Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Study of Fish Distribution and Abundance in the Upper Susitna River
Study Plan Section 9.5

Final Study Plan

Alaska Energy Authority

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

August 2013

9.5. Study of Fish Distribution and Abundance in the Upper 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 Fish Distribution and Abundance in the Upper Susitna River, Section 9.5. RSP Section 9.5 focuses on describing the current fish assemblage including spatial and temporal distribution, and relative abundance by species and life stages in the Susitna River upstream 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 Susitna River Fish Distribution and Abundance Implementation Plan (FDA IP) was filed with FERC on January 31, 2013 and was subsequently presented and discussed during a Technical Work Group (TWG) meeting on February 14, 2013. With consideration of the comments and suggestions received from licensing participants, a 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 9.5 was one of the 13 approved with modifications. In its April 1 SPD, FERC recommended the following:

Tributary Sampling Lengths

> *- We recommend that the sampling unit lengths for the seven accessible tributaries and four tributaries with unknown accessibility that would be subject to the GRTS sampling design, as specified in section 5.2 of the Implementation Plan, include the entire classified mesohabitat for those units less than 200 meters, 400 meters, or 800 meters in length (as proposed based on basin area) or sampling units of these lengths, whichever is smaller, rather than the proposed 40-meter subsample.*

Mainstem Sampling Lengths

> *- 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.*

Sample Timing

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

Catch Per Unit Effort Metrics

- 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).

Outmigrant Trap Locations

- We recommend that AEA install and operate one additional outmigrant trap in the mainstem Susitna River, downstream of the mouth of Kosina Creek near the proposed dam site. The actual location should be selected after consultation with the TWG.

Resident Fish Radio Telemetry Tagging

- 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 should 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 should be allocated for tagging adult whitefish prior to spawning in early September; and (4) a minimum of 10 tags should 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 detail.

9.5.1. 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 upstream of the proposed Watana Dam. Fishery resources in the upper sections of the Susitna River basin consist of a variety of salmonid and non-salmonid resident fish (Table 9.5-1). With one known exception (i.e., Chinook salmon), existing information indicates that anadromous fish are restricted to the mainstem Susitna River and tributaries downstream of Devils Canyon near RM 150 due to their apparent inability to pass several steep rapids. In addition to investigating the resident salmonid and non-salmonid fishes present in this part of the river, this study will also investigate the distribution and abundance of any anadromous fish above the proposed Watana Dam site. Chinook salmon have been observed in relatively low numbers above Devils Canyon (maximum peak count of 46 adult Chinook salmon during 1984; Thompson et al. 1986).

The physical habitat modeling efforts proposed in the Fish and Aquatics Instream Flow Study (Section 8.5) 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 Upper 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.

This study is designed to provide baseline biological information regarding periodicity and habitat suitability for the Instream Flow Modeling Study (see Section 8.5). Results of this study will include key life history information about fish species in the Upper Susitna River, which will provide inputs for the Study of Fish Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Section 9.12) and the Study of Fish Passage Feasibility at Watana Dam (Section 9.11).

Study Goals and Objectives

The overarching goal of this study is to characterize the current distribution, relative abundance, run timing, and life history of resident and non-salmon anadromous species (e.g., Dolly Varden, humpback whitefish, round whitefish, Arctic grayling, northern pike, and Pacific lamprey), and freshwater rearing life stages of anadromous fish (fry and juveniles) in the Susitna River above the proposed dam site (RM 184). Specific objectives include the following:

1. Describe the seasonal distribution, relative abundance (as determined by catch per unit effort [CPUE], fish density, and counts), and fish-habitat associations of resident fishes, juvenile anadromous salmonids, and the freshwater life stages of non-salmon anadromous species.
2. Describe seasonal movements of juvenile salmonids and selected fish species such as rainbow trout, Dolly Varden, humpback whitefish, round whitefish, northern pike, Pacific lamprey, Arctic grayling and burbot within the hydrologic zone of influence upstream of the Project.
    a. Document the timing of downstream movement and catch using out-migrant traps.
    b. Describe seasonal movements using biotelemetry (passive integrated transponders [PIT] and radio-tags).
    c. Describe juvenile Chinook salmon movements.
3. Characterize the seasonal age class structure, growth, and condition of juvenile anadromous and resident fish by habitat type.
4. Determine whether Dolly Varden and humpback whitefish residing in the Upper River exhibit anadromous or resident life histories.
5. Determine baseline metal concentrations in fish tissues for resident fish species in the mainstem Susitna River (see Section 5.5 Water Quality and Section 5.7, Mercury Assessment and Potential for Bioaccumulation Study).
6. Document the seasonal distribution, relative abundance, and habitat associations of invasive species (northern pike).
7. Collect tissue samples to support the Genetic Baseline Study for Selected Fish Species (Section 9.14).

9.5.2. 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 during studies in connection with Alaska Power Authority's (APA's) proposed Susitna Hydroelectric Project in the 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.

A total of nine anadromous and resident fish species have been documented inhabiting the Susitna River drainage upstream of Devils Canyon (Table 9.5-1). Chinook salmon use of the Upper Susitna River was first documented during the 1980s studies; this is the only anadromous fish documented to pass the rapids at Devils Canyon. 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 (Schmidt et al. 1985; Buckwalter 2011). To varying degrees, the relative abundance and distribution 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.

One species that has not been documented in the Susitna River, but may occur in the upper Susitna drainage, is lake trout. 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 River (Rutz 1999). Although it is considered unlikely that Pacific lamprey and northern pike are present in the Upper Susitna River, this study will be helpful for evaluating these species' distributions.

In the proposed impoundment zone, Arctic grayling are believed to be the most abundant fish species (Delaney et al. 1981a; Sautner and Stratton 1983) and were documented spawning in tributary pools. In tributaries, juvenile grayling were found in side channels, side sloughs, and pool margins and in the mainstem at tributary mouths and clear water sloughs during early summer. Dolly Varden populations in the Upper Susitna River are apparently small but widely distributed. Burbot in the Upper Susitna River were documented in mainstem habitats with backwater-eddies and gravel substrate. The abundance of longnose suckers in the Upper Susitna River was less than downstream of Devils Canyon. Specific information needs relative to fish distribution and abundance in the Upper Susitna River that were identified in the ARDGA (AEA 2011b) include the following:

- Population estimates of adult Arctic grayling and Dolly Varden in select tributaries within the proposed impoundment zone.
- The migration timing of Arctic grayling spawning in the proposed impoundment zone, the relative abundance and distribution of Dolly Varden, lake trout, and juvenile Chinook salmon in the impoundment zone.
- Physical habitat characteristics used by round whitefish, longnose sucker, and burbot within the impoundment zone.

