Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Draft Technical Memorandum

Selection of Focus Areas and Study Sites in the Middle Susitna River for Instream Flow and Joint Resource Studies – 2013 and 2014

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND SCIENTIFIC LABELS

Abbreviation	Definition
AEA	Alaska Energy Authority
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.
Baseline	Baseline (or Environmental Baseline): the environmental conditions that are the starting point for analyzing the impacts of a proposed licensing action (such as approval of a license application) and any alternative.
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.
Cascade	The steepest of riffle habitats. Unlike rapids, which have an even gradient, cascades consist of a series of small steps of alternating small waterfalls and shallow pools.
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.
Conductivity	In terms of water conductivity, the ability of water to conduct electricity, normally through the presence of dissolved solids that carry electrical charges.
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.
Distribution (species)	The manner in which a biological taxon is spatially arranged.
Edge habitat	The boundary between natural habitats, in this case between land and a stream. Level five tier of the habitat classification system.
Escapement (spawning)	The number or proportion of fish surviving (escaping from) a given fishery at the end of the fishing season and reaching the spawning grounds.
et al.	"*et alia*"; and the rest
FA	Focus Area
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.
Geomorphic reach	Level two tier of the habitat classification system. Separates major hydraulic

Abbreviation	Definition
	segments into unique reaches based on the channel's geomorphic characteristic.
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.
Groundwater (GW)	In the broadest sense, all subsurface water; more commonly that part of the subsurface water in the saturated zone.
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.
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
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.
LR	Lower River Reach
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.
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).
Mi	mile(s)
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.
Migrant (life history type)	Some species exhibit a migratory life history type and undergo a migration to from rivers/lakes/ocean.
Migration	Systematic (as opposed to random) movement of individuals of a stock from one place to another, often related to season.
MR	Middle River Reach
Multiple split main channel	Main channel habitat characterization feature where more than three distributed

Abbreviation	Definition
	dominant channels are present.
N/A	not applicable *or* not available
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.
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
PSP	Proposed Study Plan
Radiotelemetry	Involves the capture and placement of radio-tags in adult fish that allow for the remote tracking of movements of individual fish.
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.
Rearing	Rearing is the term used by fish biologists that considers the period of time in which juvenile fish feed and grow.
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.
River	A large stream that serves as the natural drainage channel for a relatively large catchment or drainage basin.
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.
Sediment	Solid material, both mineral and organic, that is in suspension in the current or deposited on the streambed.
Sediment transport	The movement of solid particles (sediment), typically due to a combination of the force of gravity acting on the sediment, and/or the movement of the fluid in which the sediment is entrained.

Abbreviation	Definition
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,
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.
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.
Thalweg	A continuous line that defines the deepest channel of a watercourse.
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.
TM	Technical Memorandum
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
U.S., US	United States
Upwelling	The movement of groundwater into rivers, stream, sloughs and other surface water features. This is also called groundwater discharge and may be associated with a gaining reach of a river or stream.

1. INTRODUCTION

Construction and operation of the Susitna-Watana Hydroelectric Project (Project) will affect Susitna River flows downstream of the dam; the degree of these effects will ultimately depend on final Project design and operating characteristics. The Project will be operated in a load-following mode. Project operations will cause seasonal, daily, and hourly changes in Susitna River flows compared to existing conditions. The potential alteration in flows will influence downstream resources/processes, including fish and aquatic biota and their habitats, channel form and function including sediment transport, water quality, groundwater/surface water interactions, ice dynamics, and riparian and wildlife communities (AEA 2011).

The potential operational flow-induced effects of the Project will need to be evaluated as part of the licensing process and a Revised Study Plan (RSP) has been prepared and submitted to the Federal Energy Regulatory Commission (FERC) that describes the Susitna-Watana Instream Flow Study (RSP Section 8.5) that will be conducted to characterize and evaluate these effects. The plan includes a statement of objectives, a description of the technical framework that is at the foundation of the Instream Flow Study (IFS), the general methods that will be applied, and the study nexus to the Project.

Since submittal of the RSP, FERC issued a Revised Study Plan Determination Schedule (January 17, 2013) that specified deliverables of two IFS related analyses; 1) results of the open-water flow routing model, and 2) identification of all proposed Focus Areas (FAs) with a description of habitat units within the FAs for all aquatic studies to be implemented in the middle Susitna River. This Technical Memorandum (TM) pertains to the Focus Areas; a separate TM has been prepared that describes the open-water flow routing model results (R2 et al. 2013).

2. OBJECTIVES

Specific objectives of this TM include:

- Review the general approach to stratification and the study site selection process used in the IFS RSP (see Section 8.5.4.2);
- Identify the 10 FAs that were initially described in the RSP (Section 8.5.4.2.1.2) and the criteria that were used in their selection;
- Describe and summarize the statistical analysis completed on the habitat mapping results of the Middle River Segment with respect to the 10 FAs and their habitat units;
- Describe the implications of the habitat analysis and any modifications to the study site selection process, including refinements in FAs, and the need to identify supplemental sites or areas;

- List all proposed FAs and study sites outside of the FAs for all IFS related studies to be implemented in the Middle River Segment of the Susitna River[1].

The overall objective of the TM is to describe the rationale and basis for selection of the FAs identified in the IFS RSP and to present the results and conclusions from the habitat mapping analysis that was completed to evaluate the representativeness of the FAs.

It is important to note that there are two lines of inquiry relative to the representativeness of the FAs for the IFS, one for the Fish and Aquatics IFS and one for the Riparian IFS. This TM is focused on the Fish and Aquatics IFS and is based on results of the habitat mapping analysis that provided information concerning in-channel habitat characteristics that lend themselves to a comparative analysis between features (habitat types) within and outside of FAs. The Riparian IFS evaluation of the FAs is different because these same in-channel characteristics are secondary to features and processes that are occurring out-of-channel that define riparian floodplain community structure (see RSP Section 8.6).

Organizationally, the TM contains seven sections that, in addition to the Introduction (Section 1) and Objectives (Section 2), include sections aligned with the five objectives noted above.

3. REVIEW OF RIVER STRATIFICATION AND STUDY AREA SELECTION PROCESS

The proposed Project will affect flows in mainstem and off-channel habitats in the Susitna River downstream of the dam site at RM 184. In order to characterize the existing and proposed flow regimes and riverine habitats and organisms, the Susitna River was stratified into geomorphic reaches based on channel type, gradient, confinement, bed material and tributary confluences. As noted in Section 8.5.4.1.2 of RSP Section 8.5, the selection of study areas or study sites represents an important aspect of all resource related studies inasmuch as the sites or areas studied are those that will ultimately be used for characterizing physical, geomorphological, chemical and biological resources and for evaluating Project effects. It was therefore fundamentally important that the logic and rationale for the selection of such areas be clearly articulated, understood, and agreed to by agencies and licensing participants.

As a result, the RSP proceeded in a series of steps that first described the stratification process used for the entire river, and then discussed and evaluated various approaches to study site selection that lead to the identification of specific FAs for intensive study within the Middle River Segment. For convenience, these steps are presented below to provide context for and as a precursor to the contemporary habitat mapping statistical analysis.

3.1. River Stratification

As an initial step in the selection process, the Susitna River was stratified into distinct stratum reflective of certain geomorphic, hydrologic, and physical characteristics shared by each stratum.

[1] Note that this TM describes sites and Focus Areas for the Middle River segment only as per January 31, 2013 FERC RSP delivery schedule received by AEA on January 17, 2013. AEA intends to discuss Lower River Segment study site selection during the February 14-15, 2013 TWG meetings and will include the Lower River Segment study sites in the March 1, 2013 submittal.

The number of strata was determined based on the realization that the effects to physical processes and aquatic resources will be resource type-, location-, and habitat-specific. For example, at the site scale level, responses of fish habitat to changes in flow are expected to be different in side sloughs versus mainstem versus side channel versus tributary delta versus riparian habitats. At a broader scale, e.g., segment, it is plausible that effects to the same mainstem habitat types will differ depending on location in the river network. In addition, there will be a cumulative effect running down the length of the Susitna River below the dam. Importantly, different Project operations will affect different habitats and processes differently, both spatially and temporally. The habitat and process models will therefore need to be spatially discrete, at potentially the site/area level, mainstem habitat type level, and segment levels, and yet able to be integrated to allow for a holistic evaluation of each alternative operational scenario.

As noted in Section 8.5.3 of the RSP, the study area at issue with respect to Project operations and flow regulation effects consists of two segments of the river:

- Middle River Segment – Susitna River from Watana Dam site to confluence of Chulitna and Talkeetna rivers (Three Rivers Confluence) (RM 184 to RM 98.5)
- Lower River Segment – Susitna River extending below Talkeetna River to mouth (RM 98.5 to RM 0)

The Middle River Segment represents the section of river below the Project dam that is projected to experience the greatest effects of flow regulation caused by Project operations. Within this reach, the river flows from Watana Canyon into Devils Canyon, the narrowest and steepest gradient reach on the Susitna River. The Devils Canyon constriction creates extreme hydraulic conditions including deep plunge pools, drops, and high velocities. Downstream of Devils Canyon, the Susitna River widens but remains essentially a single main channel with stable islands, numerous side channels, and sloughs.

The Lower River Segment receives inflow from three other large river systems. An abrupt, large-scale change in channel form occurs where the Chulitna and Talkeetna rivers join the Susitna River near the town of Talkeetna in an area referred to as the Three Rivers Confluence. The annual flow of the Chulitna River is approximately the same as the Susitna River at the confluence, though the Chulitna contributes much more sediment than the Susitna. The Talkeetna River also supplies substantial flow rates and sediment volumes. Farther downriver, the Susitna River becomes notably more braided, characterized by unstable, shifting gravel bars and shallow subchannels. The Yentna River is a large tributary to the Lower Susitna River and supplies about 40 percent of the mean annual flow at the mouth of the Susitna River.

Geomorphic analysis of both the Middle River and Lower River segments confirmed the distinct variations in geomorphic attributes (e.g., channel gradient, confinement, channel planform types, and others) (see RSP Section 6.5) and resulted in the classification of the Middle River Segment into eight geomorphic reaches and the Lower River Segment into six geomorphic reaches (see Figures 8.5-11 and 8.5-12 of RSP Section 8.5, which for convenience have been included as Figures 1 and 2 of this TM). These reaches were incorporated into a hierarchical stratification system that scales from relatively broad to more narrowly defined categories as follows:

Segment → Geomorphic Reach → Mainstem Habitat Type →

Main Channel Mesohabitat Types → Edge Habitat Types

The highest level category is termed Segment and refers to the Middle River Segment and the Lower River Segment. The Geomorphic Reach level is next and consists of the eight categories (MR-1 through MR-8) for the Middle River Segment and six categories (LR-1 through LR-4) for the Lower River Segment (see RSP Section 6.5.4.1.2.2 and RSP Section 8.5 Table 8.5 4). The geomorphic reach breaks were based in part on the following five factors: 1) Planform type (single channel, island/side channel, braided); 2) Confinement (approximate extent of floodplain, off-channel features); 3) Gradient; 4) Bed material / geology; and 5) Major river confluences. This level is followed by Mainstem Habitat Types, which capture the same general categories applied during the 1980s studies but includes additional sub-categories to provide a more refined delineation of habitat features (see RSP Section 8.5 Table 8.5 5). Major categories and sub-categories under this level include Main Channel Habitats consisting of Main Channel, Split Main Channel, Braided Main Channel, Side Channel, and Off-channel Habitats that include Side Slough, Upland Slough, Backwater and Beaver Complexes; and Tributary Habitats that consist of the segment of the tributary influenced by mainstem flow. The next level in the hierarchy is Main Channel and Tributary Mesohabitats, which classifies habitats into categories of Cascades, Riffle, Pool, Run, and Glide. The mesohabitat level of classification is currently limited to the main channel and tributary mouths for which the ability to delineate these features is possible via aerial imagery and videography. As noted in the RSP, mesohabitat mapping in side channel and slough habitat types will require ground surveys. The last level in the classification is Edge Habitat and is intended to provide an estimate of the length of shoreline in contact with water within each habitat unit. The amount of edge habitat within a given habitat unit will provide an index of habitat complexity, i.e., more complex areas that consist of islands, side channels, etc. will contain more edge habitat than uniform, single channel areas.

Overall, the goal of the stratification step was to define segments/reaches with effectively similar characteristics where, ideally, repeated replicate sampling would result in parameter estimates with similar statistical distributions. The stratification/classification system described above was designed to provide sufficient partitioning of sources of variation that can be evaluated through focused study efforts that target each of the habitat types, and from which inferences concerning habitat–flow responses in unmeasured sites can ultimately be drawn.

3.2. Selection of Study Areas/Study Sites

In general (as noted by Bovee 1982), there are three characteristic approaches to instream flow studies that pertain to site selection that were considered for application in the Project. These included representative sites/areas, critical sites/areas, and randomly selected sites/areas.

3.2.1. Representative Sites

Representative sites are those where professional judgment or numerically and/or qualitatively derived criteria are relied on to select one or more sites/areas that are considered representative of the stratum or larger river. Representative sites typically contain all habitat types of importance. In general, the representative site approach can be readily applied to simple, single thread channel reaches, where the attributes that are measured are extrapolated linearly based on stream length or area. In this case, the goal of stratification will be to identify river segments that are relatively homogenous in terms of mesohabitat mixes, and the methods used for stratification tend to be classification-based. This approach typically requires completing some form of mapping up front, and using the results to select sites that encompass the range of habitat conditions desired. The results of such habitat mapping were not available during the initial study site/area selection, but since then, the results of the habitat mapping of the Middle River Segment have been completed and analyzed and are reported on in Section 5 of this TM.

Applicability to the Susitna–Watana Project: Yes – see Section 4 of this TM.

3.2.2. Critical Sites

Critical sites are those where available knowledge indicates that either (i) a sizable fraction of the target fish population relies on that location, (ii) a particular habitat type(s) is (are) highly important biologically, or (iii) where a particular habitat type is well known to be influenced by flow changes in a characteristic way. For example, in the case of the Susitna River, historical fish studies repeatedly showed the importance of certain side slough, upland slough, and side channel areas for spawning and juvenile rearing. Critical sites or areas are typically selected assuming that potential Project effects to other areas are secondary in terms of implications to fish population structure, health, and size. This assumption can only really be tested if other sites are identified that are similar looking but were not deemed critical, and sampling is performed on those sites as well to confirm the critical nature of the sites that were identified as such.

Applicability to the Susitna–Watana Project: Yes, especially with respect to selection of side channel/side slough/upland slough complexes that have been shown to be influenced by main channel flows and that are biologically important.

