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

Chinook Bearing Streams

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Northwest Indian Fisheries Commission

and

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Introduction

In the Skagit watershed, degradation to channel edge and off-channel floodplain habitats has been identified as a limiting factor for Chinook population recovery, as juvenile fish utilize these habitats for rearing and flood refuge. Hydromodifications (i.e. armoring of natural river banks) greatly reduce the quantity and quality of floodplain habitats by limiting connectivity and altering the geomorphic processes that create off-channel features (SRSC and WDFW 2005). Furthermore, they reduce the quality of mainstem edge habitats, areas used by rearing and outmigrating juvenile salmon. With this in mind, in 2010 the Upper Skagit Indian Tribe (USIT) received a contract award from the Skagit Watershed Council to conduct a field inventory of hydromodified banks along the river's edges in the Middle Skagit River, an important rearing area for all six Skagit Chinook Salmon population segments. This inventory covered all mainstem and secondary river channels of the Skagit River between the confluence of the Sauk River and the Highway 9 Bridge in Sedro-Woolley, WA, as well as Chinook bearing tributaries located within the Skagit floodplain. Continuing efforts are using this inventory, in conjunction with other data and analyses, to prioritize restoration and protection efforts in the middle Skagit River (e.g. SRSC 2011). From these efforts, several restoration projects have already been scoped and/or initiated.

While the middle section of the Skagit River has been identified as a priority for Chinook habitat restoration, considerable opportunity exists in the upper watershed areas as well (SRSC and WDFW 2005). The Upper Skagit River and tributaries have considerable amounts of isolated floodplain and degraded edge habitat due to hydromodifications. Importantly, upper watershed Chinook populations produce higher proportions of parr migrant and stream type life histories than populations lower in the watershed (SRSC and WDFW 2005). As these fish rear longer in freshwater, they outmigrate at larger body size and have higher survival to adulthood than fish that outmigrate at smaller body size. Moreover, promoting a diversity of life history strategies is expected to have beneficial impacts on population viability, dampening population fluctuations in the face of variable habitat and climactic conditions.

With this in mind, the USIT procured funds from the Northwest Indian Fisheries Commission's program assistance under the implementation of the Puget Sound Partnership's Action Agenda and the Environmental Protection Agency to continue the hydromodified bank assessment into upper reaches of the Skagit River and its tributaries. This current report presents data collected from 2010 to 2015 and covering the entire known distribution of Chinook in the Skagit basin. This includes data described in previously released reports (USIT 2010, 2013), as well as data collected in 2014 and 2015 that is being first reported here. The inventory included areas adjacent and water ward of active/wetted mainstem and secondary channels. 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. Therefore, only those hydromodifications immediately adjacent or within the mainstem, secondary channels and Chinook bearing sections of tributaries were inventoried. The focus of the assessment was to inventory structures visually identifiable that are currently impacting edge habitat and potentially impacting floodplain processes. The assessment was conducted at a reach level, such that the data may be used to prioritize protection and restoration opportunities/needs among the different reaches. The data will also be useful in preliminary identification of site-specific restoration projects.

Methods

This inventory updates portions of a similar assessment that was conducted in 1998. Although no report describing methods was produced, one can determine what and how data was collected by reviewing the metadata for the associated GIS shapefile. The original inventory appeared to rely on hand drawing observed hydromodifications onto floodplain maps, whereas the current survey improves upon that method by utilizing GPS (Trimble 2008 Series) and software (GPS Pathfinder Office, ArcMap) to enhance the spatial accuracy of inventoried structures and organize the associated attribute data. This report includes data described in previous reports covering the middle Skagit River (2010), the upper Skagit River and Sauk River (USIT 2013), as well as previously unreported survey work completed in 2014 and 2015 of the Cascade River, Suiattle River and middle Skagit tributaries upstream of the Skagit floodplain boundary. Together, these efforts cover the entire known distribution of Chinook salmon in the Skagit River basin (Appendix 1, Figure 1), with several exceptions as noted below. The upriver extent of the surveys and the tributaries surveyed were selected based on a Limiting Factors Analysis (LFA) of Chinook distribution in the Skagit watershed (WCC 2001).

The nomenclature system for each unique hydromodified feature was replicated from the original 1998 survey. Each feature Site ID has two portions, where an alphanumeric portion before the dash refers to a floodplain reach and a number after the dash refers to the hydromodification number within the given reach (e.g. SA010-3 was the third hydromodification surveyed in reach SA010). The floodplain reach breaks and nomenclature follow those referenced in the Skagit Chinook Recovery Plan, where reach breaks represent geomorphological transitions (SRSC and WDFW 2005). For features originally surveyed in 1998 and encountered in the current survey, the Site ID stayed the same as the 1998 version, whereas newly encountered features were labeled in consecutive order following those previously surveyed. Note that gaps exist in the sequential numbering of hydromodification Site ID’s when a hydromodification was documented in the 1998 survey, but was not found in the current survey. Several of the features have lower case letters at the end of the second portion of the Site ID. This represents either 1) a hydromodification from the 1998 survey that was broken into several sections in the current survey because of distinct changes in attributes along the length of the structure (e.g. transitions in vegetation coverage or size of riprap) 2) or, a single hydromodification from 1998 that was physically split into two hydromodifications in the current survey (e.g. a landslide washed out the middle section of the structure, splitting it into two). When a single, uninterrupted hydromodification extended across two floodplain reaches, the hydromodification was broken into two sections, each section receiving a unique Site ID corresponding to the floodplain reach. Since the Chinook Recovery Plan reach breaks for the tributary creeks (i.e. streams other than Skagit, Sauk, Suiattle and Cascade Rivers) did not always encompass the extent of the LFA Chinook distribution, a single floodplain reach that included the extent of LFA Chinook distribution was designated for each tributary. The table below lists stream sections included in the LFA, but not surveyed for hydromodifications.

Table 1. Areas of stream included in LFA Chinook distribution, but not covered during the 2010-2015 hydromodification survey. Excluding the Skagit delta and Whitechuck River, which were beyond the original scope of this survey, the total length of LFA streams not surveyed was approximately 24 miles, or 8.7% of the total surveyed length. See Appendix 1 for visual representation of surveyed stream sections and LFA distribution of known Chinook presence.

Streams Not Surveyed	Reason for Excluding from Survey
Skagit delta below Highway 9 bridge	Project Scope
Hansen Creek (approx. 2 miles at downstream end)	Accessibility & Landowner permission
Morgan Creek	Accessibility & Rarity of Chinook use
Sorenson Creek	Accessibility & Rarity of Chinook use
Skagit River side channel by Morgan/Sorenson	Accessibility & dynamics of channel
Jones Creek, except bridges	Landowner permission
Mannser Creek	Accessibility and channel type (wetland)
Baker River upstream Skagit floodplain boundary	FERC Regulated hydropower
Barnaby Slough	Established reach scale assessment underway
Illabot Creek (approx. 2 miles at upstream end)	Accessibility
Diobsud Creek (approx. 0.2 miles at upstream end)	Accessibility & field logistics
Thorton Creek	Uncertainty of LFA data for this location
Newhalem Ponds	Uncertainty of LFA data for this location
Newhalem Creek[‡]	Communication
Dan Creek[‡]	Communication
Sauk River unnamed tributary (flows into SA060B)	Uncertainty of LFA data for this location
Clear Creek[‡]	Communication
Whitechuck River	Project Scope
Swift Creek[‡]	Communication
Clark Creek	Hatchery Infrastructure
Cascade gorge (Reach CAX1)	Accessibility & human safety

[‡] LFA stream section planned for follow-up survey; would be included in a future annual update

All channels surveyed for this inventory were accessed by a motor boat, an inflatable raft or by walking the river channel. Due to logistical constraints, 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 was limited to visual observations to inventory structures in or adjacent to currently active/wetted channels. Backgrounds on the Trimble GPS units and 11” x 17” laminated aerial photographs of individual reaches were developed to assist in river navigation, data collection and identification of hydromodified bank features previously surveyed in 1998. When new structures were located, the reach maps aided in identifying the proper sequential nomenclature. When a portion of a hydromodification extended from an active channel into the floodplain, the portion that extended into the floodplain was included in the inventory. After field data collection, surveyors used 2011 (USIT 2010, 2013) or 2013 (2014 and 2015 surveys first reported here) NAIP imagery as a background on which to digitize vectors in ArcMap v10.3.1 and define the channels that were walked/floated. These data were saved in a shapefile and categorized as Mainstem, Secondary or Tributary. Mainstem and Secondary were used to describe the Skagit, Sauk, Suiattle and Cascade Rivers. ‘Mainstem’ refers to the channel with greatest wetted width and ‘Secondary’ refers to wetted side channels. To be considered a Secondary channel, at the time of survey both the upstream and downstream ends must have been hydraulically connected to the mainstem and surface flows must have been uninterrupted throughout the length of the channel. Additionally, the channel must have been capable of conveying the full flow of the river during flood stage, as decided subjectively in the field. This definition excluded such features as sloughs and smaller low velocity floodplain channels, unless specifically identified in the LFA data layer as Chinook bearing. Tributary refers to all remaining streams identified in the LFA data layer as Chinook bearing, including tributary sections flowing through areas delineated as floodplain in the Skagit Chinook Recovery Plan floodplain layer. The surveyed channel lengths presented in the shapefile underestimate the total length of channel truly surveyed because in braided areas it was often possible to survey multiple channels simultaneously where views were unobstructed.

Hydromodified bank structures were defined as those that contained man-made material (e.g. angular rock riprap, concrete slabs, metal debris or pilings). While this approach certainly underestimated the amount of human-altered river bank, it was necessary to limit subjective calls in the field. Often times rounded river rock appeared to have been piled in an effort to control the flow of the river, but a method to consistently identify such areas was beyond the scope of this inventory.

Descriptive characteristics were recorded for each hydromodification in both the original and current inventories. The current assessment replicated some of the attributes from the previous inventory, including 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, length of the structure and any additional comments. The new attributes collected in this assessment included the channel type where the structure was located, a count of large woody debris (LWD) within or on the hydromodification, the origin of any LWD, amount and type of vegetation cover within the structure, height of the hydromodification and the bank in relationship to water levels at time of survey, difference in natural bank height vs. hydromodification height, slope of hydromodification, a distinction if this was a new feature compared to original survey and if maintenance was needed or recently conducted on the structure (see Table 1 for a complete list and description of collected attribute data). All field metrics recorded, such as levee height, bank height, hydromodification height, material size and slope, were visual estimates in feet or angle, with the exception of riparian width, which was estimated in meters.

Height of hydromodified structures was a visual estimate of the vertical distance from the observed water level to the top of the structure. Bank height was a visual estimate of the vertical distance from the observed water level to the top of the natural bank. 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 at the ends of the structure, or an estimation of the natural bank behind the structure. These estimates were largely influenced by the river stage height at time of survey. 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. As this metric was defined, all the features that have a negative value indicate that the hydromodified bank was taller than the natural bank. Levees were common structures encountered during the first phase of this inventory in the middle Skagit River, but no levees were encountered in subsequent surveys.