Little is known about the density and distribution of juvenile salmon in the Susitna River upstream of Devils Canyon (RM 150) and the proposed dam site at RM 184. All five species of Pacific salmon were captured in the Lower and Middle Susitna River during the 1980s licensing studies. Coho, chum, sockeye, and pink salmon have not been observed upstream of the Devils Canyon rapids. Chinook salmon are the only anadromous species known to occur in the Upper Susitna River and tributaries although the information on the extent of their distribution is limited. In 1984, Chinook spawning was documented upstream of Devils Canyon but downstream of the proposed dam site at Chinook Creek (RM 156.8), and Fog Creek (RM 176.7) (ADF&G 1985). More recent sampling has documented adults in Fog and Tsusena Creeks (RM 181.3) and upstream of the proposed dam site in Kosina Creek (RM 201). Juvenile Chinook salmon have been documented recently upstream of Devils Canyon in Fog Creek, and upstream of the proposed dam site in Kosina Creek, and in the Oshetna River (RM 225) (Buckwalter 2011). Historic data indicate that Susitna River Chinook salmon spawn exclusively in tributary streams (Thompson et al. 1986;Barrett et al.1983; Barrett 1974, 1985) and that nearly all Chinook salmon juveniles in this system out-migrate to the ocean as age-1+ fish, and very few exit the system as fry.

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

- **F1:** Effect of change from riverine to reservoir lacustrine habitats resulting from Project development on aquatic habitats, fish distribution, composition, and abundance, including primary and secondary productivity.
- **F2:** Potential effect of fluctuating reservoir surface elevations on fish access and movement between the reservoir and its tributaries and habitats.
- **F3:** Potential effect of Watana Dam on fish movement.

Site-specific knowledge of the distribution, timing, and abundance of fish likely to occupy the proposed Watana Reservoir primarily depends on 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 the functional relationship with the habitat types present. However, any significant differences in the patterns in abundance and distribution observed during the 1980s compared to current conditions need to be determined.

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

9.5.3. Study Area

The study area encompasses the mainstem Susitna River from the proposed Watana Dam site (RM 184) upstream to the Oshetna River confluence (RM 233.4) (Figure 9.5-1). The Upper Susitna River is delineated by the location of the proposed Watana Dam because effects of the Project are anticipated to be different upstream and downstream of the proposed dam. The mainstem Susitna River and its tributaries upstream of the proposed dam will 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. Tributary surveys upstream of the proposed Watana Dam are further delineated by the 3,000-foot elevation contour, which is based on the known extent of juvenile Chinook salmon distribution. Some study components, such as resident fish life-history studies and juvenile Chinook salmon distribution sampling, may extend beyond the core area.

9.5.4. 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 Upper 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. This study was initiated in 2012 and will continue over the next two years to survey as much habitat as possible. Refined and detailed study methods are presented in the Fish Distribution and Abundance Implementation Plan (FDA IP). The refinements in the IP are intended to support the methods described below and would in fact supersede any methods detail provided below.

Fish Distribution and Abundance Sampling 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 FDA IP, for Sections 9.5 and 9.6. 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. FDA IP development includes (1) a summary of relevant fisheries and an overview of the life history needs for fish species known to occur in the Susitna River to guide site selection and sampling protocols, (2) a review of the preliminary results of habitat characterization and mapping efforts (Section 9.9), (3) a description of site selection and sampling protocols, (4) development of field data collection forms, (5) development of database templates that comply with 2012 AEA QA/QC procedures, and (6) FERC's requested modifications included in the April 1 SPD. The FDA IP 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 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. Proposed sampling methods by objective are presented below and in Table 9.5-2. Brief descriptions of each sampling technique are provided in Section 9.5.4.4.

9.5.4.1. Study Site Selection

The Upper Susitna River will represent an area where the mainstem river will be inundated and tributaries will be partially altered. As a result, the sampling effort will be tailored to collect necessary information to document fish assemblages, distribution, and abundance generally within the mainstem river and more intensely within the tributary habitat inundated up to an elevation of 3,000 feet.

A nested stratified sampling scheme will be used to select study sites to cover the range of habitat type. The habitat classification hierarchy, as described in Section 9.9.5.4.1 of the Habitat Classification Study, will be composed of five levels representing (1) major hydraulic segment; (2) geomorphic reach; (3) mainstem habitat type; (4) main channel mesohabitat; and (5) edge habitat (Table 9.9-4, Nested and tiered habitat mapping units and categories).

Level 1 will generally identify the Lower River (RM 28-98), Middle River (RM 98-184), and Upper River (RM 184-233) from each other. The mainstem Susitna River and its tributaries upstream of the proposed dam will 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. In contrast, the mainstem downstream of the Project will be subject to the effects of flow modification from Project operations, which will diminish below the Three Rivers Confluence.

Level 2 will identify unique reaches established from the channel's geomorphic characteristics (established from the Geomorphology Study [Section 6.0]). The Geomorphic Study Team will delineate the Lower, Middle, and Upper River segments into large-scale geomorphic river reaches 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.

Level 3 classifies the mainstem habitat into main channel, off-channel, and tributary habitat using an approach similar 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 (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 (main channel, split main channel, multiple split main channel, side channel, and tributary), and four types of off-channel (slide slough, upland slough, backwater, and beaver complex) (Table 9.9-4).

Level 4 will further delineate Level 3 main channel and tributary habitats into mesohabitat types (pool, riffle, glide, and cascade) (Table 9.9-4). However, off-channel habitat will remain at Level 3 (side slough, upland slough, backwater, and beaver complex).

The presence, distribution, and frequency of these habitats vary longitudinally within the river depending in large part on its confinement by adjoining floodplain areas, size, and gradient. Thus, fish sampling in the Upper River will necessarily vary with habitat and will not be stratified equally among geomorphic reaches (Level 2). 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 UR1 and UR6 but not in the more confined and incised reaches UR2 through UR5. In order to ensure that representative habitats are sampled along the Upper River, six replicate sampling sites will be selected within each Level 3 habitat type for fish distribution sampling (27 sites). In addition, one replicate of each Level 4 main channel habitat nested within each Level 3 habitat will be selected for relative abundance sampling (Figure 9.5-2).

