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SUSITNA-WATANA HYDRO

ALASKA ENERGY AUTHORITY

January 31, 2013

Ms. Kimberly Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Susitna-Watana Hydroelectric Project, FERC Project No. 14241-000

Dear Secretary Bose:

By letter dated January 17, 2013, Staff of the Federal Energy Regulatory Commission (Commission) issued a modified schedule for its April 1, 2013 study plan determination (SPD) for 13 of the individual studies contained in the Alaska Energy Authority's (AEA) Revised Study Plan (RSP) for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241.[1] Among other milestones, Staff's modified schedule required AEA to file specified information related to these 13 individual studies by January 31, 2013, and to convene public meetings on February 14-15, 2013, to discuss these materials with federal and state resource agencies and other licensing participants. In accordance with Staff's modified schedule, the purposes of this filing are to: (1) submit all information specified by Staff for filing by January 31; and (2) provide details of the public meetings to be held in Anchorage, Alaska, on February 14-15, 2013.

Description of Attached Information

Commission Staff's January 17 modified schedule required AEA to file the following information by January 31, 2013:

> results of 2012 open-water flow routing model and habitat mapping; draft implementation plans for the Fish Distribution and Abundance in the Upper Susitna River (study 9.5), the Fish Distribution and Abundance in the Lower and Middle Susitna River (study 9.6), and River Productivity

[1] *See* Letter from Jeff C. Wright, Federal Energy Regulatory Commission, to Wayne Dyok, Alaska Energy Authority, Attachment A, Project No. 14241-000 (issued Jan. 17, 2013) [hereinafter, Schedule Modification Letter]. The 13 individual studies scheduled for Staff's April 1 SPD consist of the following: (1) Baseline Water Quality (RSP 5.5); (2) Water Quality Modeling Study (RSP 5.6); (3) Mercury Assessment and Potential for Bioaccumulation Study (RSP 5.7); (4) Geomorphology Study (RSP 6.5); (5) Fluvial Geomorphology Modeling Below Watana Dam Study (RSP 6.6); (6) Groundwater Study (RSP 7.5); (7) Ice Processes in the Susitna River Study (RSP 7.6); (8) Fish and Aquatics Instream Flow Study (RSP 8.5); (9) Riparian Instream Flow Study (RSP 8.6); (10) Study of Fish Distribution and Abundance in the Upper Susitna River (RSP 9.5); (11) Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (RSP 9.6); (12) River Productivity Study (RSP 9.8); and (13) Characterization and Mapping of Aquatic Habitats (RSP 9.9).

813 West Northern Lights Boulevard Anchorage, Alaska 99503 T 907.771.3000 Toll Free (Alaska Only) 888.300.8534 F 907.771.3044

(study 9.8) studies; all proposed focus areas; and a description of habitat units within the focus areas for all aquatic studies to be implemented in the middle Susitna River.[2]

In response to Staff's request, and in furtherance of its efforts to finalize study reports associated with its 2012 early licensing studies, AEA has prepared several study reports and technical memoranda containing all the requested information. The information requested by Commission Staff appears in the attachments as follows:

Requested Information	Attachment
Results of 2012 Open-Water Flow Routing	Attachment A, *Open Water HEC-RAS Flow Routing Model* (January 2013)
Results of 2012 Habitat Mapping	Attachment B, *Middle Susitna River Segment Remote Line Habitat Mapping Technical Memo* (January 2013)
Draft Implementation Plan for Study of Fish Distribution and Abundance in the Upper Susitna River (RSP 9.5)	Attachment C, *Draft Susitna River Fish Distribution and Abundance Implementation Plan* (January 2013)
Draft Implementation Plan for Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (RSP 9.6)	Attachment C, *Draft Susitna River Fish Distribution and Abundance Implementation Plan* (January 2013)
Draft Implementation Plan for River Productivity Study (RSP 9.8)	Attachment D, *Draft Susitna River Productivity Study Implementation Plan* (January 2013)
Proposed Focus Areas	Attachment E, *Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014* (January 2013)
Description of Habitat Units within Focus Areas for All Aquatic Studies to Be Implemented in the Middle Susitna River	Attachment E, *Selection of Focus Areas and Study Sites in the Middle and Lower Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014* (January 2013)

Details of Public Meetings

Commission Staff's modified schedule directed AEA to hold meetings on February 14-15, 2013, "to discuss the study results, proposed implementation plans, and selected focus areas in the middle and lower Susitna River."[3] These Technical Workgroup (TWG) meetings, which are open to federal and state resource agencies, other licensing participants, and interested members of the public, will begin each day at 8:30 a.m. (Alaska Standard Time), and will be held in the Public Conference Room of the Z.J.

[2] Schedule Modification Letter, Attachment A.

[3] *Id.*

Loussac Public Library, located at 3600 Denali Street, Anchorage, Alaska. Additional information regarding these TWG meetings—including instructions for participating online and via teleconference for those unable to attend in person—appear at AEA's licensing website, http://www.susitna-watanahydro.org/meetings/. More detailed information regarding these TWG meetings, including a draft agenda, will be posted to the website in the coming days.

AEA looks forward to discussing these materials in the upcoming TWG meetings. These discussions will inform and assist AEA in its development of the final implementation plans for the Study of Fish Distribution and Abundance in the Upper Susitna River (RSP 9.5), Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (RSP 9.6), and River Productivity Study (RSP 9.8). As provided in Commission Staff's modified schedule, AEA will file these final implementation plans with the Commission by March 1, 2013.

AEA acknowledges and greatly appreciates the participation and commitment to this licensing process of Commission Staff, federal and state resource agencies, and other licensing participants. AEA is particularly appreciative of all participants' efforts to date to work efficiently and collaboratively in developing a robust study plan that can be approved by Commission Staff in accordance with the modified schedule and implemented beginning with the 2013 field season.

If you have questions concerning this submission please contact me at wdyok@aidea.org or (907) 771-3955.

Sincerely,

Wayne Dyok
Project Manager
Alaska Energy Authority

Attachments

cc: Distribution List (w/o Attachments)

Attachment B

Middle Susitna River Segment Remote Line Habitat Mapping
Technical Memo (January 2013)

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Middle Susitna River Segment Remote Line Habitat Mapping Technical Memorandum

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

HDR Alaska, Inc
2525 C Street
Suite 305
Anchorage, AK 99503

January 2013

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LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
ADF&G	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
APA	Alaska Power Authority
APA Project	APA Susitna Hydroelectric Project
Backwater	Off-channel habitat characterization feature found along channel margins and generally within the influence of the active main channel with no independent source of inflow. Water is not clear.
Bank	The sloping land bordering a stream channel that forms the usual boundaries of a channel. The bank has a steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.
Beaver complex	Off-channel habitat characterization feature consisting of a ponded water body created by beaver dams.
Braided streams	Stream consisting of multiple small, shallow channels that divide and recombine numerous times. Associated with glaciers, the braiding is caused by excess sediment load.
cfs	cubic feet per second
Channel	A natural or artificial watercourse that continuously or intermittently contains water, with definite bed and banks that confine all but overbank stream flows.
Confluence	The junction of two or more rivers or streams.
Cross-section	A plane across a river or stream channel perpendicular to the direction of water flow.
Devils Canyon	Located at approximately Susitna River Mile (RM) 150-161, Devils Canyon contains four sets of turbulent rapids rated collectively as Class VI. This feature is a partial fish barrier because of high water velocity.
Downwelling	The downward movement of water from rivers, streams, sloughs and other surface water features into soils and bedrock.
Drainage area	The total land area draining to any point in a stream. Also called catchment area, watershed, and basin.
Edge habitat	The boundary between natural habitats, in this case between land and a stream. Level five tier of the habitat classification system.
et al.	"*et alia*"; and the rest
FERC	Federal Energy Regulatory Commission
Floodplain	1. The area along waterways that is subject to periodic inundation by out-of-bank flows. 2. The area adjoining a water body that becomes inundated during periods of over-bank flooding and that is given rigorous legal definition in regulatory programs. 3. Land beyond a stream channel that forms the perimeter for the maximum probability flood. 4. A relatively flat strip of land bordering a stream that is formed by sediment deposition. 5. A deposit of alluvium that covers a valley flat from lateral erosion of meandering streams and rivers.
Floodplain vegetation – groundwater / surface water regime functional groups	Assemblages of plants that have established and developed under similar groundwater and surface water hydrologic regimes.
Fluvial	Of or pertaining to the processes associated with rivers and streams and the deposits and landforms created by them.
Focus Area	Areas selected for intensive investigation by multiple disciplines as part of the AEA study program.

