Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Study of Fish Distribution and Abundance in the Middle and Lower Susitna River Study
Study Plan Section 9.6

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO
Clean, reliable energy for the next 100 years.

July 2013

9.6. Study of Fish Distribution and Abundance in the Middle and Lower Susitna River

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Included within the RSP was the Study of Study of Fish Distribution and Abundance in the Middle and Lower Susitna River, Section 9.6. RSP Section 9.6 focuses on describing the current fish assemblage including spatial and temporal distribution, and relative abundance by species and life stage in the Susitna River downstream of the proposed Watana Dam

On February 1, 2013, FERC staff issued its study determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. FERC requested additional information before issuing a SPD on the remaining studies. The draft Susitna River Fish Distribution and Abundance Implementation Plan (FDA IP) was filed with FERC on January 31, 2013 and the content was subsequently presented and discussed during a Technical Work Group (TWG) meeting on February 14, 2013. With consideration of the comment and suggestions received from licensing participants, a final FDA IP was filed with FERC on March 1, 2013. On April 1, 2013 FERC issued its study determination (April 1 SPD) for the remaining 14 studies; approving 1 study as filed and 13 with modifications. RSP Section 9.6 was one of the 13 approved with modifications. In its April 1 SPD, FERC recommended the following:

Middle and Lower River Mainstem Sample Unit Length

> *- We recommend that sampling unit lengths for all main channel and side channel habitat units be equal to 20 times the wetted channel width of the habitat unit, the entire length of the habitat unit, or 500 meters, whichever is less.*
>
> *- We recommend that sampling unit lengths for all slough macrohabitats encompass the entire length of the slough, a distance equal to 20 times the wetted channel width of the slough, or 200 meters, whichever is less. We also recommend that slough sampling be initiated at the downstream end of the slough.*
>
> *- We recommend that, to the extent possible based on site-specific field conditions, AEA sample all main channel and side channel macrohabitat units with boat electrofishing methods.*
>
> *- We recommend that AEA's proposed tributary mouth sampling unit lengths include the backwater area within the tributary, if present, and extend a distance 200 meters downstream of the tributary mouth/confluence with the mainstem.*

Timing of Sampling

> *- We recommend that the proposed summer sampling events be conducted in mid-July, and again in either late August or early September. We recommend that the proposed autumn sampling occur in late September to early October.*

Catch Per Unit Effort from Electrofishing Macrohabitats

> *- We recommend that calculation of CPUE from electrofishing data be based only on the first pass, as requested by NMFS and FWS.*

- We recommend that minnow traps be soaked for 24 hours and placed within locations most likely to capture fish (e.g., low-velocity habitat in close proximity to cover).

PIT Tag Antenna Array at Whiskers Creek

- We recommend that, if feasible given site-specific conditions, AEA locate the PIT tag array downstream of the confluence of the side slough and Whiskers Creek, or at the mouth of Whiskers Creek. Should these locations not be feasible for deployment, AEA should consult with the TWG and select an appropriate location for the PIT tag array at Whiskers Slough.

Radio Tagging of Resident Fish

- To the extent possible given the constraints of field sampling conditions, we recommend that AEA target its fish sampling to meet the following specific objectives: (1) a minimum of 10 tags per species be allocated for tagging adult grayling and rainbow trout of sufficient size for spawning at tributary mouths during the spring sampling event; (2) a minimum of 10 tags be allocated for tagging adult Dolly Varden of sufficient size for spawning at tributary mouths during a late summer or early fall sampling event; (3) a minimum of 10 tags be allocated for tagging adult whitefish prior to spawning in early September; and (4) a minimum of 10 tags be allocated for tagging burbot in the early fall prior to fall or winter spawning migrations.

In accordance with the April 1 SPD, AEA has adopted the FERC requested modifications in the FDA IP and this Final Study Plan. The Susitna River Fish Distribution and Abundance Implementation Plan has similarly been updated with FERC staff recommendations from the April 1, 2013 Study Plan Determination and provides further detailed information.

9.6.1. General Description of the Proposed Study

This study is focused on describing the current fish assemblage including spatial and temporal distribution, and relative abundance by species and life stage in the Susitna River downstream of the proposed Watana Dam (river mile [RM] 184) with emphasis on early life history of salmonids and seasonal movements of selected species. Fishery resources in the Susitna River basin consist of a variety of salmonid and non-salmonid resident fish (Table 9.6-1). Adult salmon species are addressed in the Salmon Escapement Study (Section 9.7).

The physical habitat modeling efforts proposed elsewhere in this RSP require information on the distribution and periodicity of different life stages for the fish species of interest. Not all life stages of the target fish species may be present throughout the Middle and Lower Susitna River, and seasonal differences may occur in their use of some habitats. For example, some fish that use tributary streams during the open-water period may overwinter in mainstem habitats such as groundwater-fed sloughs.

This study is designed to provide baseline biological information and supporting information for the Fish and Aquatics Instream Flow Study (Section 8.5). This study will obtain key life history information about the fish in Middle and Lower Susitna River using two sampling approaches. The first sampling approach is focused on gathering data on general fish distribution (presence/absence); this approach generally involves a single pass with appropriate gear types. The second sampling approach is to gather data on relative abundance as determined by catch per unit effort (CPUE) along with complementary data on fish size, age, and condition; this generally involves multi-pass sampling with standardized transects and gear soak times. The second approach will also emphasize the identification of foraging, spawning, and overwintering habitats.

Study Goals and Objectives

Construction and operation of the Project will affect flow, water depth, surface water elevation, water temperature, and sediment dynamics, among other variables, in the mainstem channel as well as at tributary confluences, side channels, and sloughs, both in the area of inundation upstream from the Watana Dam site and downstream in the potential zone of Project hydrologic influence. These changes can have beneficial or adverse effects upon the aquatic communities residing in the river. To assess the effects of river regulation on fish populations, an understanding of existing conditions is needed. Baseline information will be used to predict the likely extent and nature of potential changes that will occur due to the Project's effects on instream flow and water quality.

The overarching goal of this study is to characterize the current distributions, relative abundances, run timings, and life histories of all resident and non-salmon anadromous species encountered including, but not limited to Dolly Varden, eulachon, humpback whitefish, round whitefish, arctic grayling, northern pike, burbot, and Arctic lamprey, as well as freshwater rearing life stages of anadromous salmonids (fry and juveniles) in the Middle and Lower Susitna River. Specific objectives include the following (Table 9.6-2):

1) Describe the seasonal distribution, relative abundance (as determined by CPUE, fish density, and counts) and fish habitat associations of juvenile anadromous salmonids, non-salmonid anadromous fishes and resident fishes.
2) Describe seasonal movements of juvenile salmonids and selected fish species such as rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic lamprey, Arctic grayling, and burbot, with emphasis on identifying foraging, spawning and overwintering habitats within the mainstem of the Susitna River.
    a. Document the timing of downstream movement and catch using out-migrant traps.
    b. Describe seasonal movements using biotelemetry (passive integrated transponder [PIT] and radio-tags).
3) Describe early life history, timing, and movements of anadromous salmonids.
    a. Describe emergence timing of salmonids.
    b. Determine movement patterns and timing of juvenile salmonids from spawning to rearing habitats.
    c. Determine juvenile salmonid diurnal behavior by season.
    d. Collect baseline data to support the Stranding and Trapping Study.
4) Document winter movements and timing and location of spawning for burbot, humpback whitefish, and round whitefish.
5) Document the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type.

6) Document the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike).
7) Collect tissue samples from juvenile salmon and opportunistically from all resident and non-salmon anadromous fish to support the Fish Genetic Baseline Study (Section 9.14).

9.6.2. Existing Information and Need for Additional Information

Information regarding resident species, non-salmon anadromous species, and the freshwater rearing life stages of anadromous salmon was collected as part of the studies conducted during the early 1980s. Existing information includes the spatial and temporal distribution of fish species and their relative abundance. The Pre-Application Document (PAD) (AEA 2011a) and Aquatic Resources Data Gap Analysis (ARDGA; AEA 2011b) summarized this existing information and also identified data gaps for resident and rearing anadromous fish.

Approximately 18 anadromous and resident fish species have been documented in the Susitna River drainage (Table 9.6-1). Three additional species are considered likely to be present, but have not been documented. To varying degrees, the relative abundances and distributions of these species were determined during the early 1980s studies. For most species, the dominant age classes and sex ratios were also determined, and movements, spawning habitats, and overwintering habitats were identified for certain species. Resident species that have been identified in all three segments of the Susitna River include Arctic grayling, Dolly Varden, humpback whitefish, round whitefish, burbot, longnose sucker, and sculpin. Other species that were observed in the Middle and Lower Susitna River Segments include Bering cisco, threespine stickleback, arctic lamprey, and rainbow trout. Eulachon have been documented only in the Lower Susitna River Segment.

Species that have not been documented, but may occur in the Susitna drainage include lake trout, Alaska blackfish, and Pacific lamprey. Lake trout have been observed in Sally Lake and Deadman Lake of the Upper Susitna watershed (Delaney et al. 1981a), but have not been observed in the mainstem Susitna or tributary streams. Pacific lamprey have been observed in the Chuit River (Nemeth et al. 2010), which also drains into Cook Inlet. Northern pike is an introduced species that has been observed in the Lower and Middle Susitna River Segments (Rutz 1999; Delaney et al. 1981b).

Non-salmon species that exhibit anadromous life histories in the Susitna River include eulachon, humpback whitefish, and Bering cisco. Dolly Varden may exhibit both anadromous and resident freshwater life history forms (Morrow 1980); however, Dolly Varden in the Susitna River were regarded primarily as a resident fish during studies conducted in the 1980s (FERC 1984). Other species that can exhibit an anadromous life history include humpback whitefish, threespine stickleback, Arctic lamprey, and Pacific lamprey (Morrow 1980). Northern pike are considered an invasive species in the Susitna drainage and have spread throughout the system from the Yenta drainage after being illegally introduced in the 1950s (Rutz 1999). Alaska blackfish would also be considered an invasive species in this basin, and while not previously captured in the Susitna River, may have been introduced.

Pacific salmon (all five species) were captured in the Lower and Middle Susitna River during the 1980s. Chinook salmon spawn exclusively in tributary streams (Thompson et al. 1986; Barrett 1985; Barrett 1984; Barrett et al. 1983); nearly all Chinook salmon juveniles out-migrate to the ocean as age 1+ fish, and very few exit the system as fry. Coho salmon typically out-migrate to sea as age 1+ or age 2+ fish. Because chum and pink salmon out-migrate to sea within a few months of emergence, little is known about their dependence on the Susitna River. Most age 0+ sockeye salmon out-migrate from the Middle River. It has not been determined whether they rear in the Lower River or if they go to sea at age 0+.

Existing fish and aquatic resource information appears insufficient to address the following issues identified in the PAD (AEA 2011a):

- F4: Effect of Project operations on flow regimes, sediment transport, temperature, and water quality that result in changes to seasonal availability and quality of aquatic habitats, including primary and secondary productivity. The effect of Project-induced changes include stream flow, stream ice processes, and channel morphology (streambed coarsening) on anadromous fish spawning and incubation habitat availability and suitability in the mainstem and side channels and sloughs in the Middle River above and below Devils Canyon.
- F6: Potential influence of the proposed Project flow regime and the associated response of tributary mouths on fish movement between the mainstem and tributaries within the Middle Susitna River Segment.
- F7: Influence of Project-induced changes to mainstem water surface elevations July through September on adult salmon access to upland sloughs, side sloughs, and side channels.
- F8: Potential effect of Project-induced changes to stream temperatures, particularly in winter, changing the distribution of fish communities, particularly invasive northern pike.

Agency staff have also expressed concerns that over time (i.e., 50 years), historic salmon spawning areas downstream of the Watana Dam site may become less productive due to potential changes in habitat conditions, in particular those areas affected by sediment transport, gravel recruitment, bed mobilization, and embeddedness. Further, understanding the timing of migration of juvenile salmonids from natal habitats to rearing areas and from the Middle Susitna River Segment to the Lower Susitna River Segment is important for assessing the potential Project effects.

Site-specific knowledge of the distribution, timing, and abundance of fish in the Susitna River is available from the results of surveys conducted by the Alaska Department of Fish and Game (ADF&G) during the early 1980s using multiple sampling methods (AEA 2011a). The existing information can provide a starting point for understanding the distribution and abundance of anadromous and resident freshwater fishes in the Susitna River and understanding the functional relationship with the habitat types present. However, any significant differences between current abundance and distribution patterns and those observed during the 1980s need to be documented.

In addition to providing baseline information about aquatic resources in the Project area, aspects of this study are designed to complement and support other fish and aquatic studies.

9.6.3. Study Area

The proposed study area encompasses the mainstem Susitna River from RM 28.3 immediately upstream of the confluence with the Yentna River, upstream to the proposed Watana Dam site (RM 184) (Figure 9.6-1). The study area also includes seven tributaries known as Chinook bearing or listed in the Anadromous Waters Catalog (AWC) between Devils Canyon RM 150 and the proposed dam site. .

9.6.4. Study Methods

This study will employ a variety of field methods to build upon the existing information related to the distribution and abundance of fish species in the Middle and Lower Susitna River. The following sections provide brief descriptions of study site selection, sampling frequency, the approach, and suite of methods that will be used to accomplish each objective of this study.

Fish Distribution and Abundance Implementation Plan

Some details of the sampling scheme have been provided for planning purposes; however, a final sampling scheme has been developed as part of the detailed Fish Distribution and Abundance Implementation Plan. FDA IP development includes (1) a summary of relevant fisheries studies in the Susitna River, (2) an overview of the life-history needs for fish species known to occur in the Susitna River, (3) a review of the preliminary results of habitat characterization and mapping efforts (Section 9.9), (4) a description of site selection and sampling protocols, (5) development field data collection forms, (6) development of database templates that comply with 2012 AEA QA/QC procedures, and (7) FERC's requested modifications included in the April 1 SPD. The implementation plan includes the level of detail sufficient to instruct field crews in data collection efforts. In addition, the plan includes protocols and a guide to the decision making process in the form of a chart or decision tree that will be used in the field, specific of sampling locations, details about the choice and use of sampling techniques and apparatuses, and a list of field equipment needed. The implementation plan addresses how sampling events will be randomized to evaluate precision by habitat and gear type. The implementation plan helps ensure that fish collection efforts occur in a consistent and repeatable fashion across field crews and river segments. The Susitna River Fish Distribution and Abundance Implementation Plan has similarly been updated with FERC staff recommendations from the April 1, 2013 Study Plan Determination and provides further detail. Proposed sampling methods by objective are presented below and in Table 9.6-2. Brief descriptions of each sampling technique are provided in Section 9.6.4.4.

9.6.4.1 Study Site Selection

A nested stratified sampling scheme will be used to select study sites to cover the range of habitat types. The habitat classification hierarchy, as described in Section 9.9.5.4.1 of the Habitat Classification Study, will be composed of four levels representing the following: (1) major hydraulic segment; (2) geomorphic reach; (3) mainstem habitat type; (4) and main channel and tributary mesohabitat (FSP Table 9.9-4, Nested and tiered habitat mapping units and categories).

Level 1 separates the Susitna River into three major hydrologic segments: Lower River (below RM 98), Middle River (RM 98–RM 184), and Upper River (RM 184–233). The Upper River Hydrologic Segment consists of the mainstem Susitna River and its tributaries upstream of the proposed dam (RM 184) and will partially be within the impoundment zone and subject to Project operations that affect daily, seasonal, and annual changes in pool elevation plus the effects of initial reservoir filling (Section 9.5). In contrast, the Middle and Lower Hydrologic Segments include the mainstem downstream of the proposed dam will be subject to the effects of flow modification and water quality from Project operations, which will diminish in the Lower Segment below the Three Rivers Confluence (98.5).

Level 2 identifies unique reaches based on the channel's geomorphic characteristics (established from the Geomorphology Mapping Study). The Geomorphic Study Team will delineate the Lower, Middle, and Upper Susitna River reaches into large-scale geomorphic river segments with relatively homogeneous landform characteristics, including at generally decreasing scales: geology, hydrology (inflow from major tributaries), slope, channel planform, braiding or sinuosity index (where relevant), entrenchment ratio, channel width, and substrate size. Stratification of the river into relatively homogeneous segments will facilitate relatively unbiased extrapolation of sampled site data within the individual segments because sources of variability associated with large-scale features will be reduced. Stratification will occur across geomorphic reaches as much as possible but will be dictated by the distribution of habitat types present within each reach. For example, based on preliminary geomorphic reach delineation, we would expect to find multiple split main channel habitats in reaches MR 2, 6, and 8 but not in the more confined and incised reaches that include Devils Canyon MR 3, 4, 5, and 7.

Level 3 classifies the mainstem habitat into main channel, off-channel, and tributary habitat using a similar approach to the 1980s historical habitat mapping definitions (ADF&G 1983). The main channel includes five mainstem habitat types, whereas the off-channel habitat will be categorized into four types (FSP Table 9.9-4). The 1980s classification of riverine habitats of the Susitna River included six major mainstem habitat categories consisting of main channel, side channel, side slough, upland slough, tributaries, and tributary mouths (ADF&G 1984). These mainstem habitat categories will be maintained in the 2012 classification system, but they are further categorized into main channel, off-channel, and tributary. These will be expanded to include five types of main channel habitat (main channel, split main channel, multiple split main channel, side channel, and tributary mouth), and four types of off-channel (side slough, side slough beaver complex, upland slough, upland sough beaver complex) (FSP Table 9.9-4).

Level 4, mainstem and tributary mesohabitat, will further delineate Level 3 main channel, side channel, and tributary habitats into mesohabitat types (pool, riffle, glide, and cascade) and will include backwater, beaver complex, and clearwater plume mesohabitat types.