Habitat mapping in the tributaries will be completed differently than in the mainstem river due to the lack of complete aerial imagery, relatively smaller channel size, steep gradient, and limited on the ground accessibility for direct mapping. Because of this general inaccessibility, very rugged terrain, and mostly non-wadeable stream channels, near census mapping (100 percent coverage) is challenging and in some cases unsafe or impossible. For these reasons, only tributaries mapped by the Characterization and Mapping of Aquatic Habitats Study (Section 9.9; Table 9.9-2) will be selected for fish distribution and abundance sampling. Up to 18 tributary streams will be targeted for sampling during 2013 and 2014. All tributaries in which Chinook salmon juveniles or adults were observed within or at the mouth of a tributary during 2012, or during previous surveys by Buckwalter (2011) (i.e., Fog Creek, Kosina Creek, Tsusena Creek, Oshetna River), will be sampled. Of the remaining tributaries that are suitable for sampling (Table 9.9-2), efforts will be directed towards streams that are not already identified as supporting anadromous fishes in the ADF&G Anadromous Waters Catalog (AWC). Selected study sites will comprise a target of 25 percent of the mapped habitats in each tributary; this target will vary with access considerations. All known Chinook salmon-bearing tributaries will be sampled up to the 3,000-foot elevation contour, which is based on the known extent of Chinook salmon distribution.

Site selection includes first completing the geomorphic reach delineation and habitat mapping tasks. In addition to technical considerations, access and safety will be key non-technical attributes for site selection for all studies. This, too, influenced site selection in the 1980s studies, and will certainly influence site selection in the present studies.

9.5.4.2. Sampling Frequency

Sampling frequency will vary among sites based on specific objectives. Generally, fish distribution and abundance sampling will occur seasonally during the ice-free period in mid-July, and again in either late August or early September. Additional effort, up to bi-weekly sampling, will be required immediately following ice-out in an attempt to capture critical juvenile Chinook salmon out-migration from natal tributaries to rearing habitats.

9.5.4.3. Fish Sampling Approach

The initial task of this study will consist of a focused literature review to guide selection of appropriate sampling 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 techniques 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.

9.5.4.3.1. 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 CPUE and 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 they are repeatable on subsequent sampling occasions. This approach will also emphasize the identification of foraging and spawning habitats.

Long daylight hours during the summer may reduce the difference between day and night sampling effectiveness. The periods of twilight are important sampling periods. Sampling schedules will encompass daylight, twilight, and evening periods.

Task A: Fish Distribution Surveys

Fish distribution surveys will include seasonal sampling events during the ice-free seasons. 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.

Survey methods will likely vary for the different study areas in the Upper Susitna River. 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 about 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.

Task B: Relative Abundance

Relative abundance surveys will include seasonal multi-pass sampling events during the ice-free seasons. As mentioned above, methods will be selected based on species, life stage, and water conditions. 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.

9.5.4.3.2. 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 Upper Susitna River to the proposed dam site (RM 184) is important for assessing the potential effects of the proposed Project. Out-migrant traps (rotary screw traps and inclined plane traps) are useful for determining the timing of downstream migrating juvenile salmonids and resident fish.

A maximum of two out-migrant traps will be deployed. 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 C), recapturing previously tagged fish, collecting fish for stomach contents analysis in support of the River Productivity Study (Section 9.8), and collecting tissue samples (Objective 7) to support the Genetic Baseline Study for Selected Fish Species (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 Upper River.

PIT tag antenna arrays with automated data logging will be used at selected side channels and tributary mouths to detect movement of tagged fish into or out of the site. 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 and by boat, in conjunction with the Salmon Escapement Study (Section 9.7) to describe seasonal movements of selected fish species with emphasis on identifying spawning and overwintering habitats within the hydrologic zone of influence upstream of the Project.

Up to 30 radio transmitters will be implanted in selected species including Arctic grayling, Dolly Varden, burbot, round whitefish, humpback whitefish, and northern pike if present (Objective 6).

A PIT tag will be implanted into up to 1,000 fish of these species per PIT tag array that are in close proximity to an array and approximately 60 mm and larger.

Task C: Describe juvenile Chinook salmon movements.

Juvenile Chinook salmon movement within the Upper River will be described using out-migrant traps and biotelemetry methods outlined in Objective 2, Tasks A and B. This study proposes to implant PIT tags in all juvenile Chinook salmon >60 mm in length to document seasonal movement within the Upper River using antenna arrays placed in tributary mouths, sloughs, and side channels and on out-migrant traps to recapture fish. Because of the low number of adult Chinook salmon tracked to the Upper River with radio-tags in 2012, all juvenile Chinook salmon of taggable size need to be tagged to obtain a sufficient sample size. Out-migrant traps will be used to document juvenile Chinook salmon migratory timing and size at migration from natal tributaries to the Upper River and out-migration from the Upper River to below the proposed dam site (RM 184). The data on juvenile Chinook salmon movement patterns and timing will support the Study of Fish Passage Feasibility at Watana Dam (Section 9.11).

9.5.4.3.3. Objective 3: Characterize the seasonal age class structure, growth, and condition *of juvenile anadromous and resident fish by habitat type.*

In conjunction with Objectives 1 and 2, all captured fish will be identified to species, measured to the nearest millimeter (mm) fork length, and weighed to the nearest gram. 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.

9.5.4.3.4. Objective 4: Determine whether Dolly Varden and humpback whitefish residing in the Upper River exhibit anadromous or resident life histories.

Otoliths will be collected from Dolly Varden and humpback whitefish greater than 200 mm (7.8 inches) in length to test for marine-derived elements indicative of an anadromous life history pattern. It is assumed that larger fish are more likely to have exhibited anadromy and therefore otolith collection is proposed only from fish greater than 200 mm in length. A target of 30 fish of each species during 2013 and 2014 will be collected (60 fish of each species total).

9.5.4.3.5. Objective 5: Determine baseline metal and mercury concentrations in fish tissues for resident fish species in the mainstem Susitna River.

Tissue or whole fish samples will also be collected in the mainstem Susitna River for assessment of metals (see Section 5.5.4.7, Baseline Metal Levels in Fish Tissue) and mercury (see Section 5.7.4.2.6, Mercury Assessment and Potential for Bioaccumulation Study) concentrations. Target fish species for baseline metals testing include: Dolly Varden, Arctic grayling, whitefish species, long nose sucker, lake trout, burbot, and resident rainbow trout. Target fish species for mercury sampling include: Dolly Varden, arctic grayling, stickleback, long nose sucker, whitefish species, lake trout, burbot, and resident rainbow trout.

9.5.4.3.6. 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 its effect on salmonids and other species such as stickleback. At this time, northern pike have not been documented in the Upper River, so no targeted collection effort for pike will be made. However, the presence/absence and habitat associations of northern pike and other invasive fish species will be documented as a component of all fish capture and observation sampling events associated with Objectives 1 and 2.