Abbreviation	Definition
Geomorphic mapping	A map design technique that defines, delimits and locates landforms.
Geomorphic reach	Level two tier of the habitat classification system. Separates major hydraulic segments into unique reaches based on the channel's geomorphic characteristic.
Geomorphology	The scientific study of landforms and the processes that shape them.
GIS	Geographic Information System. An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.
Glide	An area with generally uniform depth and flow with no surface turbulence. Low gradient; 0-1 % slope.
Gradient	The rate of change of any characteristic, expressed per unit of length (see Slope). May also apply to longitudinal succession of biological communities.
Gravel	Substrate particles between 0.1 and 3.0 inches in size, larger than sand and smaller than cobble.
Groundwater (GW)	In the broadest sense, all subsurface water; more commonly that part of the subsurface water in the saturated zone.
GW/SW interactions	The physical interactions between groundwater and surface water.
Habitat	The environment in which the fish live, including everything that surrounds and affects its life, e.g. water quality, bottom, vegetation, associated species (including food supplies). The locality, site and particular type of local environment occupied by an organism.
ILP	Integrated Licensing Process
Instream flow	The rate of flow in a river or stream channel at any time of year.
Juvenile	A young fish or animal that has not reached sexual maturity.
licensing participants; Participants	Agencies, ANSCA corporations, Alaska Native entities and other licensing participants
LiDAR	Light Detection and Ranging. An optical remote sensing technology that can measure the distance to a target; can be used to create a topographic map.
Life stage	An arbitrary age classification of an organism into categories relate to body morphology and reproductive potential, such as spawning, egg incubation, larva or fry, juvenile, and adult.
Lower segment Susitna	The Susitna River from Cook Inlet (RM 0) to the confluence of the Chulitna River at RM 98.
Main channel	For habitat classification system: a single dominant main channel. Also, the primary downstream segment of a river, as contrasted to its tributaries.
Main channel habitat	Level four tier of the habitat classification system. Separates main channel habitat types including: tributary mouth, main channel, split main channel, multiple split main channel and side channel into mesohabitat types. Mesohabitat tyes include pool, glide, run, riffle, and rapid.
Mainstem	Mainstem refers to the primary river corridor, as contrasted to its tributaries. Mainstem habitats include the main channel, split main channels, side channels, tributary mouths, and off-channel habitats.
Mainstem habitat	Level three tier of the habitat classification systems. Separates mainstem habitat into main channel, off-channel, and tributary habitat types. Main channel habitat types include: tributary mouth, main channel, split main channel, multiple split main channel and side channel. Off-channel habitat types include: side slough, upland slough, backwater, and beaver complex. Tributary habitat is not further categorized.
Major hydraulic segment	Level one tier of the habitat classification system. Separates the River into three segments: Lower River (RM 0-98), Middle River (RM 98-184), and Upper River (RM 184-233).

Abbreviation	Definition
Mesohabitat	A discrete area of stream exhibiting relatively similar characteristics of depth, velocity, slope, substrate, and cover, and variances thereof (e.g., pools with maximum depth <5 ft, high gradient rimes, side channel backwaters).
Middle segment Susitna	The Susitna River from the confluence of the Chulitna River at RM 98 to the proposed Watana Dam Site at RM 184.
MR	Middle River
Multiple split main channel	Main channel habitat characterization feature where more than three distributed dominant channels are present.
N/A	not applicable *or* not available
NEPA	National Environmental Policy Act
Nested design	Nested design (sometimes referred to as a hierarchical design) is used for experiments in which there is an interest in a set of treatments and the experimental units are sub-sampled.
Off-channel	Those bodies of water adjacent to the main channel that have surface water connections to the main river at some discharge levels.
Off-channel habitat	Habitat within those bodies of water adjacent to the main channel that have surface water connections to the main river at some discharge levels.
PHABSIM	Physical Habitat Simulation, aspecific model designed to calculate an index to the amount of microhabitat available for different life stages at different flow levels. PHABSIM has two major analytical components: stream hydraulics and life stage-specific habitat requirements.
PhD	Doctor of Philosophy
Pool	Slow water habitat with minimal turbulence and deeper due to a strong hydraulic control.
PRM	Project River Mile(s) based on the digitized wetted width centerline of the main channel from 2012 Matanuska-Susitna Borough digital orthophotos. PRM 0.0 is established as mean lower low water of the Susitna River confluence at Cook Inlet.
Project	Susitna-Watana Hydroelectric Project
Rapid	Swift, turbulent flow including small chutes and some hydraulic jumps swirling around boulders. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Lower gradient and less dense concentration of boulders and white water than Cascade. Moderate gradient; usually 2.0-4.0% slope.
Resident	Resident fish as opposed to anadromous remain in the freshwater environment year-round
Riffle	A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross-section. Low gradient; usually 0.5-2.0% slope.
Riparian	Pertaining to anything connected with or adjacent to the bank of a stream or other body of water.
Riparian vegetation	Vegetation that is dependent upon an excess of moisture during a portion of the growing season on a site that is perceptively more moist than the surrounding area.
Riparian zone	A stream and all the vegetation on its banks that is influenced by the presence of the stream, including surface flow, hyporheic flow and microclimate.
RIRP	Railbelt Integrated Resources Plan
River	A large stream that serves as the natural drainage channel for a relatively large catchment or drainage basin.
River corridor	A perennial, intermittent, or ephemeral stream and adjacent vegetative fringe. The corridor is the area occupied during high water and the land immediately adjacent, including riparian vegetation that shades the stream, provides input of organic debris, and protects banks from excessive erosion.

Abbreviation	Definition
River mile	The distance of a point on a river measured in miles from the river's mouth along the low-water channel.
RM	River Mile(s) referencing those of the APA Project.
RSP	Revised Study Plan
Run (habitat)	A habitat area with minimal surface turbulence over or around protruding boulders with generally uniform depth that is generally greater than the maximum substrate size. Velocities are on border of fast and slow water. Gradients are approximately 0.5 % to less than 2%. Generally deeper than riffles with few major flow obstructions and low habitat complexity.
Run (migration)	Seasonal migration undertaken by fish, usually as part of their life history; for example, spawning run of salmon, upstream migration of shad. Fishers may refer to increased catches as a "run" of fish, a usage often independent of their migratory behavior.
sf; sq ft, ft^2	Square foot (feet)
Side channel	Lateral channel with an axis of flow roughly parallel to the mainstem, which is fed by water from the mainstem; a braid of a river with flow appreciably lower than the main channel. Side channel habitat may exist either in well-defined secondary (overflow) channels, or in poorly-defined watercourses flowing through partially submerged gravel bars and islands along the margins of the mainstem.
Side slough	Off-channel habitat characterization of an Overflow channel contained in the floodplain, but disconnected from the main channel. Has clear water,
Slope	The inclination or gradient from the horizontal of a line or surface.
Slough	A widely used term for wetland environment in a channel or series of shallow lakes where water is stagnant or may flow slowly on a seasonal basis. Also known as a stream distributary or anabranch.
Soil water storage variations	Seasonal changes in where and how water is stored in a hydraulic system.
Solar geometry	Angle of the sun's rays to the surface.
Spaghetti tag	A long, thin external tag type used to mark individual fish. Sometimes referred to as anchor or dart tags, they are usually made of vinyl tubing that can have study information printed upon.
Spawning	The depositing and fertilizing of eggs by fish and other aquatic life.
Split main channel	Main channel habitat characterization where three of fewer distributed dominant channels.
Spring	Area where there is a concentrated discharge of groundwater that flows at the ground surface.
Streambed	The bottom of the stream channel; may be wet or dry.
Three Rivers Confluence	The confluence of the Susitna, Chulitna, and Talkeetna rivers at Susitna River Mile (RM) 98.5 represents the downstream end of the Middle River and the upstream end of the Upper River.
Tributary	A stream feeding, joining, or flowing into a larger stream (at any point along its course or into a lake). Synonyms: feeder stream, side stream.
Tributary mouth	Main channel habitat characterization of clear water areas that exist where tributaries flow into Susitna River main channel or side channel habitats.
TWG	Technical Workgroup
Upland slough	Off-channel habitat characterization feature that is similar to a side slough, but contains a vegetated bar at the head that is rarely overtopped by mainstem flow. Has clear water.
Upper segment Susitna	The Susitna River upstream of the proposed Watana Dam Site at RM 184.