The Middle River habitat mapping effort completed in early 2013 provided delineation of mainstem habitat units in the main channel and off-channel areas. The length data associated with the habitat unit delineation facilitated the use of a GRTS sampling approach in the Middle River. A generalized random tessellation stratified (GRTS) sampling method (Stevens and Olsen 2004) was used to select study units within each geomorphic reach. Specifically, the *grts* routine in package *spsurvey* (Kincaid and Olsen 2012) for R (R Core Team 2012) was used to generate the GRTS samples. This sampling method is a compromise between random and systematic sampling that allows random ordering of population units with spatial balance. With a systematic sample, loss of a sampling location in the field compromises the spatial coverage of the design and the overall sample size. Using the GRTS samples, oversampling (i.e., selecting 10 samples but planning to use only the first 3) is allowed; if selected samples are determined to be inaccessible or dewatered in the field, the next sample on the randomized list can be used while maintaining spatial balance in the final sample set.

In the Middle River, the GRTS design was used to select study sites based on a habitat stratified sampling scheme nested within Middle River geomorphic reaches MR-1, MR-2, MR-5, MR-6, MR-7, and MR-8 (Figures 9.6-2 – 9.6-7). However, because geomorphic reach length and channel complexity vary greatly, not all habitat types will be found within each geomorphic reach. A summary of the Middle River habitat mapping results has been included in Section 4.4 of the Implementation Plan.

Within each geomorphic reach, two strata were formed: 1) The combined Focus Areas within the reach; and 2) the remainder of the reach not contained in Focus Areas. Within each of these strata, the total length of habitat in main channel, side channel, upland slough with beaver complexes, upland slough without beaver complexes, side slough with beaver complexes, and side slough without beaver complexes are represented by line segments from the habitat mapping. For sampling, these line segments for each habitat type were partitioned into 200-meter sampling units with spatial referencing. For the line habitats, the GRTS samples selected were these 200-meter sampling units. Fish distribution and relative abundance sampling units will be 20 x wetted channel widths or 200-m, whichever is less. Tributaries (mouth to upper extent) tributary mouths, tributary plumes, and backwaters, have been GRTS sampled as point locations. For line and point sampling, three sampling units were selected for each habitat type within each stratum. When three or fewer sampling units exist within the sample stratum, they were all selected for sampling. All of the selected sample sites within Focus Areas will be sampled for relative abundance. Outside of Focus Areas, all selected sites will be selected for fish distribution. One of the selected sites for each available habitat type will also be sampled for relative abundance. Main and side channel sampling units will be 20 x wetted channel width or 500-meters in length, whichever is less.

A GRTS model was used to randomly select fish sampling sites. The resulting number of samples by stratum are presented in Table 9.6-3. A total of 177 sites will sampled in the Middle River including 79 sites sampled for relative abundance within Focus Areas, 37 sites sampled for relative abundance outside of Focus Areas, and 61 sites sampled for fish distribution outside of Focus Area (Figures 9.6-2 – 9.6-7).

Fish distribution and relative abundance sampling in the mainstem Lower Susitna River will be conducted from RM 28.3 to 98.5. This survey area includes Geomorphic Reaches LR-1 (RM 98.6-83.8), LR-2 (RM 83.8-61.4), LR-3 (RM 61.4-40.3), and LR-4 (RM 40.3-28.3). Due to channel morphology in the Lower River and corresponding limitations of habitat mapping therein, a systematic transect approach will be employed whereby fish sampling sites will be selected within habitat units encountered along a transect. Using a random start for the Lower River study area, ten transects will be spaced at 7.4-mile intervals (Figure 9.6-8).

Because of the complex nature of the Lower River, many transects span multiple habitat types (e.g., main channel, side channel, upland slough, and side slough; Figure 9.6-9). One habitat unit of each type encountered will be selected along each transect. Where multiple habitat units of the same type occur, units will be randomized and one selected. Fish distribution and abundance sampling will then be conducted along a 20 x wetted channel width or 500-meter (whichever is smaller) length of the unit for main channel and side channel, starting at the downstream end. Boat electrofishing will be employed whenever feasible. If the randomly selected habitat unit is totally inaccessible to field crews, then a second randomly selected habitat unit will be sampled.

For the Lower River, Table 9.6-4 shows the habitat units included in each random transect and totals by geomorphic reach. One transect within each geomorphic reach will be sampled for relative abundance, with the remaining transects sampled for distribution only (i.e., single pass sampling). The transect with the most identified habitat units was selected for abundance sampling in each reach. In reach LR-1, the number of units is equal, so the transect was randomly chosen. This sampling will be conducted monthly in the Lower River Segment.

Tributaries upstream of Devils Canyon (RM 150) selected for fish distribution and abundance sampling include all known Chinook salmon-bearing tributaries and other tributaries that are not currently listed in ADF&G's Anadromous Waters Catalog (AWC; ADF&G 2012). Seven tributary streams were selected for sampling based on: AWC catalog listings, drainage basin, historical sampling efforts, and the potential for impact from the proposed Project (Table 9.6-3). These tributaries were screened for accessibility of sampling based on stream gradient, channel morphology (i.e., confined canyon), mesohabitat type (rapid and cascade) and physical access. The screening resulted in seven tributaries known to be accessible or to have substantial length of accessible reaches, nine tributaries that were largely inaccessible, and four tributaries where access was unknown.

A direct sampling methodology will be implemented on the seven tributary streams with minimal to moderate access and limited feasible sampling areas (Table 9.6-5). For these identified streams, an average effort of two days will be conducted. Sampling effort will be as follows: smaller streams will be sampled for a single day, moderate sized and accessible streams for two days, and larger more accessible streams for three days. The goal of sampling will be to distribute effort over the accessible study area in three locations. Where possible, the three locations will represent differences in elevation or other habitat features. Where aerial still or video imagery is available, proposed sample locations will be identified and reviewed prior to field activity. Habitat observed from the imagery at identified locations will be documented and field teams will attempt to sample pre-identified habitat units. Where imagery is unavailable, sampling location and effort may be determined during the first sampling effort for each tributary. Effort at each habitat unit will be considered done when the field lead judges that the unit was sufficiently represented or that additional sampling effort will not provide additional data. Finally, winter sites will be selected based on information gathered from winter 2012–2013 pilot studies at Whiskers Slough and Slough 8A (Section 9.6.4.5). At a minimum, attempts will be made to sample at all Focus Areas. The farthest upstream sites will need to be accessed by air travel; sites closer to Talkeetna may be accessed by snow machine. Safety and access are important considerations for the selection of these sites. Sampling methodologies including, but not limited to, under ice use of Dual Frequency Identification Sonar (DIDSON) and video cameras, minnow traps, seines, trot lines, pit tags, and radio tags will be tested in 2012–2013.

9.6.4.2 Sampling Frequency

Sampling frequency will vary among seasons and sites based on specific objectives. Generally, sampling will occur monthly at all sites for fish distribution and relative abundance surveys during the ice-free season. Summer sampling events will be conducted in mid-July, and again in either late August or early September. Autumn sampling events will occur in late September to early October. At Focus Areas, sampling will occur seasonally andbiweekly after break-up through July 1 to characterize the movements of juvenile salmonids during critical transition periods from spawning to rearing habitats. More information on sampling frequency specific to each objective is presented in Table 9.6-2.

9.6.4.3 Fish Sampling Approach

The initial task of this study will consist of a focused literature review to guide selection of appropriate methods by species and habitat type, sampling event timing, and sampling event frequency. Anticipated products from the literature review include the following:

- A synthesis of existing information on life history, spatial and temporal distribution, and relative abundance by species and life stage.
- A review of sampling strategies, methods, and procedures used in the 1980s fish studies.
- Preparation of periodicity charts for each species within the study area (timing of adult migration, holding, and spawning; timing of incubation, rearing, and out-migration).
- A summary of mainstem Susitna River habitat utilization for each species, by riverine habitat type (main channel, side channel, side slough, upland slough, tributary mouth, tributary).
- A summary of existing age, size, and genetics information.
- A summary of distribution of invasive species, such as northern pike.

Knowledge of behavior and life history of the target species is essential for effective survey design. Selected fish sampling methods will vary based on habitat characteristics, season, and species/ life history of interest. Timing of surveys depends on the objectives of the study and the behavior of the target fish species. Since life stage-specific information is desirable, timing of the survey must match the use of the surveyed habitat by that life stage.

9.6.4.3.1 Objective 1: Fish Distribution, Relative Abundance, and Habitat Associations

Two general approaches to fish sampling will be used. The first is focused on gathering data on general fish distribution (presence/absence). This sampling involves a single pass with appropriate gear types. To the extent possible, the selected transects will be standardized and the methods will be repeated during each sampling event at a specific site to evaluate temporal changes in fish distribution. The second sampling approach is to gather data on relative abundance as determined by catch per unit effort (CPUE) density; complementary data on fish size, age, and condition factor will also be collected. The selected transects and fish capture methods (i.e., number of passes, amount of soak time) will be standardized such that it is repeatable on subsequent sampling occasions. This approach will also emphasize the identification of foraging, spawning, and overwintering habitats.

Task A: Fish Distribution Surveys

Fish distribution surveys will include monthly 1-pass sampling events during the ice-free seasons with year-round monthly sampling in Focus Areas. Methods will be selected based on species, life stage, and water conditions. Snorkeling and electrofishing are preferred methods for juvenile fishes in clear water areas where velocities are safe for moving about in the creek. The use of minnow traps, beach seines, set nets, and fyke nets will be employed as alternatives in deeper waters and habitats with limited access, low visibility, and/or high velocities. For larger/adult fishes, gillnets, seines, trotlines, hoop traps, and angling will be used along with the opportunistic use of fishwheels in conjunction with the Salmon Escapement Study (Section 9.7).

Survey methods will likely vary for the different study areas in the Middle and Lower Susitna River Segments. Whereas snorkeling, minnow trapping, backpack electrofishing, and beach seines may be applicable to sloughs and other slow-moving waters, it is anticipated that gillnetting, boat electrofishing, hoop traps, and trot lines may be more applicable to the mainstem. The decisions as to what methods to apply will be made by field crews after initial site selection in coordination with Fish Distribution and Abundance Study Lead and the Fish Program Lead and in accordance with state and federal fish sampling permit requirements. Access may also influence survey methods and will be determined after a reconnaissance visit to the site early in the 2013 field season.

Lastly, methods will vary seasonally with the extent of ice cover. Methods for winter sampling will be based on winter 2012–2013 pilot studies. Selected methods will potentially include DIDSON, underwater video, minnow traps, e-fishing, seines, and trot lines.

Task B: Relative Abundance

Relative abundance surveys will include seasonal multi-pass sampling events during the ice-free seasons with year-round monthly sampling in Focus Areas. As mentioned above, methods will be selected based on species, life stage, and water conditions. Blocknets will be used when site conditions allow. All methods will be conducted consistent with generating estimates of CPUE that are meaningful and facilitate comparison of counts or densities of fish over space and time. This includes calibration and quality control of methods and documentation of conditions that affect sampling efficiency—such as visibility, water temperature, and conductivity—to ensure that a consistent level of effort is applied over the sampling unit.

Task C: Fish Habitat Associations

In conjunction with Tasks 1 and 2, data will be collected for fish distribution and abundance by habitat type. This task includes an analysis of fish presence, distribution, and density by mesohabitat type by season. The information on fish habitat use will help identify species and life stages potentially vulnerable to Project effects.

9.6.4.3.2 Objective 2: Seasonal Movements

Task A: Document the timing of downstream movement and catch for all fish species using out-migrant traps.

Understanding the timing of migration from natal tributaries to the mainstem Susitna River and from the Middle Susitna River Segment to the Lower Susitna River Segment is important for assessing the potential effects of the proposed Project. Out-migrant traps (rotary screw traps, inclined plane traps) are useful for determining the timing of downstream-migrating juvenile salmonids and resident fish.

Historically, out-migrant traps were fished at Talkeetna Station (historical RM 103) during open water periods from 1982 to 1985 (Schmidt et al. 1983; Roth et al. 1984; Roth and Stratton 1985; Roth et al. 1986) and at Flathorn Station (historical RM 22.4) during 1984 and 1985 (Roth and Stratton 1985; Roth et al. 1986). Data from the 1980s suggests that the majority of Chinook salmon fry out-migrate from natal creeks by mid-August and redistribute into sloughs and side channels of the Middle River or migrate to the Lower River (Roth and Stratton 1985; Roth et al. 1986).

A maximum of six out-migrant traps will be deployed. Up to three traps will be stationed in the mainstem Susitna River to characterize downstream migratory timing. Specific locations will be determined with input from the Fish and Aquatic TWG. Because Chinook salmon are predominantly tributary spawners, out-migrant traps will also be deployed in tributary mouths such as Portage Creek, Indian River, and Whiskers Creek. In addition to collection of data on migratory timing, size at migration, and growth, out-migrant traps will also serve as a platform for tagging juvenile fish (Objective 2, Task B), recapturing previously tagged fish, and collecting tissue samples (Objective 7) to support the Genetic Baseline Study (Section 9.14).

Task B: Describe seasonal movements using biotelemetry.

Biotelemetry techniques will include radio telemetry and PIT technology. PIT tags will be surgically implanted in small fish >60 mm to monitor movement and growth; radio transmitters will be surgically implanted in adult fish of sufficient body size of selected species distributed temporally and longitudinally in the Middle and Lower River.

PIT tag antenna arrays with automated data logging will be used at selected side channel, side slough, tributary mouth, and upland slough sites to detect movement of tagged fish into or out of the site. Additionally, swim-over antennas will be deployed on an experimental basis at five sites prior to ice-over and maintained throughout the winter months. All juvenile Chinook salmon of appropriate size will be PIT-tagged; other target species will be tagged based on proximity to PIT antenna arrays with a goal of 1,000 tags per species per PIT tag array. Target species are juvenile salmonids and selected fish species such as rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic lamprey, Arctic grayling, and burbot. Recaptured fish will provide information on the distance and time travelled since the fish was last handled and changes in length (growth).

Radio-tagged fish will be tracked with monthly aerial surveys, by boat, and by snow machine in conjunction with the Salmon Escapement Study. The goal is to implant 30 radio transmitters per target species including Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic grayling, burbot, and rainbow trout.

9.6.4.3.3 Objective 3: Early Life History

Task A: Describe emergence timing of salmonids.

In conjunction with the Intergravel Monitoring component of the Fish and Aquatics Instream Flow Study (Section 8.5.4), salmon redds in selected side channels and sloughs will be monitored on a monthly basis throughout the winter in Focus Areas. Because chum salmon and sockeye salmon are the principal salmon species using side channels and side sloughs for spawning in the Susitna River (Sautner et al. 1984), 1980s egg development and incubation studies were conducted on these two species and focused on chum salmon. Studies included monitoring of surface and intergravel water temperatures, egg development, spawning substrate composition, and trapping of emergent fry.

Sample sites will be selected in known chum and/or sockeye salmon spawning locations within Focus Areas. Because water temperature is the most important determinant of egg development and the timing of emergence (Quinn 2005), a component of the Fish and Aquatics Instream Flow Study (Section 8.5.4) will include continuous monitoring stations for collection of temperature data. Following methods used in the 1980s, fyke nets will be used to capture emerging fry on a biweekly basis beginning in mid-April in each of the monitored side channels.

Task B: Determine movement patterns and timing of juvenile salmonids from spawning to rearing habitats.

Bi-weekly sampling of fish distribution (Objective 1, Task A) from ice-out through July 1 will occur in Focus Areas to identify changes in fish distribution by habitat type. Sampling methods will include snorkeling, seining, electrofishing, minnow traps, fyke nets, and out-migrant traps (Objective 2, Task A). Biotelemetry cannot be used for this task because juvenile salmonids will be too small to tag at this life stage.

Task C: Determine juvenile salmonid diurnal behavior by season.

Selected sloughs in Focus Area sites will be sampled based on results from the Winter 2012–2013 Pilot Study comparing the efficacy of underwater video and DIDSON for fish observation. A stratified random sampling program over a 24-hour period will be developed to observe underwater activity and ultimately to identify juvenile overwintering behavior to support stranding and trapping analyses. Holes will be drilled in the ice where no open leads exist in a few select sloughs; fish observation apparatus will also be deployed in open leads with low velocity at pre-determined observation points. This task will be implemented in conjunction with the Intergravel Monitoring component of the Fish and Aquatics Instream Flow Study (Section 8.5.4). Depending on the efficacy of underwater imaging techniques, they may be adopted for use during the ice-free season at selected Focus Area sites. Alternatively, sampling stratified by time of day using various techniques including but not limited to downstream migrant traps, seining, fyke nets, minor traps and possibly electrofishing will be used to characterize the diurnal distribution of juvenile salmonids.

Task D: Collect baseline data to support the Fish Stranding and Trapping Study.

Susceptibility to stranding can vary with fish size and species. Based on a review of available literature, the Washington Department of Fish and Wildlife (Hunter 1992) concluded that salmonid fry smaller than 50 mm in length are most susceptible to stranding whereas larger life stages (i.e., fingerlings, smolts, and adults), while also vulnerable, can be protected by less restrictive ramping criteria. Related to this, size (or life stage) periodicity will dictate the seasonal timing during which vulnerable size classes may be present in the varial zone. Stranding and trapping susceptibility may also vary by species based on differences in periodicity, as well as species-specific habitat preferences and behavior. The focus of this task is to support the stranding and trapping component of the Fish and Aquatics Instream Flow Study (Section 8.5.4). Fish distribution sampling will occur at Focus Areas and at representative habitat units to identify seasonal timing, size, and distribution among habitat types for fish (particularly < 50 mm). Electrofishing, seining, fyke nets, and minnow traps will be the primary methods for collecting salmon fry. Additional fish size data from downstream migrant traps (Objective 2, Task A) will help identify when fish exceed the 50-mm length threshold.