9.5.4.3.7. Objective 7: Collect tissue samples from juvenile salmon and all resident and non-salmon anadromous fish.

In support of the Genetic Baseline Study for Selected Fish Species (Section 9.14), fish tissues will be collected opportunistically in conjunction with all fish capture events. The target number of samples, species of interest, and protocols are outlined 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.

9.5.4.4. Fish Sampling Techniques

A combination of gillnetting, electrofishing, angling, trot lines, minnow traps, snorkeling, out-migrant trapping, beach seines, fyke nets, hoop nets, dual-frequency identification sonar (DIDSON), and underwater video camera techniques will be used to sample or observe fish in the Upper River, and moving in and out of selected sloughs and tributaries draining to the Susitna River. Several assumptions are associated with the use of the proposed methods:

- If it can be conducted safely, snorkeling, electrofishing, and gillnetting will require nighttime sampling in clear-water areas to increase the efficacy of fish capture or observation.
- Gillnetting is likely the most effective means of capturing fish in open-water areas of the main Susitna River channel.
- All fish sampling and handling techniques described within this study 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.
- Fish sampling techniques provide imperfect estimates of habitat use and relative fish abundance. Use and comparison of multiple sampling methods provides the opportunity to identify potential biases, highlight strengths and weaknesses of each method, and ultimately improve estimates of fish distribution and relative abundance.
- Sampling in the reservoir inundation zone will be scaled based on elevation and Chinook salmon distribution. More intensive surveys will be conducted in tributaries to be inundated up to an elevation of 2,200 feet. Sampling from 2,200 feet to 3,000 feet elevation will be focused on Chinook salmon. If Chinook salmon are located, sub-sampling will continue upstream to the upper extent of suitable Chinook salmon habitat.

9.5.4.4.1. Gillnet Sampling

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. 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:

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

9.5.4.4.2. 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 otherwise 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.

9.5.4.4.3. 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 (e.g., 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.

9.5.4.4.4. Trot Lines

Trot lines can be an effective method for capturing burbot, rainbow trout, Dolly Varden, grayling, and whitefish. Trotlines are typically a long line with a multitude of baited hooks and are typically anchored at both ends and set in the water for a period of time. 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 herring or whitefish are effective for burbot. Trot line construction and deployment will follow the techniques used during the 1980s studies as described by 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.

9.5.4.4.5. 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 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, 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.

9.5.4.4.6. 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 turbid 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.

9.5.4.4.7. 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.

9.5.4.4.8. 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 meters (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 centimeters (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 and 2). Soak times will generally be overnight, but not more than 12 hours (M. Evenson pers comm 2012). All burbot captured will be measured and released. Up to 10 radio tags will be surgically implanted in burbot spatially distributed throughout the Upper Susitna River.

9.5.4.4.9. Beach Seine

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 5 feet in depth and 40 feet in length, 1/4-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.

9.5.4.4.10. Out-Migrant Trap

Rotary screw traps are useful for determining the timing of emigration by downstream migrating juvenile salmonids and resident fish (Objective 2). Out-migrant traps will be installed in a maximum of three sites: one site located near the proposed Watana Dam, one site near a tributary mouth, and one site in the mainstem Susitna River, downstream of the mouth of Kosina Creek near the proposed dam site. The location will occur with input from the Fish and Aquatic TWG and will be based on the physical conditions at the selected sites and logistics for deploying, retrieving, and maintaining the traps. 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.

9.5.4.4.11. 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 100 individuals per species per life stage per season will be measured to the nearest mm fork length, and in Focus Areas up to 30 fish per species per site will be measured on a monthly basis. 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 10, 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. If present, observations of poor fish condition, lesions, external tumors, or other abnormalities will be noted. 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, 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 a sub-sample of fish of these species that do not have tags and are approximately 60 mm and larger. Because Chinook salmon are of particular interest and in low abundance, all captured juvenile Chinook salmon of taggable size will receive tags. For selected species, up to 1,000 fish per species per PIT tag array will be tagged based on proximity to PIT arrays. Target species are Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic grayling, and burbot. Radio transmitters will be surgically implanted in up to 30 adult fish of sufficient body size of each species and distributed temporally and longitudinally in the Upper River.

In support of the bioenergetics modeling (Objective 5, Section 9.8.4.5.1), fish species targeted for dietary analysis will include juvenile Chinook and coho salmon, juvenile and adult rainbow trout. Of these species Chinook salmon and rainbow trout may be encountered in the Upper River. A total of five fish per species/age class per sampling site collection will be sampled for fish stomach contents, using non-lethal methods (described in Section 9.8.4.7). 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. At two selected sample collection locations (one each in Upper and Middle River), punch samples of muscle tissue will be obtained from each fish for use in the stable isotope analysis (Section 9.8.4.5.2).

Otoliths will be collected from Dolly Varden and humpback whitefish greater than 200 mm (7.8 inches) in length to test for marine-derived elements indicative of an anadromous life history pattern (Objective 4). It is assumed that larger fish are more likely to have exhibited anadromy and therefore it is proposed to collect otoliths only from fish greater than 200 mm. A target of 30 fish of each species during 2013 and 2014 will be collected (60 fish of each species total). Tissue, fillets, and/or liver (burbot only) samples will also be collected in the mainstem Susitna River for assessment of metals concentrations (Objective 5) (see Section 5.5.4.7 Water Quality and Section 5.7.4.2.6, Mercury Assessment and Potential for Bioaccumulation Study). Target fish species in the vicinity of the Watana Reservoir will be Dolly Varden, Arctic grayling, stickleback, whitefish species, burbot, longnose sucker, and resident rainbow trout. If possible, fillets will be sampled from seven adult individuals from each species. Larger, older fish tend to have higher mercury concentrations; these fish will therefore be targeted with a desired sample size of seven per species. Body size targeted for collection will represent the non-anadromous phase of each species' life cycle. For stickleback, whole fish samples will need to be used. Collection times for fish samples will occur in late August and early September.

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 will 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.