Abbreviation	Definition
USFS	USDA, Forest Service
Watana Dam	The dam proposed by the Susitna-Watana Hydroelectric project. The approximately 750-foot-high Watana Dam (as measured from sound bedrock) would be located at river mile (RM) 184 on the Susitna River. The dam would block the upstream passage of Chinook salmon, possibly other salmon species, and resident fish that migrate through and otherwise use the proposed Watana Dam site and upstream habitat in the Susitna River and tributaries.

1. MIDDLE RIVER MAINSTEM HABITAT MAPPING

1.1 Introduction

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project) using the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 300-mile-long river in Southcentral Alaska. The Project's dam site will be located at river mile (RM) 184, corresponding to Project RM (PRM) 187.1 of the updated GIS-based hydrography.

This study provided information to serve as the basis for the 2013–2014 formal study program, for preparing Exhibit E of the License Application, and for use in FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

AEA will initiate aquatic studies in 2013 to characterize both instream flow and fish distribution within the Susitna River. These studies are described in the Revised Study Plan (RSP) Sections 8.5, 9.5, 9.6, and 9.9. To efficiently perform this work within a narrow seasonal window an approach to subsample representative habitat has been proposed. This subsample approach is applied differently for both instream flow and fisheries methodologies; however, both resources require some understanding of what available habitat exists and needs to be represented.

Historical habitat mapping studies from the 1980s occurred in the mainstem Middle River. Channel morphology was identified and the mainstem habitat types were representative of distinct functional hydrology. The approach to the study (i.e., classification system) was informative; however, these existing data may not reflect current conditions because of habitat changes in this dynamic river over the last 30 years.

In October 2012, a small AEA resource team identified this data need. The team determined that the best pathway for characterizing the frequency and proportion of habitat in the mainstem Middle River was to use geo-rectified aerial imagery in combination with available aerial videography to map available habitat. A hierarchical and nested classification system developed specifically for the Susitna River with input from the Fish and Aquatics Technical Workgroup (TWG) was used to classify habitat (see RSP Section 9.9 and Table 9.9-4). Applying this methodology allowed for habitat to be mapped remotely during winter months when additional on-the-ground mapping could not occur. The product of this effort is presented within this report.

1.2 Study Goals and Objectives

The goal of this study was to determine the composition and frequency of mainstem aquatic habitats and delineate the proportion of habitat in the Middle Susitna River from aerial imagery or videography.

The objective was to measure, using geo-rectified imagery, river habitat in the Middle Susitna River. A spatial database of the length and composition of habitat would be developed by drawing the beginning and end point of each specific habitat unit (i.e. remotely habitat map).

The study is intended to provide baseline data for supporting the selection of representative focus areas for instream flow studies and the approach for fish distribution site selection.

1.3 Study Area

The study area for the Middle River mainstem habitat mapping encompassed the mainstem Susitna from the Chulitna River confluence (Project River Mile [PRM][1] 102.3, Figure 1) to proximally below the Watana Dam Site[2] (PRM 186.7). The effort also included identifying tributaries to the mainstem Susitna River. The tributaries were identified within a 0.5 mile buffer from a centerline of the mainstem Susitna River. The 0.5 mile buffer extent was used because it was considered a conservative standard buffer to sufficiently represent the confluence of tributaries to the mainstem Susitna River.

2. STUDY METHODS

Remote line mapping of habitats in the Middle River was conducted using hierarchically-nested habitat typing adapted to feasible identification levels based on the use of aerial still imagery, LiDAR (Light Detection And Ranging), and low-elevation high definition aerial videography collected in 2012.

The aerial videography was collected from September 7–11, 2012. During the video collection, mean daily discharge from Gold Creek steadily declined from 16,500 cfs on September 7 to 10,800 cfs on September 11, 2012.

A linear network was created in GIS (geographic information system) by drawing vector-lines (segments) through the middle of the stream channel as viewed by aerial imagery or LiDAR. The reference imagery was collected at river flows generally ranging from 10,000 to 12,000 cfs, which were considered representative of relatively lower to mid-flow levels for mapping. Divided channels had multiple segments representing that stream section.

Main channel, tributary and off-channel habitats were uniquely identified and delineated into segments. The lengths of the segments were based on mesohabitat classification for the main channel and macrohabitat classification for off-channel or tributary habitat (Table 1). Each individual vector line segment provided a length and a hierarchical-tiered habitat classification organized in "levels". Not all lines connected into a contiguous or flow-based network, as that resulted in excessively long segments for small habitat units.

The habitat classification hierarchy was composed of five levels representing: (1) major hydrologic segment; (2) geomorphic reach; (3) mainstem habitat type; (4) main channel mesohabitat; and (5) edge habitat. Table 1 summarizes the levels and provides brief definition of each habitat classification level used during the effort. Level 1 identified the Middle River. Level 2 identified one of eight unique reaches established from the channel's geomorphic characteristics (developed from the Geomorphology Study [see RSP Section 6.0]). Level 3 classified the mainstem habitat type of main, off-channel, and tributary habitat using a slightly modified approach from the 1980s historical habitat mapping definitions (ADF&G 1983a). All

[1] Note that historic river miles from work conducted in the 1980s differ from current Project river miles or PRM. Current Project river miles are referenced throughout this report.

[2] The current dam site is PRM 187.1, but was only recently revised, following the development of this report. This minor difference will not substantially affect the results reported here.

off-channel and tributary habitats were classified to Level 3 and all main channel habitats were identified to Level 4 mesohabitat type (riffle, pool, run, etc.). The final tier, Level 5 edge habitat, was a calculated length of shoreline (i.e., doubled length of each line segment). The line segment length was defined by the lowest level of classification (i.e., Level 4 for mainstem and Level 3 for off-channel and tributary habitats). Edge habitat was reported by the amount of habitat per mile and provided an indicator of habitat complexity.

2.1 GIS Habitat Mapping

Habitat in the Middle River hydrologic segment was mapped using GIS from aerial still imagery viewed at a range of scales from 1:1,000 to 1:12,000 in order to locate line segments and habitat boundaries. All habitat segments were identified using a mid-channel line, which was measured to provide habitat length. In channels that were only partially inundated or where water was present in sloughs, the line segments followed the wet areas. Polygons were drawn to demark the boundaries of tributary mouth and backwater habitat in order to characterize available fish habitat. Area mapping was generated separately from the linear database, but all data is summarized below.

Several controls were established to ensure that the habitat mapping effort was both precise and accurate. Examples of specific aerial images of habitat as related to the levels were created. These examples were reviewed and confirmed by the technical lead and provided a voucher reference to help identify habitat types. Final habitat typing was reviewed by the technical lead to ensure consistency and accurate habitat mapping.

The exact location of habitat boundaries often required professional judgment on the part of the mapper, such as the boundary between a riffle and run or glide. Due to lack of resolution in the GIS imagery and shadows along the left bank of the river, some habitat features such as tributary mouths were confirmed by referring to aerial video as a secondary reference. The aerial video was also used to confirm the more permanent gravel bars that showed some vegetation, which was sometimes not evident in the GIS imagery. If the aerial video indicated a bar had vegetation on it, but vegetation was not evident in the GIS imagery, the island was considered vegetated and the main channel line segments were split around the island.