9.6.4.3.4 Objective 4: Document Winter Movements and Timing and Location of Spawning for Burbot, Humpback Whitefish, and Round Whitefish

Radio-tags will be surgically implanted in up to 30 burbot, humpback whitefish, and round whitefish. Fish capture methods include fishwheels, gillnets, hoop traps, and angling. Radio-tagged fish will be tracked by air, boat, and snow machine (Section 9.6.4.4.12). Following methods outlined by Sundet (1986), radio-tag locations will be pin-pointed in winter with snow machines, and trot lines will be set in the area of the radio-tag to identify winter spawning aggregations and capture additional fish. The gonadal development of each captured fish will be examined to determine spawning status; the gonads for all sampling mortalities will be preserved for laboratory examination. The timing and location of all captured fish will be documented.

9.6.4.3.5 Objective 5: Document the Seasonal Age Class Structure, Growth, and Condition of Juvenile Anadromous and Resident Fish by Habitat Type

In conjunction with Objectives 1 and 3, all captured fish will be identified to species. Up to 100 per season per species per life stage will be measured to the nearest millimeter (mm) fork length, and in Focus Areas up to 30 fish per species per site will be measured on a monthly basis. Length frequency data by species will be compared to length-at-age data in the literature to infer age classes. Recaptured PIT-tagged fish (Objective 2 Task B) will provide information on changes in length and weight (growth). Recorded parameters in each habitat unit will include number of fish by species and life stage; fork length; global positioning system (GPS) location of sampling area, time of sampling, weather conditions, water temperature, water transparency, behavior, and location and distribution of observations. In concert with Objective 3 Task D, seasonal timing, size, and distribution of fishes among habitat types, particularly fish <50 mm, will be used to support the Fish Stranding and Trapping Study.

9.6.4.3.6 Objective 6: Document the Seasonal Distribution, Relative Abundance, and Habitat Associations of Invasive Species (Northern Pike)

Northern pike were likely established in the Susitna River drainage in the 1950s through a series of illegal introductions (Rutz 1999). The proliferation of this predatory species is of concern owing to their effect on salmonids and other species such as stickleback. Rutz (1999) investigated movements of northern pike in the Susitna River using radio telemetry and investigated northern pike predation on salmonids by analyzing stomach contents of juveniles captured with minnow traps. Both of these fish capture methods used by Rutz (1999) will be used in the current study, as well as angling, to capture northern pike. The presence/absence and habitat associations of northern pike and other invasive fish species will be documented in all fish capture and observation sampling events associated with Objectives 1 and 2.

9.6.4.3.7 Objective 7: Collect Tissue Samples from Juvenile Salmon and All Resident and Non-Salmon Anadromous Fish

In support of the Fish Genetic Baseline Study (Section 9.14), fish tissues will be collected opportunistically in conjunction with all fish capture events. The target species and number of samples are given in Section 9.14. Tissue samples include an axillary process from all adult salmon, caudal fin clips from fish >60 mm, and whole fish <60 mm.

9.6.4.4 Fish Sampling Techniques

A combination of gillnet, electrofishing, angling, trot lines, minnow traps, snorkeling, fishwheels, out-migrant trapping, beach seines, fyke nets, DIDSON, and video camera techniques will be used to sample or observe fish in the Lower River and Middle River, and moving in and out of selected sloughs and tributaries draining into the Susitna River. Selected methods will vary based on habitat characteristics, season, and species/life history of interest. All fish sampling and handling techniques described within this study will be selected in consultation with state and federal regulatory agencies and sampling will be conducted under state and federal biological collection permits. Limitations on the use of some methods during particular time periods or locations may affect the ability to make statistical comparisons among spatial and temporal strata.

9.6.4.4.1 Gillnets

Variable mesh gillnets (7.5-foot deep panels with 1-inch to 2.5-inch stretched mesh) will be deployed. In open water and at sites with high water velocity, gillnets will be deployed as drift nets, while in slow water sloughs, gillnets will be deployed as set (fixed) nets. Depending on conditions, gillnets may be deployed in ice-free areas, and under the ice during winter months. The location of each gillnet set will be mapped using hand-held GPS units and marked on high-resolution aerial photographs. The length, number of panels, and mesh of the gillnets will be consistent with nets used by ADF&G to sample the river in the 1980s (ADF&G 1982, 1983, 1984). To reduce variability among sites, soak times for drift gillnets will be standardized; all nets will be retrieved a maximum of 30 minutes after the set is completed. The following formula will be used to determine drifting time:

$$T = ([(\text{set time} + \text{retrieval time})/2] + \text{soak time})$$

9.6.4.4.2 Electrofishing

Boat-mounted, barge, or backpack electrofishing surveys will be conducted using standardized transects. Boat-mounted electrofishing is the most effective means of capturing fish in shallow areas (<10 feet deep) near stream banks and within larger side channels. Barge-mounted electrofishing is effective in areas that are wadeable, but have relatively large areas to cover and are too shallow or inaccessible to a boat-mounted system. Backpack electrofishing is effective in wadeable areas that are relatively narrow. The effectiveness of barge and backpack electrofishing systems can be enhanced through the use of block nets. Electrofishing methods will follow NMFS (2000) *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act*. CPUE will be calculated based only on the first pass.

Sites will be selected carefully, because electrofishing may have limited success in swift, turbid, or low conductivity waters. Suspended materials in turbid water can affect conductivity, which may result in harmful effects on fish, especially larger fish due to a larger body surface in contact with the electrical field. Sudden changes in turbidity can create zones of higher amperage, which can be fatal to young-of-year fish as well as larger fish. Electrofishing in swift current is problematic, with fish being swept away before they can be netted. Similarly, turbidity increases losses from samples. Electrofishing will be discontinued immediately in a sampling reach if large salmonids or resident fish are encountered.

Selection of the appropriate electrofishing system will be made as part of site selection, which will include a site reconnaissance. In all cases, the electrofishing unit will be operated and configured with settings consistent with guidelines established by Smith Root. The location of each electrofishing transect will be mapped using hand-held GPS units and marked on high-resolution aerial photographs. To the extent possible, the selected electrofishing system and transects will be standardized and the methods will be repeated during each sampling period at a specific site to evaluate temporal changes in fish distribution. Habitat measurements will be collected at each site using the characterization methods identified in Section 9.9. Any changes will be noted between sample periods. The electrofishing start and stop times and water conductivity will be recorded. Where safety concerns can be adequately addressed, electrofishing will also be conducted after sunset in clear water areas; otherwise, electrofishing surveys will be conducted during daylight hours.

9.6.4.4.3 Angling

Angling with hook and line can also be an effective way to collect fish samples depending on the target species. During field trips organized for other sampling methods, hook-and-line angling will be conducted on an opportunistic basis using artificial lures or flies with single barbless hooks. The primary objective of hook-and-line sampling will be to capture subject fish for tagging (i.e., northern pike) and to determine presence/absence; a secondary objective will be to evaluate seasonal fish distribution. Because it is labor- and time-intensive, angling is best used as an alternative method if other more effective means of sampling are not available. Angling can also be used in conjunction with other methods, particularly if information is required on the presence and size of adult fish.

9.6.4.4.4 Trot Lines

Trot lines can be an effective method for capturing burbot, rainbow trout, Dolly Varden, grayling, and whitefish. Trot lines are typically long lines with a multitude of baited hooks and are typically anchored at both ends and set in the water for a period of time. Trot lines can also be used during periods of winter ice cover. Trot line sampling was one of the more frequently used methods during the 1980s and was the primary method for capturing burbot; however, trot lines are generally lethal. Trot lines will consist of 14 to 21 feet of seine twine with six leaders and hooks lowered to the river bottom. Trot lines will be checked and rebaited after 24 hours and pulled after 48 hours. Hooks will be baited with salmon eggs, herring, or whitefish. Salmon eggs are usually effective for salmonids, whereas the herring or whitefish are effective for Trot line construction and deployment will follow the techniques used during the 1980s studies as described in ADF&G (1982). As per ADF&G Fish Resource Permit stipulations, all salmon eggs used as bait will be commercially sterilized or disinfected with a 10-minute soak in a 1/100 Betadyne solution prior to use.

9.6.4.4.5 Minnow Traps

Minnow traps baited with salmon eggs are an effective method for passive capture of juvenile salmonids in pools and slow-moving water (Bryant 2000). In reaches where both electrofishing and snorkeling would be ineffective due to stream conditions such as deep, fast water, baited minnow traps will be used as an alternative to determine fish presence. During the 1980s, minnow traps were also the primary method used for capturing sculpin, lamprey, and threespine stickleback. Minnow traps also captured rainbow trout and Arctic grayling. Minnow traps will be baited with salmon roe. All traps will be placed within locations most likely to capture fish (e.g., low-velocity habitat in close proximity to cover) and will be allowed to soak for 24 hours. Minnow traps will be deployed at densities of 1-2 traps for every 10-meters of habitat unit length, depending on width and habitat complexity. All fish captured will be identified to species, measured, and released alive near the point of capture. As per ADF&G Fish Resource Permit stipulations, all salmon eggs used as bait will be commercially sterilized or disinfected with a 10-minute soak in a 1/100 Betadyne solution prior to use.

9.6.4.4.6 Snorkel Surveys

This survey technique is most commonly used for juvenile salmonid populations, but can also be used to assess other species groups. Generally, snorkeling works well for detecting presence or absence of most species. Limits occur when water is or deep due to the inability to see the fish, or the water is too swift to safely survey (Dolloff et al. 1993, 1996). To get relative abundance estimates, a closed population is needed within a single habitat unit, and block nets will be used to prevent fish from leaving the unit (Hillman et al. 1992).

In stream channels with a width of less than 4 m, the survey will be conducted by a single snorkeler viewing and counting fish on both sides of the channel, alternating from left to right counts. In stream channels with a width greater than 4 m, the surveys will be conducted by two snorkelers working side by side and moving upstream in tandem, with each individual counting fish on one side of the channel. The counts from all snorkelers are then summed for the total count for the reach sampled. This expansion estimate assumes that counts are accurate and that snorkelers are not counting the same fish twice (Thurow 1994). Data will be recorded following completion of the survey. Survey reaches will be snorkeled starting at the downstream end and working upstream.

Snorkel surveys will also be used in combination with other techniques to estimate relative abundance. This use of snorkel surveys provides a calibration factor for the counting efficiency of snorkel surveys compared to other methods such as electrofishing and seining (Dolloff et al. 1996).

For most of the snorkel surveys in this study, two experienced biologists will snorkel along standardized transects in clear water areas during both day and night during each field survey effort. Snorkelers will visually identify and record the number of observed fish by size and species. The location of each snorkel survey transect will be mapped using hand-held GPS units and marked on high-resolution aerial photographs.

9.6.4.4.7 Fyke/Hoop Nets

Fyke or hoop nets will be deployed to collect fish in sloughs and side channels with moderate water velocity (< 3 feet per second). After a satisfactory location has been identified at each site, the same location will be used during each subsequent collection period. The nets will be operated continuously for up to two days. Each fyke net will be configured with two wings to guide the majority of water and fish to the net mouth. The fyke nets will have 1/8-inch mesh, 1-foot diameter hoops, and up to 4 hoops. Where possible, the guide nets will be configured to maintain a narrow open channel along one bank. Where the channel size or configuration does not allow an open channel to be maintained, the area below the fyke net will be checked regularly to assess whether fish are blocked and cannot pass upstream. A live car will be located at the downstream end of the fyke net throat to hold captured fish until they can be processed. The fyke net wings and live car will be checked daily to clear debris and to ensure that captured fish do not become injured. The location of the fyke net sets will be mapped using a hand-held GPS unit and marked on high-resolution aerial photographs.

9.6.4.4.8 Hoop Traps

Commercially available hoop traps have been used successfully by ADF&G on the Tanana River as a non-lethal method to capture burbot for tagging studies (Evenson 1993; Stuby and Evenson

1998). Two sizes of traps have been used. Small and large hoop traps are 3.05 m and 3.66 m long, respectively. The small hoop trap has seven 6.35-mm steel hoops with diameters tapered from 0.61 m at the entrance to 0.46 m at the cod end. The large trap has inside diameters tapering from 91 to 69 cm with throat diameters of 36 cm. Each trap has a double throat that narrows to an opening 10 cm in diameter. All netting is knotted nylon woven into 25-mm bar mesh. Each trap is kept stretched open with two sections of PVC pipe spreader bars attached by snap clips to the end hoops. Bernard et al. (1991) provides an account of the efficacy of the small and large traps.

Hoop traps will be deployed in mainstem areas of lower velocity to capture burbot from late August through early October for radio-tagging (Objectives 1, 2, and 4). Soak times will generally be overnight, but not more than 12 hours (M. Evenson pers comm 2012). All burbot captured will be weighed, measured, and released. Up to 30 radio-tags will be surgically implanted in burbot spatially distributed throughout the Susitna River.

9.6.4.4.9 Beach Seines

Beach seines are an effective method to capture fish in a wide variety of habitats and are most effective in shallow water areas free of large woody debris and snags such as boulders. Seining allows the sampling of relatively large areas in short periods of time as well as the capture and release of fish without significant stress or harm. Repetitive seining over time with standardized net sizes and standardized deployment in relatively similar habitat can be an effective way to quantify the relative abundance of certain species over time and space, especially for small juvenile migrating salmon (Hayes et al. 1996). Beach seines will be 4 feet in depth and 40 feet in length, ¼-inch mesh (net body) with a 1/8-inch net bag; however, the actual length of seine used will depend on the site conditions. Low water conditions may be sampled using a shorter and shallower beach seine; as long as the area sampled is noted and the net is deep enough to fill the water column, then comparisons can be made. The location fished will be mapped using hand-held GPS units and marked on high-resolution aerial photographs. The area swept will be noted. Repetitive seining over time with standardized nets and soak times in relatively similar habitats can be an effective way to quantify the relative abundance of certain species over time and space, especially for small juvenile migrating salmon. To the extent possible, the same area will be fished during each sampling event; net sizes and soak times will be standardized.

9.6.4.4.10 Out-Migrant Traps

Rotary screw traps are useful for determining the timing of emigration by downstream-migrating juvenile salmonids and resident fish (Objective 2). In the 1980s, out-migrant trapping occurred at Talkeetna Station (RM 103) during open water periods from 1982 to 1985 to determine migratory timing and size at migration to the Lower Susitna River throughout the time traps were operating (Schmidt et al. 1983; Roth et al. 1984; Roth and Stratton 1985; Roth et al. 1986). Peak catch often occurred during periods of high flows. Out-migrant traps were also fished at Flathorn Station (RM 22.4) during 1984 and 1985.

Selection of rotary screw trap locations will occur with input from the Fish and Aquatic TWG and will be based on specific species, the physical conditions at the selected sites, and logistics for deploying, retrieving, and maintaining the traps. Up to six out-migrant traps will be deployed. Three to four traps will be located in mouths of important tributary streams or spawning areas such as Fog Creek, Kosina Creek, Portage Creek, Indian Creek, and possibly Gold Creek and Whiskers Slough. The remaining two or three traps will be situated in the main channel to describe the broad timing of out-migrants from all upstream sources. Flow conditions permitting, traps will be fished on a cycle of 48 hours on, 72 hours off throughout the ice-free period. Each trap will be checked at least twice per day.

9.6.4.4.11 Fishwheels

Fishwheels will primarily be deployed to capture anadromous salmon as part of the Adult Salmon Escapement Study (Section 9.7). However, non-salmon species are occasionally captured by fishwheel. Non-salmon species collected by fishwheel will provide additional data to support the objectives of this study and will be used opportunistically as a source of fish for tagging studies and tissue sampling.

9.6.4.4.12 Remote Fish Telemetry

Remote telemetry techniques will include radio telemetry and PIT technology. Both of these methods are intended to provide detailed information from relatively few individual fish. Radio-tracking provides information on fine and large spatial scales related to the location, speed of movement, and habitat utilization by surveying large areas and relocating tagged individuals during aerial, boat, and foot surveys. The target species to radio-tag in the Middle/Lower River include: Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic grayling, burbot, longnose sucker, and rainbow trout. PIT tags will be surgically implanted in small fish >60 mm; radio transmitters will be surgically implanted in adult fish of sufficient body size of selected species distributed temporally and longitudinally throughout the Susitna River. The target species to PIT-tag include juvenile anadromous salmon,, rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic lamprey, Arctic grayling, and burbot. PIT tags can be used to document relatively localized movements of fish as well as growth information from tagged individuals across seasons and years. However, the “re-sighting” of PIT-tagged fish is limited to the sites where antenna arrays are placed. To determine movement in and out of side sloughs or tributaries requires that tagged fish pass within several feet of an antenna array, thereby limiting its use to sufficiently small water bodies. To characterize growth rates, fish must be recaptured, checked for a tag, and measured.

Radio Telemetry

The primary function of the telemetry component is to track these tagged fish spatially and temporally with a combination of fixed station receivers and mobile tracking. Time/date stamped, coded radio signals from tags implanted in fish will be recorded by fixed station or mobile positioning. All telemetry gear (tags and receivers) across both studies will be provided by ATS, Inc. (Advanced Telemetry Systems, www.atstrack.com).