In addition to the hydromodifications, the current survey also inventoried sub-hydromodifications (also referred to as Submods) – relatively short non-natural, visual hard points or flow modifying structures in or adjacent to water channels. Examples of sub-hydromodifications included debris piles, docks, bridge abutments and piers, stairs, abandoned vehicles, fishing huts and other dwellings. Attribute data for sub-hydromodifications included reach delineation, channel type where structure was located, location in channel, type of sub-hydromodification, if maintenance was needed or recently conducted on the structure, what the structure was protecting and any additional comments. Since sub-hydromodifications were not documented in the 1998 survey, all sub-hydromodifications were noted as newly surveyed structures. Hydromodification and sub-hydromodification data are presented separately in two GIS shapefiles.

All features, including both linear segments (hydromodified banks) and points (sub-hydromodified banks), were spatially referenced using a 2008 Trimble GeoXt handheld GPS using the 'NAD 1983 StatePlane Washington North FIPS 4601 Feet' projected coordinate system. Line features were collected by walking the length of the hydromodification and taking spatially referenced points every 5 seconds. To ensure accurate locations of structure end points, each end point was mapped with a minimum of 5 field-measured GPS points (i.e. stand stationary at the end of the structure for at least 20 seconds). Point features were obtained by averaging a minimum of 5 points together to reduce error in spatial positioning. In addition, a pre-formatted data dictionary was developed using GPS Pathfinder Office and loaded onto the Trimble unit. 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 among field personnel and among years. All surveyors were given training and field reference 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. These photos are provided with the hydromodification and sub-hydromodification shapefiles and may be hyperlinked to the respective features within those shapefiles.

Post processing of data consisted of downloading field data from the Trimble unit using GPS Pathfinder Office software and converting data files to GIS shapefiles. All line files (representing hydromodifications) and point files (representing sub-hydromodifications) were appended into two separate master shape files, called 'Hydromod.II.2015.shp' and 'Submod.II.2015.shp', respectively. Due to slight errors inherent with GPS locations, each line feature was smoothed to best approximate its true location and shape. Lengths of hydromodified structures were calculated with ESRI ArcMap v10.3.1 using the 'Calculate Geometry' tool in the attribute table. Each photo was converted to a PDF file, renamed with the Site ID and hyperlinked to the corresponding feature within ArcMap according to the 'Hyperlink' column in the attribute table (note: use the 'Hyperlink base' option in ArcMAP to link to the PDF pictures of each feature). A shapefile called 'SurveyedChannels.II.2015.shp' illustrates which channels were walked/boated during the survey and the designation for each channel (i.e. mainstem, secondary or tributary). The Roman numeral "II" in the file names identify this as the second hydromodification survey (i.e. update to the original 1998 survey). The year “2015” refers to the year in which the data was released. The Upper Skagit Tribe plans to solicit updates to the survey on an annual basis. Individuals or organizations with knowledge of newly constructed or otherwise altered hydromodifications can contact Upper Skagit Tribe Natural Resources staff to update the dataset. If changes to the data occur, USIT will issue an updated shapefile with the corresponding year included in the file name (e.g. an updated dataset in 2018 would be named ‘Hydromod.II.2018.shp’ and distributed to interested parties).

Table 2. Attribute table describing the metrics collected in the 2010-2015 hydromodification inventory. These fields correspond to the attribute table associated with the GIS shapefiles.

Attribute	Description
FID	Internal # automatically assigned by GIS
Shape	Geometry *i.e. line feature, point feature*
Reach	Code associated with corresponding floodplain reach identifier
Site ID	Unique identifier for each hydromodified bank *e.g. SK100-1*
Water Type	Description of the channel type. *i.e. mainstem, secondary, tributary*
Location	Right bank or left bank: looking downstream
Mod_Type	Denotes type of hydromodification e.g. *riprap, groins, bridge abutments, pilings, deflectors, barbs, other*
Sub_Mod_Type	Denotes presence of sub-hydromodification within hydromodification feature *e.g. cars, cement, large organic debris*
LWD	Using TFW (1999) size classes, count logs, root wads and jams in or associated with hydromodifications
LWD_Origin	*i.e. natural, constructed, mixed, unknown*
Slope	Visual Estimate of the degree of slope *i.e. 60˚-90˚, 45˚-60˚, < 45 ˚*
Levee	Denotes whether there is a levee or not *i.e. 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 hydromodified bank height above water's surface in feet
Difference BH-HH	Estimated difference between natural bank height and hydromodified bank height in feet
Largest_Size_Class	Estimate of diameter of the largest size of material *i.e. >4', >2'<4' , < 2', NA*
Dom _Size_Class	Estimate of diameter of the dominant size class of material *i.e. >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 *e.g. recent, follow-up, none*
Veg_Coverage	Indicates presence of vegetation within hydromodified bank structure *i.e. full, partial, absent*
Veg_Type	Indicates type of vegetation within hydromodified bank structure *i.e. none, exotic (weeds), shrubs and willows, immature <20" diameter (deciduous, coniferous, mixed), mature >20" diameter (deciduous, coniferous, mixed)*
Rip_Type	Riparian stand type *i.e. 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	Description of what the hydromodification is protecting *e.g. highway, road, houses, farm field, not apparent*
Comments	Other information unique to the site or feature
Hyperlink	Link to PDF photo of each unique site
Length _m	Length of feature in meters, computed by GIS
Length_f	Length of feature in feet, computed by GIS

Data Quality Assurance and Quality Control

In addition to the spatial data collected with the GPS unit, a list of physical and environmental metrics was collected. This list of metrics was developed and approved during the Middle Skagit survey (USIT 2010) 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 hydromodified height were left as numeric fields in order to provide a more unique site value for each entry.

All measurements recorded within the attribute table were visual estimates, with the exception of hydromodification length, which was calculated in ArcGIS. 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 periodically 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 of each hydromodification in combination with aerial background photographs of the river floodplain were used to compare against data within the attribute table. 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 and the feature in question was revisited in the field to address any discrepancies. Additionally, a subsample of features was resurveyed to ensure accuracy of feature length/position and associated attributes. This latter resurvey did not consist of refloating entire sections to determine if hydromodifications were missed. Rather, the Trimble was taken to the known location of accessible hydromodifications and data was recollected and compared to original data to ensure consistency. Spatial data matched well between the true survey and the resurvey, with the caveat that the resurvey was done by shore access, not boat, and visibility of the entire hydromodification was not always possible. Since the resurvey occurred at a different time of year than the true survey, attributes such as LWD counts and bank height were not comparable because of changes in environmental conditions (e.g. leaf growth, river stage). Attributes that were comparable (e.g. dominant size class of riprap, slope of hydromodification) almost always agreed between the original and resurvey, resulting in minimal edits to the attribute data.

Results

The results of the current assessment are summarized by reach and presented in Table 3 for hydromodifications (total length within each reach) and Table 4 for sub-hydromodifications (number within each reach). Reach-scale values in both Tables 3 and 4 are further broken down by channel type (mainstem, secondary or tributary). To offer a broader-scale summary, totals are also presented for subwatersheds (Middle Skagit River, Upper Skagit River, Sauk River, Suiattle River, Cascade River), tributaries and for the entire survey area. At the finest scale, feature-specific spatial data and associated attribute data can be found in shapefiles called ‘Hydromod.II.2015.shp’ and ‘Submod.II.2015.shp’ for hydromodifications and sub-hydromodifications, respectively.

The areas encompassed by the survey reaches are illustrated in GIS-rendered maps in Appendix 1. These maps also show the channels that were floated or walked down. These georeferenced lines are available in a shapefile call ‘SurveyedChannels.II.2015.shp’. Each surveyed channel is defined in the shapefile attribute table as either ‘Mainstem’, ‘Secondary’ or ‘Tributary’. Note that the ‘SurveyedChannels.II.2015.shp’ file and the Appendix 1 maps underestimate the actual area and number of side-channels surveyed because it was often possible to survey multiple channels simultaneously when views were unobstructed.

Table 3. Summed lengths (meters) of hydromodifications for each reach, and subdivided by water type (i.e. mainstem, secondary, tributary). Subtotals for rivers (Middle Skagit, Upper Skagit, Sauk, Suiattle, Cascade) and tributaries are presented by subwatershed, and further subdivided by water type (note: no tributaries in Sauk subwatershed were sampled). Length of individual hydromodifications are found in the attribute table associated with the final GIS shapefile. Reach locations are delineated in Appendix 1.

Subwatershed (Year Surveyed)	Reach ID	Hydromodification Length by Water Type			Length (m)
		Mainstem (m)	Secondary (m)	Tributary (m)	
Middle Skagit (2010, 2015)	SK050	2138.5		50.1	2188.6
Middle Skagit (2010)	SK060A	7508.2	3072.3	353.7	10,934.2
Middle Skagit (2010)	SK060B	4751.5	309.4	105.8	5166.7
Middle Skagit (2010)	SK070A	154.3	123.3		277.6
Middle Skagit (2010)	SK070B	781.2		8.3	789.5
Middle Skagit (2010)	SK080A	450.9			450.9
Middle Skagit (2010)	SK080B	953.3	984.2	21.0	1958.5
Middle Skagit (2010)	SK080C	1265.0			1265.0
Middle Skagit (2010)	SK090	485.6	107.7		593.3
Middle Skagit (2010)	SK100	412.4	182.6		595.0
Middle Skagit River	**Subtotal**	**18,900.9**	**4779.5**	**538.9**	**24,219.3**
Upper Skagit (2012)	SK100A	2221.6	409.8	95.8	2727.2
Upper Skagit (2012)	SK110	2063	102.2		2165.2
Upper Skagit (2012)	SK120A	768.1			768.1
Upper Skagit (2012)	SK120B	554.4			554.4
Upper Skagit (2012)	SK130A	1040.4			1040.4
Upper Skagit (2012)	SK130B	254.8			254.8
Upper Skagit (2012)	SK140				0
Upper Skagit River	**Subtotal**	**6902.3**	**512**	**95.8**	**7510.1**
Sauk (2012)	SA010	31.2	300.3		331.5
Sauk (2012)	SA020A	1020.6	79.4		1100.0
Sauk (2012)	SA020B	429.5			429.5
Sauk (2012)	SA030		698.8		698.8
Sauk (2012)	SA040	985.2			985.2
Sauk (2012)	SA050	620.9	535.0		1155.9
Sauk (2013)	SA060A	205.0			205.0
Sauk (2013)	SA060B	1140.3			1140.3
Sauk (2013)	SA060C	85.3			85.3
Sauk (2013)	SA060D	382.3	129.4		511.7
Sauk (2013)	SA070	371.9			371.9
Sauk (2013)	SFSA010				0.0
Sauk (2013)	SFSA020				0.0
Sauk (2013)	NFSA010	17.2			17.2
Sauk River	**Subtotal**	**5289.4**	**1742.9**	**0.0**	**7032.3**

Table 3 continued:

Subwatershed (Year Surveyed)	Reach ID	Hydromodification Length by Water Type			Length (m)
		Mainstem (m)	Secondary (m)	Tributary (m)	
Suiattle (2015)	SU010				0.0
Suiattle (2015)	SU020A	459.9			459.9
Suiattle (2015)	SUX1				0.0
Suiattle (2015)	SU030	87.6	9.6		97.2
Suiattle (2015)	SU040A		276.6		276.6
Suiattle (2015)	SU040B	81.7			81.7
Suiattle (2015)	SU040C				0.0
Suiattle (2015)	SU050				0.0
Suiattle River	**Subtotal**	**629.2**	**286.2**	**0.0**	**915.4**
Cascade (2014, 2015)	CA010	768.6	472.5		1241.1
Cascade (2015)	CA020	93.5			93.5
Cascade (2014)	CA040A				0.0
Cascade (2014)	CA040B				0.0
Cascade (2014)	CA040C	31.1			31.1
Cascade (2014)	CA040D				0.0
Cascade (2014)	CAX2				0.0
Cascade (2014)	CA060	78.1			78.1
Cascade (2014)	SFCA010				0.0
Cascade (2014)	NFCA010	18.2			18.2
Cascade River	**Subtotal**	**989.5**	**472.5**	**0.0**	**1462.0**
Alder (2015)	ALD010			89.0	89.0
Day (2014)	DAY010			331.4	331.4
East Fork Nookachamps (2015)	ENK010			1595.0	1595.0
Finney (2014)	FIN010			805.7	805.7
Grandy (2014)	GRA010			2497.9	2497.9
Hansen (2014)	HAN010			808.9	808.9
Jackman (2014)	JKMN010			194.3	194.3
Jones (2015)	JON010			49.8	49.8
Mundt (2015)	MNDT010			323.0	323.0
Pressentin (2014)	PRE010			222.2	222.2
Walker (2015)	WLK010			431.8	431.8
Middle Skagit Tributaries	**Subtotal**	**NA**	**NA**	**7349.0**	**7349.0**

Table 3 continued:

Subwatershed (Year Surveyed)	Reach ID	Hydromodification Length by Water Type			Length (m)
		Mainstem (m)	Secondary (m)	Tributary (m)	
Bacon (2012)	BAC010			686.0	686.0
Diobsud (2012)	DIOB010			307.5	307.5
Goodell (2012)	GODL010			830.6	830.6
Illabot (2012)	ILL010			820.6	820.6
Upper Skagit Tributaries	**Subtotal**	**NA**	**NA**	**2644.7**	**2644.7**
All (2015)	ALL010				0.0
Big (2014)	BIG010				0.0
Buck (2014)	BUC010			79.1	79.1
Circle (2015)	CIR010				0.0
Downey (2015)	DOW010			23.0	23.0
Lime (2015)	LIM010			54.6	54.6
Milk (2015)	MLK010				0.0
Straight (2014)	STR010			56.0	56.0
Sulphur (2015)	SUL010			20.9	20.9
Tenas (2015)	TEN010			282.6	282.6
Suiattle Tributaries	**Subtotal**	**NA**	**NA**	**516.2**	**516.2**
Boulder (2015)	BLD010			25.4	25.4
Found (2014)	FND010				0.0
Jordan (2014)	JRD010				0.0
Kindy (2014)	KIN010				0.0
Marble (2014)	MRB010				0.0
Sibley (2014)	SIB010				0.0
Cascade Tributaries	**Subtotal**	**NA**	**NA**	**25.4**	**25.4**
Skagit Basin	**Total**	13810.4	3013.6	21166.4	51,674.4

Table 4. Number of sub-hydromodifications surveyed in each reach, and subdivided by water type (i.e. mainstem, secondary channel, tributary). Subtotals for rivers (Middle Skagit, Upper Skagit, Sauk, Suiattle, Cascade) and tributaries are presented by subwatershed, and further subdivided by water type (note: no tributaries in Sauk subwatershed were sampled). Reach locations are delineated in Appendix 1.

Subwatershed (Year Surveyed)	Reach ID	Number of Sub-hydromodifications by Water Type			No.
		Mainstem (no.)	Secondary (no.)	Tributary (no.)	
Middle Skagit (2010, 2015)	SK050	22		20	42
Middle Skagit (2010)	SK060A	11	5	19	35
Middle Skagit (2010)	SK060B	11	4	2	17
Middle Skagit (2010)	SK070A				0
Middle Skagit (2010)	SK070B	2		3	5
Middle Skagit (2010)	SK080A	12			12
Middle Skagit (2010)	SK080B	5	4		9
Middle Skagit (2010)	SK080C	5			5
Middle Skagit (2010)	SK090	2	1		3
Middle Skagit (2010)	SK100	5			5
Middle Skagit River	**Subtotal**	**75**	**14**	**44**	**133**
Upper Skagit (2012)	SK100A	9		1	10
Upper Skagit (2012)	SK110	11			11
Upper Skagit (2012)	SK120A				0
Upper Skagit (2012)	SK120B	1			1
Upper Skagit (2012)	SK130A				0
Upper Skagit (2012)	SK130B				0
Upper Skagit (2012)	SK140				0
Upper Skagit River	**Subtotal**	**21**	**0**	**1**	**22**
Sauk (2012)	SA010	3	1		4
Sauk (2012)	SA020A	8	1		9
Sauk (2012)	SA020B				0
Sauk (2012)	SA030	1	2		3
Sauk (2012)	SA040	13			13
Sauk (2012)	SA050	1	1		2
Sauk (2013)	SA060A	2			2
Sauk (2013)	SA060B	5			5
Sauk (2013)	SA060C	4			4
Sauk (2013)	SA060D	6			6
Sauk (2013)	SA070	5	1		6
Sauk (2013)	SFSA010				0
Sauk (2013)	SFSA020	4			4
Sauk (2013)	NFSA010	4			4
Sauk River	**Subtotal**	**56**	**6**	**0**	**62**

Table 4 continued:

Subwatershed (Year Surveyed)	Reach ID	Number of Sub-hydromodifications by Water Type			No.
		Mainstem (no.)	Secondary (no.)	Tributary (no.)	
Suiattle (2015)	SU010				0
Suiattle (2015)	SU020A	2			2
Suiattle (2015)	SUX1	1			1
Suiattle (2015)	SU030	5	2		7
Suiattle (2015)	SU040A	1			1
Suiattle (2015)	SU040B				0
Suiattle (2015)	SU040C				0
Suiattle (2015)	SU050	3			3
Suiattle River	**Subtotal**	**12**	**2**	**0**	**14**
Cascade (2014, 2015)	CA010	4			4
Cascade (2015)	CA020	3			3
Cascade (2014)	CA040A				0
Cascade (2014)	CA040B				0
Cascade (2014)	CA040C	3			3
Cascade (2014)	CA040D				0
Cascade (2014)	CAX2				0
Cascade (2014)	CA060	4			4
Cascade (2014)	SFCA010				0
Cascade (2014)	NFCA010	2			2
Cascade River	**Subtotal**	**16**	**0**	**0**	**16**
Alder (2015)	ALD010			26	26
Day (2014)	DAY010			17	17
East Fork Nookachamps (2015)	ENK010			19	19
Finney (2014)	FIN010			31	31
Grandy (2014)	GRA010			17	17
Hansen (2014)	HAN010			31	31
Jackman (2014)	JKMN010			5	5
Jones (2015)	JON010			16	16
Mundt (2015)	MNDT010			5	5
Pressentin (2014)	PRE010			4	4
Walker (2015)	WLK010			23	23
Middle Skagit Tributaries	**Subtotal**	**NA**	**NA**	**194**	**194**

Table 4 continued:

Subwatershed (Year Surveyed)	Reach ID	Number of Sub-hydromodifications by Water Type			No.
		Mainstem (no.)	Secondary (no.)	Tributary (no.)	
Bacon (2012)	BAC010			16	16
Diobsud (2012)	DIOB010			4	4
Goodell (2012)	GODL010			4	4
Illabot (2012)	ILL010			3	3
Upper Skagit Tributaries	**Subtotal**	**NA**	**NA**	**27**	**27**
All (2015)	ALL010				0
Big (2014)	BIG010				0
Buck (2014)	BUC010			4	4
Circle (2015)	CIR010			1	1
Downey (2015)	DOW010			6	6
Lime (2015)	LIM010			2	2
Milk (2015)	MLK010				0
Straight (2014)	STR010			4	4
Sulphur (2015)	SUL010			3	3
Tenas (2015)	TEN010			4	4
Suiattle Tributaries	**Subtotal**	**NA**	**NA**	**24**	**24**
Boulder (2015)	BLD010			4	4
Found (2014)	FND010				0
Jordan (2014)	JRD010				0
Kindy (2014)	KIN010			3	3
Marble (2014)	MRB010				0
Sibley (2014)	SIB010				0
Cascade Tributaries	**Subtotal**	**NA**	**NA**	**7**	**7**
Skagit Basin	**Total**	**180**	**22**	**297**	**499**

Discussion

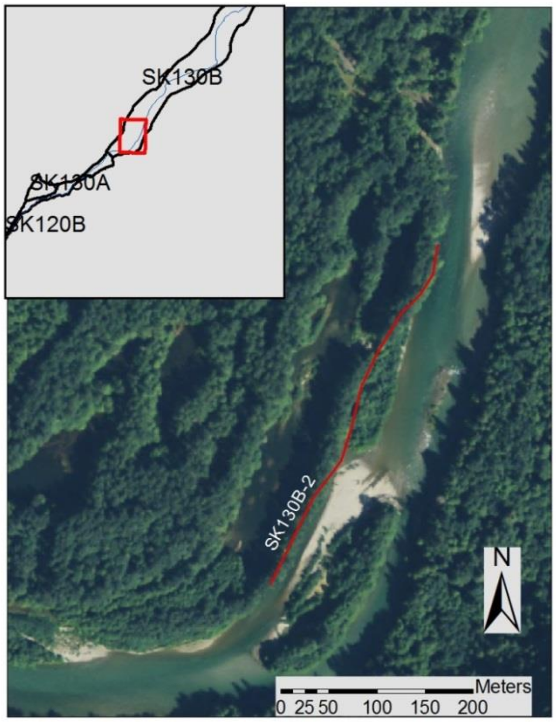
The assessment was conducted over the years 2010 to 2015 between December and March. Weather and flow conditions largely dictated when the surveys could be conducted. Early field surveys in September and October of 2012 were deemed overly cumbersome due to extreme low flows that restricted boat mobility, and leaf litter obscured visual observations. Fall weather and flows throughout much of November and December in 2012 also restricted the surveys, when the river was at or near flood flows. 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. During 2013 a small portion of the survey was conducted in March and early April, but these sections were short and were conducted before high flow increased turbidity.

It is also important to note the limitations of the data set based on the intentions of the survey. This was a reach level assessment for use in a prioritization scheme for restoration projects to improve salmonid productivity and habitat conditions. The rapid field assessment was an inventory to gain spatially explicit information about floodplain and edge habitat impacts that could be used 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 and banks 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. 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.