Tributaries were delineated in the GIS imagery to 0.5 mile from the centerline of the mainstem confluence, using a buffer. Tributaries were differentiated from upland sloughs based on their gradient characteristics and if they originated above the general floodplain. The exact locations of some tributary segments were difficult to determine using the imagery in heavily forested areas. As such, locations were estimated based on visual cues in the canopy. Tributary mouths were mapped using a single line segment showing the length of the wetted area of the tributary mouth that extended from the vegetation line out to the edge of the gravel bank. In some of the larger tributaries, the mouth habitat was extended inland beyond the vegetation line based on habitat breaks visible between the tributary channel and the alluvial gravel areas at the mouth.

Mainstem habitats were classified as main channel when only a single dominant channel was present; split main channel when the flow was dispersed into two relatively evenly sized channels such as around a central island; and multiple split main channel when the mainstem split into three or more separate channels each carrying a significant portion of the flow. Mesohabitats were classified from interpretation of both the GIS imagery and aerial video. Riffles were distinguished from areas of wind waves or standing waves by the presence of white

water and protruding boulders in the area that indicate the water is relatively shallow and passes over cobbles and boulders. White water in a reach was classified as a run, if only one or two protruding boulders were producing isolated areas of turbulence.

The presence of clear or turbid water was used as a main indicator to differentiate between side sloughs and side channels. Side sloughs had clear water and were open to main channel flow at both ends, but water was connected at only one end of the slough during the time of the survey. These areas could be partially dry but showed evidence that they were inundated regularly during high flows by lack of vegetation. Upland sloughs had similar characteristics in that the water was relatively clear, but these were not open to the main channel at both ends as indicated by the presence of vegetation in the area between the upstream end of the slough and the main channel.

Side channels were either completely inundated with turbid water connected at both upstream and downstream ends to the main channel or contained portions that held turbid water. The dry portions of the channel were delineated based on gravel bed and lack of any vegetation indicating that water periodically inundated the channel during higher flow periods. The distance that the side channel line segments extended into the main channel were determined by an estimation of the continuation of the vegetated or high water shoreline on either side of the mouth of the side channel.

Only mainstem habitat was further classified into mesohabitats consisting of run/glide, pool, riffle, or rapid (Table 1). Off-channel habitat (which includes side and upland sloughs) and tributaries were not classified into mesohabitats due to the lack of resolution of aerial imagery and the confounding presence of shadows or riparian cover.

The amount of edge habitat was determined by doubling the segment lengths that delineated each mainstem and off-channel habitat type. In order to compare amounts of edge habitats between different reaches, the length of each was divided by the total reach length to calculate edge habitat per mile.

2.2 Study Deviations

The development of the current study came about through a collaborative and adaptive process in October of 2012. Initially, there was an expectation to potentially mesohabitat map tributary and off-channel habitat types. As the mapping effort progressed it became clear that many of these units could not be mapped to the mesohabitat level and that only main channel habitat could be entirely mapped to the mesohabitat level. This limitation was a result of the quality of the aerial imagery, small size of the habitat unit, and potential for vegetative canopy that obstructed overhead viewpoints.

Finally, mapping the mainstem habitat to the mesohabitat level was challenging for certain habitat types that include differentiating run and glide habitat and identifying pool habitat. Run and glide habitat was closely examined through aerial stills and videography to make a professional judgment of the habitat type; however, it is realized that wind-waves and glare can confound the typing of these habitats. Pool habitat required identifying a hydraulic control and was only found in the Devils Canyon area, where the control was very obvious. Small, less obvious pools may have not been identified from this methodology.

3. RESULTS

The Middle River was divided into 8 geomorphic reaches based on geomorphic characteristics established from the Geomorphology Mapping Study (Figure 1, Table 2). Reaches were numbered sequentially from Middle River 1 (MR-1) at the upstream end to Middle River 8 (MR-8) at the downstream end at the confluence with the Chulitna River. These reaches are not equally distributed in length, but separated based on the presence of distinct geomorphic processes and channel characteristics as described in RSP Section 6.0. Note that since there are multiple habitat types laterally distributed at any one time within the channel, the total distance of habitat is significantly greater than the actual length of the reach alone.

3.1 Main Channel Habitat

Main channel habitat varied by geomorphic reach and generally increased in complexity from upstream to downstream locations (Figure 2, Table 3). The single confined channel type represented the majority of habitat from the proposed dam site (MR-1) through Devils Canyon (MR-5). Downstream of Devils Canyon (i.e., MR-6 to MR-8), channel types were broadly distributed between all four channel types and main channel habitat was not the majority in any of those reaches. The downstream reaches contained multiple split main channel habitat and many side channels (Figure 2; Table 3). These areas also contained many gravel bars and islands. These were differentiated by the presence of vegetation as described in Section 2.1. Side channels varied widely in size and length.

Mesohabitat in the main channel was generally dominated by a mixture of run and glide habitats (Figure 3, Table 4). Run and glide habitats were not distinguished from each other at this level of classification and were combined into a single element referred to as 'glide or run'. This included smooth-flowing, low turbulence reaches as well as areas with some standing or wind waves and occasional solitary protruding boulders. Only in the reach where Devils Canyon is situated (MR-4) was the mesohabitat not dominated by run and glide habitat. Riffle habitat was most prevalent in MR-4. There was no riffle habitat in MR-1 and very small amounts in MR-2 and MR-5 (Figure 3, Table 4).

Side channels were predominantly glide or run, with some riffle areas in the lower reaches. Many side channels were not completely inundated with flowing water and so identification of riffle or run habitat was not possible; these were classified as unidentified and were most prevalent in reach 6 (Table 4).

Cascade habitat was not found within any Middle River reach. The geomorphic reach through Devils Canyon (MR-4) contained the only rapids in the Middle River, which accounted for 38% of the mainstem habitat in that reach. Only 3 pools were found in the Middle River and these were also contained in MR-4 between rapids in Devils Canyon.

The habitat associated with the confluence of tributaries with the main channel river was documented as tributary mouth and clear water plume (Table 3 and 6). Tributary mouth habitat was not associated with every tributary that entered the Middle River. Small tributaries, where the vegetation line was close to the mainstem, did not fan out and create the areas classified as tributary mouth habitat. These areas were most frequent in the larger tributaries within MR-2, MR-4, and MR-6 (Table 6). Named tributaries by geomorphic reach are identified in Table 8.

The largest total tributary mouth habitat area was in MR-2, which also had the second largest average area. The largest average area was represented by a single tributary mouth in MR-5.

Clear water plume habitat was marked in areas along the shoreline of the main channel where the water remained clear for some distance downstream prior to mixing with the turbid main channel waters. These habitats resulted from the outflow of tributaries and commenced at tributary mouths and extended downstream. Small tributaries or tributaries that flowed into fast moving or turbulent sections of the mainstem did not produce these clear water plumes. Clear water plume habitats were located in reaches MR-2, MR-3, MR-5, and MR-7, with the most being in reach MR-2 (Table 4). Associated named tributaries in each of the identified reaches are identified in Table 8.

3.2 Off Channel Habitats

Sloughs were prevalent throughout the Middle River reaches outside of Devils Canyon and downstream of the uppermost reach at MR-1. Side sloughs were most abundant in MR-5, followed by MR-6 (Table 5). Upland sloughs were most abundant in MR-8, and generally increased in abundance towards the downstream reaches (Table 5). Beaver dams were rarely present in side slough habitat, and slightly more prevalent in upland sloughs. Beaver dams were only observed in reaches MR-6 and MR-7 (Table 5).

Backwater habitat was also relatively rare and primarily represented in the lower reaches from MR-6 through MR-8 (Figure 3; Table 5). A single backwater was also delineated in MR-2 and MR-4, but accounted for less than 1 percent of the linear habitat in each reach due to small size. The greatest total area of backwater habitat was in MR-7, but the greatest frequency was found in MR-6 (Table 5).