The types of behavior to be characterized include the following:

- Arrival and departure timing at specific locations/positions
- Direction of travel
- Residence time at specific locations/positions

- Travel time between locations/positions
- Identification of migratory, holding, and spawning time and locations/positions
- Movement patterns in and between habitats in relation to water conditions (e.g., discharge, temperature, turbidity)

Locating radio-tagged fish will be achieved by fixed receiver stations and mobile surveys (aerial, boat, snow machine, and foot). Fixed stations will largely be those used for the Salmon Escapement Study. In addition, up to five additional fixed stations will be established at strategic locations with input from the TWG. These stations will be serviced in conjunction with the Salmon Escapement Study during the July through October period and during dedicated trips outside this period. Fixed stations will be downloaded as power supplies necessitate and up to twice monthly during the salmon spawning period (approximately July through October). The Salmon Escapement Study will provide approximately weekly aerial survey coverage of the study area (approximately July through October). At other times of the year, the frequency and location of aerial surveys will be at least monthly and bi-weekly during critical species-specific time periods (e.g., burbot spawning). Telemetry surveys will also be conducted by boat, snow machine, and on foot to obtain the most accurate and highest resolution positions of spawning fish. Using the guidance of fixed-station and aerial survey data on the known positions of tagged fish, specific locations of any concentrations of tagged fish that are suspected to be spawning will be visited to obtain individual fish positions. Foot and boat surveys will be conducted approximately July through October as part of the spawning ground and habitat sampling in the Salmon Escapement Study. Spatial and temporal allocation of survey effort will be finalized based on the actual locations and number of each species of fish tagged.

The fundamental reason for using radio telemetry as a method to characterize resident and non-salmonid anadromous species is that it can provide useful information to address the overarching goal of the study and several of its objectives. In particular, radio telemetry can provide data on seasonal distribution and movement of the target fish throughout the range of potential habitats. Relocation data from the radio telemetry component of this study will be used to characterize the timing of use and degree of movements among habitats and over periods during which the radio-tags remain active (potentially two or three seasons for large fish). This objective may be achieved by the use of long-life tags (e.g., greater than one year) and shorter-life tags (e.g., three-month tags) applied to appropriate-sized fish over time. In general, successful radio telemetry studies use a tag weight to fish weight guideline of 3 percent (with a common range of 2 to 5 percent depending on the species). The range in size encountered for a particular species may be broad enough to warrant the use of different sized tags with different operational life specifications. Actual tag life will be determined by the appropriate tag for the size of the fish available for tagging.

In this regard, the range in weights for the seven target species to be radio-tagged has been estimated. Fish weights and the respective target weight of radio-tags (Table 9.6-6) were calculated using existing or derived length–weight relationships for Alaska fish (Figure 9.6-12), and length frequency distributions for Susitna River fish. This analysis illustrates that there is a relatively broad range of potential tag weights (0.5 g to 81 g) that are necessary to tag each species over the potential range in fish size. Further, it is evident that some life stages will require tags with a relatively short (30- to 200-day) operational period (tag life).

The broad range in tag weight complicates the scope of the task in terms of technological feasibility. In general, there is a preference for using coded tags because it allows the unique identification of a hundred tags on a single frequency. Conversely, standard tags (not coded) require a single frequency for each tagged fish to allow unique identification. The radio telemetry industry provides a variety of equipment to match research needs, but there are always trade-offs in terms of tracking performance and cost between different systems. This plan intends to capitalize on the use of the existing telemetry platform (ATS telemetry equipment) to sufficiently monitor the target species, but directly constrains the potential options for tagging and monitoring. More specifically, the smallest ATS coded tag weighs 6 g and therefore precludes application to all of the species at the lower portion of their most frequently occurring size range (Table 9.6–6). For example, if fish need to weigh a minimum of 200 g to be tagged, then Dolly Varden would be tagged only at its largest samples, and burbot would be tagged almost across its entire range (Table 9.6–6) based on its respective length–frequency distributions.

The use of non-coded tags on the smaller fish would require the use of many frequencies (e.g., 50–150) and an entirely separate array of receivers. Overall, tagging fish weighing less than 200 g would be expensive and logistically inefficient. The only viable option to cover the entire range of fish sizes would be to use alternate vendors' radio telemetry receivers and tags that use coded technology through the entire range of tag sizes (e.g., Lotek Wireless).

Tags will be surgically implanted in up to 30 fish of sufficient body size of each species distributed temporally and longitudinally throughout the Middle and Lower River. These fish will be captured opportunistically during sampling events targeting adult fish and with directed effort using a variety of methods. Preference will be given fish caught with more benign techniques that cause minimal harm and stress to fish. The final spatial and temporal allocation of tags will be determined after 2012 study results are available (i.e., preliminary fish abundance and distribution). To the extent possible given the constraints of field sampling conditions, the following specific objectives tagging objectives will be followed: (1) a minimum of 10 tags per species will be allocated for tagging adult grayling and rainbow trout of sufficient size for spawning at tributary mouths during the spring sampling event; (2) a minimum of 10 tags will be allocated for tagging adult Dolly Varden of sufficient size for spawning at tributary mouths during a late summer or early fall sampling event; (3) a minimum of 10 tags will be allocated for tagging adult whitefish prior to spawning in early September; and (4) a minimum of 10 tags will be allocated for tagging burbot in the early fall prior to fall or winter spawning migrations. The tag's signal pulse duration and frequency, and, where appropriate, the transmit duty cycle, will be a function of the life history of the fish and configured to maximize battery life and optimize the data collection. Larger tags can accommodate the greatest battery life and therefore will be used when fish are large enough, but smaller, shorter-life tags will be used across the range of body sizes.

PIT Tag Antenna Arrays

Half-duplex PIT tags either 12 mm in length or 23 mm in length will be used, depending upon the size of the fish. Each PIT tag has a unique code that allows for identification of individuals. Half-duplex tags have been selected over full-duplex tags due to the increased flexibility and reduced cost of working with the Texas Instruments technology. Texas Instruments has recently produced a smaller half-duplex tag (12 mm) comparable to the original full-duplex (11 mm) tag; this will allow tagging of fish down to approximately 60 mm. Increased read distance and reduced power consumption are additional advantages of the half-duplex tag. Recaptured fish will provide information on the distance and time travelled since the fish was last handled and changes in length (growth).

PIT tag antenna arrays with automated data logging will be used at selected side channel, side slough, tributary mouth, and upland slough sites to detect movement of tagged fish into or out of the site. A variety of antenna types may be used including hoop antennas, swim-over antennas, single rectangle (swim-through) antennas, or multiplexed rectangle antennas to determine the directionality of movement.

Up to 10 sites will be selected with input from the Fish and Aquatic TWG for deploying PIT tag antenna arrays. If feasible, a PIT tag array will be located downstream of the confluence of the side slough and Whiskers Creek, or at the mouth of Whiskers Creek. Antennas will be tested in the Winter 2012–2013 Pilot Study and deployed shortly after ice-out in 2013 (See Section 9.6.4.5). Data loggers will be downloaded every two to four weeks, depending on the need to replace batteries and the reliability of logging systems. Power to the antennas will be supplemented with solar panels.

PIT tag arrays will be tested in a winter 2012/13 pilot study. Assuming the pilot testing is successful, swim-over antennas will be deployed at five sites prior to ice-over and will be maintained throughout the winter months. Downloading of data and battery replacement every three to four weeks, weather permitting, will be the objective during winter months. Depending on the detectability of tags during the winter of 2012–2013 Winter Pilot Study, winter deployment of antennas may be expanded during the two subsequent winter field seasons. Data on fish growth and movements into and out of habitats will inform bioenergetics and trophic analysis modeling in the River Productivity Study.

All juvenile Chinook salmon of appropriate size will be PIT-tagged. For other target species, up to 1,000 tags per species per PIT tag array will be tagged based on proximity to PIT arrays. Target species are juvenile salmonids and selected fish species such as rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic lamprey, Arctic grayling, and burbot.

9.6.4.4.13 DIDSON and Video Cameras

Pending results of the 2012–2013 winter pilot study, the use of DIDSON and video cameras is proposed to survey selected sloughs and side channels. The sloughs will be the same as those selected for the wintertime deployment of PIT tag antennas. The deployment techniques will follow those described by Mueller et al. (2006). Mueller et al. (2006) found that DIDSON cameras were useful for counting and measuring fish up to 52.5 feet (16 meters) from the camera and were effective in turbid waters. In contrast, they found that video cameras were only effective in clear water areas with turbidity less than 4 nephelometric turbidity units (NTU). In addition to fish observations, video cameras may also be used to characterize micro-habitat attributes such as the presence of anchor ice, hanging dams, macrophytes, structure, and substrate type. Depending on the efficacy of underwater imaging techniques, they may be adopted for use during the ice-free season at selected Focus Area sites.

DIDSON is a high-resolution imaging sonar that provides video-type images over a 29-degree field of view and can thus be used to observe fish behavior associated with spawning, i.e., dynamic behavior that cannot be identified on the static side-scan images. To obtain high-quality images of adult salmon, the maximum range will be limited to 15 meters (49 feet). Within this field of view, evidence of spawning behavior, e.g., redd digging, chasing, and spawning, will be clearly identifiable. Furthermore, on DIDSON images fish can be classified by size category, e.g., <40 centimeters, 40–70 centimeters, >70 centimeters (<25 inches, 25–44 inches, >44 inches, respectively). Although this is not sufficient for definitive species identification, it will allow recognition of smaller resident fish, medium-sized adult salmon, and large Chinook salmon.

Underwater video imaging can record images in real-time over short time intervals and can provide information on fish species presence/absence in the immediate vicinity. Video systems can also be configured to record images for longer periods of time using time lapse or motion triggered recorders. Although water clarity and lighting can limit the effectiveness of video sampling, a distinct advantage of video over DIDSON is the ability to clearly identify fish species. In clear water under optimal lighting, video can capture a much larger coverage area than DIDSON (Mueller et al. 2006). Video is often combined with a white or infrared (IR) light source especially under ice and in low light northern latitudes; however, lighting may affect fish behavior. Since nighttime surveys will be required to identify possible diurnal changes in fish behavior and habitat use, the video system will be fitted with IR light in the form of light-emitting diodes that will surround the lens of the camera. Muller et al. (2006) reported that most fish are unaffected by IR lights operated at longer wavelengths because it falls beyond their spectral range. In addition, the video system will be equipped with a digital video recorder for reviewing and archiving footage of fish observations.

9.6.4.4.14 Fish Handling

Field crews will record the date, start and stop times, and level of effort for all sampling events, as well as water temperature and dissolved oxygen at sampling locations. All captured fish will be identified to species. Up to 30 individuals per species per life stage per site will be measured to the nearest millimeter (mm) fork length. Sampling supplies will be prepared before sampling begins. For example, the date, location, habitat type, and gear type recorded in log book, beginning fish number in proper sequence, daily sample objective by gear type, and an adequate live box and clean area should be available. To increase efficiency, fish should be sampled in order in groups of ten, and the sample routine followed in a stepwise manner: (1) identify species and life stage, (2) measure lengths, (3) remove tissue samples for genetic analysis, and (4) cut all dead fish for accurate sex identification. Care will be taken to collect all data with a consistent routine and to record data neatly and legibly.

For methods in which fish are observed, but not captured (i.e., snorkeling, DIDSON, and underwater video), an attempt will be made to identify all fish to species. For snorkeling, fork length of fish observed will be estimated within 40-mm bin sizes. When fish are captured observations of poor fish condition, lesions, external tumors, or other abnormalities will be noted if present. When more than 30 fish of a similar size class and species are collected at one time, the total number will be recorded and a subset of the sample will be measured to describe size classes for each species. All juvenile salmon, rainbow trout, Arctic grayling, Dolly Varden, burbot, longnose sucker, and whitefish greater than 60 mm in length will be scanned for PIT tags using a portable tag reader. A PIT tag will be implanted into up to 1,000 fish of these species per PIT tag array that do not have tags and are in close proximity to an array and approximately 60 mm and larger. Radio transmitters will be surgically implanted in up to 30 fish of sufficient body size of each species distributed temporally and longitudinally throughout the Susitna River.

In support of the bioenergetics modeling component of the River Productivity Study (Section 9.8), targeted fish species will be collected for dietary analysis. These species include juvenile coho salmon, juvenile and adult rainbow trout, and juvenile and adult northern pike, as identified in consultation with agencies and other licensing participants. A total of five fish per species/age class per sampling site collection will be sampled for fish stomach contents, using non-lethal methods. All fish will have fork length and weight recorded with the stomach sample. In addition, scales will be collected from the preferred area of the fish, below and posterior to the dorsal fin, for age and growth analysis.

Tissue samples will be collected opportunistically in conjunction with all fish capture methods from selected resident and non-salmon fish to support the Genetic Baseline Study (Objective 7; Section 9.14). Tissue samples include an axillary process from all adult salmon, caudal fin clips from fish >60 mm, and whole fish <60 mm. The target number of samples, species of interest, and protocols are outlined in Section 9.14.

The number of fish per species or species assemblage and the handling protocols will be determined with input from the Fish and Aquatics TWG and the Subsistence Group for species consumed by humans, and the Wildlife TWG for piscivorous furbearers and birds.

9.6.4.5 Winter Sampling Approach

Over the 2012/2013 winter, pilot studies will be conducted at the Whiskers Slough (RM 101-102) and Slough 8A (RM 125-126) Middle Segment Focus Area sites of the Susitna River (Figures 9.6-11 & 9.6-12). These sites were selected based on their accessibility from Talkeetna, because they contain a diversity of habitat types, and because sampling in the 1980s and 2012 revealed that these sites were used for spawning as well as rearing by salmonids. Three winter pilot studies will be initiated in 2012–2013 focusing on (a) intergravel temperature, D.O., and water level monitoring; (b) winter fish observations using DIDSON and underwater video; and (c) winter fish sampling techniques.

Overall study objectives for the winter pilot study include:

1. Evaluate the effectiveness and feasibility of winter sampling methods for each study including: intergravel temperature, D.O. and water level monitoring, underwater fish observations via DIDSON sonar and underwater video, and fish populations using minnow traps, seines, electrofishing, trotlines, PIT tags, and radio tags.
2. Assess winter sampling logistics. This includes safety, sampling methods in different habitat types under varying degrees of ice cover, transportation and access to and from sample sites, travel time, and winter-specific gear needs.
3. Evaluate the feasibility of sampling during spring break up.

Develop recommendations for 2013–2014 study plans.

Intergravel Temperature Monitoring

For the intergravel temperature component (Section 8.5.4.5.1.2.1), a detailed sampling design will subsequently be developed that will be based on a stratified random sampling approach. Both Whiskers Slough and Slough 8A will be stratified into specific habitat types (Beaver complex, backwater, side slough, upland slough, tributary mouth, mainchannel) within which 10-12 candidate monitoring sites will be randomly selected. Special emphasis will be giving to including areas with known fish spawning. Dissolved oxygen will be measured in conjunction with intergravel temperature at one location at each of the two Focus Areas. To the extent possible, locations with groundwater upwelling will be distinguished from seepage locations that may represent lateral intergravel flow from mainstem Susitna River surface flow. Sites will include areas of recent spawning activity as well as areas with no spawning activity. Depending on individual site characteristics, temperature monitoring devices will be installed at locations of 1) groundwater upwelling, 2) bank seepage and lateral flow from mainstem, 3) mixing between upwelling and bank seepage, 4) no apparent intergravel discharge, fish spawning, and 5) main channel Susitna River flow.

At each intergravel temperature monitoring location, Hobo TidBit temperature probes will be deployed at three separate gravel depths (5 cm, 20 cm, and 35 cm) corresponding to observed burial depth ranges of chum and sockeye eggs (Bigler and Levesque 1985, DeVries 1997). Intergravel temperature probes will be attached to stainless steel cable and inserted into the gravel using a scour chain installation device (Nawa and Frissell 1993). Additional above gravel temperature recorders will be co-located at a subset of the intergravel sampling sites. These latter devices allow for the downloading of temperature data without removing the recorders from the gravel and allow for the detection of differences between surface and groundwater temperature. The D.O. sensors (HOBO D.O. logger with optical sensor) will likewise be inserted into the gravel to a depth of approximately 20 centimeters using a stainless steel cable. In addition, a series of pressure transducers (Solinst level loggers) will be deployed at the upper and lower ends of select side channel and slough habitats and in adjoining areas of the main channel Susitna River to monitor water surface elevations and stage response with changes in main channel stage. The final number and location of monitoring sites will vary depending on site conditions and safety concerns.

The temperature, D.O., and pressure transducers will be deployed in January 2012 following the chum and sockeye salmon spawning period and will be retrieved in April 2013 prior to ice break-up. Data from the above gravel recorders will be downloaded on a monthly basis and will occur concurrently with times specified as part of the under ice fish observation study.

Underwater Fish Observations

Under-ice fish observations will be made using DIDSON sonar and underwater video cameras. The two systems will be run concurrently in tannic water to determine which method is more effective for underwater fish observations in varying water clarity. Underwater video and DIDSON sonar observations will be made during the January–April 2013 sampling. Video sampling will occur in both slough and side channel habitats in the same general study sites as the intergravel temperature recorders. Observation will take place in 5 locations in Whiskers Slough and 6 locations in Slough 8A (Figures 9.6-11 & 9.6-12). A stratified random sampling program over a 24-hour period will be developed to observe underwater activity during day and nighttime conditions and ultimately to identify juvenile overwintering behavior to support stranding and trapping analyses. In addition to fish observations, Habitat Suitability Criteria (HSC) sampling methods will be used to characterize local habitat characteristics (velocity, water depth, substrate, cover, etc.) throughout the winter at all observed fish locations. Water velocity and depth measurements will be made either through the ice (ice holes) or in open water leads using a topset wading rod and Price AA meter. Channel substrate composition will be visually characterized using a modified Wentworth size scale. HSC measurements will only be collected at those fish observations points where positive fish species identification and estimates of total length can be made.

Winter Fish Sampling Techniques

Winter fish sampling will employ multiple methods to determine which are most effective for each fish species, life stage, and habitat type. Because sampling efforts will occur in both open water and ice covered sites, methods will vary depending on conditions. In ice-covered sites the primary sampling methods will be trotlines and minnow traps. In open water sites, the fish capture methods will be baited minnow traps, electrofishing, and beach seines. Remote telemetry techniques will include radio telemetry and PIT technology. Both of these methods need to be tested for detectability of tags fish under ice cover.

All fish sampling will occur once a month from January through March 2013 and will be coordinated with the intergravel temperature monitoring and the underwater fish observation components.