There may be a tendency to compare the results from this survey with that of the original 1998 survey. Caution should be used on such efforts. The intent and methods of these two surveys were different, making comparative analysis or temporal trend assumptions difficult. The original survey used cartography to map structures, whereas the current assessment used GPS technology and computer software to map structures. The precision and accuracy differences in these methods may account for some discrepancies between the results in the two data sets.

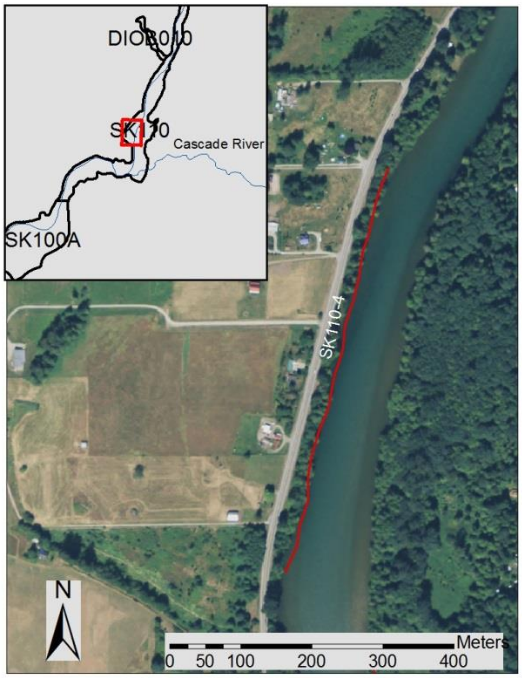
In addition to technology differences, much time has elapsed with several large floods between the original and current inventories. These floods have had the power to potentially move the river away from hardened banks and points, to dislodge riprap from protected banks and deposit in the river, or to bury riprap via landslides or deposited sediments. For example, SA070-2 was originally surveyed in 1998, but not included in the current survey because the river channel reconfigured and the hydromodification was wholly in the floodplain. In another example, SA060B-7 was surveyed in both 1998 and the current survey, but a landslide washed out an unknown amount of the upper portion of the structure sometime between the two surveys, resulting in a shorter hydromodification length. Alternatively, restoration projects may have changed the lengths or attributes of structures since last surveyed, such as occurred with SA050-2. Lastly, while survey efforts were made to maximize visibility of hydromodifications by surveying when flows were low and vegetative growth limited, variations in river depth and ten plus years of riparian growth may still have hid structures from the visual surveyors.

It is also useful to acknowledge that the 1998 survey appeared to include several hydromodifications that were outside the methodological scope of the current survey. In one example, the figure below illustrates a feature that was included in the 1998 survey, called SK130B-2.



It may seem obvious that the river bank was altered to protect the County Line Ponds, which are visible behind the hydromodification in the map; however, because no angular rock or constructed material was observed the feature was not included in the current survey. This example illustrates a difficulty encountered in this project; to reduce subjectivity and keep methods consistent, only structures with angular rock (or clearly man-made pieces such as cement) were included in the final list of hydromodifications, even when other evidence may have suggested alterations to bank edges. Without such conservative constraints, the field surveys could easily have ballooned into an overly subjective inventory containing questionable data.

In another example, the figure below shows a hydromodification included in the 1998 survey, but not the current survey. This feature was located along an oddly straightened bank where the river appears in danger of damaging or overtaking State Highway 20, and it seems plausible, if not likely, that a hydromodification exists here. However, since no angular rock was observed, no feature was collected in the field.



Despite the potential pitfalls of comparing the current survey to the 1998 survey, there is one instance in which comparisons seem justified. After a thorough vetting of the two surveys and as evidenced in the above paragraphs, it appears that the constraints of identifying a hydromodification were consistently more stringent in the current survey than the 1998 survey. Thus, if a hydromodification was observed in the current survey, but was not identified in 1998, it seems likely that this feature was newly constructed sometime between the two surveys. Considering this, a temporal comparison between the two surveys is presented in Table 5, which summarizes the construction of assumed new hydromodifications at the reach-scale. According to this analysis, a total of 3.59 kilometers (or over 2.2 miles) of new hydromodified river bank was constructed in the time period between the two surveys.

Table 5. Lengths of hydromodifications (meters) summed by reach that were sampled between 2010 and 2015, but not identified in the original 1998 survey, thus **assumed to be newly constructed since the 1998 survey**. Subtotals are presented for subwatershed (I.e. Middle Skagit, Upper Skagit, Sauk, Suiattle, Cascade), and subdivided by water type (i.e. mainstem, secondary, tributary). Table does not include hydromodifications in the tributaries, as these areas were not surveyed for the 1998 report. Length of individual hydromodifications are found in the attribute table associated with the final GIS shapefile. Reach locations are delineated in Appendix 1.

Subwatershed	Reach ID	Hydromodification Length by Water Type		Total (m)
		Mainstem (m)	Secondary (m)	
Middle Skagit	SK050	76.2		76.2
Middle Skagit	SK060A	362.1	247.1	609.2
Middle Skagit	SK060B	207.1	164.5	371.6
Middle Skagit	SK070A			0.0
Middle Skagit	SK070B	16.5		16.5
Middle Skagit	SK080A	18.4		18.4
Middle Skagit	SK080B	155.7		155.7
Middle Skagit	SK080C			0.0
Middle Skagit	SK090			0.0
Middle Skagit	SK100			0.0
Middle Skagit	**Subtotal**	**836.0**	**411.6**	**1247.6**
Upper Skagit	SK100A	226.6	77.9	304.5
Upper Skagit	SK110	172.4	102.2	274.6
Upper Skagit	SK120A			0.0
Upper Skagit	SK120B			0.0
Upper Skagit	SK130A			0.0
Upper Skagit	SK130B	22.9		22.9
Upper Skagit	SK140			0.0
Upper Skagit	**Subtotal**	**421.9**	**180.1**	**602.0**
Sauk	SA010	31.2		31.2
Sauk	SA020A		79.4	79.4
Sauk	SA020B			0.0
Sauk	SA030		353.9	353.9
Sauk	SA040	335.3		335.3
Sauk	SA050		50.7	50.7
Sauk	SA060A	71.2		71.2
Sauk	SA060B	216.7		216.7
Sauk	SA060C			0.0
Sauk	SA060D	63.0		63.0
Sauk	SA070			0.0
Sauk	SFSA010			0.0
Sauk	SFSA020			0.0
Sauk	NFSA010			0.0
Sauk	**Subtotal**	**717.4**	**484.0**	**1201.4**

Table 5 continued:

Subwatershed	Reach ID	Hydromodification Length by Water Type Mainstem (m)	 Secondary (m)	Total (m)
Suiattle	SU010			0.0
Suiattle	SU020A	334.4		334.4
Suiattle	SUX1			0.0
Suiattle	SU030		9.6	9.6
Suiattle	SU040A			0.0
Suiattle	SU040B	81.7		81.7
Suiattle	SU040C			0.0
Suiattle	SU050			0.0
Suiattle	**Subtotal**	**416.1**	**9.6**	**425.7**
Cascade	CA010	25.9		25.9
Cascade	CA020	71.1		71.1
Cascade	CA040A			0.0
Cascade	CA040B			0.0
Cascade	CA040C			0.0
Cascade	CA040D			0.0
Cascade	CAX2			0.0
Cascade	CA060			0.0
Cascade	SFCA010			0.0
Cascade	NFCA010	18.2		18.2
Cascade	**Subtotal**	**115.2**	**0.0**	**115.2**
Skagit Basin	**Total**	**2506.6**	**1085.3**	**3591.9**

The figure below shows an example of a hydromodification, SA060B-8, that clearly appears to be newly constructed. The lack of vegetative cover and the conspicuousness of the structure seem to make it unlikely that this hydromodification was present, but missed, during the 1998 survey.

An important next step with this dataset is to develop a prioritization scheme, whereby reaches and individual hydromodifications are ranked for the potential to restore natural geomorphic processes and instream salmonid habitat. A useful framework might rank restoration potential in terms of two overarching criteria, the first being probability that any restoration activity could take place at a given site, and the second being the expected gain in habitat quality and salmonid population productivity. The first criterion could consider such issues as property ownership, whether permits were properly acquired for construction of the hydromodification, the amount and condition of the infrastructure that the hydromodification is protecting (e.g. undersized bridge, abandoned road), downstream property issues, and the chance to coordinate with other restoration/mitigation projects that might occur around the hydromodification. The second criterion may be harder to define, as responses of physical river process and salmonid population dynamics are difficult to predict. Some potential responses to consider include benefits to species other than Chinook (e.g. federally listed steelhead), diversity of habitat and life-history types supported by restoration (e.g. high flow velocity refugia, off-channel rearing habitats, low summer flow thermal refugia, low angle bars, natural bank), the use of reach scale metrics to prioritize across reaches (e.g. sinuosity, confinement, gradient), and hydrodynamic modeling analyses that estimate habitat area and/or type under different restoration and flow scenarios (SRSC 2011).

In addition to restoration, this inventory can be used to help identify means of protecting currently functioning, but at risk, habitat. The example shown above, SA060B-8, illustrates one area where protection efforts may be failing. It is well understood that when riparian vegetation is removed, as it apparently was around SA060B-8, bank stability is greatly reduced, resulting in increased erosion. While it is beyond the scope of this report to document the history of vegetation removal, bank erosion and hydromodification construction at specific sites, poor planning and lack of oversight appears at least partly responsible for the need to riprap SA060B-8. The data collected in this survey may offer useful tools to improve permitting and/or enforcement. A useful exercise would be to investigate the permitting history, or lack thereof, of newly constructed hydromodifications and identify areas that are inadequately addressed under the current permitting system and/or promote a more robust enforcement of environmental protection codes.

Authors of this report would like to share some anecdotal observations made during the survey that are relevant to comprehensive restoration strategies. First, a case should be made that all derelict vehicles be removed from the river to mitigate habitat impacts and other environmental pollution as a first step in protecting natural resources. Second, recreational impacts to fishery resources were observed during the study. For instance, ATV use was observed in wetted channels, resulting in channel modifications and direct effects of driving over redds. A third example is the illegal harvest of large trees in the floodplain riparian area. If the goal of the project is to determine proper protection and restoration strategies, there should be an outreach effort to the residents and recreational users in the area.

The hydromodification survey conducted between 2010-2015, which provided the first update to the survey conducted in 1998, inventoried approximately 257 kilometers (160 miles) of mainstem channel, 88 kilometers (55 miles) of secondary channel and 96 kilometers (60 miles) of tributary channel in the Skagit basin, encompassing the known distribution of Chinook salmon. Assessments of additional salmonid bearing waters would continue to offer useful guidance for restoration and protection efforts in the Skagit watershed. Potential areas for future survey could include the many smaller tributaries more typically used by species such as Steelhead trout and Coho salmon. Such efforts would help further refine restoration and protection needs across the watershed and offer a starting point for the scoping and development of additional habitat improvement projects.