3.2.3. Randomly Located Sites

Randomly located sites are those where sites, areas, or measurement locations are selected randomly from each defined stratum or habitat type, and replicate sites or cross-sections are sampled to estimate variance (e.g., Williams, 1996; Payne et al. 2004). Site selection based on random sampling tends to involve statistical multivariate grouping or stratification approaches, such as cluster analysis or ordination techniques. The approach is the least subject to potential for bias, because it relies on distinct rules and algorithms. However, the approach becomes increasingly difficult to apply in site selection when the sites become more complex, such as is the case on the Susitna River. In addition, the number of sites will be contingent on the variability within the universal data set: the greater the number of clusters, the greater the potential number of sites. Strict random sampling is therefore not likely applicable for evaluating off-channel habitats and sloughs where the morphology of multiple channels varies substantially and in complex ways within and across sites.

Applicability to the Susitna–Watana Project: Yes, but more appropriate with respect to main channel mesohabitat sampling (i.e., riffle, run, glide, pool) or selection of mainstem habitat types for Habitat Suitability Criteria (HSC) sampling.

3.2.4. Focus Areas

During the September 11, 2012, Technical Workgroup (TWG) meeting, the concept of "intensive study areas" was introduced and discussed. This concept evolved around the realization that a prerequisite to determining the effects of Project development and operations on the Susitna River is the need to first develop an understanding of the basic physical, chemical and ecological processes of the river, their interrelationships, and their relationships with flow.

Two general paths of investigation were considered, 1) process and resource specific and 2) process and resource interrelated. Under the first, process and resource specific, studies would focus on determining relationships of flow with specific resource areas (e.g., water quality, habitat, ice, groundwater, etc.) and at specific locations of the river without considering interdependencies of other resource areas at different locations. Under the second, process and resource interrelated, studies would be concentrated at specific locations of the river that would be investigated across resource disciplines with the goal of providing an overall understanding of interrelationships of river flow dynamics on the physical, chemical, and biological factors that influence fish habitat.

Because the flow dynamics of the Susitna River are complex, it was reasoned that concentrating study efforts across resource disciplines within specific locations would provide the best opportunity for understanding flow interactions and evaluating potential Project effects and therefore major emphasis was placed on selecting those areas, which were termed Focus Areas (FA). However, it was also reasoned that there will be a need to collect information and data from other locations to meet specific resource objectives. As a result, the study site/area selection process presented in the RSP actually represents a combination of both approaches that includes sampling within specified FAs as well as sampling outside of FAs (see Section 3.2.5 for discussion of sites outside of FAs).

Composition wise, the FAs contain *combinations* of different habitat types and features as characterized according to the hierarchical classification system noted above that may function and respond differently or similarly (compared to other areas) to changes in flow depending on flow timing, magnitude, duration, etc., and their interrelationships with each other and other resource processes. Thus, these areas would be the focus of concentrated studies across disciplines enabling an integrated assessment of resource characteristics and processes and providing a more meaningful understanding of resource interrelationships and how flow regulation would influence these. This approach of concentrating study efforts within selected areas should allow for a more comprehensive evaluation of Project effects on the different resources, than if such features were evaluated solely in isolation resulting in a more fragmented analysis.

As noted in the RSP, the FA concept represents a combination of all three of the study site selection methods described above, inasmuch as (1) the areas would contain habitat types representative of other areas; (2) the areas would include certain habitat types repeatedly used by fish and therefore can be considered “critical areas”; and (3) sampling of certain habitat features or mesohabitat types within the areas would be best approached via random sampling. Since the RSP, results of the habitat mapping of the Middle River Segment have been completed which has allowed for an evaluation of the “representativeness” of the habitat types within the ten FAs described below, compared to areas outside of the FAs. Results of that analysis are presented in Section 5.

4. FOCUS AREAS AND STUDY SITES IDENTIFIED IN THE IFS RSP

4.1. Focus Areas

The RSP identified and described 10 FAs that had been discussed with the TWG and were originally proposed for detailed study within the Middle River Segment. Locations of the FAs are depicted in Figure 1 and their specific characteristics and rationale for selection were described in RSP Section 8.5 Table 8.5.6, which for convenience has been included as Table 1 of this TM. Schematic photos of each of the areas were likewise depicted in RSP 8.5 as Figures 8.5-13 through Figure 8.5-22 reproduced herein as Figures 3 through 12. The 10 FAs were intended to serve as specific geographic areas of the river that will be the subject of intensive investigation by multiple resource disciplines including Fish and Aquatics Instream Flow, Riparian Instream Flow (see Section 8.6), Groundwater (see Section 7.5), Geomorphology (see Section 6.0), Ice Processes (see Section 7.6), Water Quality (see Section 5.0), and Fish Distribution and Abundance in the Middle/Lower River (see RSP Section 9.6). The FAs were selected during an inter-disciplinary resource meeting that involved a systematic review of aerial imagery within each of the Geomorphic Reaches (MR-1 through MR-8) for the entire Middle River Segment. Focus Areas were selected within Geomorphic Reach MR-1 (one Focus Area), Geomorphic Reach MR-2 (two Focus Areas), Geomorphic Reach MR-5 (one Focus Area), Geomorphic Reach MR-6 (four Focus Areas), Geomorphic Reach MR-7 (one Focus Area), and Geomorphic Reach MR-8 (one Focus Area). FAs were not selected for Geomorphic Reaches MR-3 or MR-4 due to safety considerations related to Devils Canyon.

The FAs were those deemed representative of the major features within each geomorphic reach and included mainstem habitat types of known biological significance (i.e., where fish have been observed based on previous and/or contemporary studies), as well as some locations (e.g., Slough 17) where previous sampling revealed few/no fish. The FAs were assumed to have included side channels, side sloughs, upland sloughs, and tributary mouths that were representative of these habitat types in other portions of the river. This assumption has now been evaluated based on the results of the habitat mapping and is discussed in Section 6 of this TM.

Three of the Focus Areas in Geomorphic Reach MR-6 and one in Geomorphic Reach MR-8 contain specific habitat types that were found, during the 1980s studies, to be consistently used by salmon for spawning and/or rearing. These areas included Slough 21, Slough 11, and Skull Creek in Geomorphic Reach MR-6 and Whiskers Slough in Geomorphic Reach MR-8. Overall, 92 percent of the sockeye, 70 percent of the chum, and 44 percent of the slough-spawning pink salmon were found in just these four sloughs. By definition, these areas represent “critical areas” and were included in the FAs to allow some comparisons with the 1980s data. The upper three FAs (one in Geomorphic Reach MR-1 and two in Geomorphic Reach MR-2) were selected based on their representativeness of the respective geomorphic reaches and the inclusion of a mix of side channel and slough habitat types. However, there is no existing fish information on these areas because they were not sampled in the 1980s. Nominally, the FAs range in length from 0.5 mile to 1.9 miles (Table 1).

Selection criteria for the FAs considered the following:

- All major habitat types (main channel, side channel, side slough, upland slough, tributary delta) will be sampled within each geomorphic reach.

- At least one (and up to three) FA(s) per geomorphic reach (excepting geomorphic reaches associated with Devils Canyon – MR-3 and MR-4) will be studied that is/are representative of other areas.
- A replicate sampling strategy will be used for measuring habitat types within each FA, which will include a random selection process of mesohabitat types.
- Areas that are known (based on existing and contemporary data) to be biologically important for salmon spawning/rearing in mainstem and lateral habitats will be sampled (i.e., critical areas).
- Some areas for which little or no fish use has been documented or for which information on fish use is lacking will also be sampled.

It is important to note that the FA concept and approach will work for the Middle River Segment since the main channel is relatively confined. However, below the Three Rivers Confluence where the Chulitna and Talkeetna rivers enter, the Susitna River main channel widens and becomes heavily braided and therefore the same FA approach, which includes measurement of the entire main channel, would not be applicable in the Lower River Segment. Rather, the selection of study sites/areas there will be more targeted to specific biologically important and representative habitat features, such as tributary mouths, side and upland sloughs, and side channels. More details describing the general approach that will be used in selecting study sites in the Lower River Segment will be presented during the February 14, 2013 TWG meeting and described further in the March 1, 2013 Final Focus Area TM.

4.2. Sites Outside of the Focus Areas

The boundaries of the FAs do not limit the geographic extent of other studies, as many other study sites and areas already have been or will be located as part of resource specific investigations. Indeed, other resource studies have identified study sites outside of FAs as necessary to achieve specific resource study goals and objectives (see Fisheries (RSP Section 9.6, 9.8, and 9.9), Groundwater (RSP Section 7.5), Geomorphology (RSP Section 6.0), Ice Processes (RSP Section 7.6), and Water Quality (RSP Section 5.0). Fisheries studies for example, have and will be conducted in multiple locations both within and outside of FAs as a means to fully characterize fish distributions in the Middle and Lower River segments (see Draft Fish Distribution and Abundance Implementation Plan for Study 9.6 (R2 2013). In addition, the salmon escapement studies will be monitoring fish movements within a 184-mile section of the river extending from RM 22 and extending upstream to Kosina Creek at RM 206.8. In addition, 17 fixed telemetry stations will be installed within a mixture of tributaries and slough habitats at locations throughout the entire length of the river. Water quality studies will likewise occur at locations within and outside of FAs. A total of 39 water quality monitoring stations have been identified that extend from RM 15.1 to RM 233.4. These sites will be used for collection of baseline water quality data. In addition, water quality sampling will be conducted in selected FAs to provide a more detailed characterization of water quality characteristics in those areas as they relate to fish productivity and main channel flow conditions (see RSP Section 5). Fluvial geomorphology studies involving sediment transport and large woody debris distribution likewise include areas both within and outside of FAs, as do the Ice Processes studies. The Ice Processes studies include time-lapse photography at more than 25 sites in the river extending from RM 11 to RM 223, as well as winter discharge measurements at selected cross-sections, and winter field studies of FAs as a means to understand how winter conditions affect fish habitats and geomorphology.

In terms of the IFS, there are a total of 80 cross-sectional transects in the Middle River Segment and 8 transects in the Lower River Segment that have been established and flow data collected to support development of the open-water flow routing model (see Open-water Flow Routing Model Results TM [R2 2013], and RSP Section 8.5.4.3 and Table 8.5-7 reproduced herein as Table 2). These transects were primarily located across single thread sections of the river; however, some do extend across more complex sections. In most cases, two to three sets of flow measurements have been made at each transect. The resulting data sets can be used, at a minimum, for evaluating velocity-depth distributions across the channel that can be related to biologically relevant criteria associated with various life stage requirements (e.g., spawning, adult holding, juvenile rearing). In many cases (pending review of the cross-sectional data), it should be possible to develop actual habitat-flow relationships following a 1-D PHABSIM type analysis (see RSP Section 8.5.4.6). The cross-sectional transects represent an important dataset that can be used to characterize habitat-flow response characteristics of the main channel of the Susitna River. These types of data were never collected during the 1980s studies and no main channel habitat-flow relationships were developed. Importantly, now that the main channel habitat mapping is completed (see Section 6), the transect locations have been assigned to specific mainstem habitat types (main channel, side channel, split channel, etc.) and main channel mesohabitat types (e.g., riffle, run, glide, pool) and can be randomly selected for analysis. These additional transects may also be useful for extrapolating results/relationships from measured to unmeasured sites (see RSP Section 8.5.4.7).

As noted in the RSP, results of the 2013 studies will be carefully reviewed and evaluated, and will likely result in some refinements to existing study sites/areas and/or establishment of supplemental sites that target specific habitat-flow relationship types. For example, the scaling up/expansion of flow – habitat relationships derived from measured to unmeasured sites or locations within the river will likely require measurement of certain flow attributes (e.g., determination of the relationships of main channel flow to side channel and side slough breaching flows; defining areas of turbid/non-turbid waters; defining areas of groundwater upwelling) at unmeasured areas. The point is that the study sites/areas presented in RSP Section 8.5 and in other resource RSPs are subject to refinement based on results of 2013 investigations and study needs.

5. HABITAT MAPPING ANALYSIS

Habitat mapping of the Middle River Segment of the Susitna River was completed using a combination of geo-rectified aerial imagery (2011 Matsu Ortho Imagery at 1:8000 scale. http://matsu.gina.alaska.edu/wms/imagery) in combination with High Definition aerial videography that was taken of the river in August 2012 (≈ 10,000 cfs) (HDR 2013). The results of the habitat mapping provided a spatial depiction of the distribution of habitat types and features throughout the entire length of the Middle River Segment. Specific habitat types were digitized using ARC GIS and lineal distances computed of each discrete habitat feature. Results of the habitat mapping were used to evaluate the "representativeness" of the Focus Areas with respect to other areas of the river. In this context, representativeness specifically refers to how well habitat units within the FAs represent habitat units outside of these areas within the same geomorphic reach.

There are multiple ways to examine or measure representativeness of the FAs but the most valuable examination will occur after the first year of sampling when more direct information will have been obtained of the existing habitat types from field work. However, at the current planning stage of the study, representativeness was examined by 1) comparing the representation of habitat types within the FAs to the representation of habitat types in the entire geomorphic reach; 2) determining if the habitat types have been proportionately represented (focus vs. non-focus areas); 3) determining if there was a bias in the habitat types that were selected in the FAs; and 4) evaluating whether a random systematic approach in the selection of FAs would yield different results than the selection process and criteria applied to the current FAs.

5.1. Methods

The methods used in completing the habitat mapping analysis are described below.

5.1.1. Habitat Data Compilation and Review

The overall objective of Middle River Segment mainstem mapping was to characterize and classify river habitat in the mainstem from the proposed Watana Dam site to the Chulitna River confluence. These data were used to evaluate the selection of FAs for the IFS studies (this TM) as well as to develop a study site selection approach for the fish distribution and abundance studies (see Draft Fish Distribution and Abundance Implementation Plan for Study 9.6 [R2 2013]). The mapping effort also included tributaries extending 0.5 miles upstream from the confluence with the mainstem. The 0.5 mile extent was used because it was considered a conservative standard that is greater than the expected hydrologic influence. The actual hydrologic influence is currently not known.

As a preliminary step in the analysis, the results of the GIS based habitat mapping were presented and discussed during an IFS internal technical review meeting. Habitat mapping generally followed the hierarchical and nested classification system developed specifically for the Susitna River that was described above. Digital mapping results were displayed and reviewed with technical staff who had been in the field and were familiar with channel characteristics. The review process proceeded from the upper to lower geomorphic reaches and resulted in a number of modifications to the habitat types. These modifications were subsequently made and a final draft database of habitat mapping results developed. Overall, the geo-rectified imagery in combination with aerial videography was sufficient to map the Middle River Segment mainstem habitat to the mesohabitat level. However, the imagery was not suitable for mapping off-channel or tributary habitats to this level; mapping of these features will require field surveys.

5.1.2. Evaluation of Representativeness – Representation and Proportionality

The habitat classifications can be summarized by counts or lengths of identified units inside and outside of FAs. However, the length of river that is included in FAs is less than that not included in the FAs, so some scaling of counts and lengths is necessary for proportional comparisons. A suite of scaled metrics were identified and developed that were used in a comparative analysis of the representativeness of habitat types within and outside of FAs. These metrics included the major habitat categories specified in the classification and consisted of percentages or, proportions of lineal distances, and densities (length per mile) (Table 3).