Trot Lines

Trot lines will be used to capture resident fish species including burbot, whitefish, Arctic grayling and possibly rainbow trout and Dolly Varden. This was the primary method for sampling resident fish (mostly burbot and whitefish) used by ADF&G during the 1980s winter studies (Sundet 1986). Following methods outlined by ADF&G, trotlines will be 15 to 20 feet in length with 6 hooks and leaders weighted to the bottom of the river. Holes will be drilled in the ice with a two-man ice auger. Trot lines will be baited with salmon roe or herring and set for 24 hours at a time once a month from January through March. Trot lines will be set in main channel sites at Whiskers Slough and at Slough 8A within slough (Figures 9.6-11 and 9.6-12). Sites will be marked with a hand-held GPS to ensure that sites can be relocated and resampled during future sampling events. All captured fish will be identified to species, measured for length, and. gonads examined to determine spawning status. The gonads for all sampling mortalities will be preserved for laboratory examination. Tissue samples will be collected from all captured fish and sent to the ADF&G Conservation Genetics Lab for genetic analysis.

Minnow Traps

Minnow traps will be deployed in attempt to capture juvenile salmonids and other juvenile resident fish species overwintering in mainstem and slough habitats. Minnow traps were a common winter method utilized by ADF&G in 1980s and were found to be effective for anadromous and resident juvenile fish species (Stratton 1986) but also were able to catch non-target species such as stickleback, sculpin and lamprey. Minnow traps will be deployed in the same holes drilled for trotlines, baited with salmon roe and set for 24 hours. Minnow traps will be deployed at 8 sites at Whiskers Slough and 3 sites at Slough 8A monthly from January – March 2013. Minnow trapping locations will be marked with hand-held GPS units in order to resample the same habitats each month. All captured fish will be identified to species, measured, and released to the stream unharmed.

Beach Seines

Beach seines will be used to collect a range of anadromous and resident fish species that may be present in open-water habitats. Beach seines will be used in shallow, open-water reaches free of woody debris and boulders and will be swept through the water walking upstream. Seines will be 15 and 25 feet wide by 5 feet depth with ¼ inch mesh. Locations of the habitats seined will be marked with hand-held GPS units such that transects are standardized and repeatable. Single passes with beach seines will occur at multiple locations between sites on a monthly basis. All fish captured by beach seining will be identified to species, measured for length, and returned to the stream unharmed.

Electrofishing

Single-pass backpack electrofishing surveys will be conducted in open-water leads (i.e., sloughs and side channels) in attempt to capture a range of anadromous and resident fish species. The location of each electrofishing transect will be mapped using a hand-held GPS unit. The electrofishing start and stop times and water conductivity will be recorded. To the extent possible, the selected electrofishing sites and transects will be standardized and the methods will be repeated during each sampling period at each specific site to evaluate temporal changes in fish distribution. All captured fish will be identified to species, measured for length, and returned to the stream unharmed.

PIT Tag Arrays

Using 12 and 23 mm PIT tags and a mobile antenna array, we will test PIT tag detection in varying ice thickness. This pilot effort will help determine the maximum depth of ice that PIT tags can be detected and inform future PIT tagging studies in 2013 and 2014. Holes will be drilled in the ice and PIT tags will be attached to floats at the end of a tethered fishing line and allowed to drift down stream under the ice. The orientation of a PIT tag relative to the antenna array field will affect the tag detection rate, so the position of all test PIT tags will be fixed within the float for each test. Mobile antenna arrays will be used to determine the maximum ice thickness and distance PIT tags can be detected.

Radio Tags

The primary function of the telemetry component is to track tagged fish spatially and temporally. Radio telemetry is intended to provide detailed information from relatively few individual fish. Locating radio-tagged fish will be achieved by fixed receiver stations and mobile surveys (aerial, boat, snow machine, and foot). Although wintertime radio tracking of adult fish was successfully completed during the 1980s studies, there is some question as to the limitations of detecting radio tags under ice cover. The process for testing the detectability of radio tags will follow similar methods as outlined above for testing PIT tags. Holes will be drilled in the ice and radio tags will be attached to the end of a fishing line and allowed to drift down stream under the ice. Mobile antenna arrays will be used to determine the maximum ice thickness and distance radio tags can be detected.

9.6.5. Consistency with Generally Accepted Scientific Practices

This study plan was developed by fisheries scientists in collaboration with the Fish and Aquatic TWG and draws upon a variety of methods including many that have been published in peer review scientific journals. As such, the methods chosen to accomplish this effort are consistent with standard techniques used throughout the fisheries scientific community. However, logistical and safety constraints inherent in fish sampling in a large river in northern latitudes also play a role in selecting appropriate methodologies. To describe the seasonal distribution, relative abundance, and habitat associations of the various fish species in winter, alternative methods involving snorkel and dive surveys were considered. These alternative methods were dismissed based on safety concerns owing to potentially extreme cold temperatures and remoteness of the sampling locations, and because sampling would most appropriately be conducted at night.

9.6.6. Schedule

Initial data collection efforts for this multi-year study will begin with the Winter Pilot Study (January-April 2013) and will continue through March 2015. The schedule allows for two open water and three ice-over study seasons. The proposed schedule for the completion of the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River Segments is given below and in Table 9.6-7:

- Conduct Winter Pilot Studies to inform 2013/14 and 2014/15 efforts – January through April 2013
- Development of Implementation Plan and selection of study sites – January through March 2013
- Continuation of Field studies after FERC Study Plan Determination – May 2013 through March 2015
- Refined methods for winter sampling methods based on results of Winter 2012-2013 Pilot Study – June 2013
- Reporting of interim results – September 2013 and September 2014
- Quality control check of geospatially-referenced relational database – December 2013 and December 2014
- Data analysis – October to December 2013 and October to December 2014
- Initial and Revised Study Reports on 2013 and 2014 activities – anticipated to be filed during the first quarter of 2014 and 2015, one and two years, respectively, after the FERC Study Plan Determination (February 2013)
- Supplemental technical memorandum on winter 2014–2015 effort – May 2015

9.6.7. Relationship with Other Studies

Over the two-year study implementation phase, an iterative process of information exchange will take place between interrelated studies that depend upon one another for specimen collection or data (Figure 9.6-13). Planning milestones include: segment delineation (Q2 2012) from the Geomorphology Study (Section 6.0), mesohabitat delineation (Q4 2012) from the Aquatic Habitat Study (Section 9.9), and Focus Area selection (Q4 2012) by the interdisciplinary study (Section 8.5) will aid in site selection and development of the detailed Fish Distribution and Abundance in the Middle and Lower Susitna River Implementation Plan (Q1 2013). In addition to review of historic studies, the intergravel temperature component of the ISF Study (Q1 2013; Section 8.5) and the Winter Pilot Study (Q1 2013; Section 8.5 and 9.6.4.5) will aid with the estimation of fry emergence timing and planning and development of the Fish Distribution and Abundance in the Middle and Lower Susitna River Implementation Plan (Q1 2013). Delivery of information on spawning site locations and fishwheel collections from the Salmon Escapement Study (9.7) will occur in an iterative fashion during the migration and spawning seasons.

Data checked for quality on fish distribution from this study will be provided to many studies including the Instream Flow Study (Section 8.5) in the fourth quarter of 2014 to validate fish periodicity, habitat associations, and selection of target species for reach-specific analyses. Additionally, data collected on movement patterns and growth will be delivered to the Fish and Aquatics Instream Flow Study (Section 8.5) in the fourth quarter of 2014 to aid in the identification of seasonal timing, size and distribution among habitat types for fish (particularly < 50 mm) in support of the stranding and trapping component. Distribution and abundance data will be delivered to the Salmon Escapement Study (Section 9.7) in the fourth quarter of 2014 help validate and complement information from radio telemetry, fishwheel, and sonar observations of adult salmon. Fish movement, habitat association, and growth data will provide inputs for bioenergetics and trophic analysis modeling in the fourth quarter of 2014, a component of the River Productivity Study (Section 9.8). Further, target species will be sampled iteratively throughout the course of the study for fish stomach contents in support of bioenergetics modeling (Section 9.8). The opportunistic collection of tissue samples will occur iteratively throughout the course of the study and be coordinated with the Fish Genetics Study (Section 9.14). Information gathered on fish distribution and abundance will be delivered to the Fish Harvest Study (Section 9.15) in the fourth quarter of 2014 to complement information about harvest rates and to better understand commercial, sport, and subsistence fisheries. Fish collections and observations in conjunction with aquatic habitat characterization (Aquatic Habitat Study, Section 9.9) will occur iteratively throughout the course of the study and aid in the development of fish and habitat associations. In fourth quarter of 2014, fish collections will provide data on fish use in sloughs and tributaries with seasonal flow-related or permanent fish barriers to better classify barrier or corroborate the Fish Passage Barriers Study (Section 9.12).

9.6.8. Level of Effort and Cost

This is a multi-year study that will begin in early 2013 and end in March 2015. The study will include two winter periods and two ice-free periods. Sampling will be conducted according to a stratified sampling scheme designed to cover the range of habitat types with a minimum of six replicates each. The level of effort at each sample site and sampling frequency will vary based on tasks and objectives. The number and size of sample sites and sampling frequency require a large-scale field effort and subsequent data compilation, quality assurance/quality control (QA/QC), and analysis efforts. Generally:

- Sampling will be conducted monthly during the ice-free seasons in all study sites and year-round in Focus Area sites.
- Sampling will be conducted bi-weekly from ice-out through July 1 in selected Focus Areas to document seasonal movement patterns of juvenile salmonids from spawning to rearing habitats.
- Fish capture and observation methods may include snorkeling, seining, gillnetting, minnow trapping, angling, trot lines, out-migrant traps, DIDSON, and underwater video depending on stream conditions such as depth, flow, turbidity, target species, and life stage.

- Field crews will consist of two to four individuals, depending on the sampling method used.
- Sampling in remote areas requires helicopter, fixed-wing airplane, snow machine, and boat support.
- Radio-tracking of tagged fish includes 12 aerial surveys, and foot, boat, and snow machine surveys as necessary.

Total study costs are estimated at $4,500,000.

9.6.9. Literature Cited

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9.6.10. Tables

Table 9.6-1. Summary of life history, known Susitna River usage, and known extent of distribution of fish species within the Lower, Middle, and Upper Susitna River Segments (from ADF&G 1981 a, b, c, etc.).

Common Name	Scientific Name	Life History[a]	Susitna Usage[b]	Distribution[c]
Alaska blackfish	*Dallia pectoralis*	F	U	U
Arctic grayling	*Thymallus arcticus*	F	O, R, P	Low, Mid, Up
Arctic lamprey	*Lethenteron japonicum*	A,F	O, M_2, R, P	Low, Mid
Bering cisco	*Coregonus laurettae*	A	M_2, S	Low, Mid
Burbot	*Lota lota*	F	O, R, P	Low, Mid, Up
Chinook salmon	*Oncorhynchus tshawytscha*	A	M_2, R	Low, Mid, Up
Chum salmon	*Oncorhynchus keta*	A	M_2, S	Low, Mid
Coho salmon	*Oncorhynchus kisutch*	A	M_2, S, R	Low, Mid
Dolly Varden	*Salvelinus malma*	A,F	O, P	Low, Mid, Up
Eulachon	*Thaleichthys pacificus*	A	M_2, S	Low
Humpback whitefish[d]	*Coregonus pidschian*	A,F	O, R, P	Low, Mid, Up
Lake trout	*Salvelinus namaycush*	F	U	U
Longnose sucker	*Catostomus catostomus*	F	R, P	Low, Mid, Up
Northern pike	*Esox lucius*	F	P	Low, Mid
Pacific lamprey	*Lampetra tridentata*	A,F	U	U
Pink salmon	*Oncorhynchus gorbuscha*	A	M_2, R	Low, Mid
Rainbow trout	*Oncorhynchus mykiss*	F	O, M_2, P	Low, Mid
Round whitefish	*Prosopium cylindraceum*	F	O, M_2, P	Low, Mid, Up
Sculpin[e]	*Cottid*	M_1[f], F	P	Low, Mid, Up
Sockeye salmon	*Oncorhynchus nerka*	A	M_2, S	Low, Mid
Threespine stickleback	*Gasterosteus aculeatus*	A,F	M_2, S, R, P	Low, Mid

[a] A = anadromous, F = freshwater, M_1 = marine

[b] O = overwintering, P = present, R = rearing, S = spawning, U = unknown, M_2 = migration

[c] Low = Lower River, Mid = Middle River, Up = Upper River, U = Unknown

[d] Whitefish species that were not identifiable to species by physical characteristics in the field were called humpback by default. This group may have contained Lake (*Coregonus clupeaformis)*, or Alaska (*Coregonus nelsonii*) whitefish.

[e] Sculpin species generally were not differentiated in the field. This group may have included Slimy (*Cottus cognatus*), Prickly (*Cottus asper)*, Coastal range (*Cottus aleuticus*), and Pacific staghorn (*Leptocottus armatus*).

[f] Pacific staghorn sculpin were found in freshwater habitat within the Lower Susitna River Segment.

Table 9.6-2. Proposed methods by objective, task, species, and life stage.

Obj	Task	Species/ Life Stage	Study Sites	Proposed Methods by Season
1A	Distribution	Juvenile salmon, non-salmon anadromous, resident	Focus Areas + representative habitat types Select Focus Areas (accessible)	Ice Free Season: • Single pass sampling • Selection of methods will be site-specific, species-specific, and life-stage-specific. • For juvenile and small fish sampling, electrofishing, snorkeling, seining, fyke nets, angling, DIDSON and video camera where feasible and appropriate. • For adults, directed efforts with seines, gillnets, trot lines, and angling. • To the extent possible, the selected transects will be standardized and the methods will be repeated during each sampling period at a specific site to evaluate temporal changes in fish distribution. • Additional info from radio telemetry studies (Objective #2). Winter: • Based on winter 2012-2013 pilot studies • Potentially DIDSON, video camera, minnow traps, e-fishing, seines, and trot lines.
1B	Relative abundance	Juvenile salmon, non-salmon anadromous, resident	Focus Area study sites + representative habitat types	• Multi-pass sampling with blocknets where applicable • To the extent possible, the selected transects will be standardized and the methods will be repeated during each sampling period at a specific site to evaluate temporal changes in fish distribution. • Snorkeling, beach seine, electrofishing, fyke nets, gillnet, minnow traps, fishwheels, out-migrant traps, etc.
1C	Fish habitat associations	Juvenile salmon, non-salmon anadromous, resident	Focus Area study sites+ representative habitat types	• Analysis of data collected under Objective 1: Distribution. Combination of fish presence, distribution, and density by mesohabitat type by season.

Obj	Task	Species/ Life Stage	Study Sites	Proposed Methods by Season
2A	Timing of downstream movement and catch using out-migrant traps	All species; juveniles	At selected out-migrant trap & PIT tag array sites	• Out-migrant Traps: Maximum of 6. 2-3 Main channel to indicate broad timing of out-migrants from all upstream sources. 3-4 in tributary mouths and sloughs, such as Fog Creek, Kosina Creek, Portage Creek, Indian Creek and possibly Gold Creek and Whiskers Slough. Combine with fyke net sampling to identify key site-specific differences. • Sampling in mainstem off-channel habitats downstream of tributaries with fyke nets, seines, and out-migrant traps • Fishwheels (adults only) opportunistically in conjunction with the Salmon Escapement Study
2B	Describe seasonal movements using biotelemetry (PIT and radio-tags)	All species		Ice-Free Season: • PIT tags: tags opportunistically implanted in target species from a variety of capture methods in Focus Areas. Antenna arrays in up to 10 sites at selected side channel, side slough, tributary mouth, and upland sloughs in the Middle River and Lower River. • Radio-tags surgically implanted in up to 30 individuals of sufficient body size of each target species distributed temporally and longitudinally. . Winter: • Based on winter 2012-2013 pilot studies. • Potentially DIDSON, video camera, minnow traps, electrofishing, seines and trot lines. • Aerial tracking of radio-tags (adults).
3A	Describe emergence timing of salmonids;	Juvenile salmonids	Select Focus Areas	• Bi-weekly sampling from breakup to July 1 using fyke nets, seines, electrofishing and minnow traps in salmon spawning areas within Focus Areas.
3B	Determine movement patterns and timing of juvenile salmonids from spawning to rearing habitats;	Juvenile salmonids	Focus Areas	• Focus on timing of emergence and movement of newly emergent fish from spawning to rearing areas or movement of juvenile fish <50 mm in winter (i.e., the post-emergent life stages most vulnerable to load-following operations) • DIDSON or underwater video to monitor movement into or out of specific habitats
3C	Determine juvenile salmonid diurnal behavior by season	Juvenile salmonids	Focus Areas	• Stratified time of day sampling to determine whether fish are more active day/night • DIDSON and/or video camera methods to observe fish activity • Potentially electrofishing and seining

Obj	Task	Species/ Life Stage	Study Sites	Proposed Methods by Season
3D	Collect baseline data to support the Stranding and Trapping Study		Focus Areas + supplement with additional representative habitat types as necessary.	• Opportunistic support to ID seasonal timing, size and distribution among habitat types for fish <50 mm in length. • Estimate presence/absence, relative abundance, and density using similar methods as Objectives 1A, 1B, 1C, and 2 for fish <50 mm • Focus on slough and other mainstem off-channel habitats • DIDSON, video camera, electrofishing, seines, out-migrant traps and fyke nets. • Seasonal measurements of fish size/growth
4	Winter movements, timing, and location of spawning	burbot, humpback whitefish, and round whitefish	Mainstem habitats	• Radio-tags surgically implanted in up to 30 fish of sufficient body size of each species distributed temporally & longitudinally. • To capture burbot for radio-tagging, use hoop traps late Aug-early Oct following methods by Evenson (1993). • To capture whitefish for radio-tagging, use fishwheels opportunistically and directed efforts including angling, seines & gillnets. • Use aerial & snow machine tracking of radio-tags to pinpoint winter aggregations of fish; sample these areas with trot lines (similar to 1980s). Trot lines are lethal sampling. • Collect, examine, and preserve gonads to determine spawning status.
5	Document age structure, growth, and condition by season	juvenile anadromous and resident fish	All study sites for Obj 1B and Focus Areas	• Stock biology measurements- length from captured fish up to 100 individuals per season per species per life stage and up to 30 fish per month per species per habitat type in Focus Areas. • Emphasis placed on juvenile salmonids <50mm. • Opportunistically support Stranding and Trapping Study
6	Seasonal presence/absence and habitat associations of invasive species	northern pike	All study sites	• Same methods as #1 and #2 above. • The presence/absence of northern pike and other invasive fish species will be documented in all samples • Additional direct efforts with angling as necessary
7	Collect tissue samples to support the Genetic Baseline Study	All	All study sites in which fish are handled	• Opportunistic collections in conjunction with all capture methods listed above. • Tissue samples include axillary process from all adult salmon, caudal fin clips from fish >60 mm, and whole fish <60 mm.