9.5.4.4.12. Remote Fish Telemetry

Remote telemetry techniques will include radio telemetry and PIT tags. Both of these methods are intended to provide detailed information from relatively few individual fish. 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 in the Upper River. The target species to radio-tag include Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic grayling, rainbow trout, lake trout, longnose sucker, and burbot. Radio-tracking provides information on fine and large spatial scales related to location, speed of movement, and habitat utilization by surveying large areas and relocating tagged individuals during aerial, boat, and foot surveys. 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 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, and foot). Fixed stations will largely be those used for the Salmon Escapement Study

(Section 9.7), of which, only one is slated for installation in the Upper River at the Kosina Creek confluence (RM 206.8). Up to three additional fixed stations may be established at strategic locations with input from the Fish and Aquatic TWG. These stations will be serviced in conjunction with the Salmon Escapement Study during the July through October period, but will be extended to begin on June 1 to track resident fish. 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 of aerial surveys will be monthly and during critical species-specific time periods (e.g., burbot spawning), bi-weekly. 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 Salmon Escapement Study (Section 9.7). 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 macrohabitats 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 was estimated. Fish weights and the respective target weight of radio-tags (Table 9.5-3) were calculated using existing or derived length–weight relationships for Alaska fish (Figure 9.5-3), and length frequency distributions for Susitna River fish. This analysis illustrates that there is a relatively broad range of potential tag weights (0.5 grams [g] to 81 g) that are necessary to tag each species over the potential range in fish size. Further, it is evident that some species will require tags with a relatively short (30 to 200 days) 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 the species at the lower portion of their most frequently occurring size range (Table 9.5-3). 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 adult size range (Table 9.5-3) based on their respective length–frequency distributions.

The use of non-coded tags on the smaller adult fish would require the use of many frequencies (e.g., 50 to 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 alternative 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 in the Upper River. These fish will be captured during sampling events targeting adult fish and with directed effort using a variety of methods. 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, tags will be allocated as follows: (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 at late summer of 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 adult body sizes.

PIT Tag Antenna Arrays

As described above, fish of appropriate size from target species will be implanted with a PIT tagged for mark-recapture studies. Half-duplex PIT tags either 12 mm in length or 23 mm in length will be used, depending on the size of the fish to be implanted. Each PIT tag has a unique code that allows identification of individuals. Recaptured fish will provide information on the distance and time travelled since the fish was last handled and changes in fish length and weight.

PIT tag antenna arrays with automated data logging will be deployed at up to six selected side channel, slough, and tributary mouths to detect movement of tagged fish into or out of the site with particular focus on juvenile Chinook salmon. With input from the Fish and Aquatic TWG, site selection for antenna arrays will be based on habitats and tributaries identified as suitable habitat for juvenile Chinook salmon. 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. Antennas will be deployed shortly after ice-out in 2013. Data loggers will be downloaded every two to four weeks depending on the need to replace batteries and on reliability of logging systems. Power to the antennas will be supplemented with solar panels.

All juvenile Chinook salmon 60 mm or greater in length will be PIT-tagged. For selected species, up to 1,000 fish per species per PIT tag array will be tagged based on proximity to PIT arrays. Target species are Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic grayling, and burbot.

9.5.4.4.13. DIDSON and Video Cameras

DIDSON and video cameras are proposed to survey selected sloughs and side channels. 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 of less than four nephelometric turbidity units (NTU). However, Mueller et al. (2006) noted that identifying species and observing habitat conditions were more effective with video cameras than DIDSON cameras.

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 sonar 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, 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 (<5 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.

9.5.5. 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-reviewed 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. In addition, some survey methods may not be used in the mainstem river immediately upstream of Devils Canyon to avoid any risk of being swept into the canyon. During the 1980s studies, no surveys were conducted on the mainstem river from RM 150 to RM 189.0, except for spawning surveys conducted by helicopter.

9.5.6. Schedule

Initial data collection efforts for this multi-year study began in the summer/fall of 2012 and will commence after the FERC study plan determination in early 2013 and continue through October 2014. The schedule allows for two complete open water study seasons. The proposed schedule (Table 9.5-6) for completion of the Study of Fish Distribution and Abundance in the Upper Susitna River is as follows:

- Initial collection efforts (Chinook salmon spawning surveys and fish trapping targeting juvenile Chinook salmon) in Upper River tributary streams – July to October 2012
- File a supplemental memorandum with the FERC reporting interim 2012 collection results – First quarter 2013
- Development of Implementation Plan and selection of study sites – January to March 2013
- Open water fieldwork – May to October 2013 and May to October 2014
- Reporting of interim results – September 2013 and 2014
- Quality control check of geospatially-referenced relational database – December 2013 and 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)

9.5.7. Relationship with Other Studies

Over the 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. As studies collect and synthesize data, findings will be disseminated to interdependent studies.

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 (Figure 9.5-10). Fish collections in the Upper River will identify species that could colonize the future reservoir site (Section 9.10) and help validate fish periodicity, habitat associations, and selection of target species for reach-specific analyses for the Fish and Aquatics Instream Flow Study (Section 8.5). Patterns of distribution and abundance from traditional sampling methods will help validate and complement information from radio telemetry, fishwheel, and sonar observations of salmon in the Salmon Escapement Study (Section 9.7). The Salmon Escapement Study will provide fixed receiver and aerial tracking of fish radio-tagged in this study. Fish movement, habitat association, and growth data will provide inputs for bioenergetics and trophic analysis modeling for the River Productivity Study (Section 9.8). Additionally, targeted species will be sampled for fish stomach contents in support of the bioenergetics modeling component.

Fish distribution and abundance will complement information about harvest rates and effort expended by commercial, sport, and subsistence fisheries to support the Fish Harvest Study (Section 9.15). Fish collections and observations in conjunction with aquatic habitat characterization will aid in the development of fish and habitat associations for the Characterization and Mapping of Aquatic Habitats Study (Section 9.9). Fish collections will provide data on fish use in sloughs and tributaries with seasonal flow-related or permanent fish barriers for the Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries (Section 9.12) and will provide information for the Study of Fish Passage Feasibility at Watana Dam (Section 9.11). Fish tissue sample collections will support the Genetics Baseline Study for Selected Fish Species (Section 9.14) and the Mercury Assessment and Potential for Bioaccumulation Study (Section 5.7).

9.5.8. Level of Effort and Cost

Initial data collection efforts for this multi-year study began in the summer/fall 2012 and will commence after the FERC study plan determination in early 2013 and continue until March 2015. Sampling will be conducted according to a stratified scheme designed to cover a range of habitat types with a minimum of three replicates each. The level of effort at each sample site and sampling frequency will vary based on tasks and objectives. Selection of sampling sites will be influenced by the results of the Characterization and Mapping of Aquatic Habitats Study (Section 9.9) and tributary habitat mapping and fish sampling conducted by AEA during 2012, which may indicate that some tributaries are unsuitable for sampling because of safety issues or passage barriers.