These metrics are compared graphically. There are two bases for comparison: 1) is each habitat type contained in the geomorphic reach represented in FAs within the reach; and 2) is the representation proportional. The metrics cannot be statistically compared within geomorphic reaches (focus area vs. non-focus area) because they do not represent independent random samples. Thus, there is no estimation of variance available.

5.1.3. Evaluation of Representativeness – Bias

Statisticians define the representativeness of samples based on the absence of bias. Statistical bias is a consistent under- or over- estimation of a known population parameter. In this application, bias could exist if the FAs are consistently over sampling braided main channels, for example. For model inferences specific to habitat units, bias in proportional sampling is not a large issue. However, if selected samples for any particular part of the program not related to the instream flow-habitat models are used to make inference to entire geomorphic reaches, this selection bias could result in estimation bias.

In this analysis, bias in the selection method was examined by considering the geomorphic reaches as independent replicates of potential bias, and testing if the average bias is different from zero using a t-test or a non-parametric equivalent. For example, if the FAs selection has consistently under-represented upland sloughs, this analysis would highlight that result.

5.2. Results

5.2.1. Habitat Data Compilation and Review

Results of the habitat mapping as presented and summarized in HDR (2013) indicated that the main channel habitats within the Middle River Segment of the Susitna River varied by geomorphic reach and generally increased in complexity moving from the upper end of the segment to downstream locations (Table 4). Mesohabitat in the main channel was generally dominated by a mixture of run and glide habitats (Table 5). Glide and run habitats were not distinguished from each other at this level of classification and included smooth-flowing, low turbulence reaches as well as areas with some standing or wind waves and occasional solitary protruding boulders. Run-glide mesohabitat dominated all reaches except MR-4, the reach where Devils Canyon is located. Riffle habitat was most prevalent in MR-4. Riffle habitat was lacking or only found in small amounts in the other Middle River Segment geomorphic reaches.

Side channels were predominantly glide or run, with some riffle areas in the lower reaches (Table 5). 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 MR-6.

Cascade habitat was not found within any Middle River Segment geomorphic reach. The geomorphic reach through Devils Canyon (MR-4) contained the only rapids in the Middle River Segment, which accounted for 38% of the mainstem habitat in that reach. Only 3 pools were found in the Middle River Segment 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. Not all tributaries that entered the Middle River had tributary mouth habitat. Small tributaries where the vegetation line was close to the mainstem did not fan out and create the areas classified as tributary mouth habitat. In addition, small tributaries or tributaries that flowed into fast moving or turbulent sections of the mainstem did not produce clear water plume habitats. 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.

Off-channel habitat was assigned to one of three habitat types observed: upland sloughs, side sloughs, and backwaters. Upland and side sloughs were prevalent throughout the Middle River reaches outside of Devils Canyon and downstream of the uppermost reach at MR-1 (Table 6). Side sloughs were most abundant in MR-5, followed by MR-6. Upland sloughs were most abundant in MR-8, and generally increased in abundance towards the downstream reaches.

Beaver complexes always were associated with slough habitats and as such were not categorized as a habitat type but were noted as a characteristic of that slough habitat unit. Beaver dams were rarely present in side slough habitat, and slightly more prevalent in upland sloughs. Beaver dams were only observed in reaches MR-5, MR-6 and MR-7.

Backwater habitat was also relatively rare and found in a few areas in the lower reaches from MR-5 through MR-8. A single backwater was also delineated in MR-2 and MR-4, but accounted for less than 1 percent of the linear habitat in that reach due to small size. The greatest total area of backwater habitat was in MR-6.

5.2.2. Evaluation of Representativeness

5.2.2.1. Representation and Proportionality

The FAs have captured the majority of habitat types represented in each geomorphic reach. Below, the proportionality metrics are graphically displayed and discussed and the minor cases where FAs may have fallen short of representativeness described.

Main channel proportionality metrics are displayed graphically in Figure 5.1. MR-1 is all single main channel. MR-2, MR-5 and MR-6 have a small amount of split main channel, which is not represented within the FA. In MR-7, the split main channel is represented, but at a higher proportion than exists in the full reach. In MR-8, the braided main channel is not represented in the FA.

Side channels and sloughs proportionality metrics are displayed graphically in Figure 5.2. MR-1 side channels appear to be represented proportionately. MR-2 FAs contain all habitats, with a higher portion of side slough than the full reach. MR-5 side channels and side sloughs are not represented in FAs. MR-7 side sloughs are not represented in FAs, and upland sloughs are proportionally higher in FAs than in the total reach. In MR-8, all habitats are represented in the FAs, but there is proportionately more side slough habitat than in the reach at large.

Beaver complex proportionality is displayed in Figure 5.3. Beaver habitat is represented in MR-6 at a higher proportionality in FAs than without. In MR-7, existing beaver habitat in the reach is not represented in the FA.

Backwater and tributary-related habitat counts and proportionality are both displayed in Figure 5.4. MR-1 does not contain these habitat types. In MR-2, identified plumes and backwaters are not represented in FAs, and tributaries are proportionately under-represented. In MR-5, there is only one tributary with a mouth and plume, and it is contained in the FA. In MR-6, all habitats are represented, but tributaries are not proportionately represented. In MR-7, identified tributary mouths and plumes are not represented. In MR-8, the single backwater is not in the FA, but the two tributaries are both in the FA.

The main channel mesohabitat comparison is shown in Figure 5.5. MR-1 is all glide/run habitat. MR-2 and MR-5 have a small amount of identified riffle that is not represented in the FAs. The other reaches are generally well represented.

It should be noted that tributary and tributary features (mouths and plumes) are subject to some interpretation from aerial photos, and depend upon flow. As a result, tributaries were further classified based on the habitat mapping and other sources to identify potential fish bearing tributaries that should be considered for sampling in the Middle River. Table 7 shows the counts of potential tributaries by geomorphic reach and focus area vs. non-focus area. This table shows that tributaries may still be under-represented in FAs, but not by as large a margin as the habitat mapping results indicated.

5.2.2.2. Bias

Bias estimates are displayed in Table 8. A negative number in this table indicates that a habitat was over-represented in the Focus Areas, and a positive number indicates that a habitat was under-represented. There is a fairly even distribution of cases where habitat was under-represented and over-represented across reaches. Thus, there is no strong evidence (i.e., no statistically significant results at an alpha level of 0.10) of bias in the habitat types that were selected within the FAs. Tributary mouths were consistently under-represented, however (p-value = 0.10). Overall, these results indicate there was no obvious systematic bias in the selection of FAs.

6. IMPLICATIONS OF HABITAT MAPPING RESULTS AND STUDY AREA REFINEMENTS

The results of the habitat mapping analysis have provided insight into the types and distributions of habitats present in the Middle River Segment of the Susitna River. This information and the GIS mapping layers that have been generated and provided in HDR (2013) have been useful for evaluating the representativeness of the original Focus Areas presented in the IFS RSP. Results of that analysis have addressed the following questions:

1. Are the Focus Areas representative of areas and habitat types within the entire Middle River Segment?

   Answer: Yes – the combined FAs contain one or more of the habitat types and features found within areas outside of the FAs in the Middle River Segment.

2. Are the Focus Areas within a given Geomorphic Reach representative of areas and habitat types found within other portions of the same Geomorphic Reach?

   Answer: In general, Yes – in most instances the FAs within a given Geomorphic Reach contain one or more of the habitat types and features found within other portions of the same Geomorphic Reach. However, there were a few exceptions primarily related to the absence of certain main channel habitat types (i.e., split main channel and braided channel) from within FAs. Two off-channel habitat types were likewise absent from within certain FAs; side channels and side sloughs in MR-5 and side sloughs found in MR-7 are not represented in the respective FAs. Consideration will be given to either adjusting the length of the FAs to capture the respective habitat types or simply identifying and adding discrete sites that include these habitat types that are outside of the FAs.

3. Are there certain habitat types detected as part of the habitat mapping that warrant special consideration relative to sampling?

   Answer: Yes – very few backwater habitats were detected within the entire Middle River Segment and none are included in FAs within MR-2 or MR-8. Likewise, relatively few tributary plume areas were identified in the segment and again, none were included in FAs within MR-2 and MR-8 even though present within those reaches. These habitats are important to fish and therefore consideration will be given to adding sites specifically targeting backwater and tributary plume habitats.

4. Was there a detectable bias in the way in which the FAs were selected?

   Answer: No – results of the analysis did not indicate any systematic bias in terms of the FAs selected and the habitat types they contain.

5. What about the habitat types that have not been included in the FAs but are represented in the Geomorphic Reaches? Should those be sampled?

   Answer: Yes – if those habitat types are not already captured by the cross-sectional transects located outside of the FAs, then consideration will be given to locating and adding discrete habitat types to ensure they are captured and measured within a given Geomorphic Reach. Table 9 shows the habitat types that are represented by FAs, cross-sections and those that are still needed.

6. Based on the results of the habitat mapping and subsequent analysis of representativeness of the FAs, is there a need to establish additional Focus Areas within any of the Geomorphic Reaches?

   Answer: No – the existing FAs, with a few exceptions relative to specific habitat types noted in 2 and 3 above, capture the habitat characteristics and diversity of a given Geomorphic Reach.

7. FINAL LISTING OF FOCUS AREAS AND STUDY SITES

The results of the habitat mapping analysis indicate that the FAs identified in the IFS Fish and Aquatic RSP (RSP Section 8.5) are generally representative of habitat types found in other portions of the river. Those FAs should be finalized for study in 2013 in accordance with the respective resource specific RSPs. Those FAs, coupled with the existing sites (i.e., cross-sections) that have been established outside of the FAs, the study sites outside of the FAs that have been identified as part of other resource studies, as well as a few supplemental sites (to be determined and presented during the February 14, 2013 TWG) that will be added in 2013 to fill-in specific habitat types missing from certain FAs, will collectively provide a comprehensive and spatially expansive array of study areas and sites within the Middle River Segment of the Susitna River.

8. REFERENCES

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9. TABLES

Table 1. Locations, descriptions and selection rationale of proposed Focus Areas for detailed study in the Middle River Segment of the Susitna River. Focus Area identification numbers (e.g., Focus Area 184) represent the truncated Project River Mile (PRM) at the downstream end of each Focus Area.

Focus Area ID	Common Name	Description	Geomorphic Reach	Location (PRM)		Area Length (mi)	Habitat Types Present							Fish use in 1980s		Instream Flow Studies in 1980s			Rationale for Selection
				Upstream	Downstream		Main Channel, Single	Main Channel, Split	Side Channel	Tributary Mouth	Side Slough	Upland Slough	Beaver Complex	Spawning	Rearing	IFG	DIHAB	RJHAB	
Focus Area-184	Watana Dam	Area approximately 1.4 miles downstream of dam site	MR-1	185.7	184.7	1.0	X	X	X					*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	Focus Area-184 length comprises 50% of MR-1 reach length (2 miles long) and contains split main channel and side channel habitat present in this reach.
Focus Area-173	Stephan Lake, Complex Channel	Wide channel near Stephan Lake with complex of side channels	MR-2	175.4	173.6	1.8	X		X	X	X			*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	Focus Area-173 contains a complex of main channel and off-channel habitats within wide floodplain. Represents greatest channel complexity within MR-2. Reach MR-2 is 15.5 miles long and channel is generally straight with few side channels and moderate floodplain width (2-3 main channel widths).
Focus Area-171	Stephan Lake, Simple Channel	Area with single side channel and vegetated island near Stephan Lake	MR-2	173.0	171.6	1.4	X		X	X				*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	The single main channel with wide bars, single side channel and moderate floodplain channel width in Focus Area-171 are characteristic of MR-2. Reach MR-2 channel morphology is generally straight with few side channels and moderate floodplain width (2-3 main channel widths).
Focus Area-151	Portage Creek	Single channel area at Portage Creek confluence	MR-5	152.3	151.8	0.5	X			X				X	X				Focus Area-151 is a single main channel and thus representative of the confined Reach MR-5. Portage Creek is a primary tributary of the Middle Segment and the confluence supports high fish use.
Focus Area-144	Side Channel 21	Side channel and side slough complex approximately 2.3 miles upstream Indian River	MR-6	145.7	144.4	1.3	X	X	X	X	X		X	X	X	X			Focus Area-144 contains a wide range of main channel and off-channel habitats, which are common features of Reach MR-6. Side Channel 21 is a primary salmon spawning area. Reach MR-6 is 26 miles long (30% of Middle Segment length) and is characterized by a wide floodplain and complex channel morphology with frequent channel splits and side channels.
Focus Area-141	Indian River	Area covering Indian River and upstream channel complex	MR-6	143.4	141.8	1.6	X	X	X	X		X	X	X	X		X		Focus Area-141 includes the Indian River confluence, which is a primary Middle Susitna River tributary, and a range of main channel and off-channel habitats. Channel and habitat types present in Focus Area-141 are typical of complex Reach MR-6. High fish use of the Indian River mouth has been documented and DIHAB modeling was performed in main channel areas.
Focus Area-138	Gold Creek	Channel complex including Side Channel 11 and Slough 11	MR-6	140.0	138.7	1.3	X	X	X		X	X	X	X	X	X			The Focus Area-138 primary feature is a complex of side channel, side slough and upland slough habitats, each of which support high adult and juvenile fish use. Complex channel structure of Focus Area-138 is characteristic of Reach MR-6. IFG modeling was performed in side channel habitats.
Focus Area-128	Skull Creek Complex	Channel complex including Slough 8A and Skull Creek side channel	MR-6	129.7	128.1	1.6	X	X	X	X	X			X	X	X	X		Focus Area-128 consists of side channel, side slough and tributary confluence habitat features that are characteristic of the braided MR-6 reach. Side channel and side slough habitats support high juvenile and adult fish use and habitat modeling was completed in side channel and side slough habitats.
Focus Area-115	Lane Creek	Area 0.6 miles downstream of Lane Creek, including Upland Slough 6A	MR-7	116.5	115.3	1.2	X	X	X			X	X		X	X		X	Focus Area-115 contains side channel and upland slough habitats that are representative of MR-7. Reach MR-7 is a narrow reach with few braided channel habitats. Upland Slough 6A is a primary habitat for juvenile fish and habitat modeling was done in side channel and upland slough areas.
Focus Area-104	Whiskers Slough	Whiskers Slough Complex	MR-8	106.0	104.8	1.2	X	X	X	X	X	X		X	X	X	X	X	Focus Area-104 contains diverse range of habitat, which is characteristic of the braided, unconfined Reach MR-8. Focus Area-104 habitats support juvenile and adult fish use and a range of habitat modeling methods were used in side channel and side slough areas.

