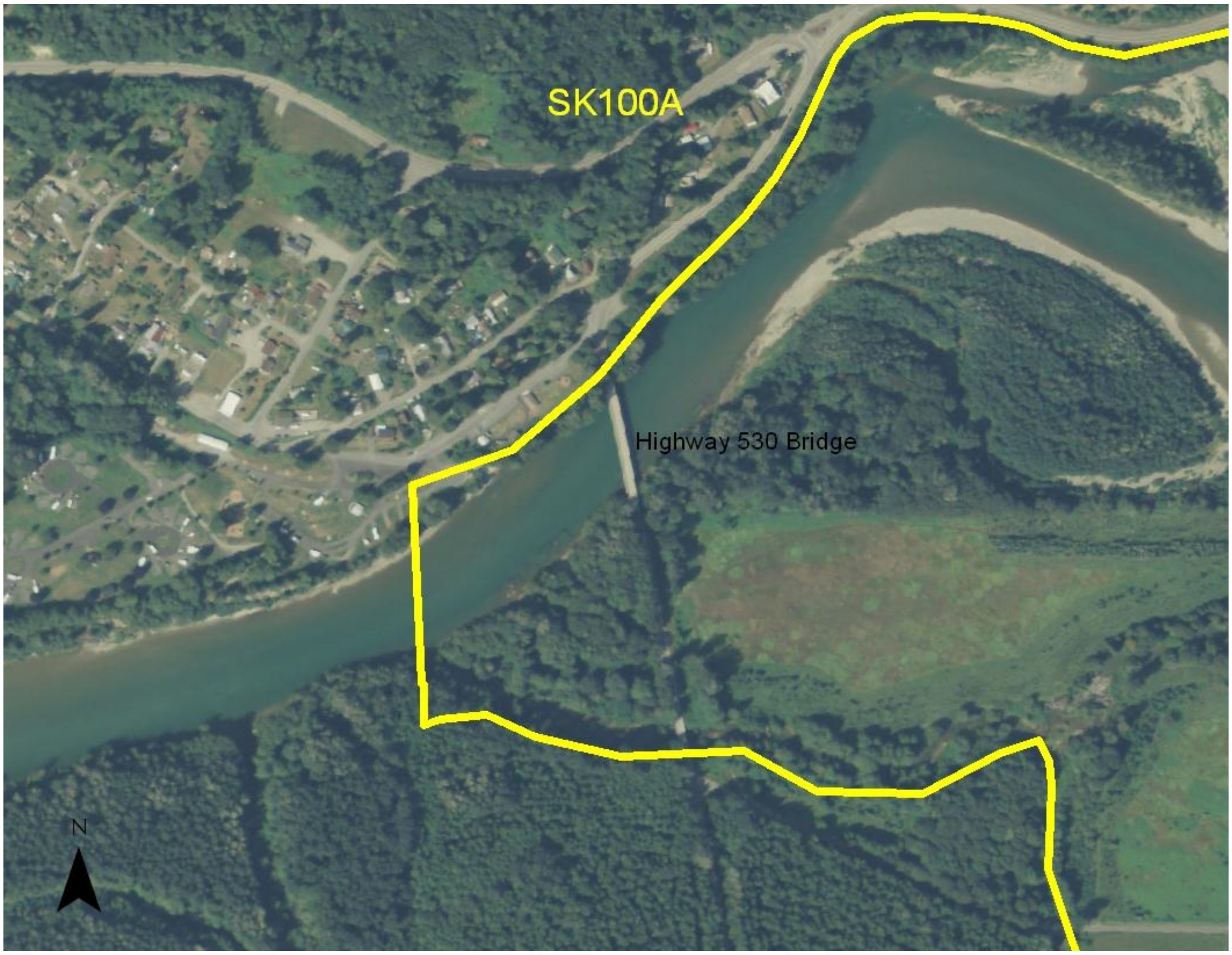
SK100A
Highway 530 Bridge
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