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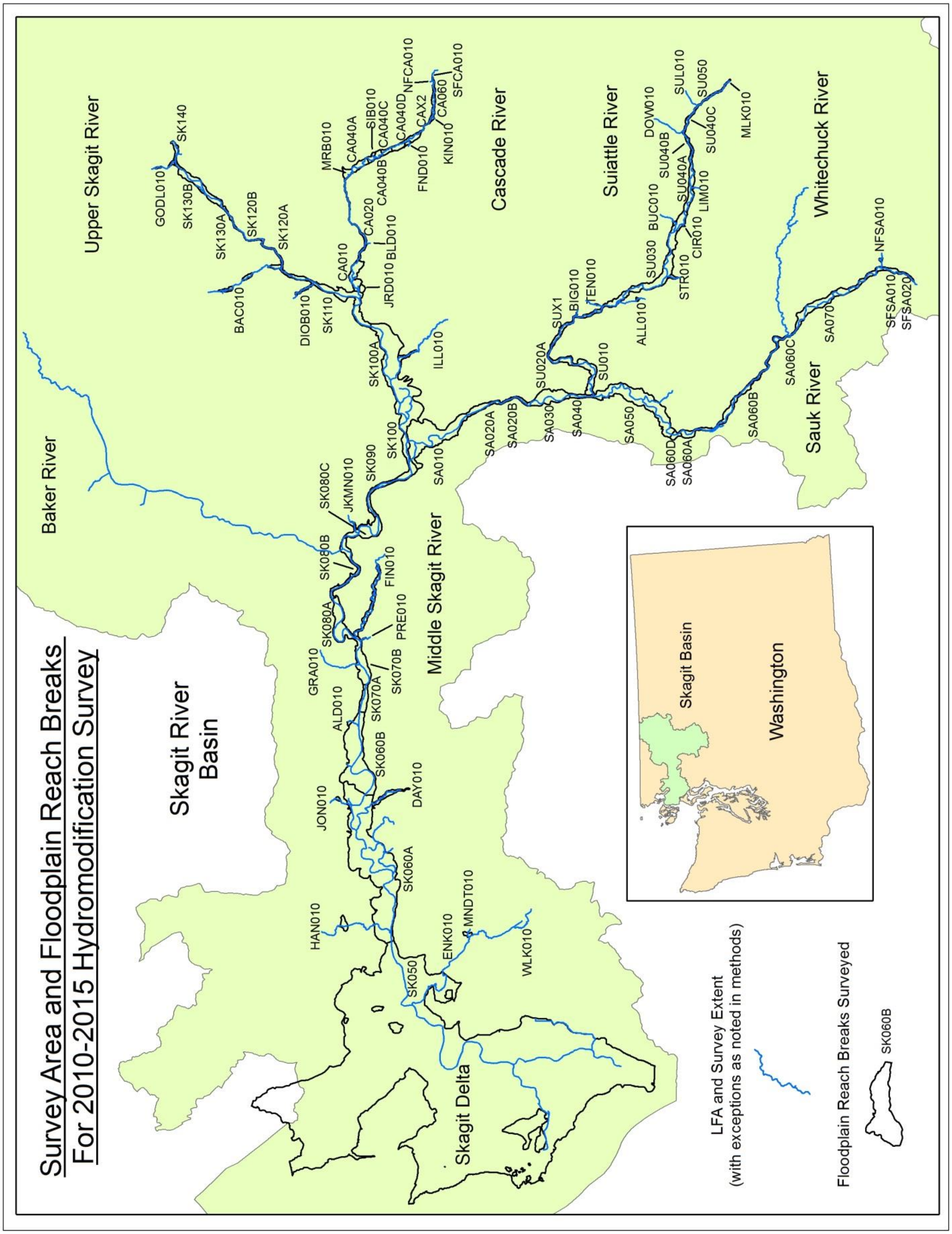
Appendix 1

Floodplain reach breaks used to summarize results of the hydromodification survey (see Tables 2 and 3 for results summary). The floodplain reach breaks and nomenclature are those referenced in the Skagit Chinook Recovery Plan (SRSC and WDFW, 2005).

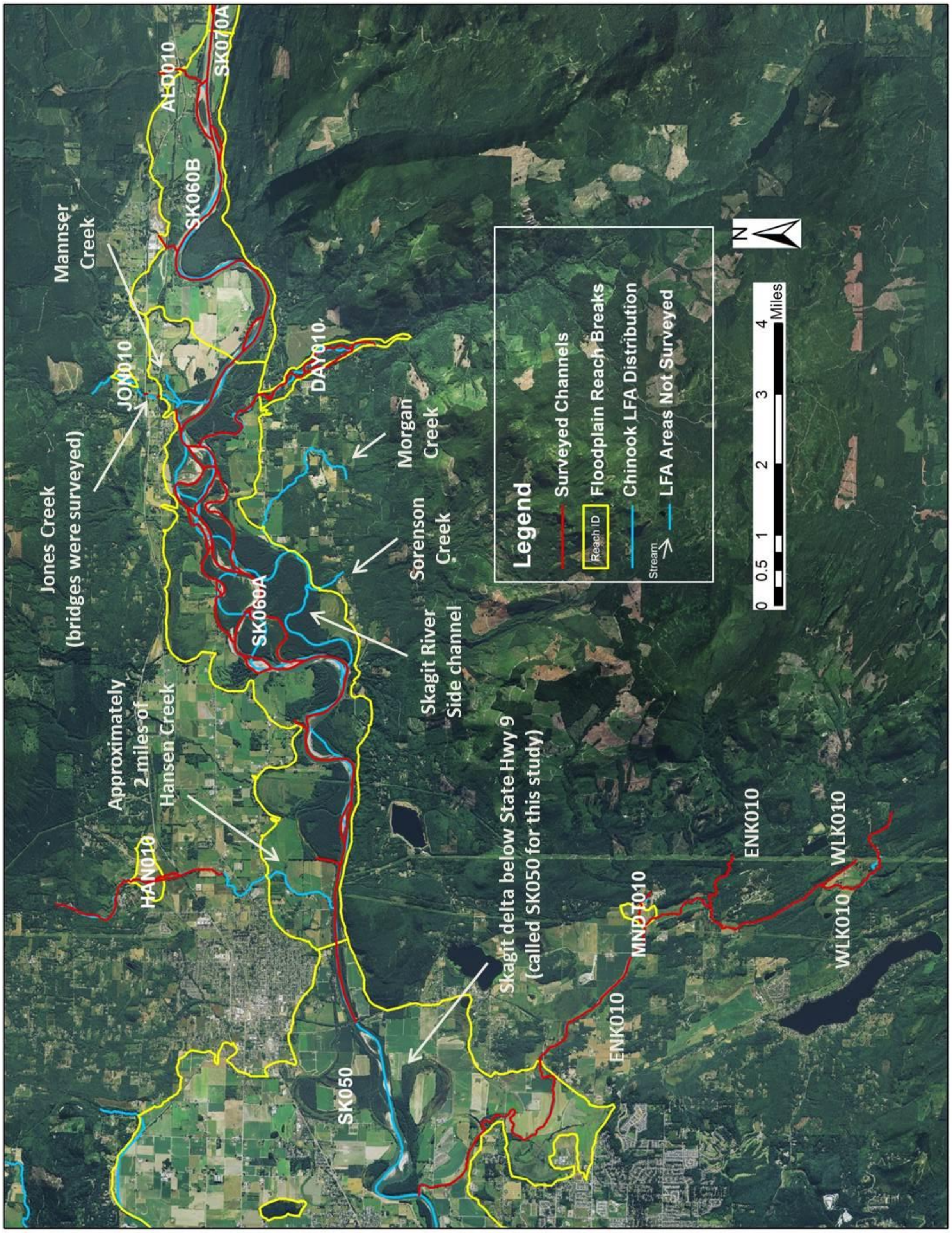
The first appendix map shows the survey area, where blue lines indicate the extent of LFA habitat and of the survey (with exceptions as noted in the methods section for extent of survey). Black lines indicate the floodplain reach boundaries, labeled in black lettering. In the tributaries, the reach boundaries do not always include the extent of LFA and for the purposes of this survey we did not relate hydromodification names to the tributary reach break nomenclature**.** Rather, we gave each tributary a single alphanumeric nomenclature (e.g. Bacon Creek hydromodifications were all labeled BAC010, regardless of which, if any, floodplain reach they were located in).

The subsequent appendix maps, numbered 2 through 10, show the location of individual reaches in greater detail, with reaches outlined in yellow and labeled in white lettering. Red lines indicate the channels that were boated/hiked during the survey and blue lines represent the LFA Chinook distribution data. Since multiple channels were surveyed simultaneously in highly braided sections of river, the red lines underestimate the actual length of channel that was surveyed. White lettering and arrows pointing to LFA sections indicate areas that were not covered in this survey (see Table 1).

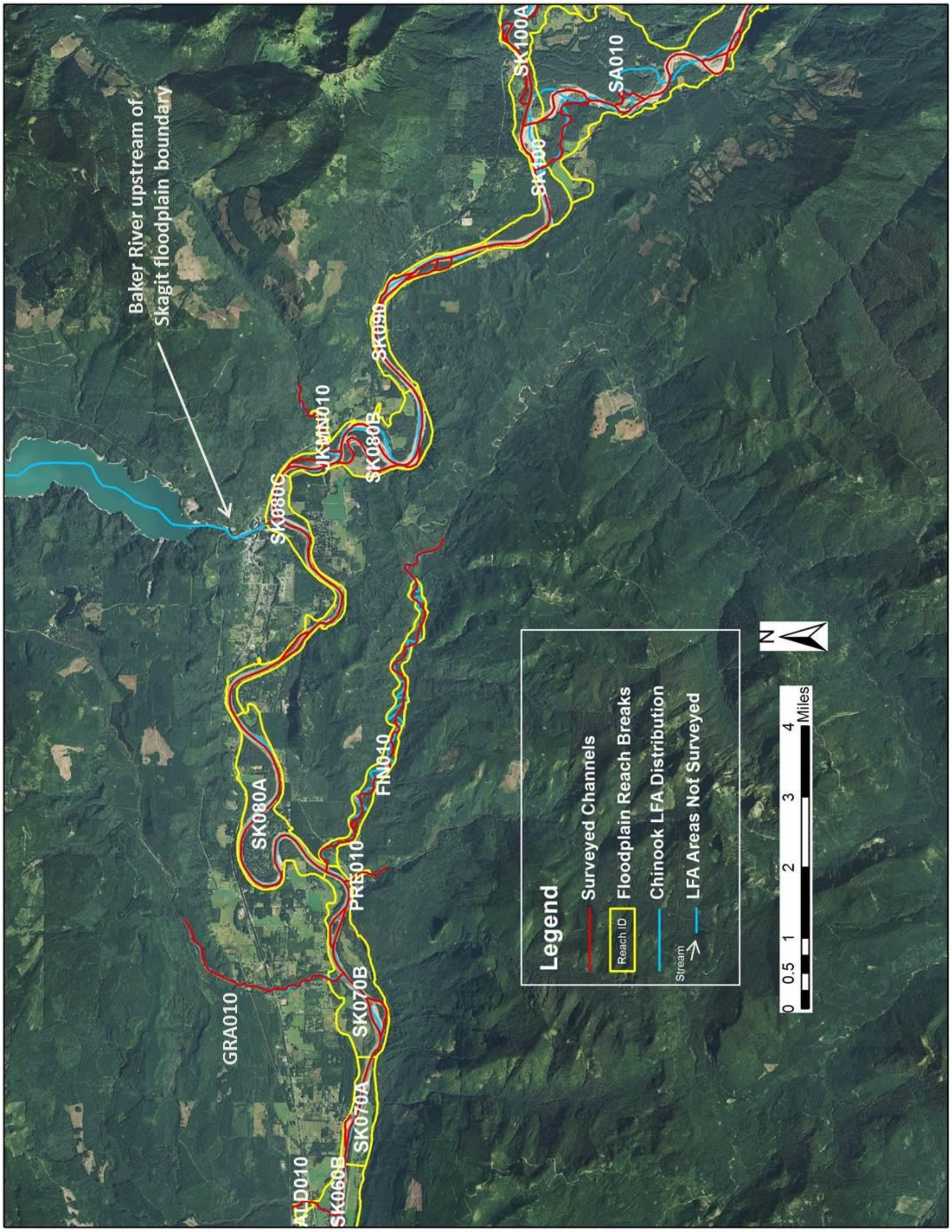
Appendix map 1:



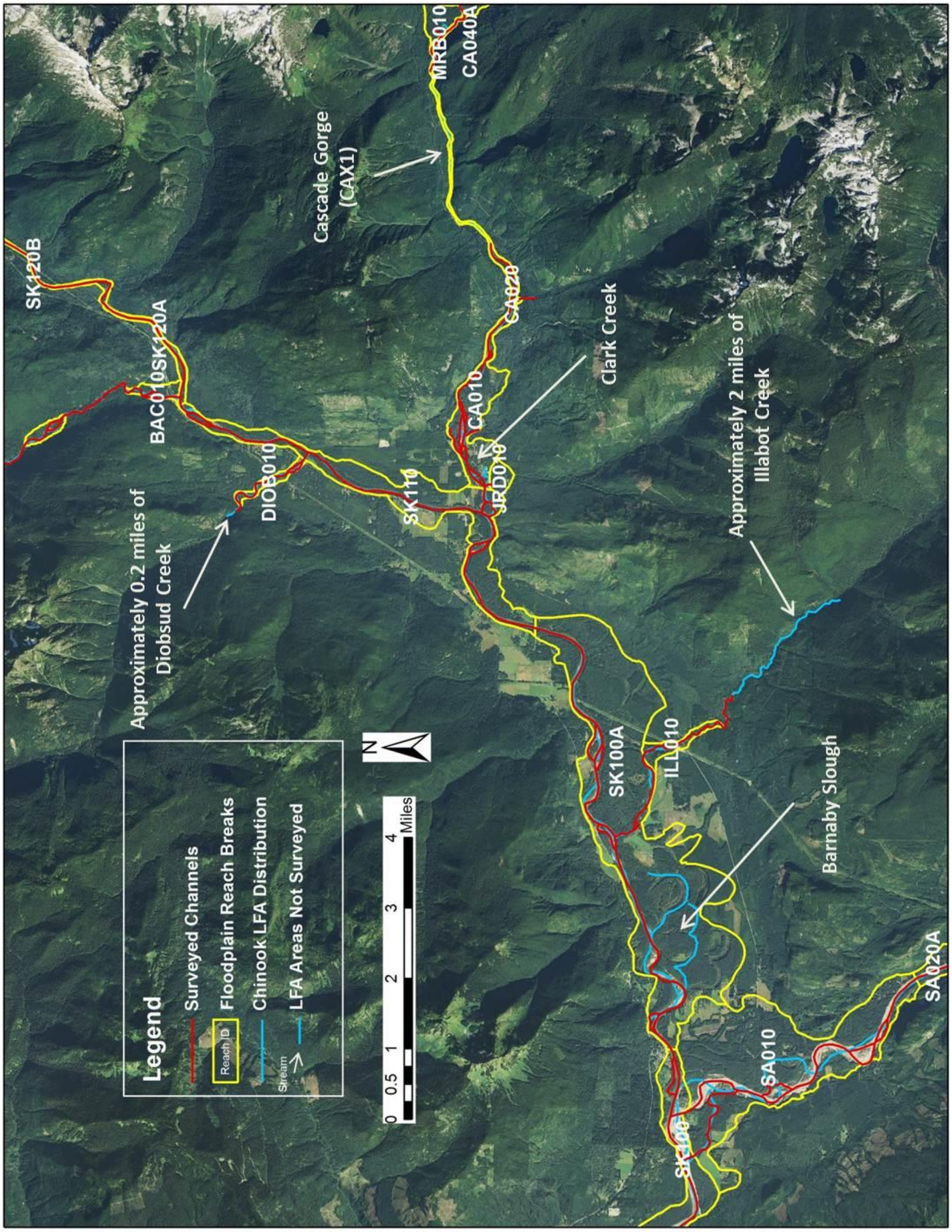
Appendix map 2:



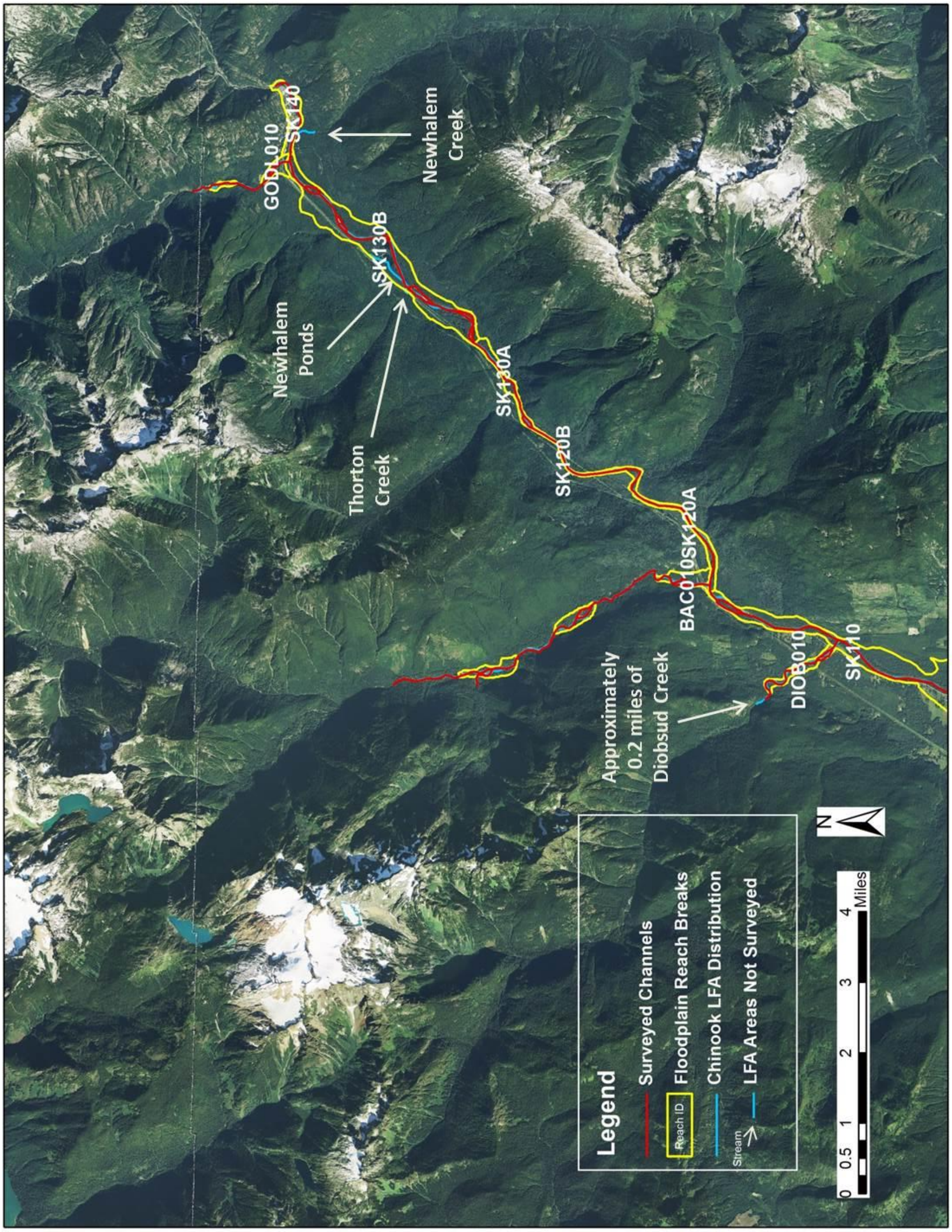
Appendix map 3:



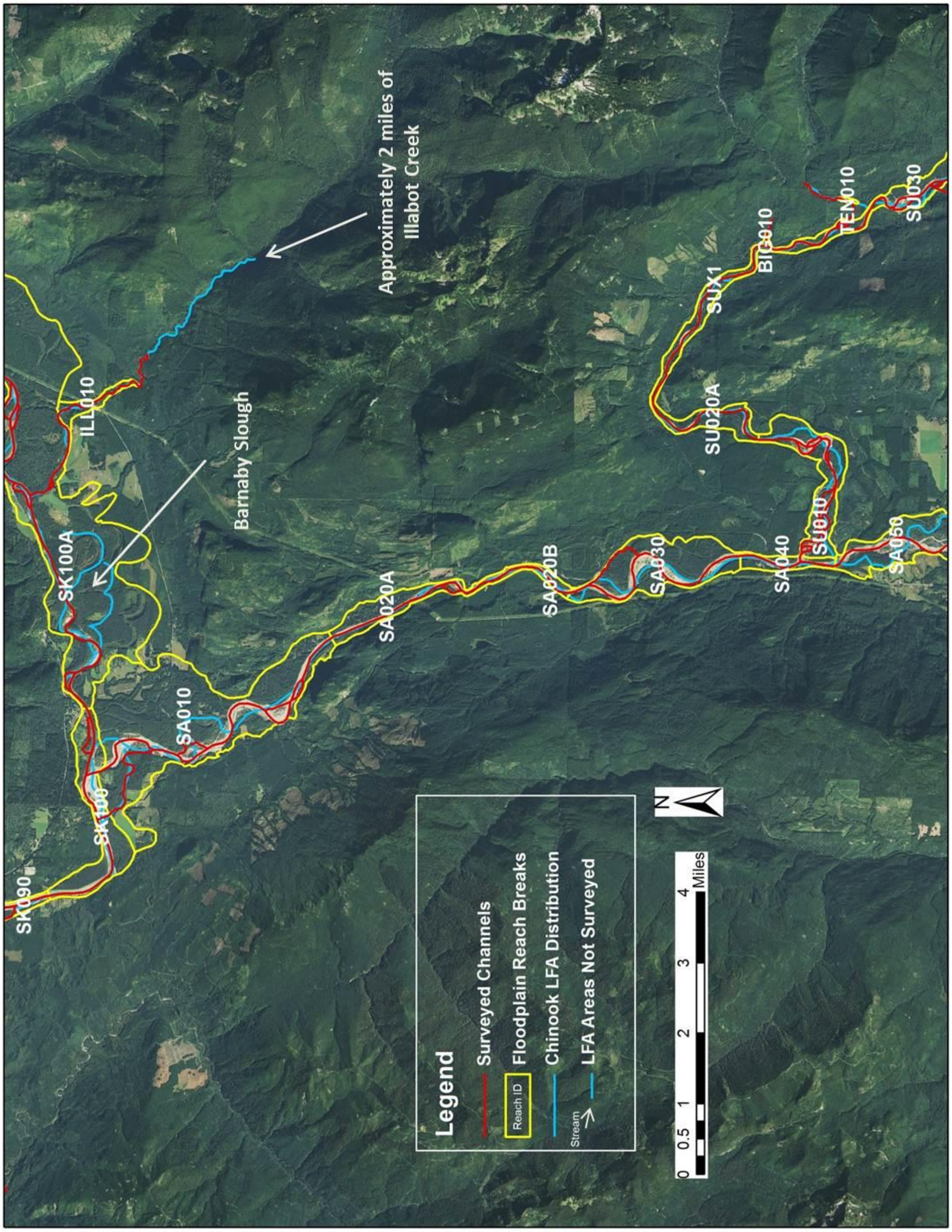
Appendix map 4:



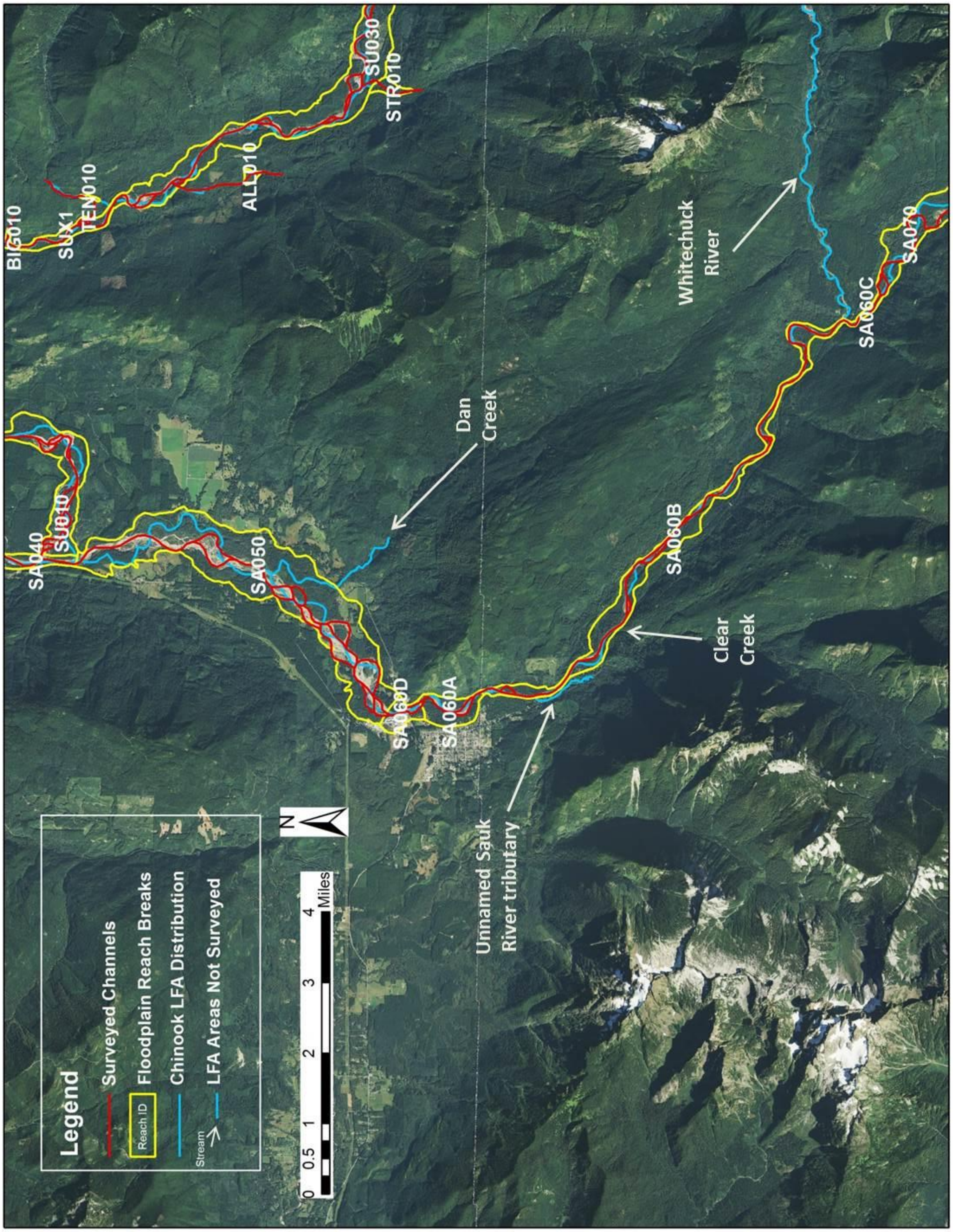
Appendix map 5:



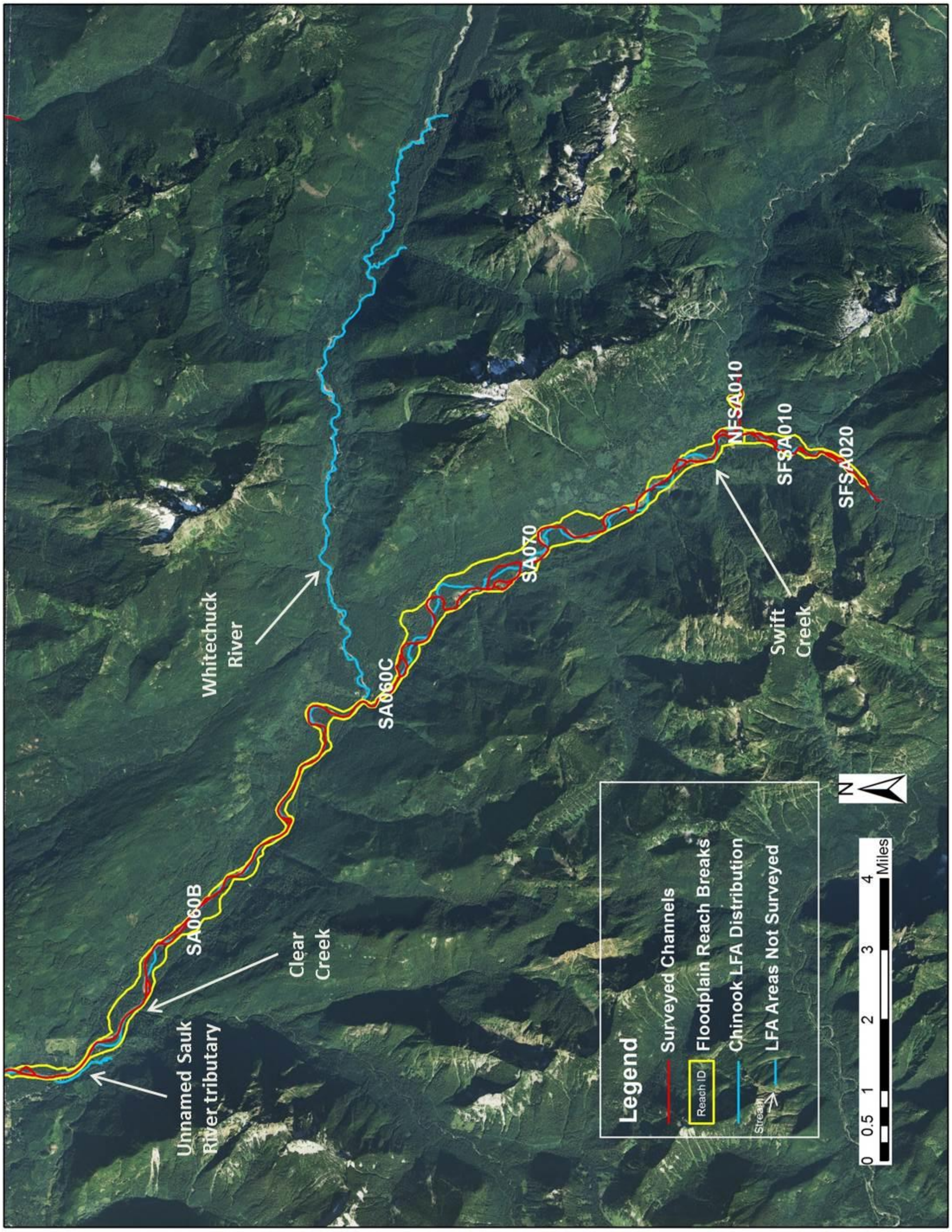
Appendix map 6:



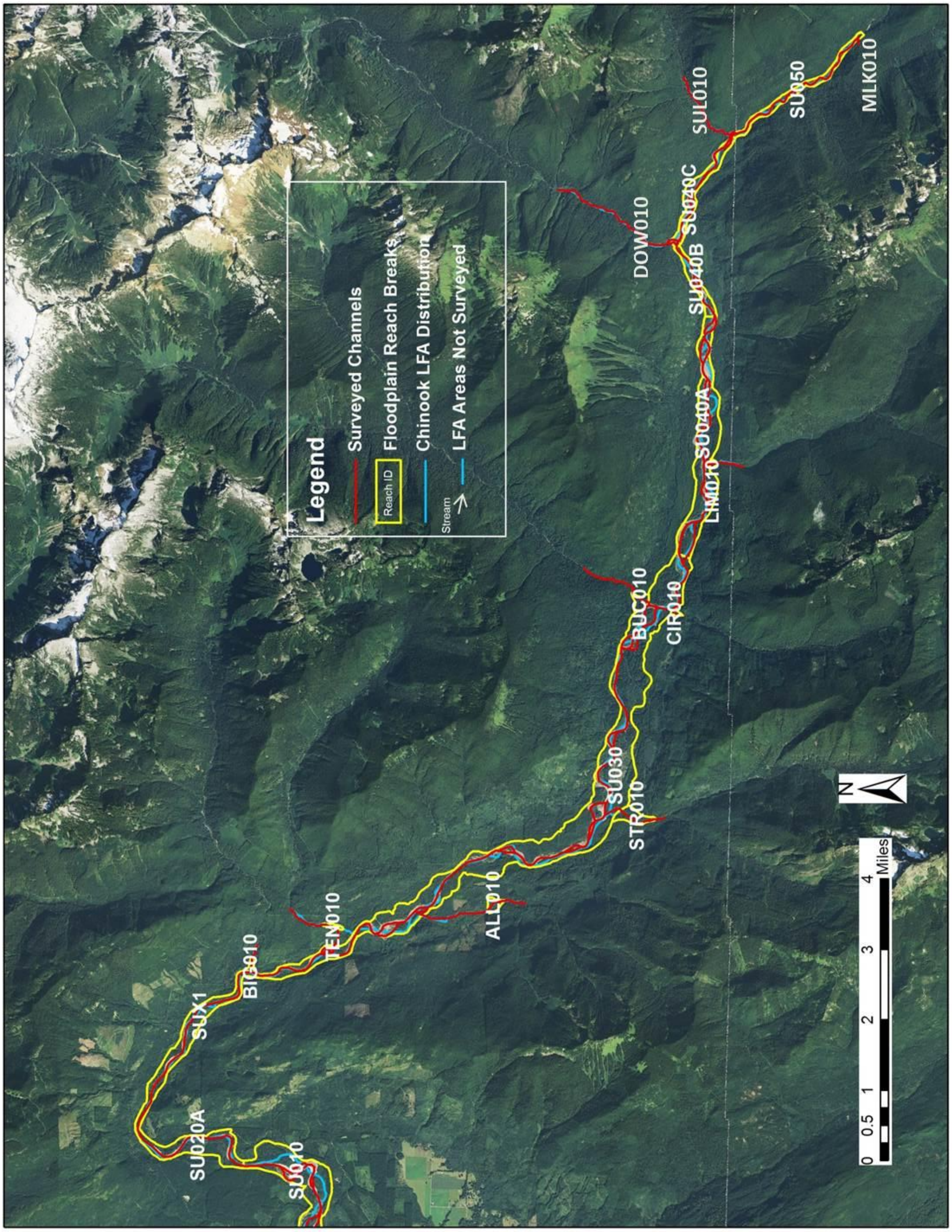
Appendix map 7:



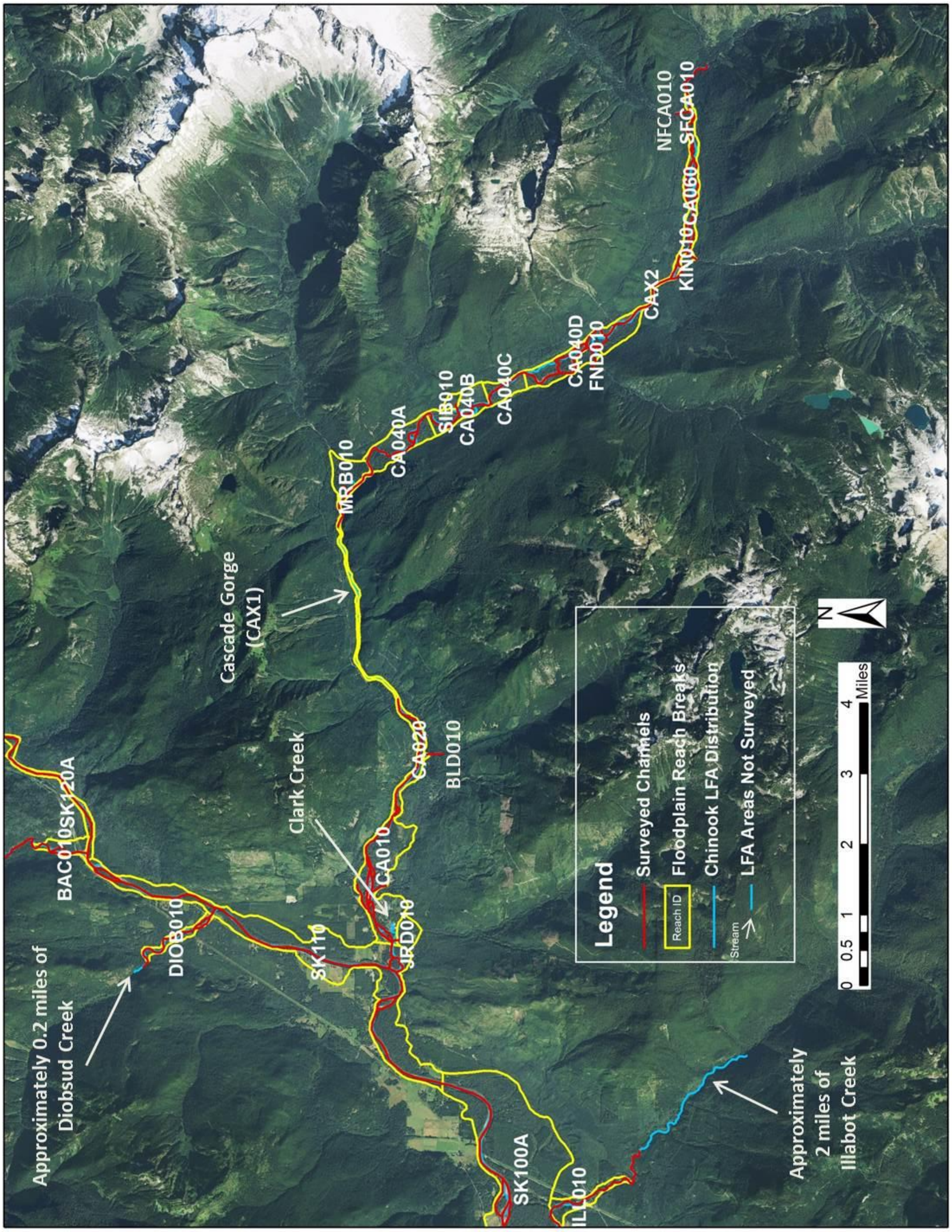
Appendix map 8:



Appendix map 9:



Appendix map 10:



Appendix 2

Distribution Letter and Disclaimer:

Upper Skagit Indian Tribe
25944 Community Plaza Way,

Sedro Woolley, WA 98284
Phone (360) 854-7090 Fax (360) 854-7042

December 7, 2015

RE: Hydromod.II.2015 - hydromodification survey of Chinook Salmon streams in the Skagit basin

To whom it may concern,

The Upper Skagit Indian Tribe Natural Resources Department ("The Tribe") is disseminating data from a basin-wide survey of hydromodified river banks in an effort to foster broad-scale coordination and partnerships for protecting and restoring Chinook and other anadromous salmonid populations throughout the Skagit watershed. Hydromodified stream banks, such as riprap armoring, are a common approach for protecting property because they limit natural fluvial processes of erosion and channel migration. However, these structures cause significant reductions in the quality and quantity of stream habitats and habitat forming processes that are currently limiting recovery of multiple salmonid populations and species. Many of the attributes in this data set were visual estimates collected during a rapid field assessment and if site specific actions are being proposed a more detailed assessment should be conducted.

This survey updated a similar survey conducted in 1998 by Skagit System Cooperative (now Skagit River System Cooperative). The first year of the updated survey, completed in 2010, quantified hydromodifications in the Middle Skagit floodplain, an important habitat zone for all six unique populations of Skagit Chinook and other salmonids. Subsequent surveys, conducted between 2012 and 2015, covered the portions of the anadromous zone upstream of the Middle Skagit and tributaries outside the Skagit floodplain. Taken together, these surveys covered a diverse suite of salmonid habitats, from coldwater tributaries to large river floodplains. It will be necessary to restore and preserve such spatial habitat diversity in order to support the multitude of habitat functions that drive Chinook and other salmonid populations, from spawning to flood refuge to freshwater rearing conditions. Considerable amounts of both intact and isolated floodplain habitat exist throughout the Skagit watershed and there is potential to have significant benefits to salmonid population recovery through restoration of hydromodified river channels. The Tribe is hopeful that this dataset will provide an important tool in preserving and restoring floodplain processes and edge habitats throughout the basin. To this end, The Tribe will use this updated survey to develop a prioritization scheme to help identify individual hydromodifications for restoration.

Attached with this letter is a data disc containing GIS shapefiles and pictures. We quantified hydromodifications along the edges of active channels. We also measured point disturbances, referred to as sub-hydromodifications, which included such structures as bridge piers, abandoned vehicles, staircases and culverts. The specific locations of surveys where based off the known distribution of Chinook Salmon, according to a Limiting Factors Analysis (2001). We organized the data in two shapefiles called 'Hydromod.II.2015.shp' and 'Submod.II.2015.shp', and included PDF pictures relating to the specific shapefile features. Also included is a shapefile called 'SurveyedChannels.II.2015.shp' that illustrates the river and tributary channels that we surveyed. The "II" in the file names refers to this being the second such survey, updating the original that was conducted in 1998. We plan to solicit updates and/or revisions to the dataset on an annual basis. Updates could include hydromodifications that we missed during the survey that should be added to the dataset, that were removed through restoration, that were newly constructed since the completion of the survey, or those that were altered by natural river processes or human intervention. File names for subsequent updates will include the year of the update (e.g. next year's data will be named "Hydromod.II.2016").

The party receiving this data agrees to the following:

No less than fifteen (15) business days prior to public disclosure of any results of a Project that uses the data attached with this letter, data Recipient will provide Sponsor (i.e. Upper Skagit Indian Tribe), a manuscript or other draft of the proposed publication. Within fifteen (15) business days following receipt thereof, Sponsor will notify Recipient in writing if the proposed disclosure contains any Sponsor confidential information and specify the portions of the proposed disclosure requiring redaction. Confidential information may include, but not be limited to, management strategies for future production or harvest objectives. Recipient shall provide Sponsor a copy or notice of any publication that includes a report of the results of the Project. Recipient further agrees to provide, in accordance with customary standards, an appropriate acknowledgement in any such publication of Sponsor's support or other role in the Project. Please cite the use of this data as:

Hartson, R., and Shannahan, J. 2015. Inventory and Assessment of Hydromodified Bank Structures in the Skagit River Basin: Chinook Bearing Streams. Upper Skagit Indian Tribe, Sedro Woolley, Washington.

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Please contact Rick Hartson at (360) 854-7049 or by email rickh@upperskagit.com if you have any technical issues.

Sincerely,

Jon-Paul Shannahan
Managing Biologist

Cc:
National Park Service, North Cascades National Park Service Complex
Northwest Indian Fisheries Commission -
- Main Office
- North Sound Office

Puget Sound Energy, Hydro Licensing
Puget Sound Partnership, Main Office
Sauk-Suiattle Tribe
Seattle City Light, Environmental Affairs and Real Estate Division
Skagit County, Natural Resources Management
Skagit Fisheries Enhancement Group
Skagit Land Trust
Skagit River System Cooperative -
- Environmental Services
- Forest and Fish
- Research
- Restoration
- Salmon Recovery

Skagit Watershed Council
The Nature Conservancy, Washington Program
US Forest Service, Mt. Baker-Snoqualmie National Forest -
- Darrington Ranger District
- Mt. Baker Ranger District

Washington Department of Ecology, NW Regional Office
Washington Department of Fish and Wildlife -
- LaConner Office, Habitat Program
- North Puget Sound, Region 4 Office, Habitat Program

Washington Department of Natural Resources, NW Region
Washington State Department of Transportation, NW Region, Burlington Office