Table 2. Partial list of river cross-sections, and flow and water surface elevations measured in 2012 on the Susitna River between River Miles 75 and 184. The list does not include additional measurements in late September/October. Those measurements had not been processed at the time this study plan was prepared.

Project River Mile	High Q Trip			Mid Q Trip			Low Q Trip		
	Date	Time	Discharge	Date	Time	Discharge	Date	Time	Discharge
PRM 225.0	6/14/12	17:57	26,932	8/9/12	15:03	11,260	--	--	--
PRM 187.2	6/17/12	16:30	27,698	8/6/12	16:13	14,707	9/15/12	13:17	7,838
PRM 186.2	6/18/12	14:13	24,493	8/6/12	17:05	14,419	9/15/12	14:05	7,630
PRM 185.5	6/18/12	16:10	25,389	--	--	--	--	--	--
PRM 185.2	6/19/12	13:00	26,676	--	--	--	--	--	--
PRM 184.9	6/19/12	15:49	27,619	8/6/12	18:24	14,239	9/15/12	14:57	7,714
PRM 184.4	6/19/12	16:51	27,886	8/7/12	12:38	14,775	9/15/12	15:52	8,353
PRM 183.3	6/20/12	13:19	29,426	8/7/12	13:35	14,183	9/15/12	16:41	8,310
PRM 182.9	6/20/12	16:01	29,218	--	--	--	--	--	--
PRM 181.6	6/20/12	17:56	29,645	8/7/12	14:44	14,705	9/15/12	17:55	8,689
PRM 179.5	6/21/12	12:28	30,866	8/7/12	15:41	14,345	9/14/12	17:05	8,361
PRM 178.5	6/16/12	18:35	29,756	8/7/12	16:37	14,799	9/14/12	17:47	8,738
PRM 176.5	6/21/12	14:40	31,240	8/8/12	12:07	14,559	9/16/12	14:50	10,768
PRM 174.9	6/21/12	16:12	31,163	--	--	--	--	--	--
PRM 173.1	6/21/12	17:39	30,571	--	--	--	9/16/12	16:29	11,082
PRM 170.1	6/22/12	12:56	31,121	8/8/12	15:16	14,568	9/16/12	17:33	11,137
PRM 168.1	6/22/12	14:33	32,265	8/8/12	16:03	14,655	9/17/12	15:19	14,619
PRM 153.7	6/25/12	17:15	32,162	8/10/12	15:03	14,588	--	--	--
PRM 152.9	6/26/12	13:43	30,487	--	--	--	--	--	--
PRM 152.1	6/26/12	15:38	30,036	8/10/12	16:07	15,351	9/29/12	15:20	18,488
PRM 151.1	6/25/12	14:00	33,180	--	--	--	--	--	--
PRM 148.3	6/26/12	18:24	32,114	8/10/12	18:03	14,941	--	--	--
PRM 146.6	6/27/12	12:24	31,030	--	--	--	--	--	--
PRM 145.7	6/27/12	13:51	31,396	8/12/12	13:12	17,354	9/29/12	16:51	18,131
PRM 145.5	6/27/12	14:40	31,868	--	--	--	--	--	--
PRM 144.9	6/27/12	17:01	31,949	--	--	--	--	--	--
PRM 144.3	6/27/12	18:50	31,121	--	--	--	--	--	--
PRM 143.5	6/28/12	12:17	30,330	8/12/12	14:58	17,006	--	--	--
PRM 143.0	6/28/12	13:53	29,492	--	--	--	--	--	--
PRM 142.2	6/28/12	15:15	29,753	8/12/12	16:29	16,798	9/29/12	17:45	18,301
PRM 141.9	6/28/12	16:27	30,583	8/12/12	17:13	16,803	--	--	--
PRM 141.7	6/28/12	17:41	30,555	--	--	--	--	--	--
PRM 140.0	6/29/12	14:48	30,378	8/13/12	12:54	16,350	9/30/12	13:56	17,619
PRM 139.8	6/29/12	16:21	30,378	--	--	--	--	--	--
PRM 139.0	6/30/12	13:56	28,039	8/13/12	13:58	16,449	--	--	--

Project River Mile	High Q Trip			Mid Q Trip			Low Q Trip		
	Date	Time	Discharge	Date	Time	Discharge	Date	Time	Discharge
PRM 138.7	6/30/12	14:51	28,230	8/13/12	14:48	16,344	--	--	--
PRM 138.1	6/30/12	16:33	28,203	--	--	--	--	--	--
PRM 137.6	6/30/12	18:13	27,893	8/13/12	16:14	16,409	9/30/12	15:00	17,382
PRM 136.7	7/1/12	13:35	26,756	--	--	--	--	--	--
PRM 136.2	7/1/12	16:06	26,943	--	--	--	--	--	--
PRM 135.0	7/1/12	18:33	26,526	8/13/12	17:41	15,627	--	--	--
PRM 134.3	7/2/12	12:16	25,463	--	--	--	10/1/12	13:40	15,568
PRM 134.1	7/2/12	13:18	26,166	8/14/12	13:14	16,491	--	--	--
PRM 133.8	7/2/12	14:30	25,715	8/14/12	14:05	16,275	--	--	--
PRM 133.3	7/2/12	16:22	25,678	--	--	--	--	--	--
PRM 132.6	7/2/12	17:57	25,046	8/14/12	15:17	16,039	--	--	--
PRM 131.4	7/3/12	22:08	28,628	--	--	--	--	--	--
PRM 129.7	7/3/12	17:33	28,243	8/14/12	17:00	16,330	10/1/12	16:16	15,731
PRM 128.1	7/4/12	15:40	26,748	8/15/12	12:50	15,926	--	--	--
PRM 126.8	7/4/12	17:22	27,608	8/15/12	13:40	16,078	10/1/12	17:02	15,582
PRM 126.1	7/5/12	14:24	27,248	--	--	--	--	--	--
PRM 125.4	7/5/12	16:38	26,427	--	--	--	--	--	--
PRM 124.1	7/5/12	18:11	26,132	8/15/12	14:27	16,161	10/1/12	17:42	15,582
PRM 123.7	7/6/12	12:18	23,875	--	--	--	--	--	--
PRM 122.7	7/6/12	14:23	23,331	--	--	--	--	--	--
PRM 122.6	7/6/12	15:59	22,890	8/15/12	16:13	16,287	--	--	--
PRM 120.7	7/6/12	17:19	22,687	--	--	--	--	--	--
PRM 119.9	7/7/12	12:19	20,715	8/16/12	12:54	16,005	10/3/12	14:47	13,998
PRM 118.4	7/7/12	14:06	20,656	--	--	--	--	--	--
PRM 117.4	7/7/12	16:15	20,747	--	--	--	--	--	--
PRM 116.6	7/7/12	17:36	20,665	8/16/12	14:15	16,136	10/3/12	15:53	14,323
PRM 116.3	7/8/12	12:42	23,766	--	--	--	--	--	--
PRM 115.7	7/8/12	14:05	25,006	--	--	--	--	--	--
PRM 115.4	7/8/12	16:13	25,958	--	--	--	--	--	--
PRM 114.4	7/8/12	18:29	25,860	--	--	--	--	--	--
PRM 113.6	7/9/12	14:23	28,329	8/16/12	16:38	16,311	10/3/12	16:41	13,476
PRM 111.9	7/9/12	15:23	28,296	--	--	--	--	--	--
PRM 110.5	7/9/12	16:46	28,825	8/17/12	14:57	15,254	10/3/12	17:33	14,172
PRM 108.3	--	--	--	8/17/12	17:55	16,394			
PRM 107.1	7/9/12	18:26	28,409	8/18/12	13:12	15,508	10/4/12	14:10	14,558
PRM 106.1	--	--	--	8/18/12	14:22	15,278	--	--	--
PRM 105.3	--	--	--	8/18/12	15:52	15,362	--	--	--

Project River Mile	High Q Trip			Mid Q Trip			Low Q Trip		
	Date	Time	Discharge	Date	Time	Discharge	Date	Time	Discharge
PRM 104.7	--	--	--	8/18/12	17:48	15,377	--	--	--
PRM 104.1	--	--	--	8/19/12	12:49	15,345	--	--	--
PRM 103.5	--	--	--	--	--	--	10/4/12	16:49	14,575
PRM 102.7	7/10/12	13:53	26,635	--	--	--	--	--	--
PRM 101.4	--	--	--	--	--	--	--	--	--
PRM 98.4	7/11/12	14:09	46,499	8/20/12	14:51	40,623	10/5/12	14:37	39,065
PRM 97.0	7/11/12	18:27	45,118	8/20/12	17:03	40,261	--	--	--
PRM 91.6				8/21/12	14:55	46,330	--	--	--
PRM 91.0	7/12/12	15:39	43,922	8/21/12	16:51	46,197	--	--	--
PRM 88.4	--	--	--	8/22/12	15:01	41,697	--	--	--
PRM 87.1	7/12/12	18:00	42,550	--	--	--	--	--	--
PRM 86.3	7/13/12	13:13	41,895	--	--	--	--	--	--
PRM 85.4	--	--	--	8/22/12	18:01	40,468	--	--	--
PRM 84.4	--	--	--	8/23/12	15:16	36,988	--	--	--
PRM 83.0	7/13/12	16:09	41,975	--	--	--	--	--	--
PRM 82.3	--	--	--	8/23/12	17:52	37,947	--	--	--
PRM 80.0	--	--	--	8/24/12	15:07	36,580	--	--	--

Table 3. Metrics used to compare the representation and proportionality of habitat types between focus areas and non-focus areas within each geomorphic reach.

Level	Habitat Type	Comparison Metric	Numerator	Denominator
Macro-Habitat	Main Channel	Percent of main channel that is single unsplit main channel	Length of main channel habitat (HDR)	Total length of main channel (thalweg, R2)
	Split Main Channel	Percent of main channel that is in split main channel	Length of main channel that is in split main channel (R2 calculated)	Total length of main channel (thalweg, R2)
	Braided Main Channel	Percent of main channel that is in braided main channel	Length of main channel that is in braided main channel (R2 calculated)	Total length of main channel (thalweg, R2)
	Side Channel	Side channel length per river mile	Total length of side channels (HDR)	Total length of main channel (thalweg, R2)
	Upland Slough	Upland slough length per river mile	Total length of upland slough habitat (HDR)	Total length of main channel (thalweg, R2)
	Side Slough	Side slough length per river mile	Total length of side channel habitat (HDR)	Total length of main channel (thalweg, R2)
	Backwater	density of backwaters (#/mile)	# backwaters (HDR)	Total length of main channel (thalweg, R2)
	Tributary	density of tributaries (#/mile)	# tributaries (HDR)	Total length of main channel (thalweg, R2)
	Tributary Mouth	density of tributary mouths (#/mile)	# Tributary Mouths (HDR)	Total length of main channel (thalweg, R2)
	Clear Water Plume	density of plumes (#/mile)	# plumes (HDR)	Total length of main channel (thalweg, R2)
Mesohabitat	Glide or Run	Percent of main/side channel habitat in glide/run	Total length of Glide or Run (HDR)	Total Length of Main + Side Channel Habitat (HDR)
	Riffle	Percent of main/side channel habitat in riffle	Total length of Riffle (HDR)	Total Length of Main + Side Channel Habitat (HDR)
	Beaver Complex	Percent of slough habitat that is beaver complex	Total length of Beaver Complex Habitat (HDR)	Total length of slough habitat (HDR)

Table 4. Main channel habitat classifications by geomorphic reach in the Middle Susitna River

Main Channel Type	MR-1		MR-2		MR-3		MR-4		MR-5		MR-6		MR-7		MR-8	
	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	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 5. Main Channel mesohabitat classifications in the Middle Susitna River.

Main Channel Mesohabitat	MR-1		MR-2		MR-3		MR-4		MR-5		MR-6		MR-7		MR-8	
	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	Total (ft)	%	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 6. Off channel habitats classified in the Middle Susitna River.

Off-Channel and Tributary Habitats	MR-1		MR-2		MR-3		MR-4		MR-5		MR-6		MR-7		MR-8	
	%	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 7. Counts of tributaries with potential fish habitat in the Middle River.

	Inside FAs	Outside of FAs	Total
MR-2	2	8	10
MR-5	1	0	1
MR-6	3	19	22
MR-7	1	12	13
MR-8	1	0	1

Table 8. Estimated bias for each proportionality metric (total for reach – focus area) where estimates could be made. Statistical comparison was made using a t-test or nonparametric alternative when the sample size (number of geomorphic reaches with bias estimate) was greater than three.

	MR-1	MR-2	MR-5	MR-6	MR-7	MR-8	Average Bias	p-value
Main Channel		-5.0%	-9.5%	-17%	42%	-23%	-2.3%	0.85
Split Main		5.0%	9.5%	22%	-42%	-3.7%	-1.8%	0.87
Braided Main				-5.5%		26%	10.4%	n/a
Side Channel	-0.021	-0.032	0.073	0.17	0.14	-0.13	0.033	0.52
Side Slough		-0.33	0.17	-0.070	0.13	-0.14	-0.049	0.62
Upland Slough		0.035		0.035	-0.55	-0.024	-0.12	1
Backwaters				0.012	-1.3		-0.66	n/a
Tributaries		1.7		1.4	0.70	-0.86	0.72	0.29
Tributary Mouth		0.42		0.10	0.27		0.26	0.10
Clear Water Plumes		0.33		0.012			0.17	n/a
Beaver Complex				-10%	13%		1.4%	n/a
Glides/Runs		-3.3%	-2.0%	3.7%	13%	0.42%	2.4%	0.46
Riffles		3.3%	2.0%	-3.7%	-13%	-0.42%	-2.4%	0.46

Table 9. Habitat types by geomorphic reach and how representativeness will be achieved. (FA=Focus Area; CS=Cross-section).