3.3 Tributary Habitat

Tributaries were generally smaller and could be completely obscured by vegetation. Therefore, the tributaries were not further identified to a mesohabitat type as part of this specific effort. Tributaries structure was variable and ranged from confined linear channels to multi-channel complexes. Tributaries were absent in MR-1 and relatively less frequent in MR-5 and MR-8 (Figure 4 and Table 5). Tributaries represented more than 60 percent of off-channel and tributary habitats in MR-2, MR-3, and MR-4 (Table 5). Associated named tributaries in each of the identified reaches are identified in Table 8.

3.4 Edge Habitat

Standardized edge per mile provided an index of complexity to compare geomorphic reaches. The results of this analysis are presented in Figure 5 and Table 7. Complexity generally increased in downstream locations. MR-8 was the most complex reach, followed by MR-6 and MR-7, respectively. The lower reaches were characterized by split main channels, along with off-channel and tributary habitat. The least complexity was within MR-4 (Devils Canyon Reach) and remained low in MR-5. Above MR-4, complexity was moderate.

4. DISCUSSION

The results of the study provide a complete index of the frequency and proportion of main channel, off-channel, and tributary habitat within the Middle River. The resolution of the data varied based on the size and visibility of each habitat unit and relied upon the professional interpretation of biologists. Nonetheless, the final product provides a tool and current resource to make informed decisions and plan for representing the Middle River for instream flow and fish distribution studies for 2013. It is important to note that this tool represents only a small portion of habitat mapping study activity for 2013. Significant on-the-ground activity is planned for 2013 that will expand the resolution and working knowledge of available habitat in the Susitna River and surrounding tributaries.

5. REFERENCES

ADF&G (Alaska Department of Fish and Game). 1983a. Su Hydro draft basic data report,

Harper, D.M., C.D. Smith, and P.J. Barham. 1992. Habitats as the building blocks for river conservation assessment. *In* River Conservation and Management, Boon P.J., Calow, P., Petts, G.E. (eds). John Wiley: Chichester; 311–319.

Trihey, E. W. 1982. Preliminary assessment of access by spawning salmon to side slough habitat above Talkeetna. Susitna Hydroelectric Project Doc. No. 134. 24 pp.

USFS (U.S. Forest Service). 2001. Chapter 20 – Fish and Aquatic Stream Habitat Survey. FSH 2090-Aquatic Habitat Management Handbook (R-10 Amendment 2090.21-2001-1).

6. TABLES

Table 1. Middle River levels of habitat classification hierarchy.

Note that mentions of the Upper and Lower River are included, but those areas were not mapped as part of this report.

Level	Unit	Category	Definitions
1	Major Hydrologic Segment	Upper, Middle, Lower River	Defined Segment Breaks (*used in this report*) *Upper River* – RM 186.7 – 261.3 (*habitat mapping will only extend up to mainstem RM 233 and will include the Oshetna River.* *Middle River* - RM 102.3 – 186.7 *Lower River* - RM 0 – 102.3
2	Geomorphic Reach	Upper River Segment Geomorphic Reaches 1-6 Middle River Segment Geomorphic Reaches 1-8 Lower River Segment Geomorphic Reaches 1-6	Geomorphic reaches that uniquely divide the Major Hydrologic Segments based on geomorphic characteristics.
3	Mainstem Habitat	Main Channel Habitat Off-Channel Habitat Types Tributary Habitat	Main Channel Habitat: *Main Channel* – Single dominant main channel. *Split Main Channel* – Three or fewer distributed dominant channels. *Multiple Split Main Channel* – Greater than three distributed dominant channels. *Side Channel* – Channel that is turbid and connected to the active main channel but represents non-dominant proportion of flow. *Tributary Mouth* - Clear water areas that exist where tributaries flow into Susitna River main channel or side channel habitats (upstream Tributary habitat will be mapped as a separate effort). Off-Channel Habitat (also referred to as macrohabitat): *Side Slough* - Overflow channel contained in the floodplain, but disconnected from the main channel. Has clear water.[1] *Upland Slough* - Similar to a side slough, but contains a vegetated bar at the head that is rarely overtopped by mainstem flow. Has clear water.[1] *Backwater* - Found along channel margins and generally within the influence of the active main channel with no independent source of inflow. Water is not clear. *Beaver Complex* – Complex ponded water body created by beaver dams. Tributary Habitat: Tributaries will be mapped to the upper limit of Susitna River hydrological influence.

Level	Unit	Category	Definitions
4	Main Channel	Main Channel	<u>Main Channel Mesohabitat</u> *Pool* – slow water habitat with minimal turbulence and deeper due to a strong hydraulic control. *Glide* – An area with generally uniform depth and flow with no surface turbulence. Low gradient; 0-1 percent slope. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. Generally deeper than riffles with few major flow obstructions and low habitat complexity.[2] *Run* – A habitat area with minimal surface turbulence over or around protruding boulders with generally uniform depth that is generally greater than the maximum substrate size.[2] Velocities are on border of fast and slow water. Gradients are approximately 0.5 percent to less than 2 percent. Generally deeper than riffles with few major flow obstructions and low habitat complexity.[2] *Riffle* – A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross section. Low gradient; usually 0.5-2.0 percent slope.[5] *Rapid* - Swift, turbulent flow including small chutes and some hydraulic jumps swirling around boulders. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Lower gradient and less dense concentration of boulders and white water than Cascade. Moderate gradient; usually 2.0-4.0 percent slope.[2]
5	Edge Habitat	Length of Shoreline Habitat	*Calculation*- will be determined by doubling the length of the mapped habitat unit.

[1] The terms Side Channel, Slough, and Upland Slough are similar but not necessarily synonymous with the terms for macrohabitat type as applied by Trihey (1982) and ADF&G (1983a).
[2] Adapted from Moore et al. 2006.

Table 2. Locations of Middle Rive (MR) geomorphic reaches by Project river mile.

Geomorphic Reach	Downstream Project River Mile	Upstream Project River Mile	Length (miles)	Description[1]
MR-1	184.7	186.7	2.0	Tertiary-Cretaceous Gneiss
MR-2	169.7	184.7	15.0	Cretaceous Kahiltna Flysch Tertiary-Cretaceous Gneiss
MR-3	166.1	169.7	3.6	Paleocene Granites
MR-4	153.5	166.1	12.6	Paleocene Granites
MR-5	148.5	153.5	5.0	Cretaceous Kahiltna Flysch
MR-6	122.7	148.5	25.8	Cretaceous Kahiltna Flysch with undifferentiated Upper Pleistocene moraines, kames, lacustrine deposits
MR-7	107.7	122.7	15.0	Cretaceous Kahiltna Flysch with undifferentiated Upper Pleistocene moraines, kames, lacustrine deposits
MR-8	102.3	107.7	5.4	Upper Pleistocene moraines, outwash and Holocene Alluvial Terrace deposits

[1] Characterization from internally updated geomorphic reach characterization

Table 3. Total length and percent composition (by geomorphic reach) of main channel habitat classifications by geomorphic reach in the Middle Susitna River.