Table 9.6-3. Habitat types and number of sites proposed for distribution and relative abundance sampling for the MR.

Focus Stratum	Habitat Stratum	GeomReach						Total
		MR-1	MR-2	MR-5	MR-6	MR-7	MR-8	
Focus Areas	Main Channel	3	3	2	3	3	3	17
	Side Channel	2	3		3	3	3	14
	Side Slough		3		3		3	9
	Side Slough Beaver Complex				3			3
	Upland Slough		3		3	3	3	12
	Upland Slough Beaver Complex				3	3		6
	Backwater				1	2		3
	Tributary		1	1	2	3	1	8
	Tributary Mouth		1	1	2	1		5
	Clear Water Plume			1	1			2
	Subtotal Focus Areas Abundance	5	14	5	24	18	13	79
Non Focus Areas	Main Channel	3	3	3	3	3	3	18
	Side Channel	1	3		3	3	3	13
	Side Slough		3	3	3	3	3	15
	Side Slough Beaver Complex					3		3
	Upland Slough		3		3	3	3	12
	Upland Slough Beaver Complex				3	3		6
	Backwater		1		3	1	1	6
	Tributary		3		3	3		9
	Tributary Mouth		3	1	3	2		9
	Clear Water Plume		3		3	1		7
	Subtotal Non-Focus Areas Distribution[1]	2	14	4	18	15	8	61
	Subtotal Non-Focus Abundance	2	8	3	9	10	5	37
Subotal Samples For Distribution		2	14	4	18	15	8	61
Subtotal Samples For Abundance		7	22	8	33	28	18	116
Total number of sampling sites		9	36	12	51	43	26	177

Table 9.6.4. Habitat units to be sampled for fish distribution in the LR by transect and reach. Transects selected for relative abundance sampling are bolded.

Transect (PRM)	Main Channel (MC)	Side Channel Complex(SCC)	Bar Island Complex (BIC)	Side Channel (SC)	Upland Slough (US)	Side Slough (SS)	Tributary (TR)	Tributary Delta (TD)	Additional Open Water (AOW)	Total
100.27	*1*	*1*	*1*		*1*					*4*
92.91	1	1	1	1						4
LR-1 Total	2	2	2	1	1					8
85.55	1	1	1							3
78.19	1	1	1	1						4
70.83	*1*	*1*	*1*	*1*	*1*					*5*
LR-2 Total	3	3	3	2	1					12
63.47	1	1	1		1					4
56.11	*1*	*1*	*1*	*1*			*1*		*1*	*6*
48.75	1	1	1		1		1			5
LR-3 Total	3	3	3	1	2		2		1	15
41.39	1	1	1	1						4
34.03	*1*	*1*	*1*	*1*					*1*	*5*
LR-4 Total	2	2	2	2					1	9
Subtotal LR Abundance	*4*	*4*	*4*	*3*	*2*	*0*	*1*	*0*	*2*	*20*
Subtotal LR Distribution	6	6	6	3	2	0	1	0	0	21
Total Number Samples	10	10	10	6	4	0	2	0	2	42

Table 9.6-5. Tributaries selected for fish distribution and abundance sampling upstream of Devils Canyon.

Tributary	Susitna River Mainstem RM	Listed in AWC Catalog	Stream Access-ibility	Average Wetted Width[1] (m)	Drainage Basin Area (km^2)	Average Channel Width[2] (m)	GRTS Sampling Unit Size (m)
Tsusena Creek	181.3	no	no	10	374.3	NA	DIR
Unnamed Tributary	181.2	no	no	NA	NA	NA	DIR
Fog Creek	176.7	yes	no	9	381.2	20	DIR
Fog Creek Tributary	NA	no	no	NA	NA	NA	DIR
Devil Creek	161	no	no	22	190.6	11	DIR
Chinook Creek	157	yes	no	9	58.3	8	DIR
Cheechako Creek	152.4	yes	no	12	94.3	8	DIR

Notes:

1 Data taken from HDR (unpublished 2012 data).

2 Data taken from Saunter and Stratton (1983).

NA = data not available or applicable

DIR = tributary subject to direct rather than statistical sampling due to accessibility issues.

Table 9.6-6. Length and weight of fish species to be radio-tagged in the Middle/Lower River and respective target radio-tag weights.

Species	Known Distribution [a]	Target number for tagging	All sizes		Most likely to be caught			Tag Weight of Min (3%)	Tag Weight of Max (3%)	Fish length (mm) @ 200 g weight
			Length (millimeter)	Weight (g)	Fish Length (millimeter)	Est. Weight Min (g)	Est. Weight Max (g)			
Arctic grayling	Low, Mid, Up	30 Mid/Low	36–444	<1–830	120–420	18	705	0.5	21.2	270
Dolly Varden	Low, Mid, Up	30 Mid/Low	30–470	<1–1,007	130–300	20	256	0.6	7.7	277
Round whitefish	Low, Mid, Up	30 Mid/Low	23–469	<1–1,035	150–390	23	553	0.7	16.6	287
Rainbow trout	Low, Mid,	30 Mid/Low	27–612	<1–3,327	180–480	96	1635	2.9	49.1	232
Humpback whitefish	Low, Mid, Up	30 Mid/Low	30–510	<1–1,544	210–450	180	1141	5.4	34.2	219
Burbot	Low, Mid, Up	30 Mid/Low	26–791	<1–3,532	300–510	186	931	5.6	27.9	307
Northern pike	Low, Mid	30 Mid/Low	83–713	5–2707	200-700	62	2700	1.9	81.0	296
Longnose Sucker	Low, Mid, Up	30 Mid/Low	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

[a] Low = Lower River, Mid = Middle River, Up = Upper River, NA = indicates data not available.

Table 9.6–7. Schedule for implementation of the Fish Distribution and Abundance in the Middle and Lower Susitna River Study.

Activity	2012				2013				2014				2015	
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2Q
Winter Pilot Study					—	—								
Study Site Selection					—									
Develop and File Implementation Plan					—♦									
Open Water and Winter Fish Sampling						—	—	—	—	— -----	—	—	—	
Data Entry							—	—			—	—		
Preliminary Data Analysis							—	—						
Initial Study Report								—	Δ					
Final Data Analysis											—	—		
Updated Study Report											—	—	▲	
Winter 2014-15 Technical Memo														●

Legend:

—— Planned Activity
----- Follow-up activity (as needed)
♦ Implementation Plan
Δ Initial Study Report
▲ Updated Study Report
● Winter 2014-15 Technical Memorandum

9.6.11. Figures

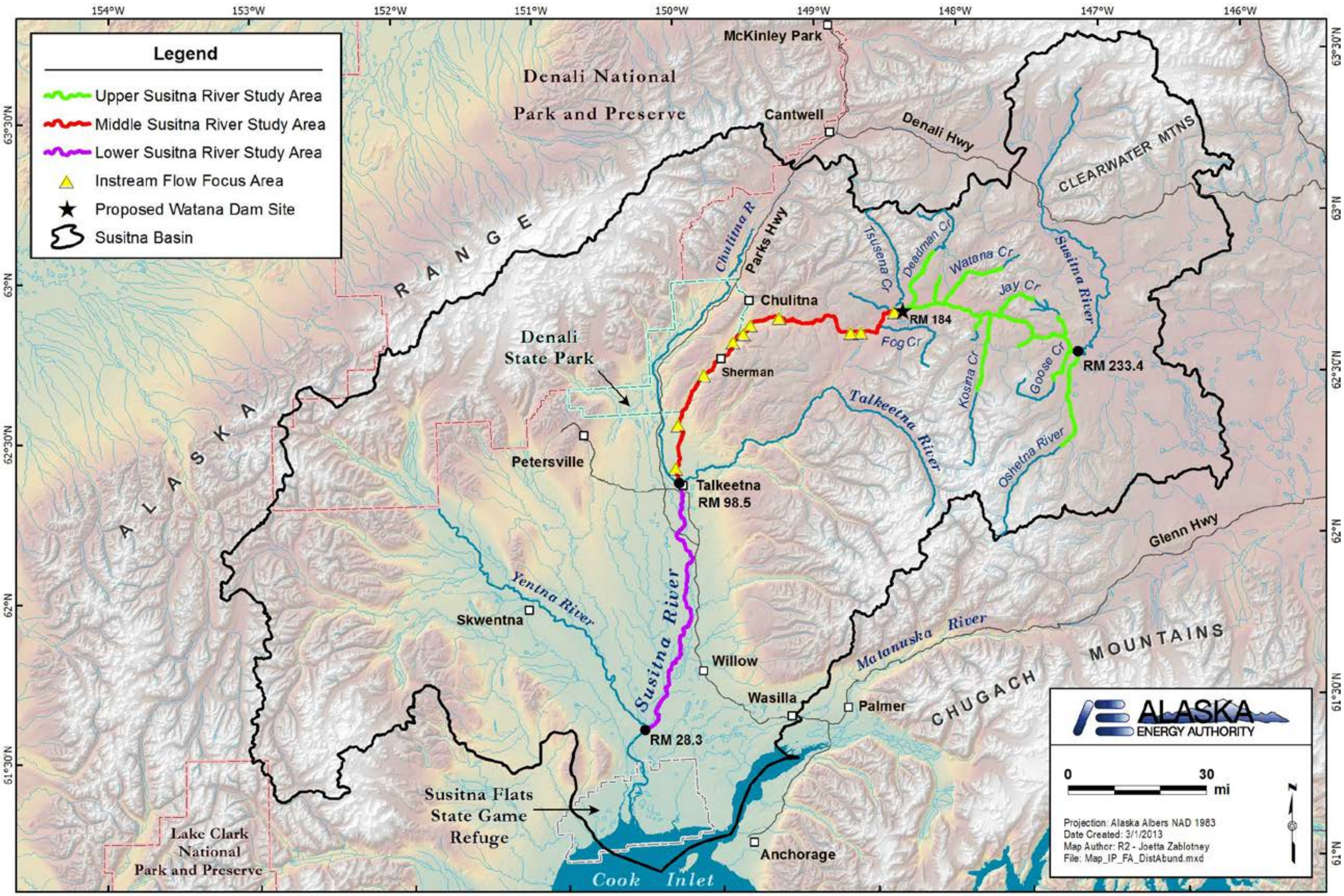

Figure 9.6-1. Map for Fish Distribution and Abundance in the Upper, Middle, and Lower Susitna River.

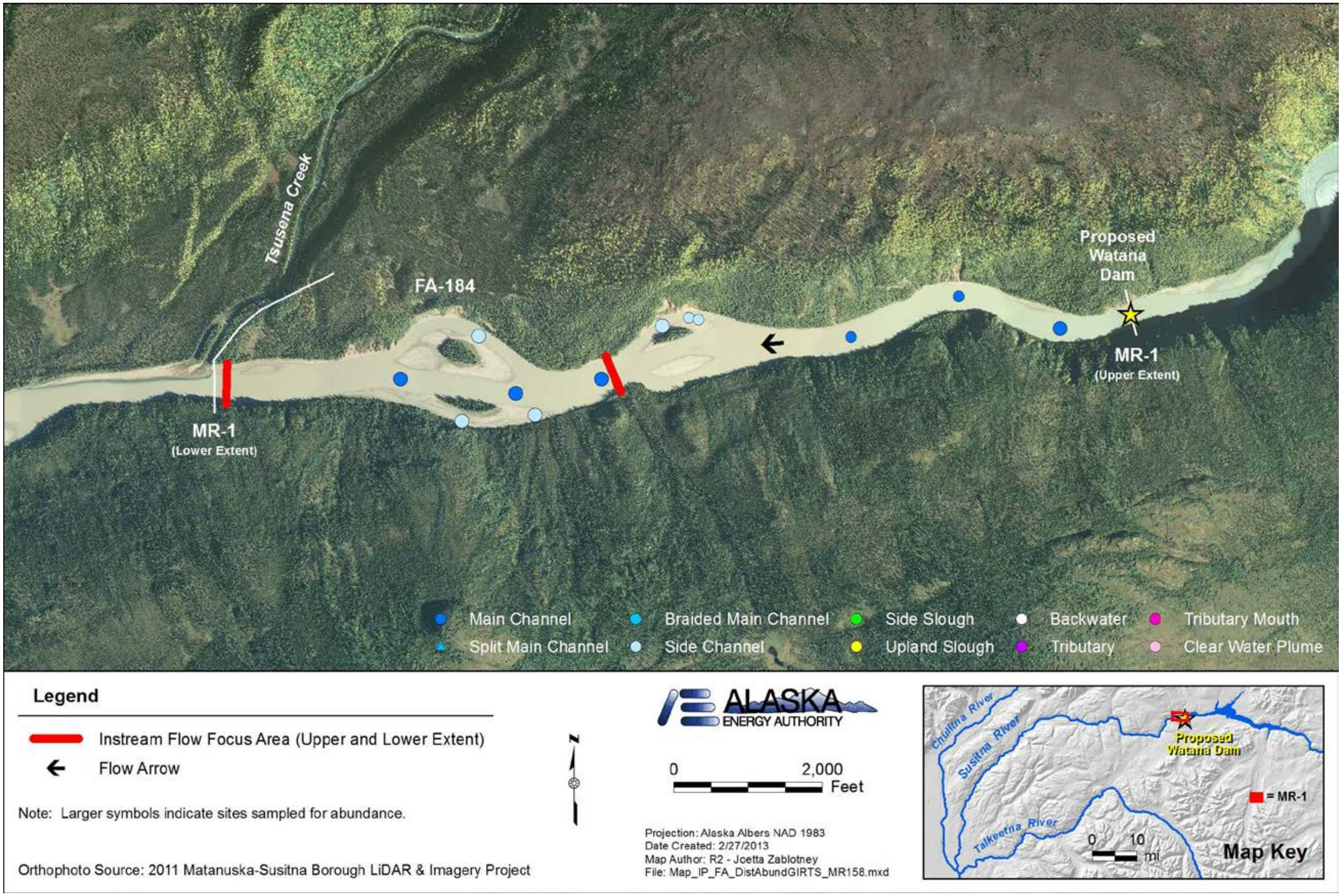

Figure 9.6-2. GRTS site selection by habitat type for Geomorphic Reach MR-1.

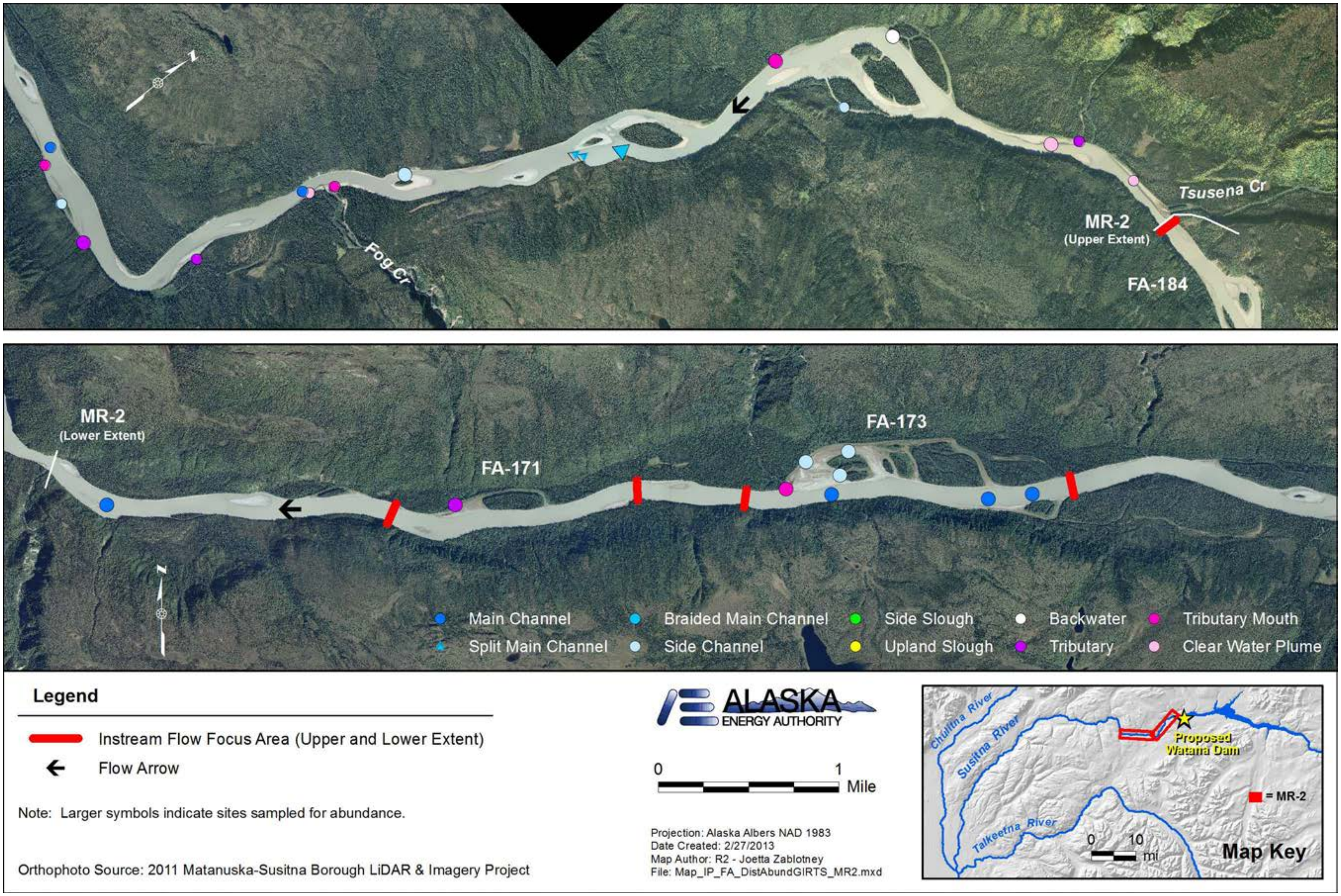

Figure 9.6-3. GRTS site selection by habitat type for Geomorphic Reach MR-2.