	MR-1			MR-2			MR-5			MR-6			MR-7			MR-8		
Habitat	**FA**	**CS**	**NEED**	**FA**	**CS**	**NEED**	**FA**	**CS**	**NEED**	**FA**	**CS**	**NEED**	**FA**	**CS**	**NEED**	**FA**	**CS**	**NEED**
Main Channel	X			X			X			X			X			X		
Split Main Channel	n/a					X			X		X		X			X		
Braided Main Channel	n/a			n/a			n/a			X			n/a				X	
Side Channel	X			X					X	X			X			X		
Side Slough	n/a			X					X	X				X		X		
Upland Slough	n/a			X			n/a			X			X			X		
Beaver Complex	n/a			n/a			n/a			X					X	X		
Backwater	n/a					X	n/a			X			X					X
Tributary	n/a			X			X			X			X			X		
Tributary Mouth	n/a			X			X			X					X	n/a		
Clear Water Plume	n/a				X		X			X					X	n/a		

10. FIGURES

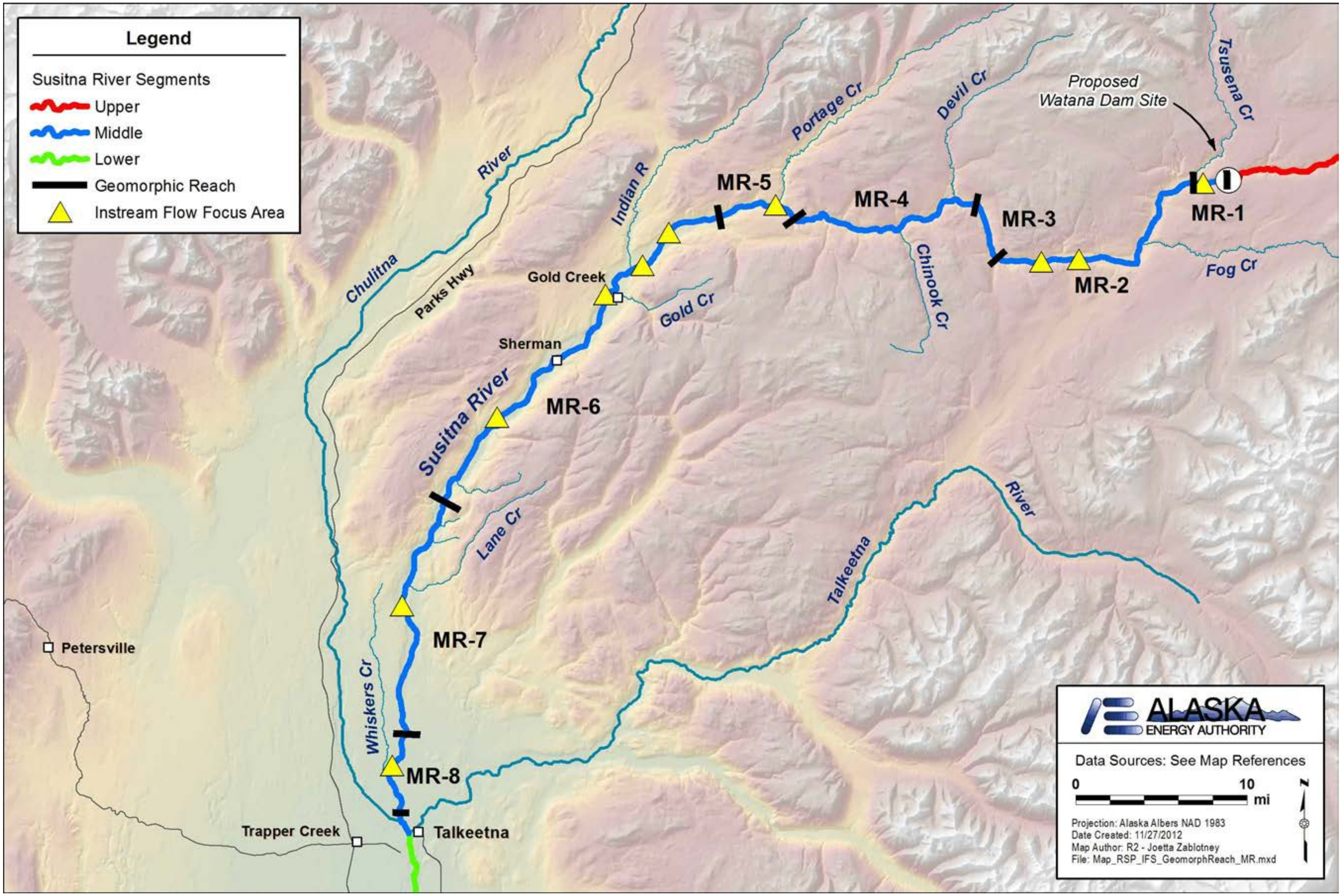

Figure 1. Map of the Middle Segment of the Susitna River depicting the eight Geomorphic Reaches and locations of proposed Focus Areas. No Focus Areas are proposed for in MR-3 and MR-4 due to safety issues related to sampling within or proximal to Devils Canyon.

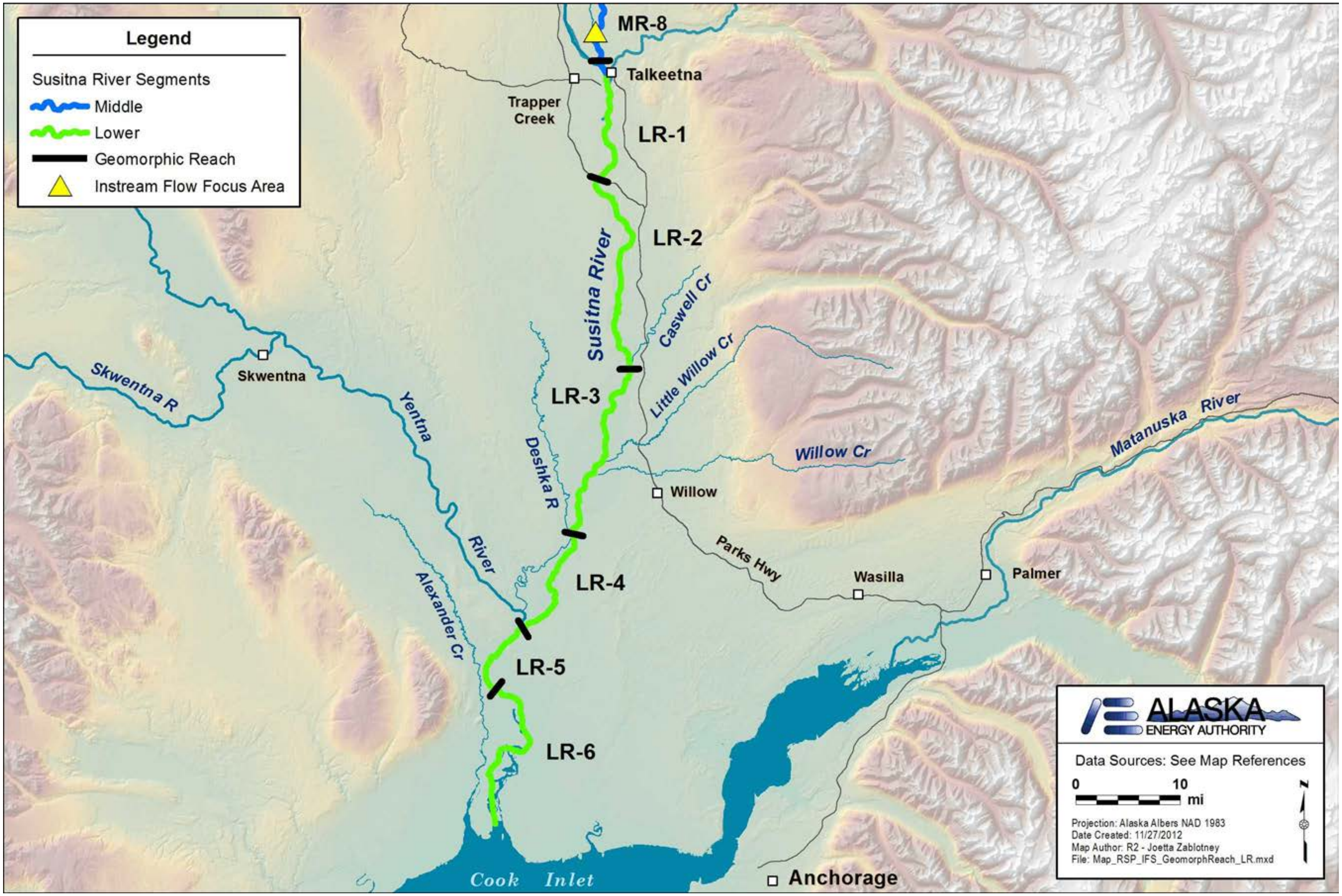

Figure 2. Map of the Lower Segment of the Susitna River depicting the six Geomorphic Reaches. Focus Areas have not been identified in this segment but will be considered pending results of open-water flow routing modeling.

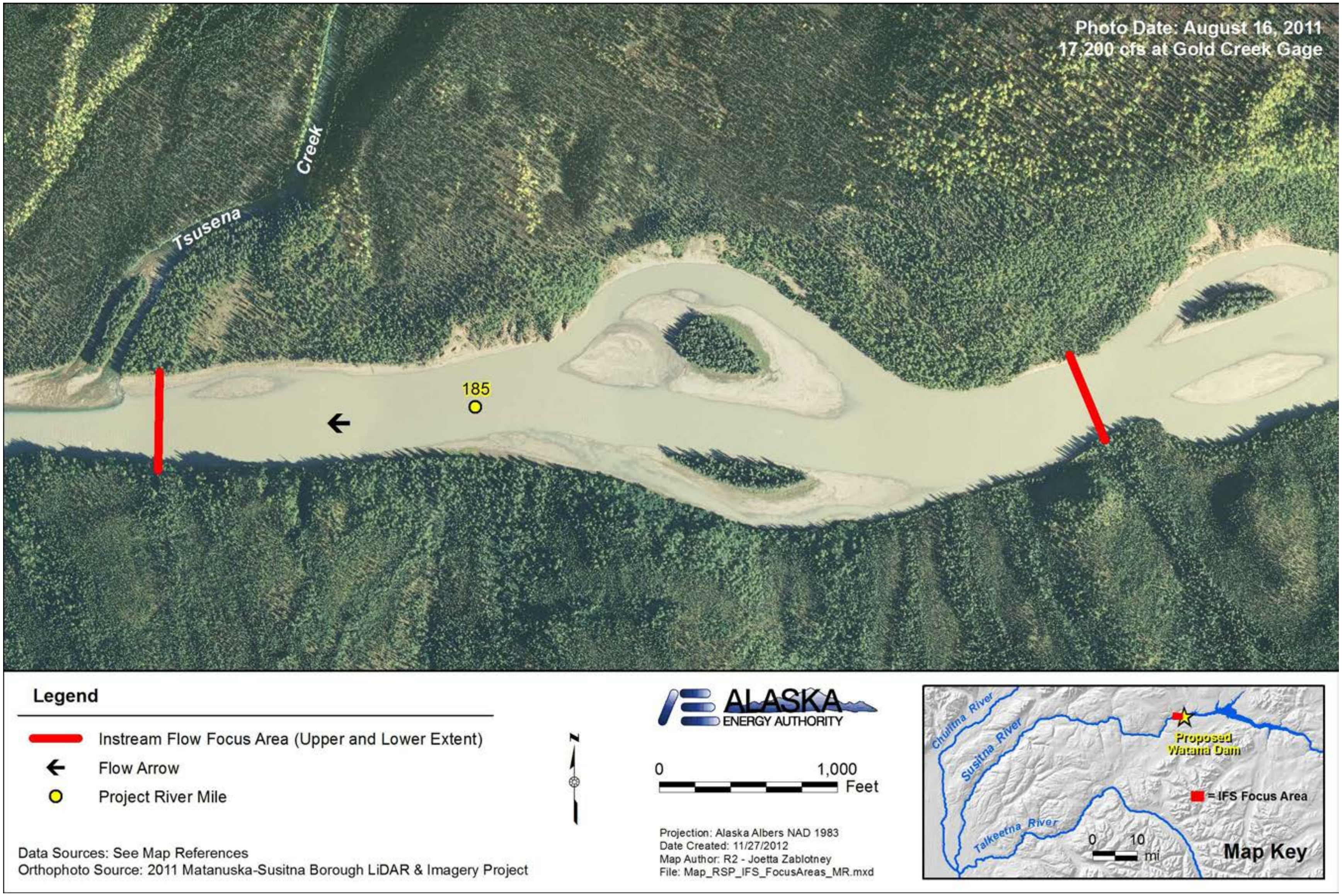

Figure 3. Map showing Focus Area 184 that begins at Project River Mile 184.7 and extends upstream to PRM 185.7. The Focus Area is located about 1.4 miles downstream of the proposed Watana Dam site near Tsusena Creek.

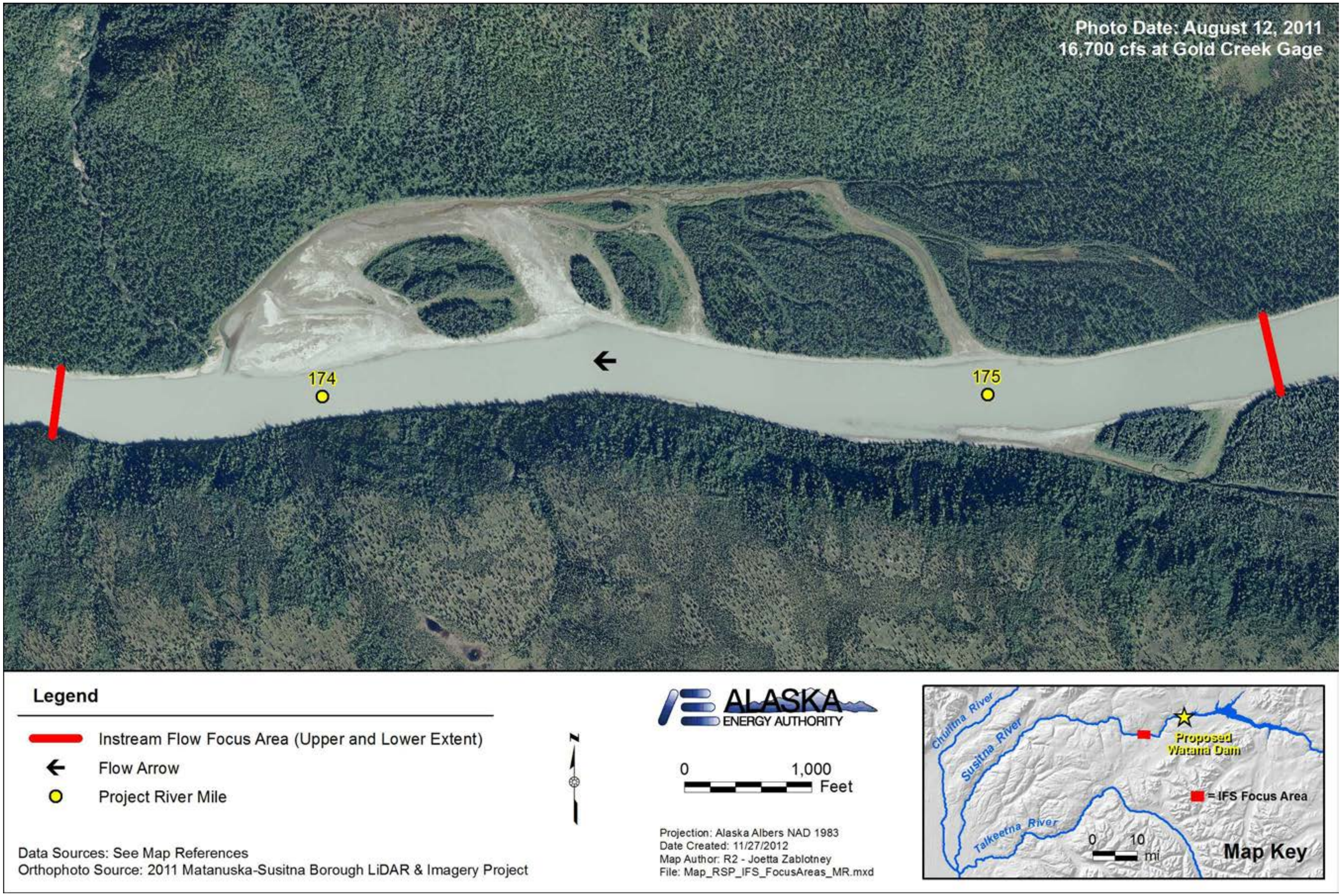

Figure 4. Map showing Focus Area 173 beginning at Project River Mile 173.6 and extends upstream to PRM 175.4. This Focus Area is near Stephan Lake and consists of main channel and a side channel complex.