Main Channel Type	MR-1 (PRM 186.7 – 184.7)		MR-2 (PRM 184.7-169.7)		MR-3 (PRM 169.7-166.1)		MR-4 (PRM 166.1-153.5)		MR-5 (PRM 153.5-148.5)		MR-UR(PRM 148.5-122.7)		MR-7 (PRM 122.7-107.7)		MR-8 (PRM 107.7-102.3)	
	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)
Main Channel	67.2%	10,702	68.5%	74,908	73.2%	16,935	98.3%	66,004	75.9%	24,114	27.5%	96,245	28.0%	41,756	24.3%	18,432
Split Main Channel	0.0%	0	7.5%	8,148	15.6%	3,600	0.0%	0	15.2%	4,835	18.0%	62,885	52.0%	77,407	5.9%	4,453
Multi-Split Main Channel	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	7.5%	26,400	0.0%	0	32.3%	24,430
Side Channel	32.8%	5,235	16.1%	17,646	9.0%	2,090	1.0%	699	6.2%	1,954	45.9%	160,659	19.6%	29,178	37.5%	28,398
Tributary Mouth	0.0%	0	1.0%	1,113	0.6%	129	0.6%	426	1.0%	305	0.4%	1,545	0.2%	319	0.0%	0
Clear Water Plume	0.0%	0	6.8%	7,470	1.7%	383	0.0%	0	1.7%	549	0.6%	2,143	0.2%	240	0.0%	0
Grand Total	100%	15,937	100%	109,285	100%	23,137	100%	67,128	100%	31,758	100%	349,877	100%	148,900	100%	75,714

Table 4. Total length and percent composition (by geomorphic reach) of main Channel mesohabitat classifications in the Middle Susitna River.

Main Channel Mesohabitat	MR-1 (PRM 186.7 – 184.7)		MR-2 (PRM 184.7-169.7)		MR-3 (PRM 169.7-166.1)		MR-4 (PRM 166.1-153.5)		MR-5 (PRM 153.5-148.5)		MR-6 (PRM 148.5-122.7)		MR-7 (PRM 122.7-107.7)		MR-8 (PRM 107.7-102.3)	
	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)	% of Total	Total (ft)
Main Channel	67.2%	10,702	68.5%	74,908	73.2%	16,935	98.3%	66,004	75.9%	24,114	27.5%	96,245	28.0%	41,756	24.3%	18,432
Glide or Run	67.2%	10,702	65.8%	71,956	71.3%	16,495	30.2%	20,305	75.9%	24,114	25.9%	90,760	22.9%	34,058	24.3%	18,432
Pool	0.0%	0	0.0%	0	0.0%	0	0.7%	500	0.0%	0	0.0%	0	0.0%	0	0.0%	0
Rapid	0.0%	0	0.0%	0	0.0%	0	38.0%	25,519	0.0%	0	0.0%	0	0.0%	0	0.0%	0
Riffle	0.0%	0	2.7%	2,953	1.9%	440	29.3%	19,680	0.0%	0	1.6%	5,485	5.2%	7,698	0.0%	0
Split Main Channel	0.0%	0	7.5%	8,148	15.6%	3,600	0.0%	0	15.2%	4,835	18.0%	62,885	52.0%	77,407	5.9%	4,453
Glide or Run	0.0%	0	7.5%	8,148	15.6%	3,600	0.0%	0	15.2%	4,835	17.7%	61,922	42.1%	62,623	5.9%	4,453
Riffle	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.3%	963	9.9%	14,784	0.0%	0
Multi-Split Main Channel	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	7.5%	26,400	0.0%	0	32.3%	24,430
Glide or Run	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	7.1%	24,922	0.0%	0	31.7%	24,008
Riffle	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.3%	882	0.0%	0	0.6%	422
Unidentified	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.2%	595	0.0%	0	0.0%	0
Side Channel	32.8%	5,235	16.1%	17,646	9.0%	2,090	1.0%	699	6.2%	1,954	45.9%	160,659	19.6%	29,178	37.5%	28,398
Glide or Run	32.8%	5,235	5.2%	5,716	7.2%	1,677	0.0%	0	4.2%	1,329	25.3%	88,662	13.1%	19,536	28.4%	21,528
Pool	0.0%	0	0.0%	0	0.0%	0	0.5%	342	0.0%	0	0.0%	0	0.0%	0	0.0%	0
Riffle	0.0%	0	0.0%	0	0.0%	0	0.5%	357	2.0%	625	0.7%	2,522	0.2%	279	9.1%	6,870
Unidentified	0.0%	0	10.9%	11,930	1.8%	414	0.0%	0	0.0%	0	19.9%	69,475	6.3%	9,363	0.0%	0
Tributary Mouth	0.0%	0	1.0%	1,113	0.6%	129	0.6%	426	1.0%	305	0.4%	1,545	0.2%	319	0.0%	0
Clear Water Plume	0.0%	0	6.8%	7,470	1.7%	383	0.0%	0	1.7%	549	0.6%	2,143	0.2%	240	0.0%	0
Total	100%	15,937	100%	109,285	100%	23,137	100%	67,128	100%	31,758	100%	349,877	100%	148,900	100%	75,714

Table 5. Total length and percent composition (by geomorphic reach) of off channel habitats classified in the Middle Susitna River.

Off-Channel and Tributary Habitats	MR-1 (PRM 186.7–184.7)		MR-2 (PRM 184.7-169.7)		MR-3 (PRM 169.7-166.1)		MR-4 (PRM 166.1-153.5)		MR-5 (PRM 153.5-148.5)		MR-6 (PRM 148.5-122.7)		MR-7 (PRM 122.7-107.7)		MR-8 (PRM 107.7-102.3)	
	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)
Backwater	0.0%	0	0.0%	0	0.4%	91	0.0%	0	0.9%	1,236	1.5%	1,458	1.5%	453	0.3%	201
Side Slough	0.0%	0	4.5%	712	0.0%	0	66.8%	4,482	27.5%	38,898	10.0%	10,038	20.6%	6,195	20.2%	16,130
Beaver Complex	0.0%	0	0.0%	0	0.0%	0	0.0%	0	3.8%	5,393	2.6%	2,584	0.0%	0	0.0%	0
Side Slough	0.0%	0	4.5%	712	0.0%	0	66.8%	4,482	23.7%	33,505	7.4%	7,454	20.6%	6,195	20.2%	16,130
Tributary	0.0%	0	95.5%	14,946	99.6%	24,700	33.2%	2,232	41.7%	59,066	38.8%	38,945	24.1%	7,266	60.4%	48,143
Upland Slough	0.0%	0	0.0%	0	0.0%	0	0.0%	0	29.9%	42,361	49.8%	50,067	53.8%	16,190	19.1%	15,261
Beaver Complex	0.0%	0	0.0%	0	0.0%	0	0.0%	0	8.8%	12,512	5.0%	5,011	0.0%	0	0.0%	0
Upland Slough	0.0%	0	0.0%	0	0.0%	0	0.0%	0	21.1%	29,849	44.8%	45,056	53.8%	16,190	19.1%	15,261
Grand Total	0.0%	0	100%	79,735	100%	15,658	100%	24,791	100%	6,713	100%	141,561	100%	100,508	100%	30,104

Table 6. Summary of the frequency, total area, and average area of tributary mouth and backwater habitat by geomorphic reach.

Geomorphic Reach	Tributary Mouth Area			Backwater Area		
	Count	Total Area (sq ft)	Mean Area (sq ft)	Count	Total Area (sq ft)	Mean Area (sq ft)
MR-1 (PRM 186.7–184.7)	0	0	0	0	0	0
MR-2 (PRM 184.7-169.7)	10	143,473	14,347	1	41,237	41,237
MR-3 (PRM 169.7-166.1)	3	5,951	1,984	0	0	0
MR-4 (PRM 166.1-153.5)	9	13,136	1,460	1	1,434	1,434
MR-5 (PRM 153.5-148.5)	1	36,510	36,510	0	0	0
MR-6 (PRM 148.5-122.7)	10	105,007	10,501	4	51,761	12,940
MR-7 (PRM 122.7-107.7)	4	14,820	3,705	2	124,645	62,322
MR-8 (PRM 107.7-102.3)	0	0	0	1	21,004	21,004

Table 7. Edge habitat (in miles) reported per mile in each geomorphic reach in the Middle Susitna River.