The number and size of sample sites and sampling frequency require a large-scale field effort and subsequent data compilation, as well as quality assurance/quality control (QA/QC) and analysis efforts. Generally:

- Sampling will be conducted seasonally during the ice-free period in all study sites.
- Sampling will be conducted more frequently immediately following break-up to document seasonal movement patterns of juvenile Chinook salmon from natal tributaries to rearing habitats.
- Fish capture and observation methods may include snorkeling, seining, gillnetting, minnow trapping, angling, trot lines, and out-migrant traps depending on stream conditions such as depth, flow, and turbidity, target species, and life stage.
- Field crews will consist of two to four individuals, depending on sampling method used.
- Sampling in remote areas requires helicopter, fixed-wing airplane, and boat support.
- Radio-tracking of tagged fish includes 12 aerial surveys, and foot and boat surveys as necessary.

The estimated cost for implementing the Study of Fish Distribution and Abundance in the Upper Susitna River is $2,500,000.

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9.5.10. Tables

Table 9.5-1. Summary of life history, known Susitna River usage of fish species within the Upper Susitna River Segment (compiled from Delaney et al. 1981).

Common Name	Scientific Name	Life History[a]	Susitna Usage[b]	Distribution[c]
Arctic grayling	*Thymallus arcticus*	F	O, R, P	Low, Mid, Up
Burbot	*Lota lota*	F	O, R, P	Low, Mid, Up
Chinook salmon	*Oncorhynchus tshawytscha*	A	M_2, R	Low, Mid, Up
Dolly Varden	*Salvelinus malma*	A,F	O, P	Low, Mid, Up
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
Round whitefish	*Prosopium cylindraceum*	F	O, M_2, P	Low, Mid, Up
Sculpin[e]	*Cottid*	M_1, F	P	Low, Mid, Up

[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*).

Table 9.5-2. 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	Representative habitat types	• 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).
1B	Relative abundance	Juvenile salmon, non-salmon anadromous, resident	Representative habitat types	• Multi-pass sampling • 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	Representative habitat types	• Analysis of data collected under Objective 1: Distribution. Combination of fish presence, distribution, and density by mesohabitat type 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 2. One near the proposed dam site; one near the mouth of a known Chinook salmon spawning tributary. • 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
2B	Describe seasonal movements using biotelemetry (PIT and radio-tags)	All species	PIT arrays sites River-wide aerial tracking surveys	• PIT tags: tags opportunistically implanted from a variety of capture methods in Focus Areas. Antenna arrays in up to 6 sites at selected side channel, side slough, tributary mouth, and upland sloughs in the Upper River. • Radio-tags surgically implanted in up to 30 fish of sufficient body size of each species distributed temporally & longitudinally.

Obj	Task	Species/ Life stage	Study Sites	Proposed Methods by Season
2C	Describe juvenile Chinook salmon movements	Juvenile Chinook salmon	Representative habitat types	• PIT tag arrays at tributary mouths, sloughs, and side channels (Obj 2B) • Outmigrant trap in known Chinook spawning tributary • DIDSON or underwater video to monitor movement into or out of specific habitats • Monthly measurements of fish size/ growth
5	Document age structure, growth, and condition by season	Juvenile anadromous and resident fish	All study sites for Obj 1B	• Stock biology measurements – length from captured fish up to 100 individuals per season per species per life stage . • Emphasis placed on juvenile Chinook salmon.
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 9.5-3. Upper River tributaries selected for fish distribution and abundance sampling.

Tributary	Susitna River Mainstem PRM	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)
Oshetna River	235.1	yes	yes	17	1424.5	34	800
Black River	NA	no	yes	14	NA	NA	400
Goose Creek	232.8	yes	yes	10	269.1	12	200
Jay Creek	20	no	no	8	160.1	14	DIR
Kosina Creek	209.1	yes	partial	33	1036.5	45	800
Tsisi Creek	NA	no	yes	58	NA	NA	400
Unnamed Tributary	206.3	no	unknown	NA	<80.3	NA	200
Unnamed Tributary	204.5	no	unknown	NA	<80.3	NA	200
Unnamed Tributary	197.7	no	unknown	NA	<80.3	NA	200
Watana Creek	196.9	yes	partial	11	452.7	16	400
Watana Creek Tributary	NA	no	yes	NA	NA	13	200
Unnamed Tributary	194.8	no	unknown	NA	321.2	NA	400
Deadman Creek	184.9	no	no	32	453.5	27	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 9.5-4. GRTS Based Sampling Target by Upper River Tributary.

Tributary	Susitna River Historic River Mile	Chinook Salmon Presence Documented	Percent Sampling by Length	Number of Population Sample Units	Number of Distribution Samples[1]	Number of Abundance Samples
Oshetna River	235.1	yes	25	52	8	5
Black River	NA	no	25	24	3	3
Goose Creek	232.8	yes	25	81	12	8
Kosina Creek	209.1	yes	25	24	3	3
Tsisi Creek	NA	no	25	23	3	3
Unnamed Tributary	206.3	no	15	29	1	3
Unnamed Tributary	204.5	no	15	21	0	3
Unnamed Tributary	197.7	no	15	41	2	4
Watana Creek	196.9	yes	25	60	9	6
Watana Creek Tributary	NA	no	25	67	10	7
Unnamed Tributary	194.8	no	15	32	2	3
Total	--	--	--	**454**	**53**	**48**

Notes:

1 These are single-pass samples without block nets; abundance samples will also be used for distribution (101 total samples).

Table 9.5-5. Length and weight of fish species to be radio-tagged and respective target radio-tag weights.

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

Notes:

U = Unknown size distribution.

Table 9.5–6. Schedule for implementation of the Fish Distribution and Abundance in the Upper Susitna River.

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
Initial Studies and Technical Memo			—		●								
Study Site Selection					—								
Develop and File Implementation Plan					—♦								
Fish Sampling						—	—	—		---—	—	—	
Data Entry							—	—			—	—	
Preliminary Data Analysis							—	—					
Initial Study Report								—	Δ				
Final Data Analysis											—	—	
Updated Study Report											—	—	▲

Legend:

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

9.5.11. Figures

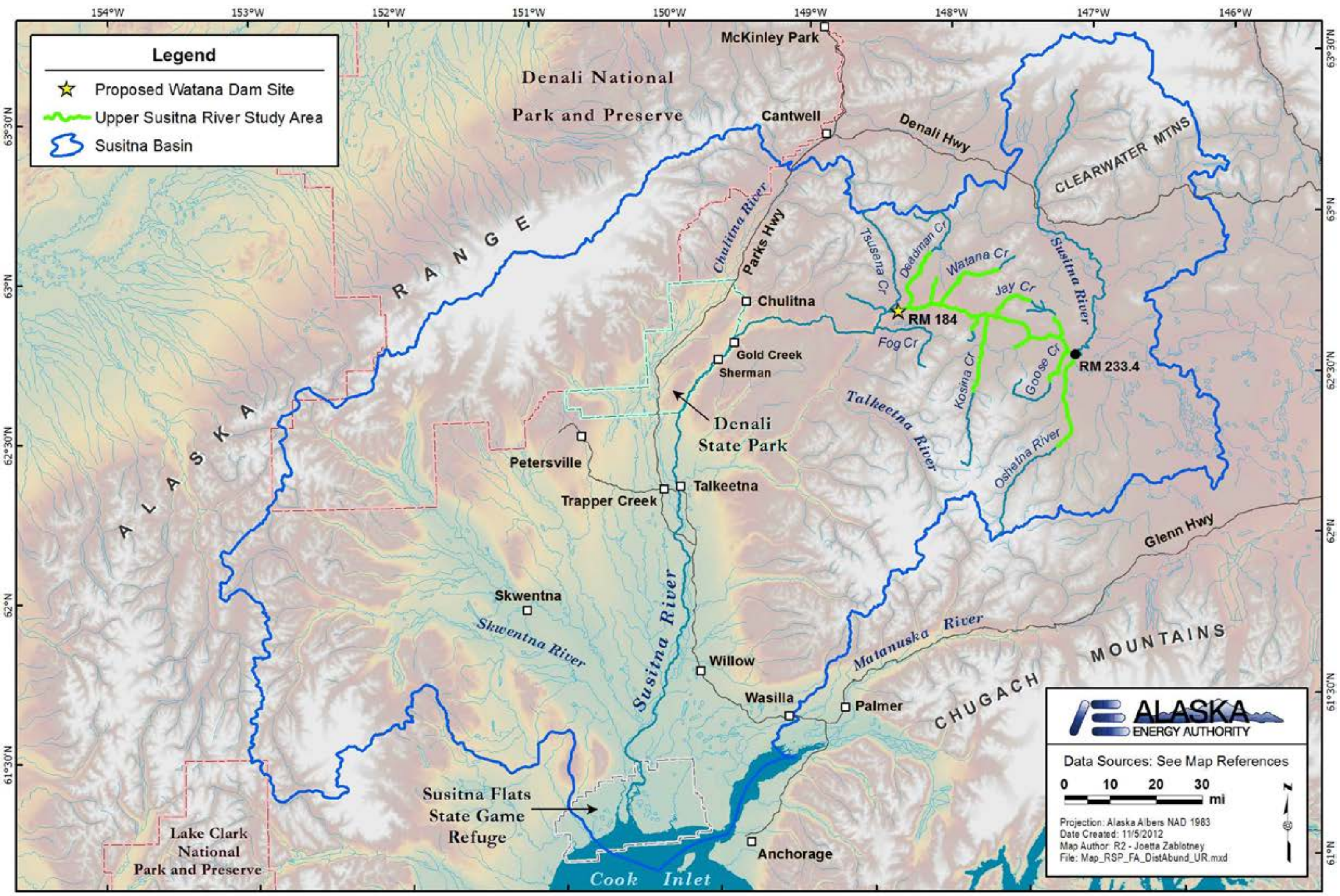

Figure 9.5-1. Fish distribution and abundance study area.

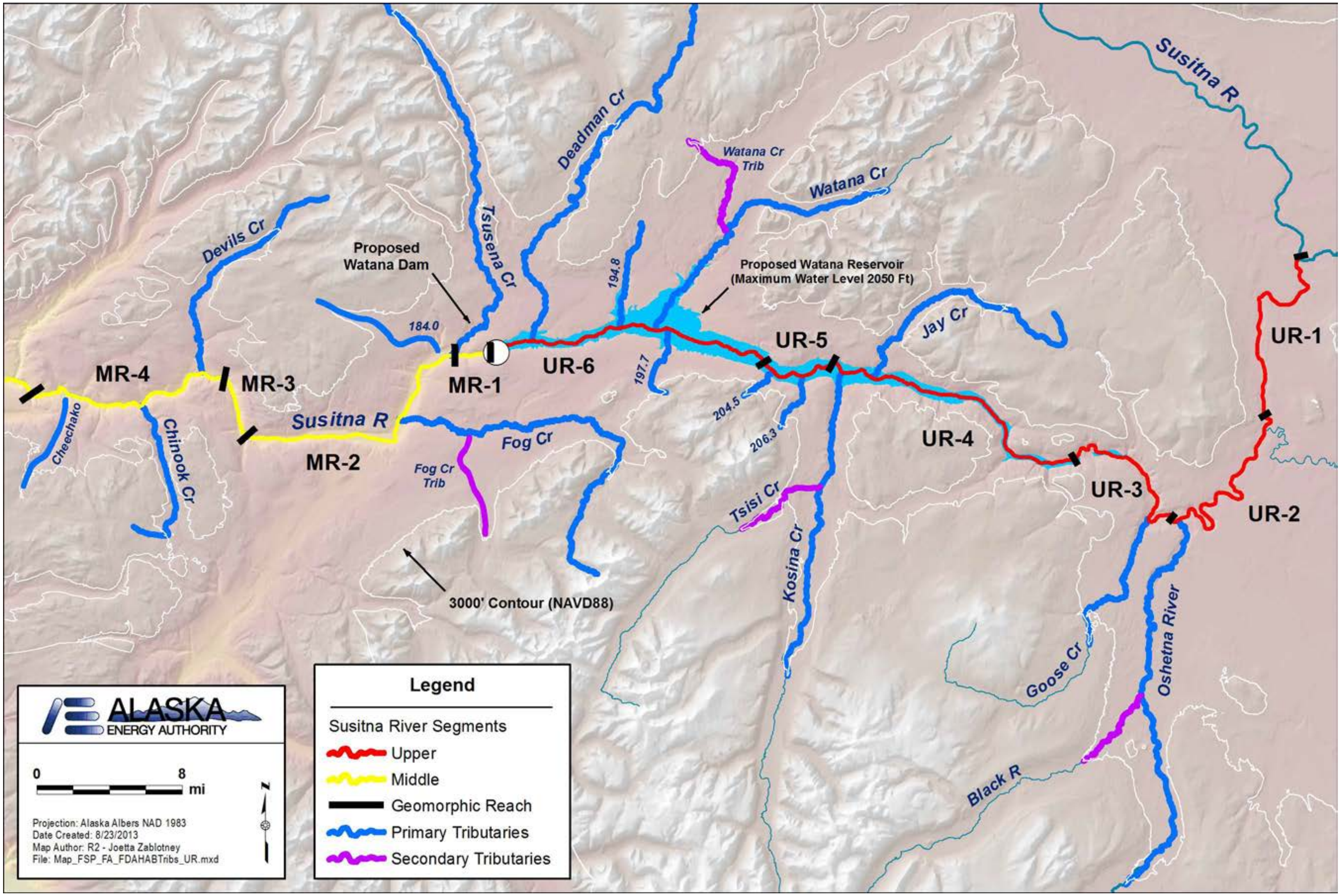

Figure 9.5-2. Locations of 20 tributaries upstream of Devils Canyon selected for sampling.