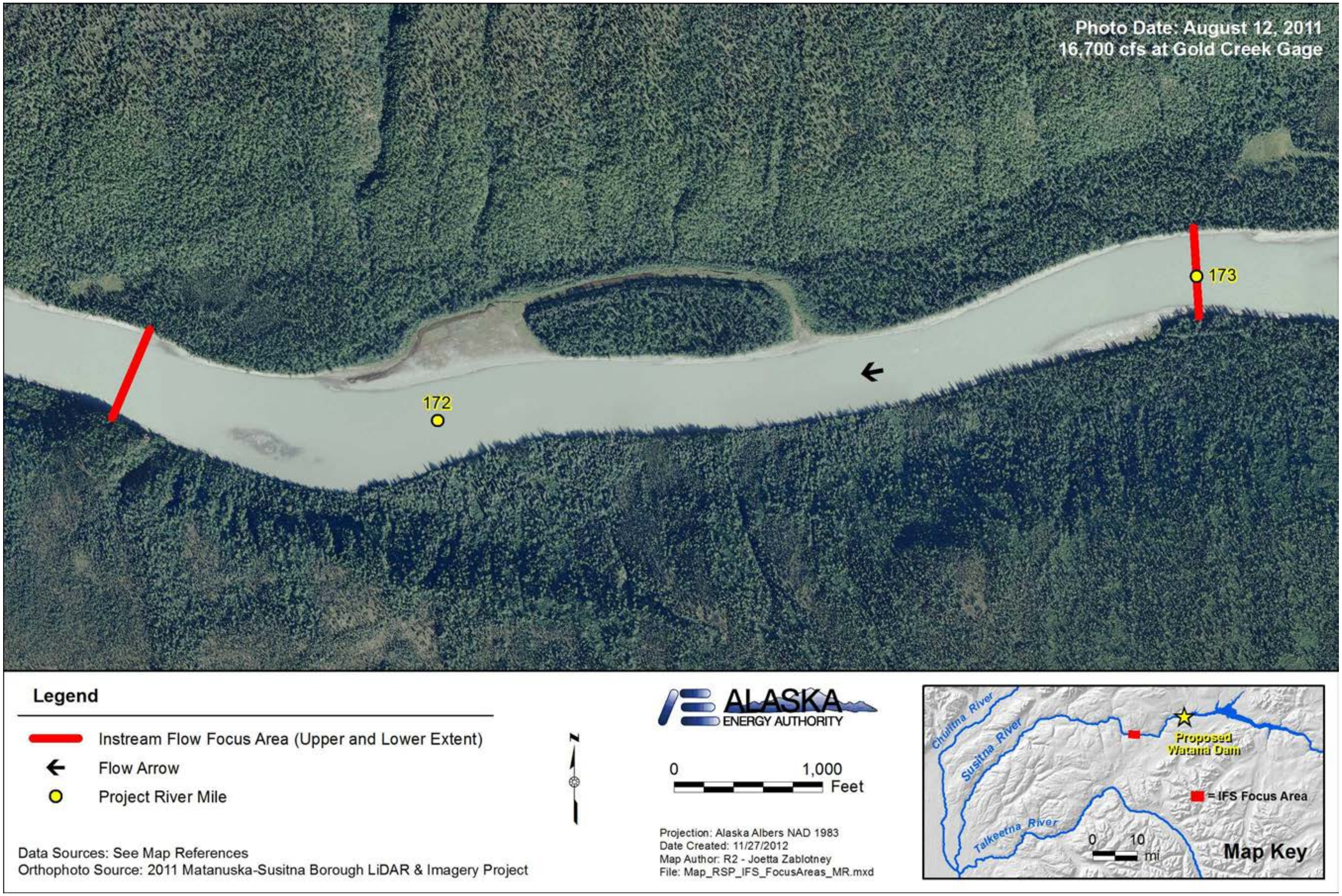

Figure 5. Map showing Focus Area 171 beginning at Project River Mile 171.6 and extends upstream to PRM 173. This Focus Area is near Stephan Lake and consists of main channel and a single side channel with vegetated island.

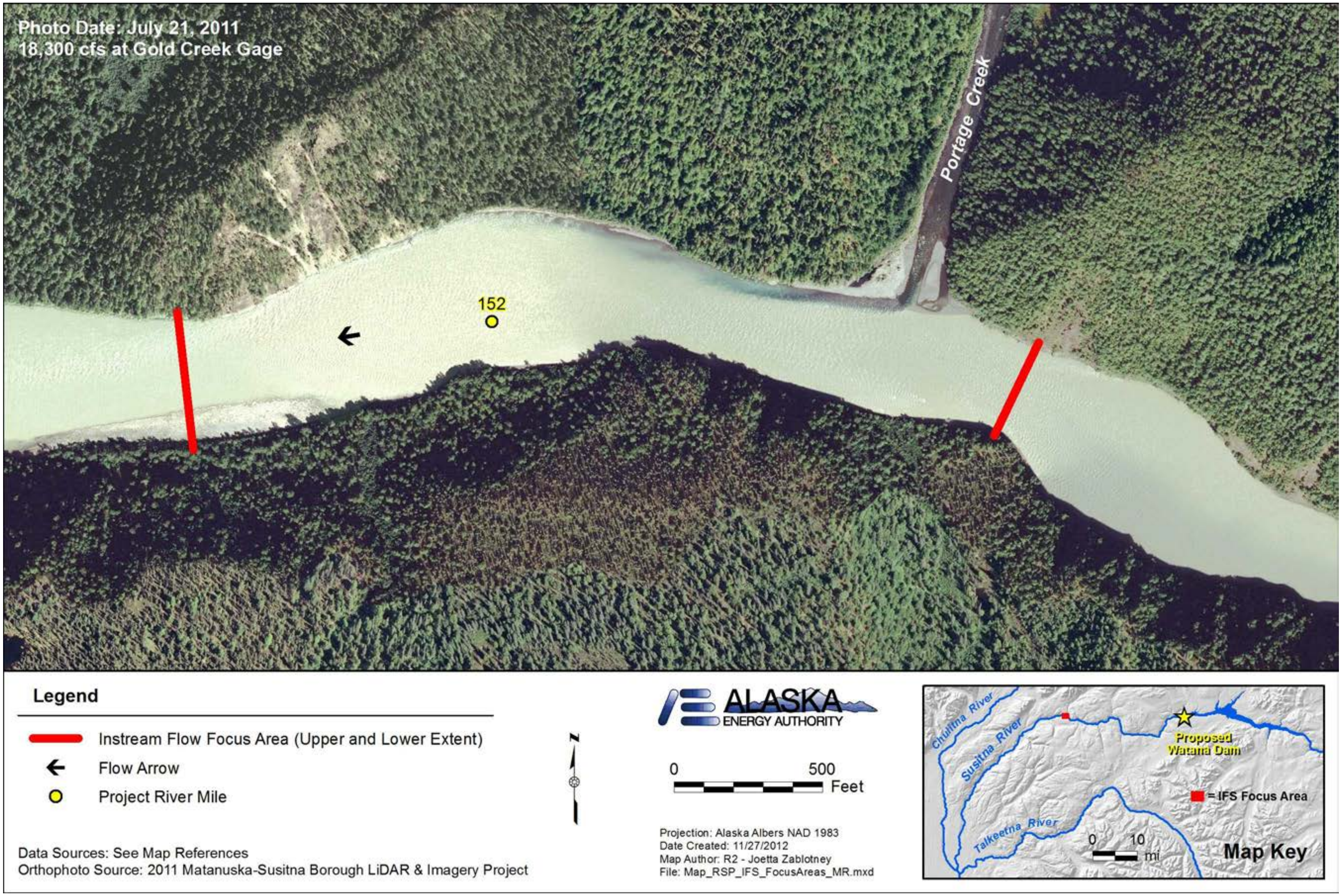

Figure 6. Map showing Focus Area 151 beginning at Project River Mile 151.8 and extends upstream to PRM 152.3. This single main channel Focus Area is at the Portage Creek confluence.

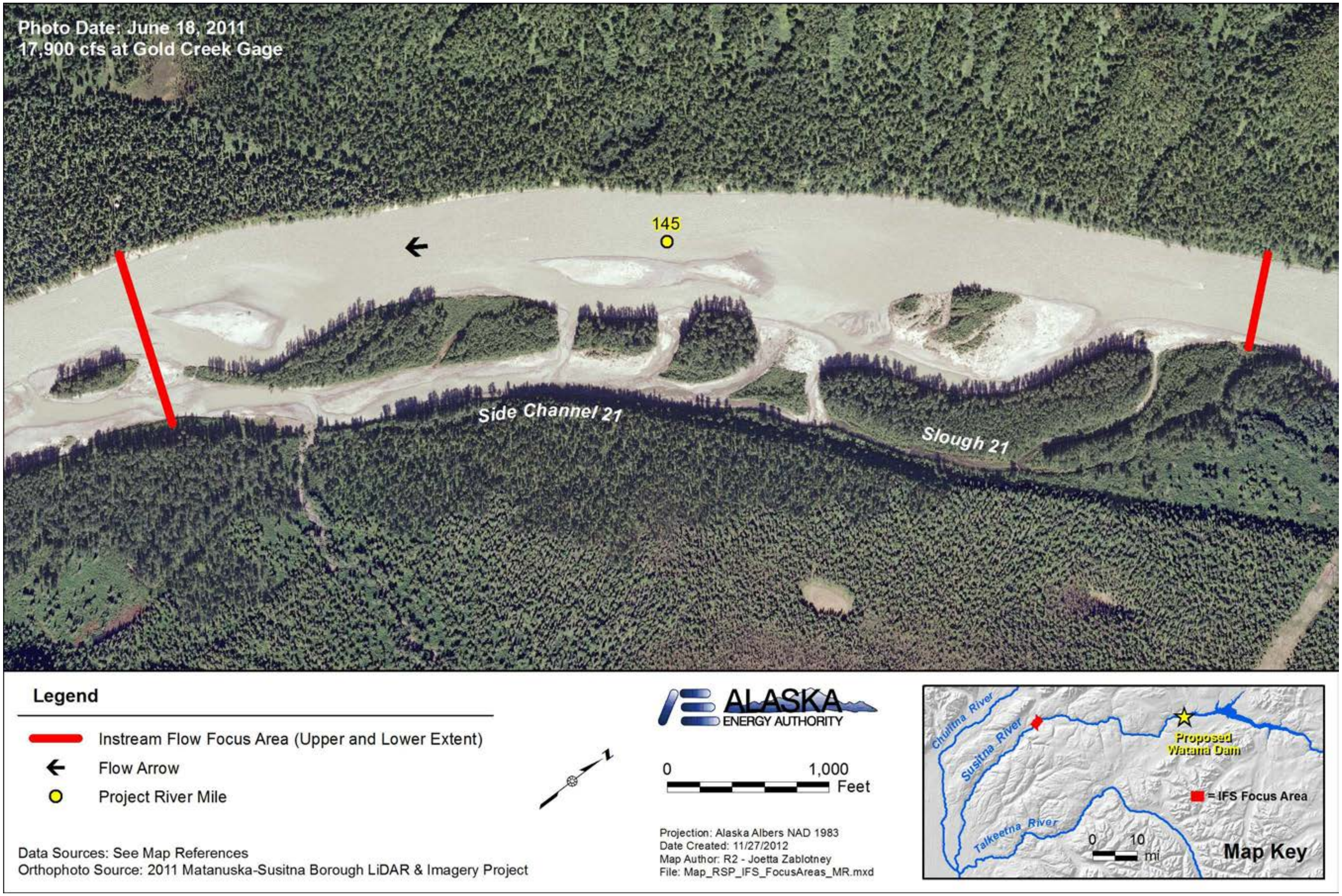

Figure 7. Map showing Focus Area 144 beginning at Project River Mile 144.4 and extends upstream to PRM 145.7. This Focus Area is located about 2.3 miles upstream of Indian River and includes Side Channel 21 and Slough 21.

Figure 8. Map showing Focus Area 141 beginning at Project River Mile 141.8 and extends upstream to PRM 143.4. This Focus Area includes the Indian River confluence and a range of main channel and off-channel habitats.