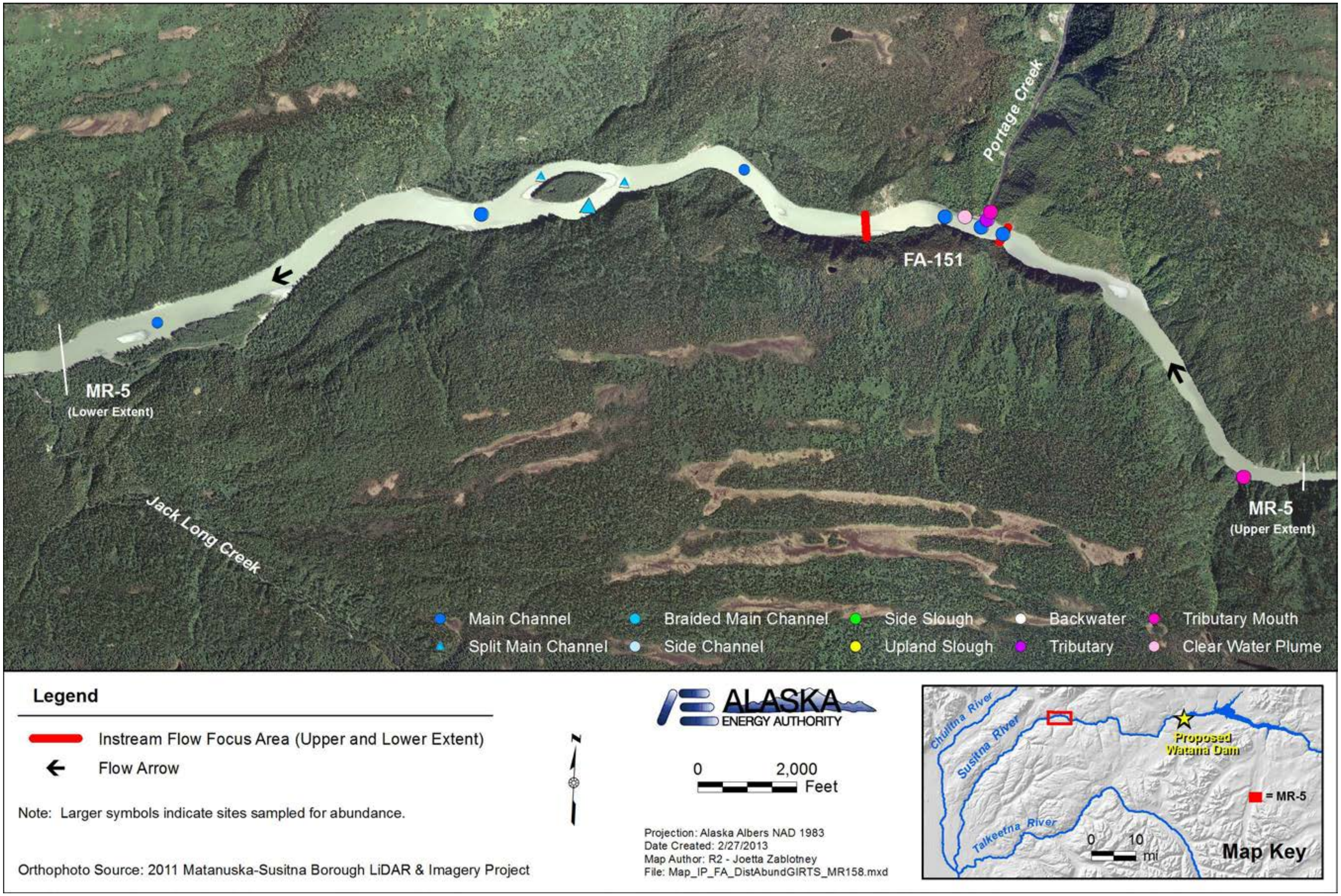

Figure 9.6-4. GRTS site selection by habitat type for Geomorphic Reach MR-5.

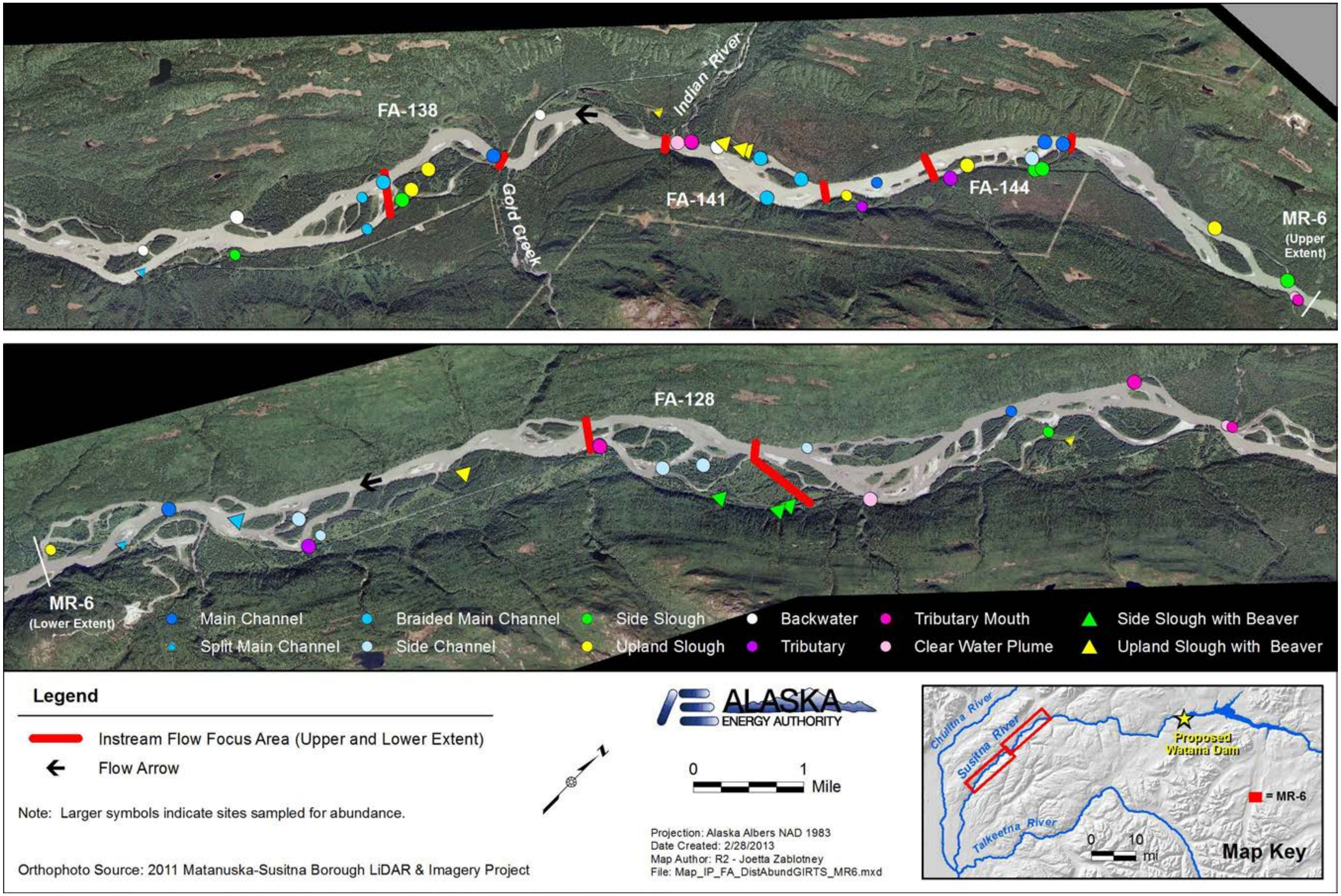

Figure 9.6-5. GRTS site selection by habitat type for Geomorphic Reach MR-6.

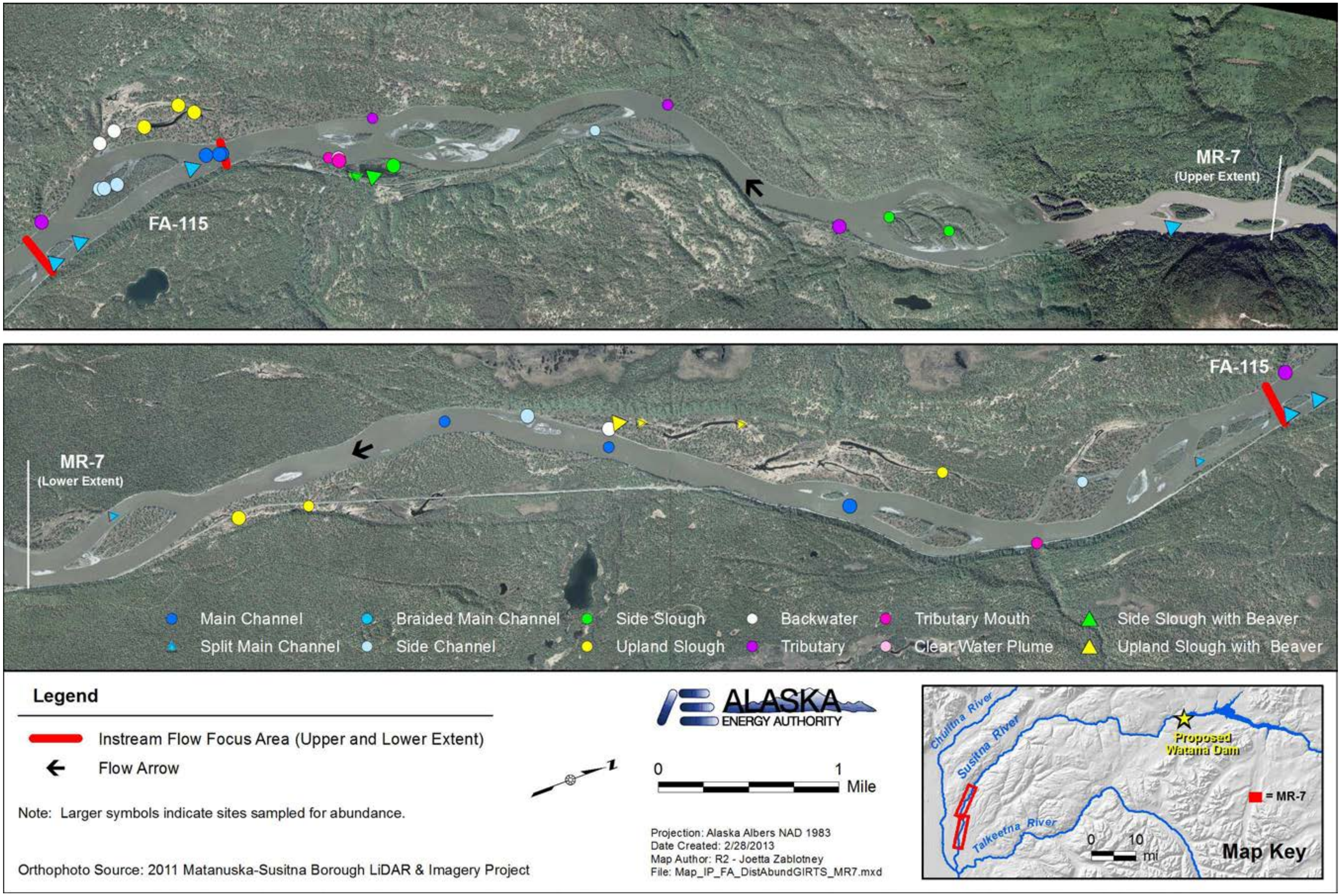

Figure 9.6-6. GRTS site selection by habitat type for Geomorphic Reach MR-7.

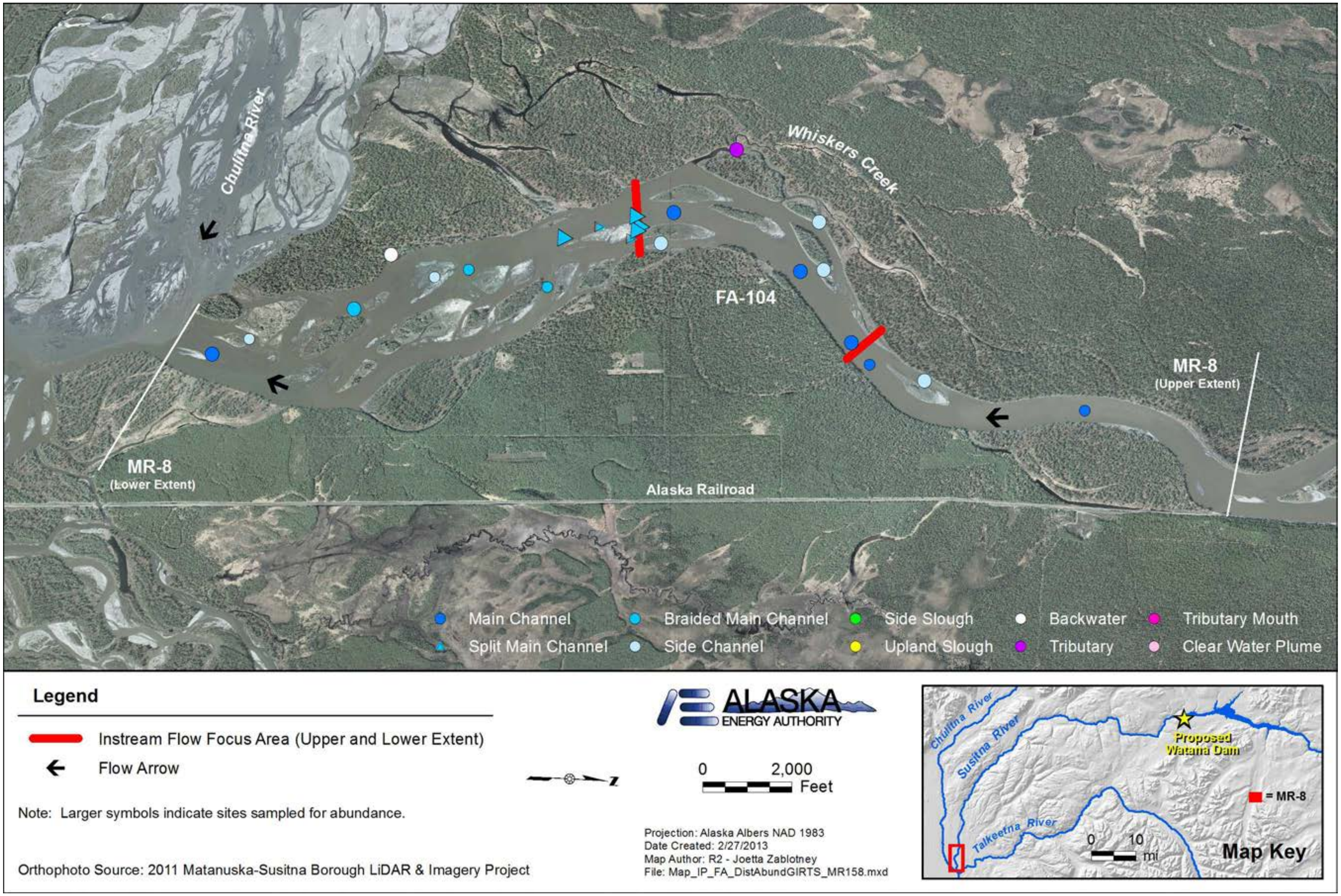

Figure 9.6-7. GRTS site selection by habitat type for Geomorphic Reach MR-8.