Geomorphic Reach	MR-1 (PRM 186.7 – 184.7)	MR-2 (PRM 184.7-169.7)	MR-3 (PRM 169.7-166.1)	MR-4 (PRM 166.1-153.5)	MR-5 (PRM 153.5-148.5)	MR-6 (PRM 148.5-122.7)	MR-7 (PRM 122.7-107.7)	MR-8 (PRM 107.7-102.3)
Backwater	0.00	0.01	0.00	>.01	0.00	0.02	0.04	0.03
Main Channel	2.03	1.89	1.78	1.98	1.83	1.41	1.05	1.29
Split Main Channel	0.00	0.21	0.38	0.00	0.37	0.93	1.95	0.31
Multi-Split Main Channel	0.00	0.00	0.00	0.00	0.00	0.39	0.00	1.71
Side Channel	0.99	0.45	0.22	0.02	0.15	2.36	0.74	1.99
Tributary Mouth	0.00	0.03	0.01	0.01	0.02	0.02	0.01	0.00
Side Slough	0.00	0.41	0.07	0.00	0.34	0.57	0.25	0.43
Tributary	0.00	1.22	1.57	0.74	0.17	0.87	0.98	0.51
Upland Slough	0.00	0.39	0.00	0.00	0.00	0.62	1.26	1.14
Total Edge Habitat Per Mile	3.02	4.58	4.04	2.76	2.87	7.18	6.29	7.42

Table 8. List of major tributaries by geomorphic reach. Identified Project river miles for each tributary specifies the mainstem Susitna River location where the tributary confluence occurs.

Geomorphic Reach	Major Named Tributaries (in order from upstream to downstream)
MR-1 (PRM 186.7–184.7)	None
MR-2 (PRM 184.7-169.7)	Tsusena Creek (PRM 184.5), Fog Creek (PRM179.3)
MR-3 (PRM 169.7-166.1)	None
MR-4 (PRM 166.1-153.5)	Devils Creek (PRM 165.8), Chinook Creek (PRM 160.4), Cheechako Creek (PRM 155.8)
MR-5 (PRM 153.5-148.5)	Portage Creek (PRM 152.2)
MR-6 (PRM 148.5-122.7)	Indian River (142.0),Gold Creek (PRM 140.1), Deadhorse Creek (PRM 124.3)
MR-7 (PRM 122.7-107.7)	Portage Creek (PRM 121.3), McKenzie Creek (PRM 120.2), Lane Creek (PRM 117.1)
MR-8 (PRM 107.7-102.3)	Whiskers Creek (PRM 104.8)

7. FIGURES

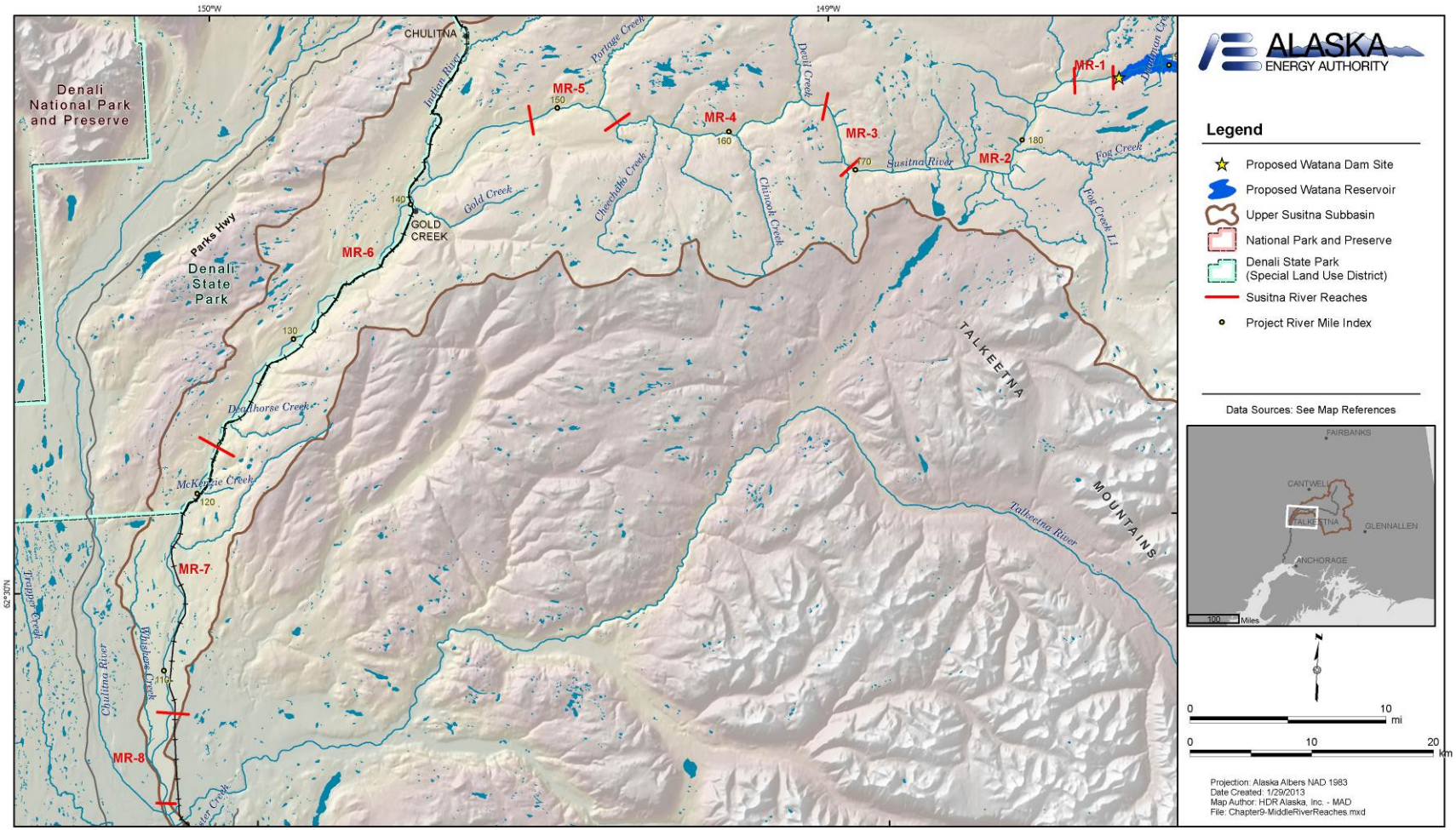

Figure 1. Main Channel Habitat classifications by geomorphic reach in the Middle Susitna River.

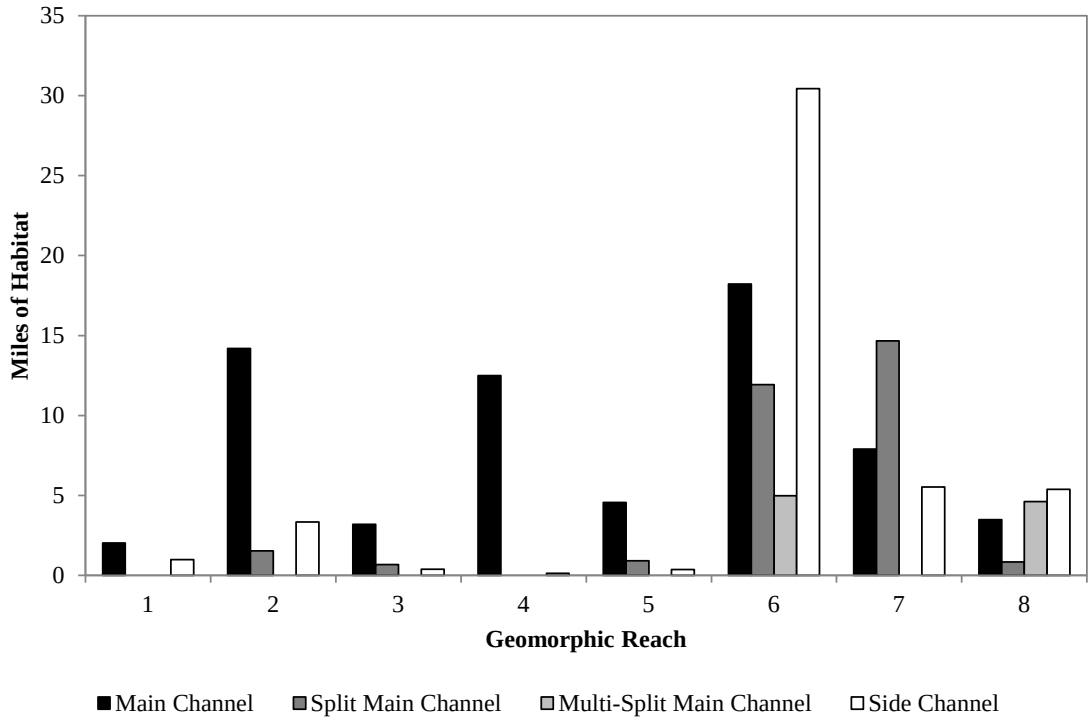

Figure 2. Main Channel Habitat classifications by geomorphic reach in the Middle Susitna River.