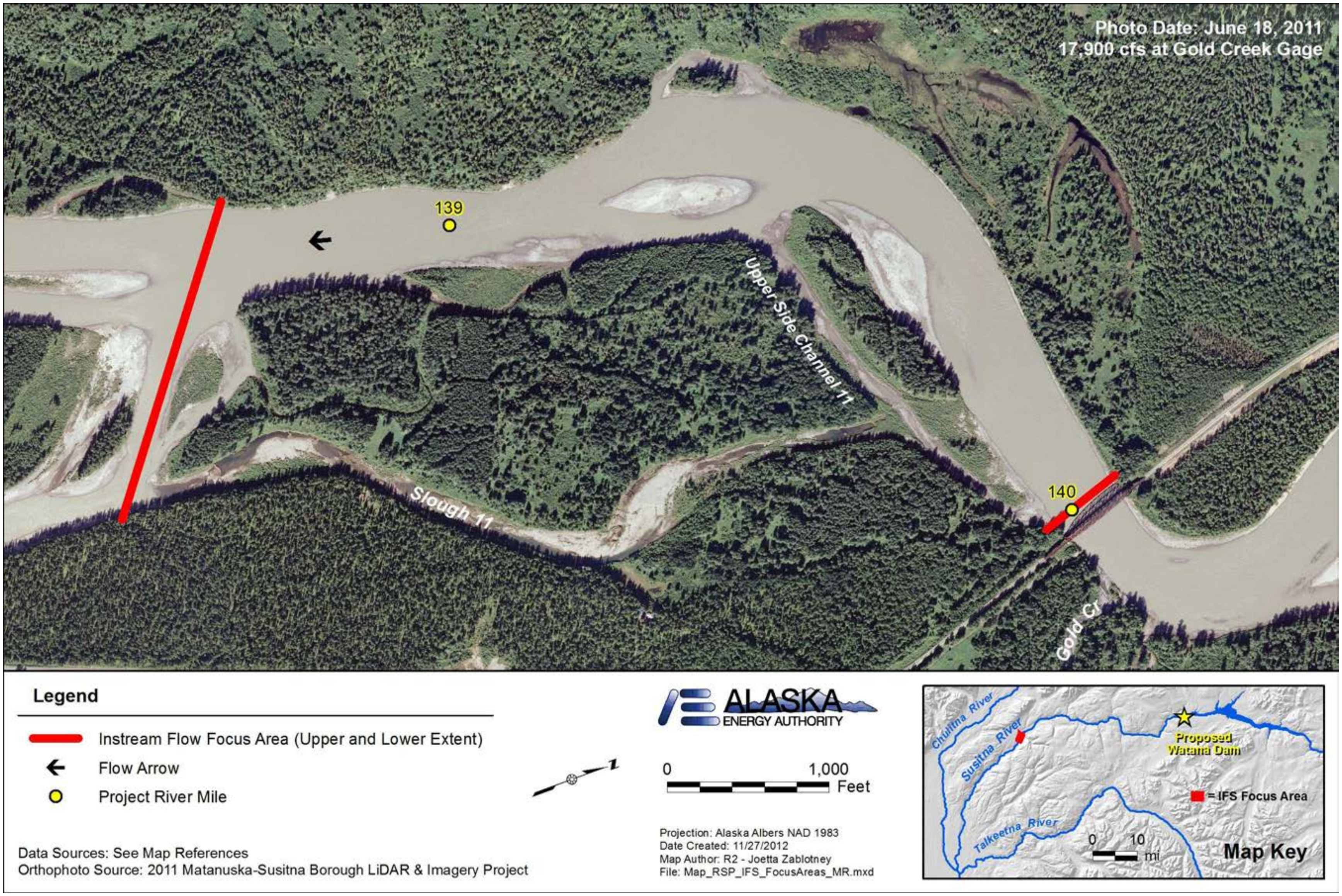

Figure 9. Map showing Focus Area 138 beginning at Project River Mile 138.7 and extends upstream to PRM 140. This Focus Area is near Gold Creek and consists of a complex of side channel, side slough and upland slough habitats including Upper Side Channel 11 and Slough 11.

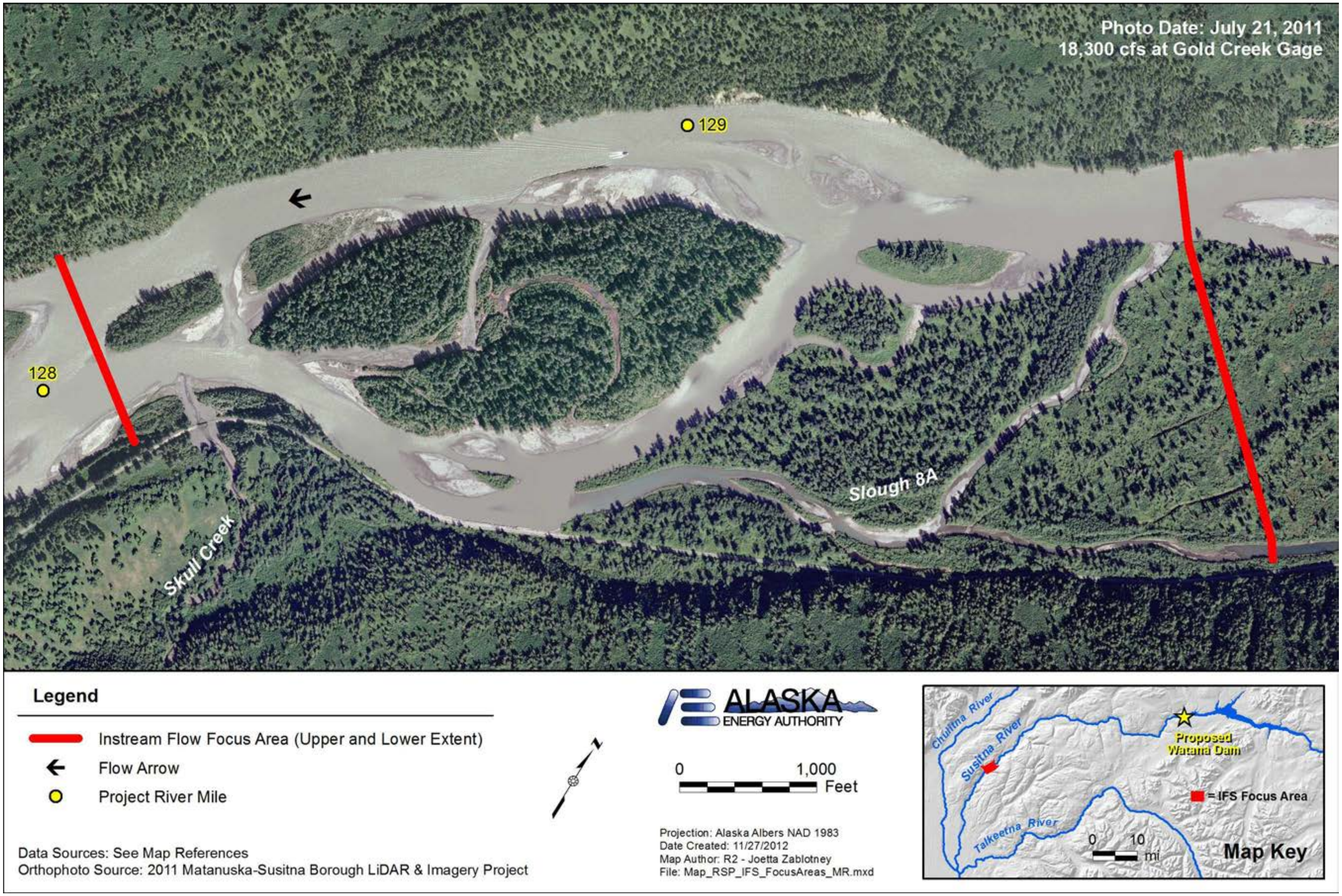

Figure 10. Map showing Focus Area 128 beginning at Project River Mile 128.1 and extends upstream to PRM 129.7. This Focus Area consists of side channel, side slough and tributary confluence habitat features including Skull Creek.

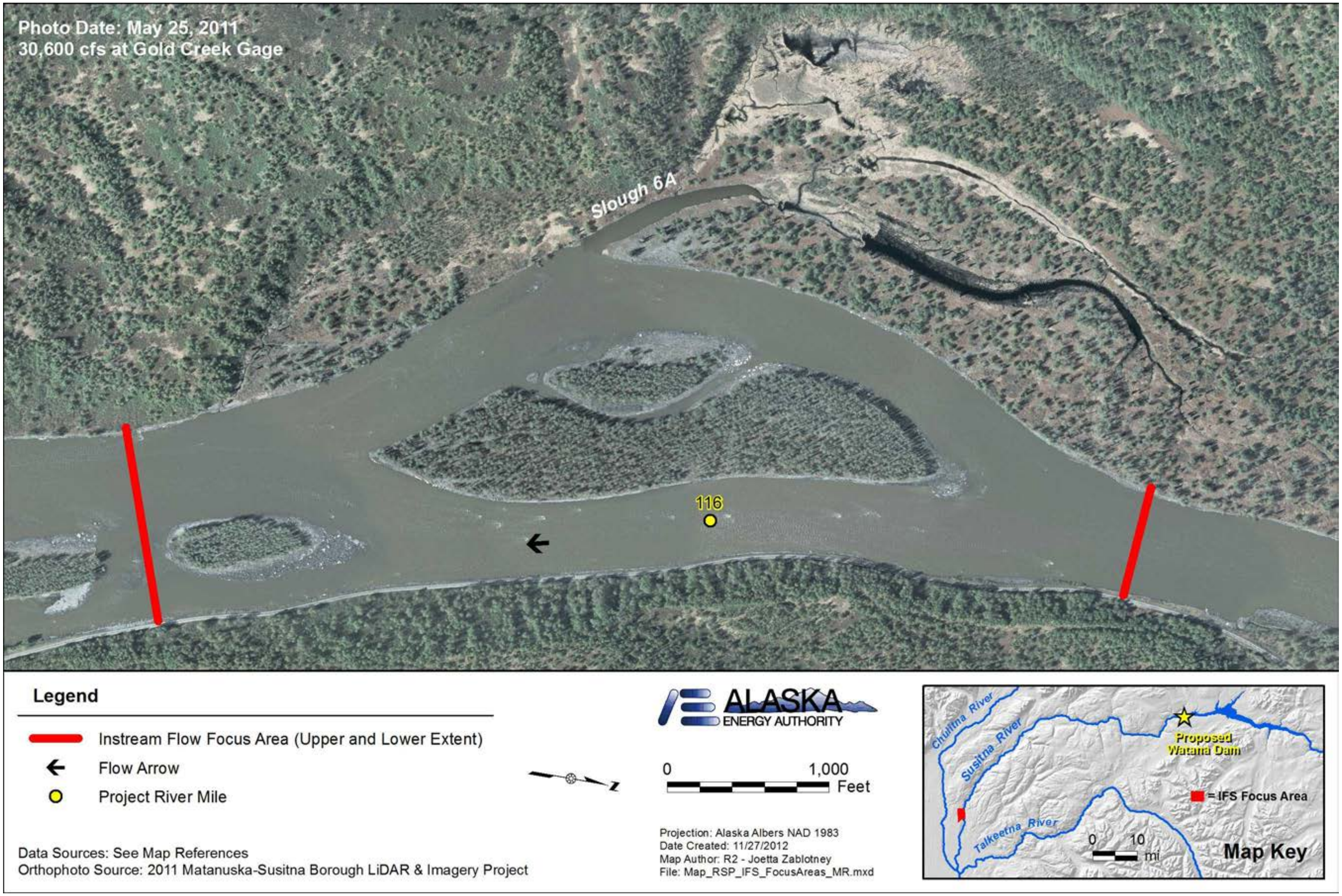

Figure 11. Map showing Focus Area 115 beginning at Project River Mile 115.3 and extends upstream to PRM 116.5. This Focus Area is located about 0.6 miles downstream of Lane Creek and consists of side channel and upland slough habitats including Slough 6A.

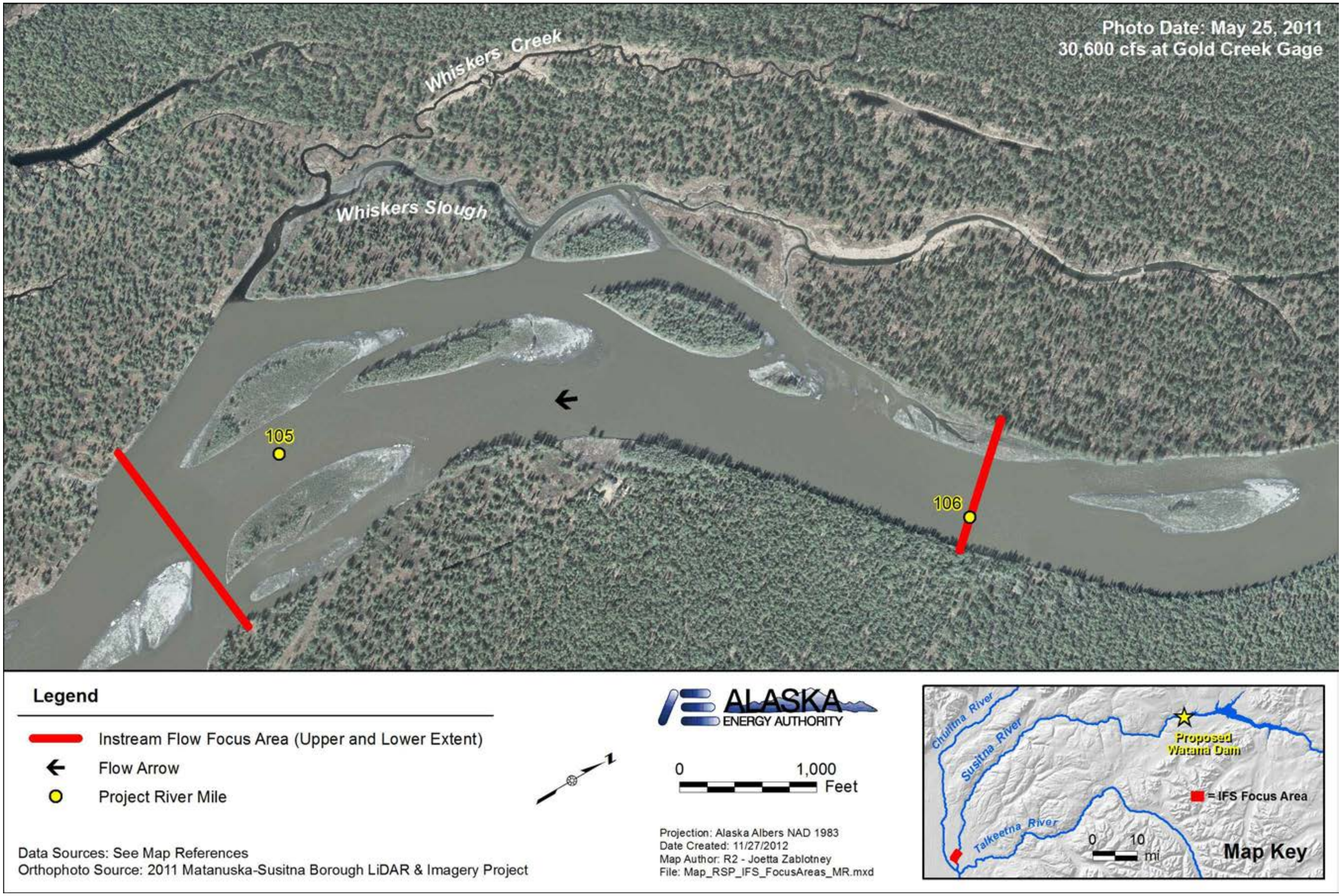

Figure 12. Map showing Focus Area 104 beginning at Project River Mile 104.8 and extends upstream to PRM 106. This Focus Area covers the diverse range of habitats in the Whiskers Slough complex.