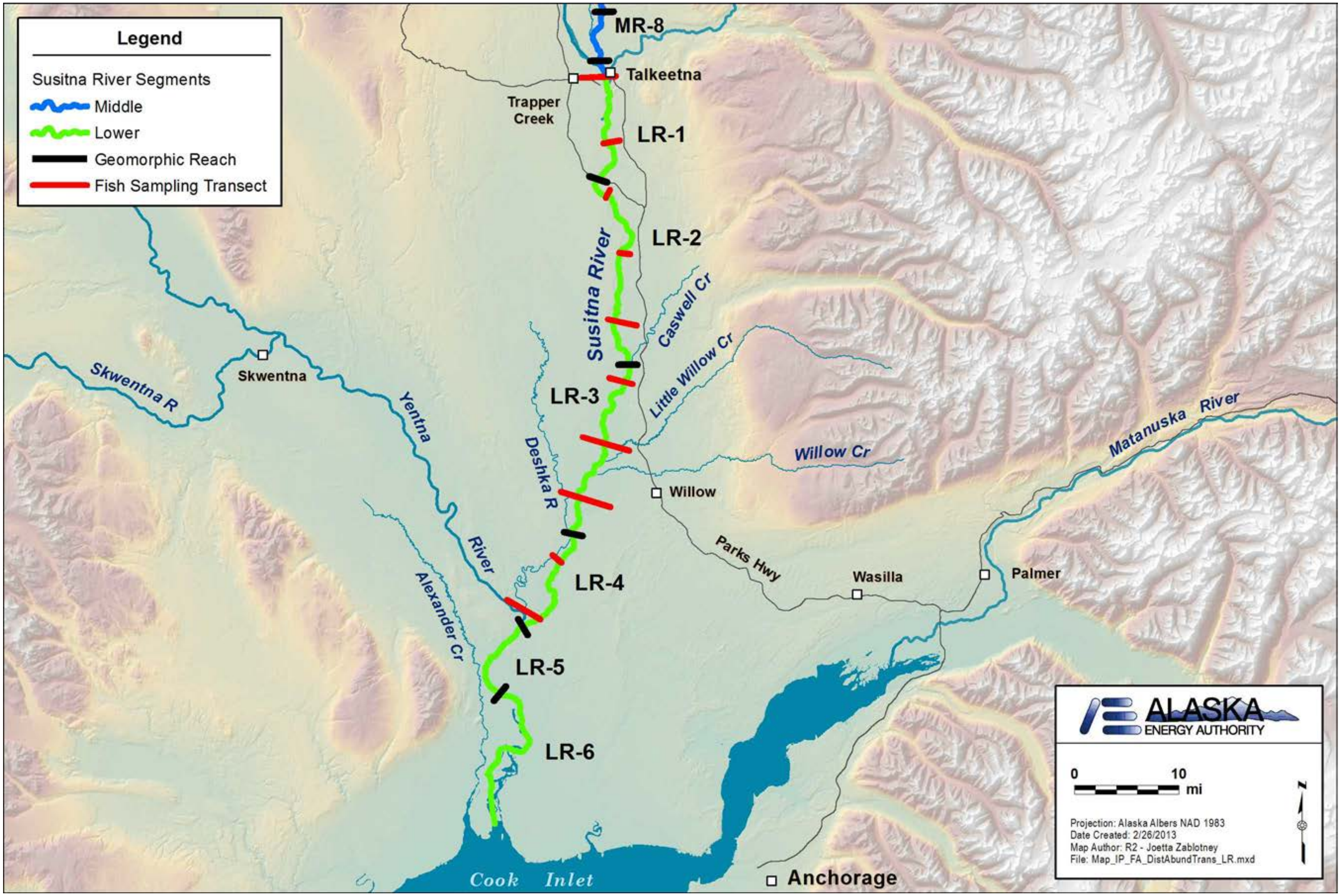

Figure 9.6-8. Fish distribution and abundance sampling transects in the Lower Susitna River. Transect widths represent width of the active floodplain.

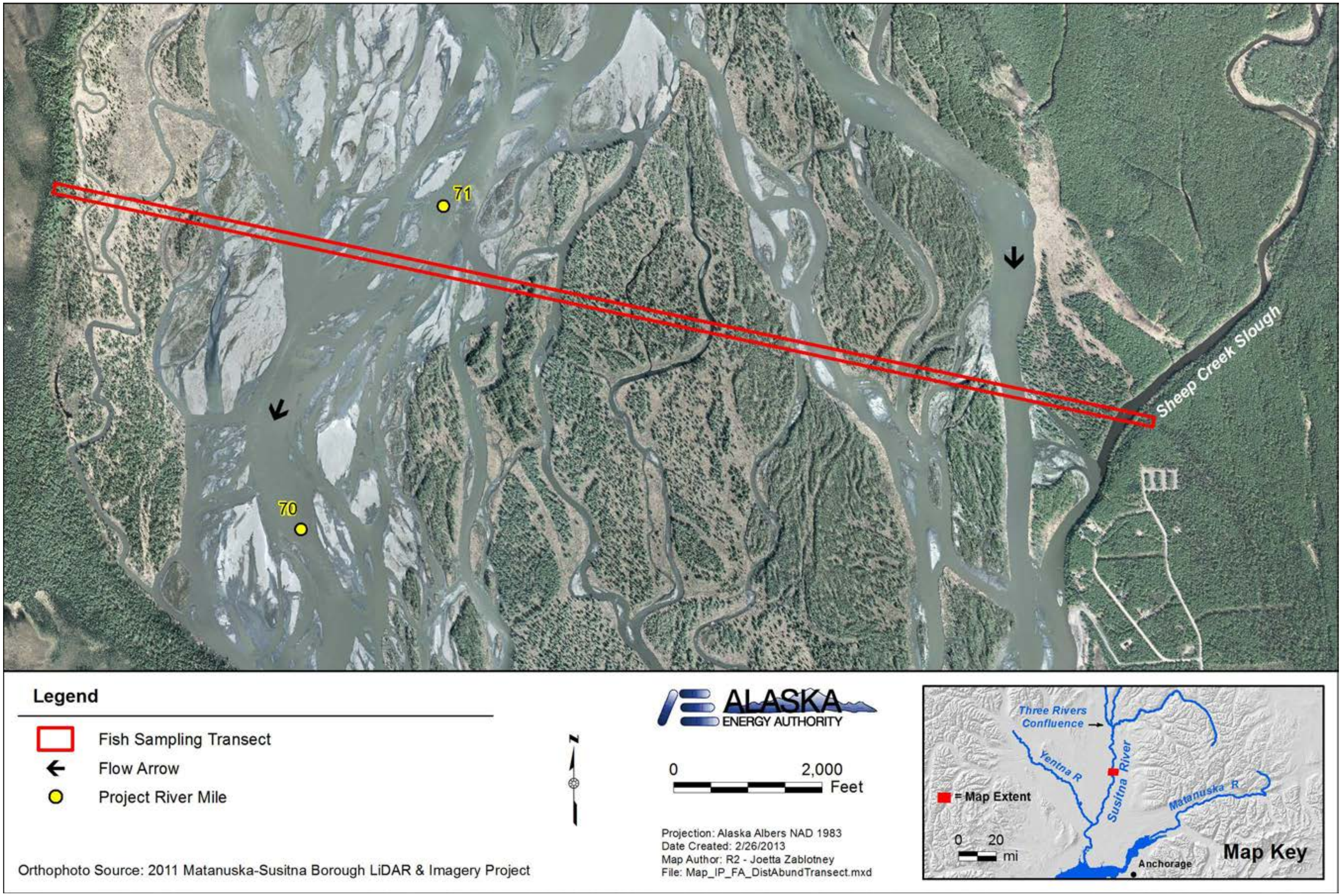

Figure 9.6-9. Example of a fish distribution and abundance sampling transect at RM 70.8 in the Lower Susitna River.

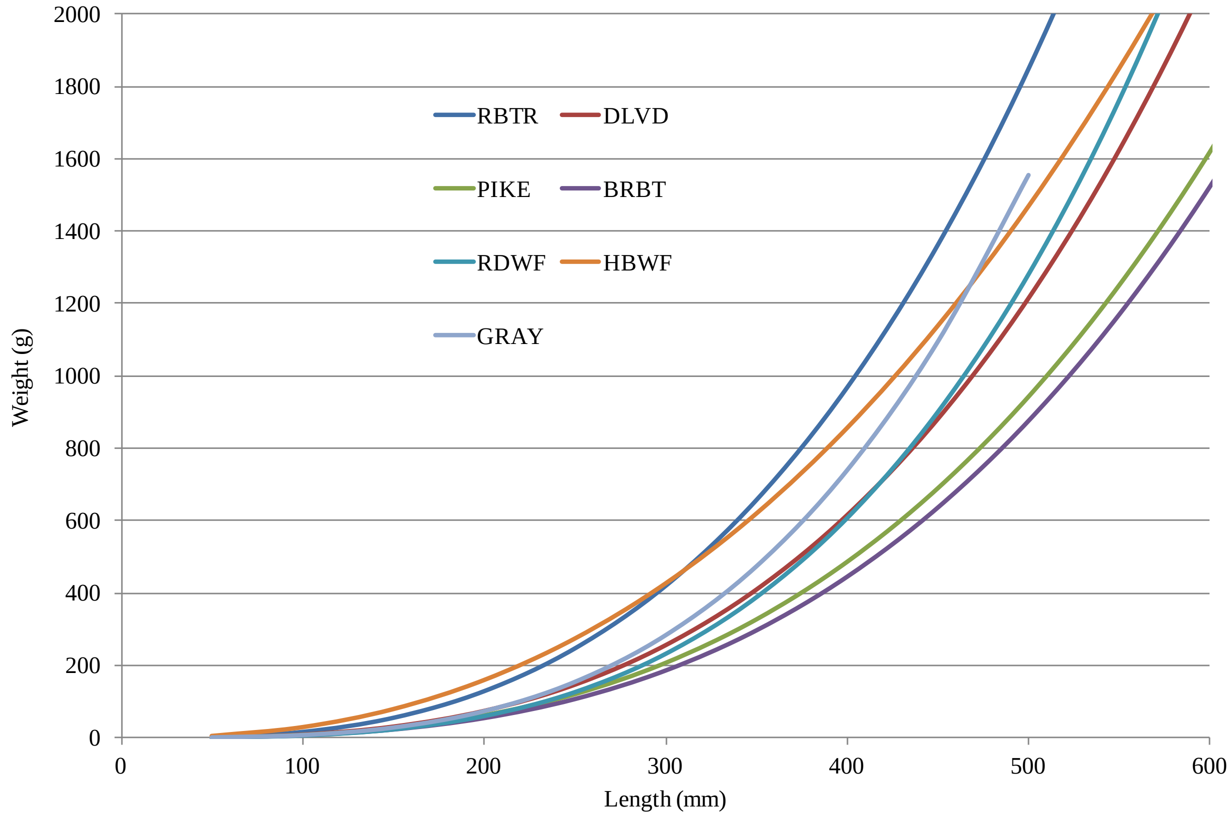

Figure 9.6-10. Existing or derived length-weight relationships for fish species to be radio-tagged.

Figure 9.6-11. Distribution of winter sampling sites in Slough 8A, Susitna River.

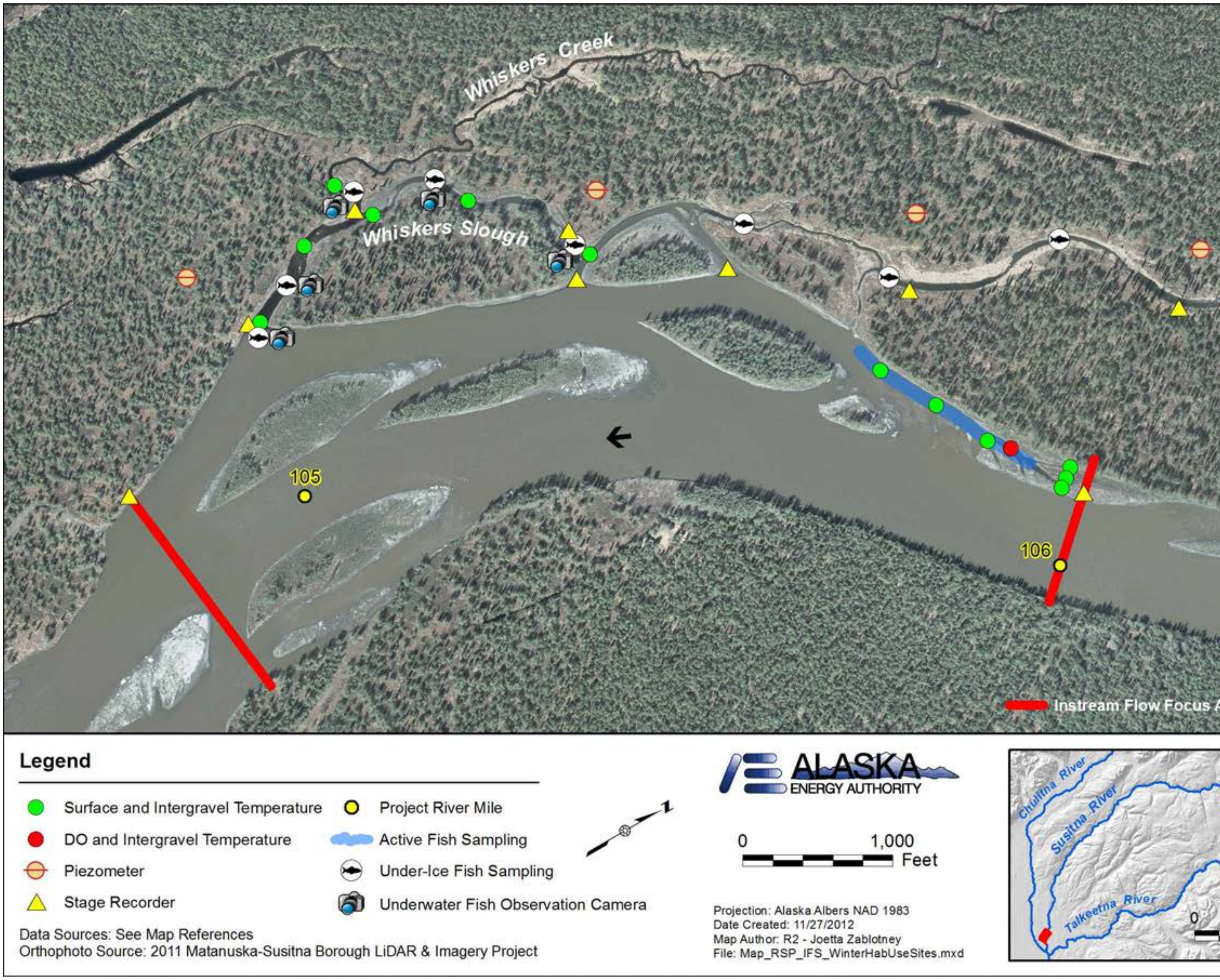

Figure 9.6-12. Distribution of winter sampling sites in Whiskers Slough, Susitna River.

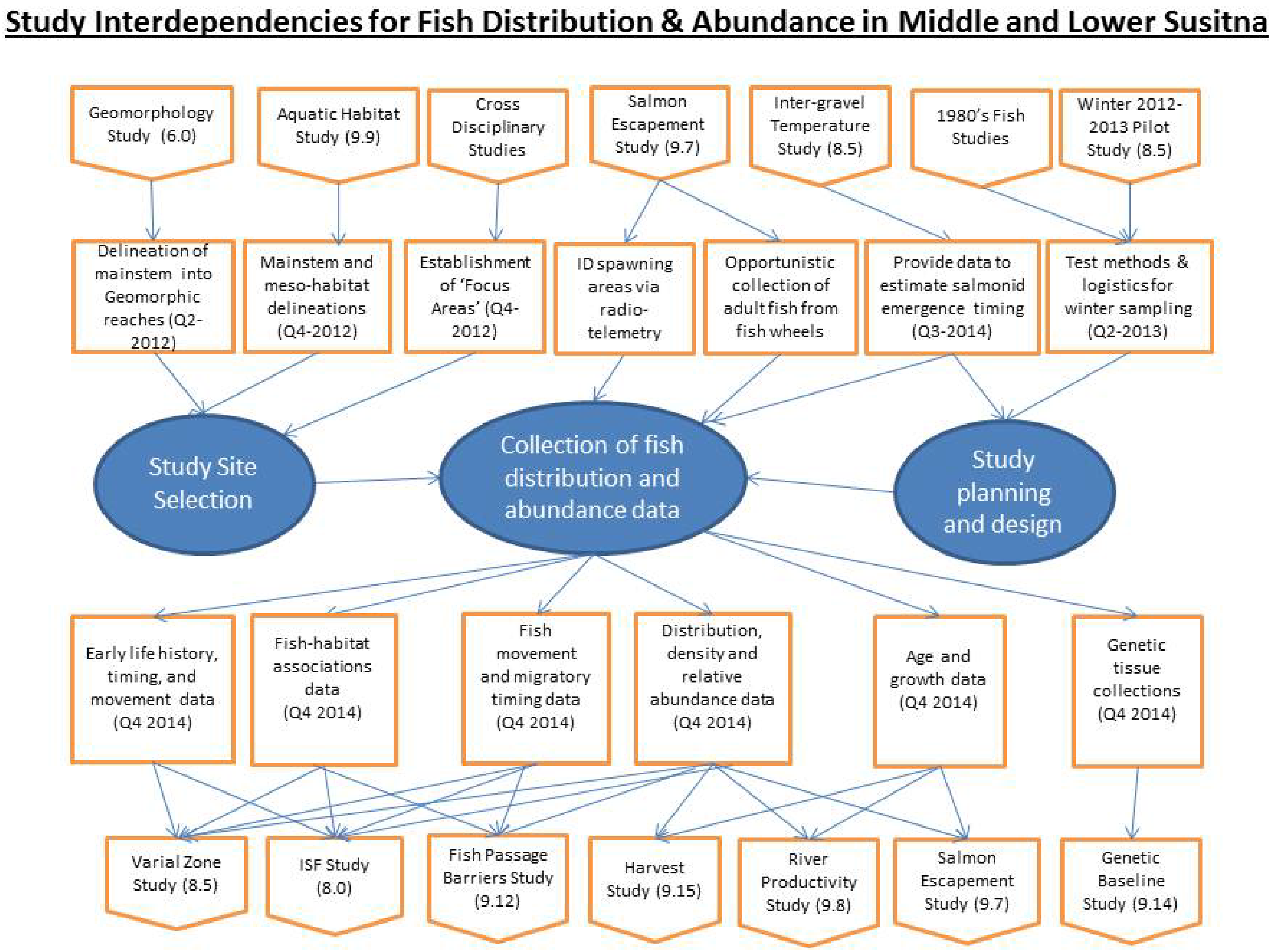

Figure 9.6-13. Flow chart of study interdependencies for Fish Distribution and Abundance in the Middle and Lower Susitna River Study Plan.