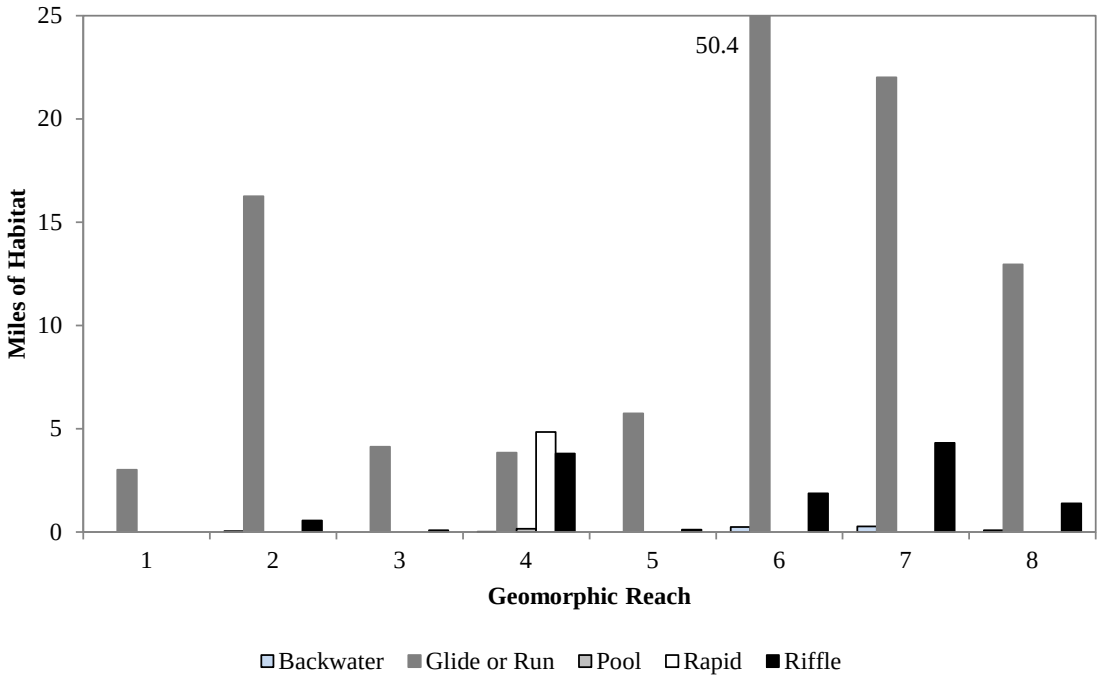

Figure 3. Mesohabitat classifications by geomorphic reach in the main and side channels in the Middle Susitna River.

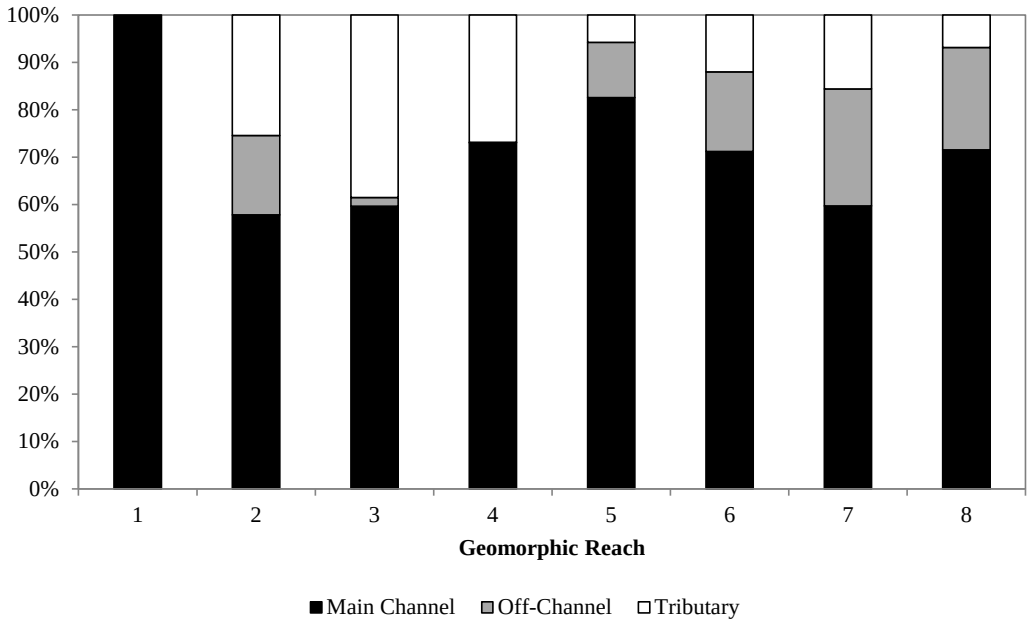

Figure 4. Summary of level 3 habitat classifications in each geomorphic reach in the Middle Susitna River.

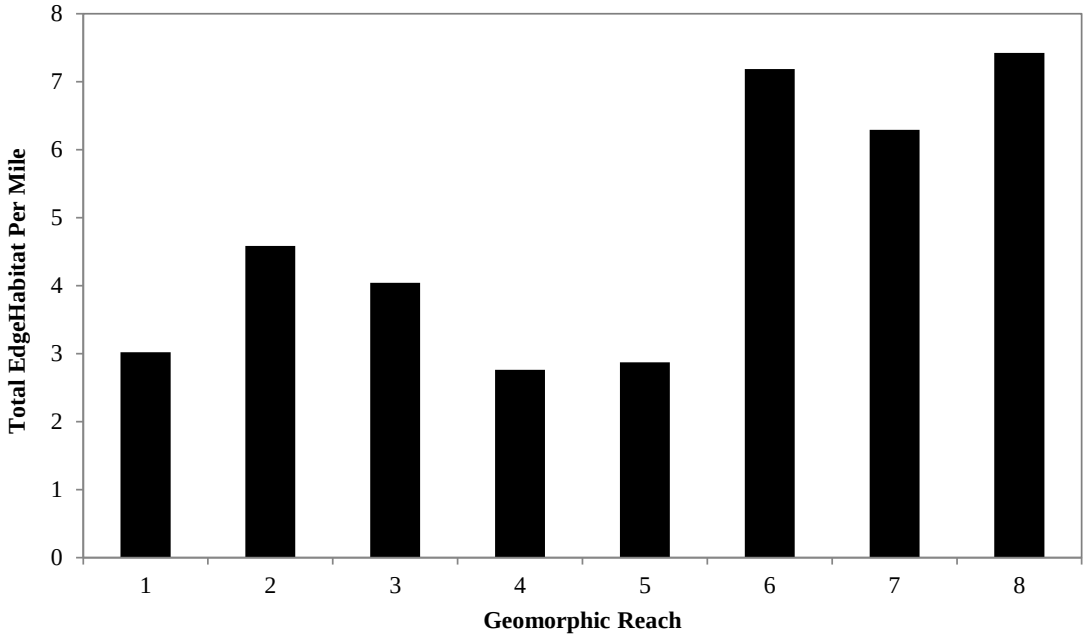

Figure 5. Summary of the amount of edge habitat per mile in each geomorphic reach of the Middle Susitna River as an indicator of habitat complexity.