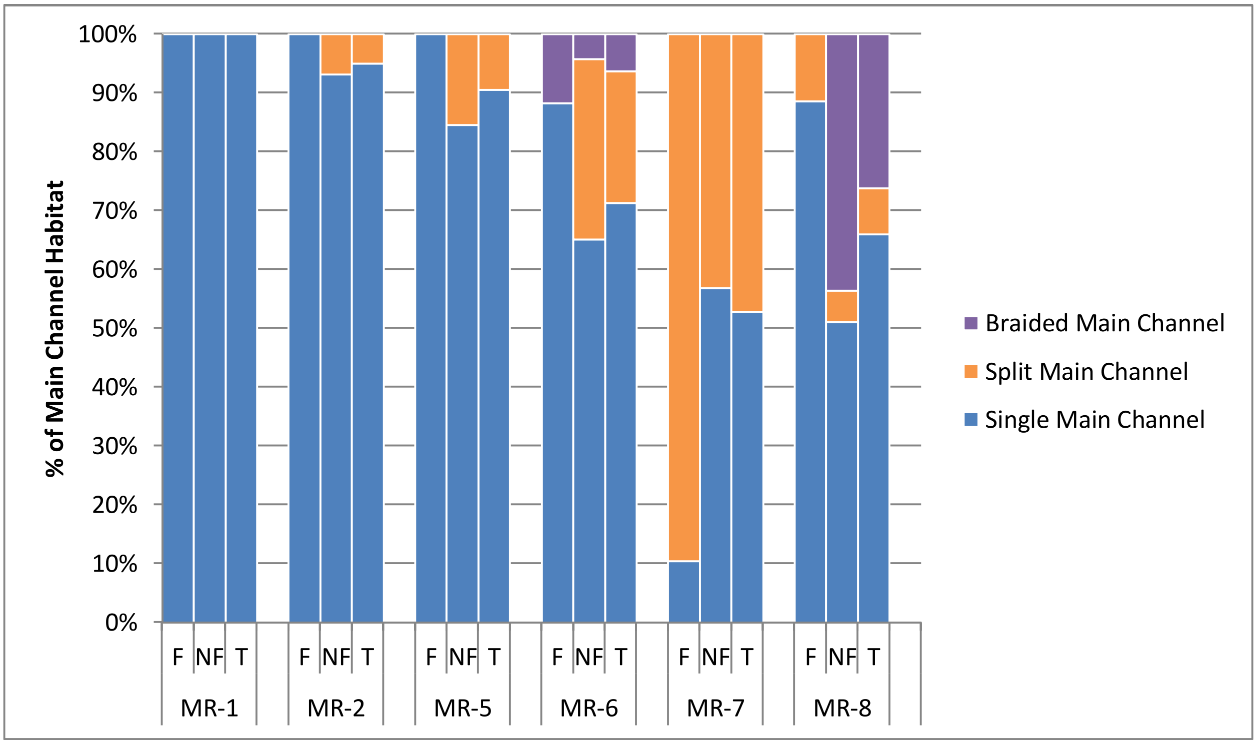

Figure 13. Percent of main channel in single main, split main, and braided main channel habitat by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

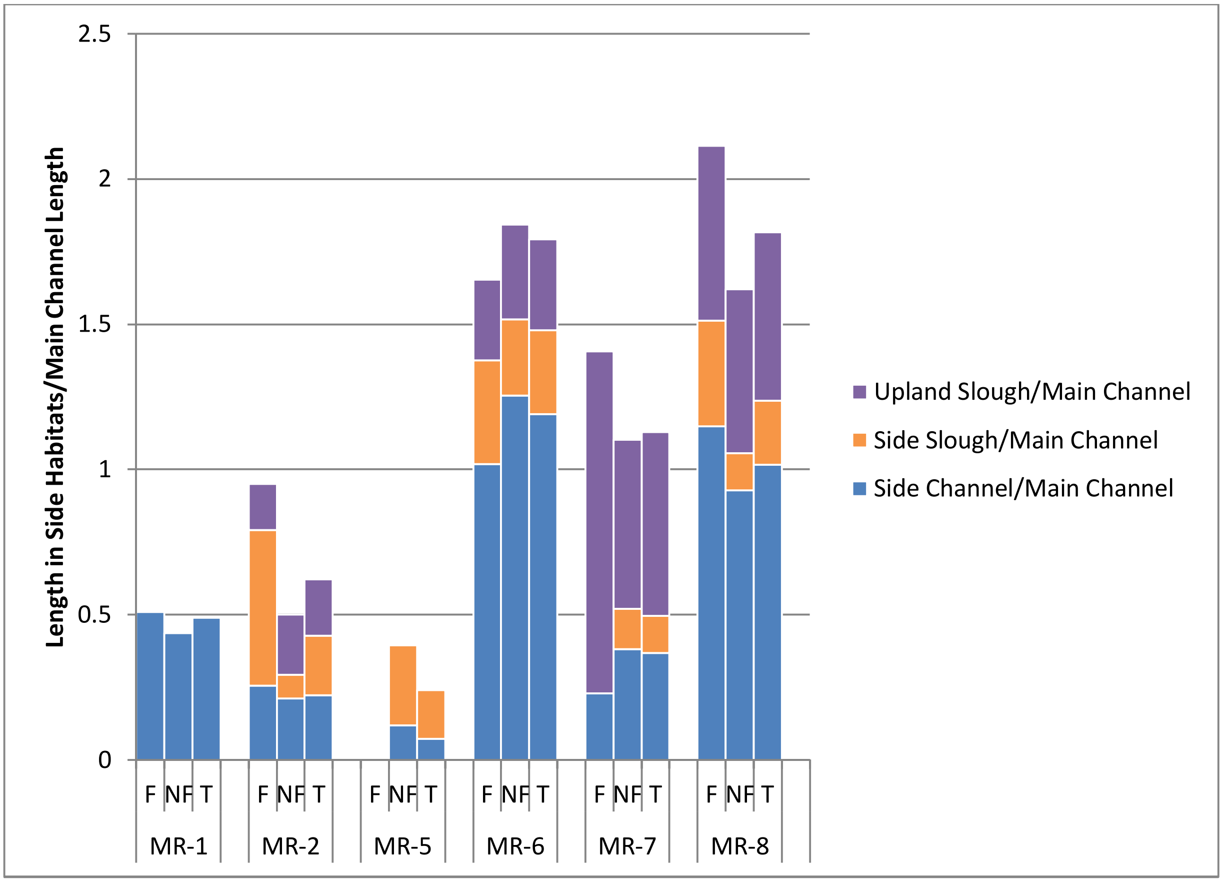

Figure 14. Side channel, side slough, and upland slough lengths per mile of main channel by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

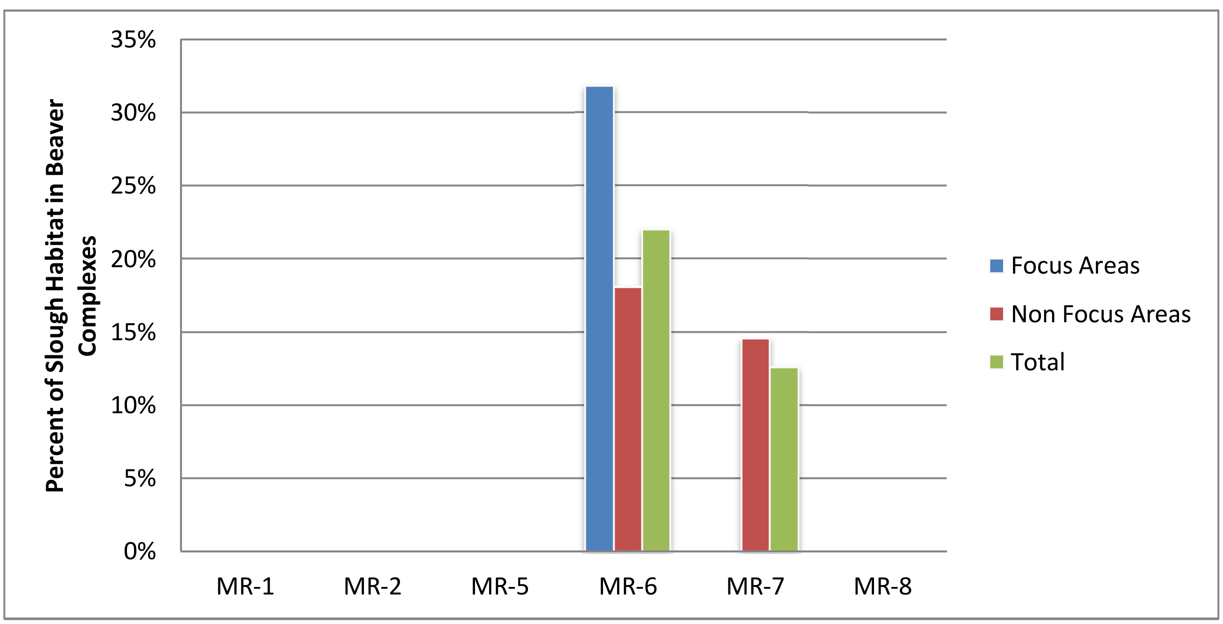

Figure 15. Percent of slough habitat that is in beaver complex by geomorphic reach and focus area (F), non-focus area (NF), and total (T).

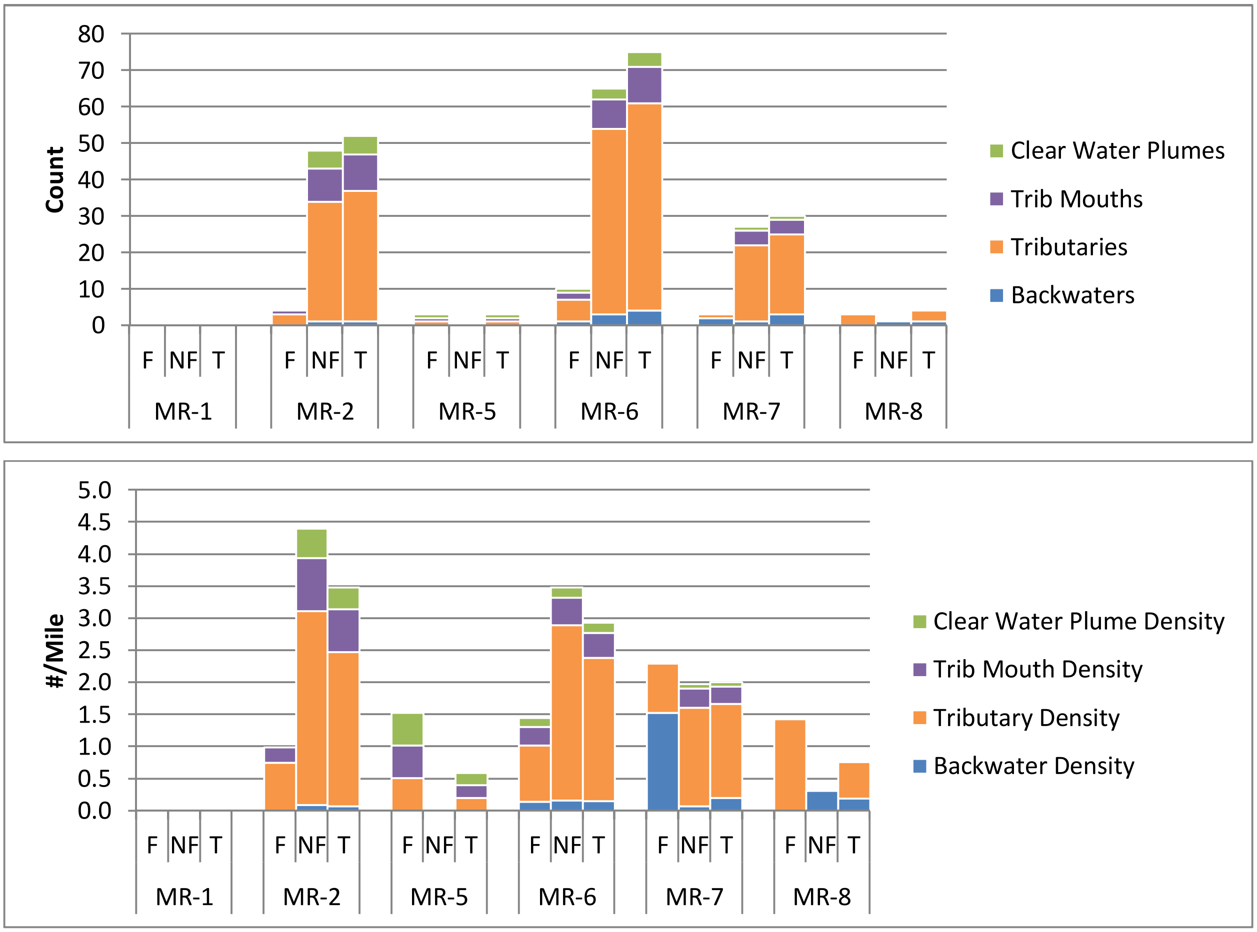

Figure 16. Backwaters, tributaries, tributary mouths, and plumes by geomorphic reach and focus area (F), non-focus area (NF), and total (T). Top graph is counts. Bottom graph is density (#/mile).

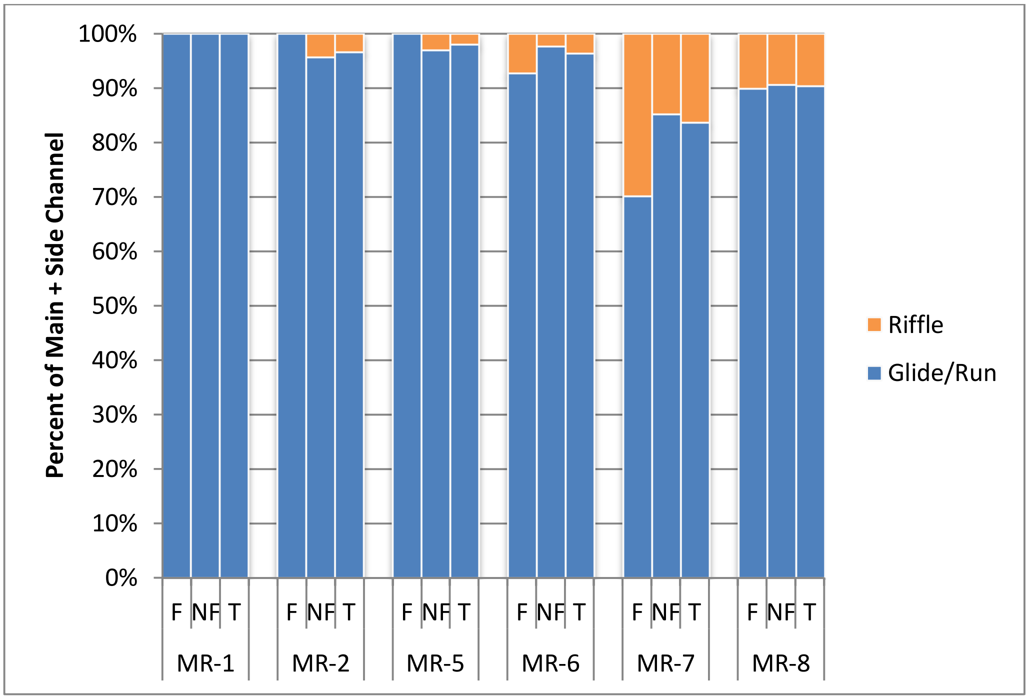

Figure 17. Percent of main and side channel habitat that is in riffle vs. glide/run habitat by geomorphic reach and focus area (F), non-focus area (NF), and total (T).