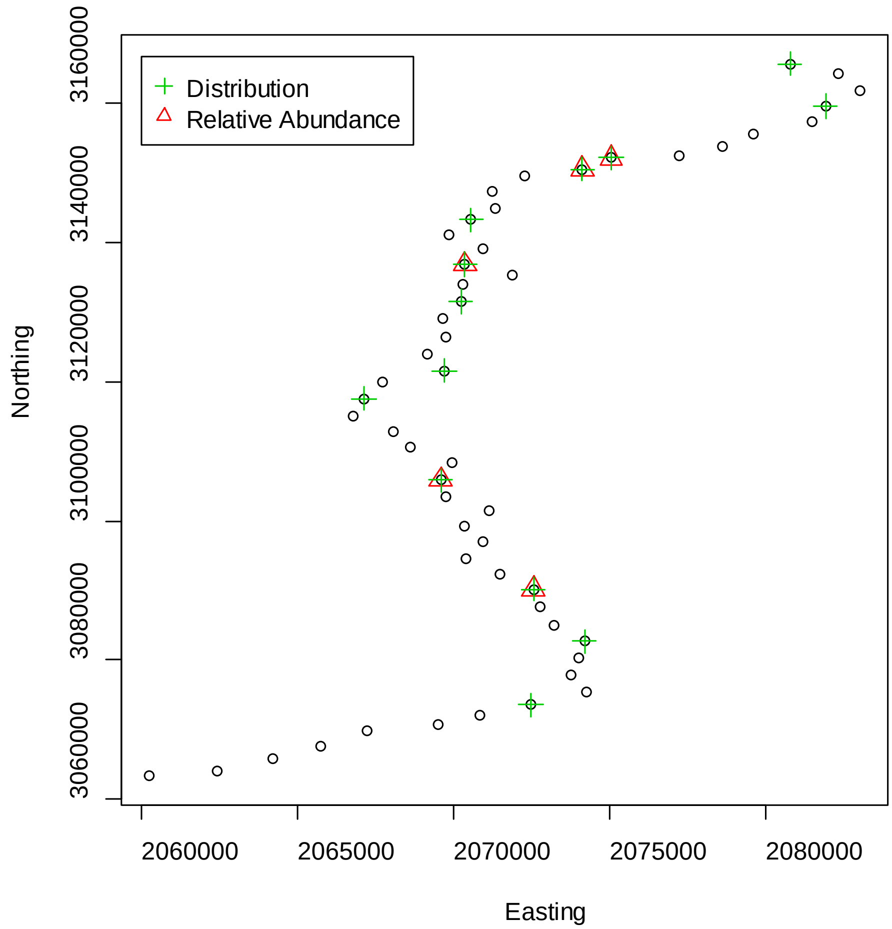

Figure 9.5-3. GRTS sample locations selected for the Oshetna River. Each black circle represents the downstream edge of an 800m sample unit.

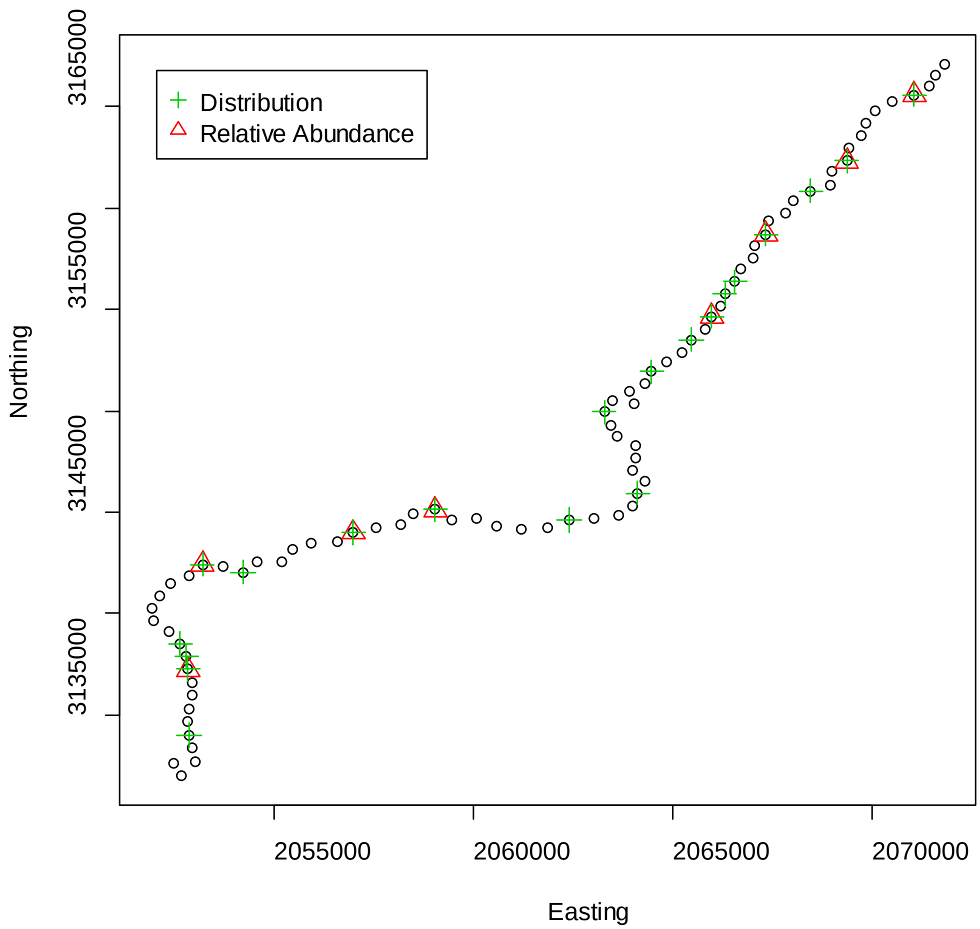

Figure 9.5-4. GRTS sample locations selected for Goose Creek. Each black circle represents the downstream edge of a 200- meter sample unit.

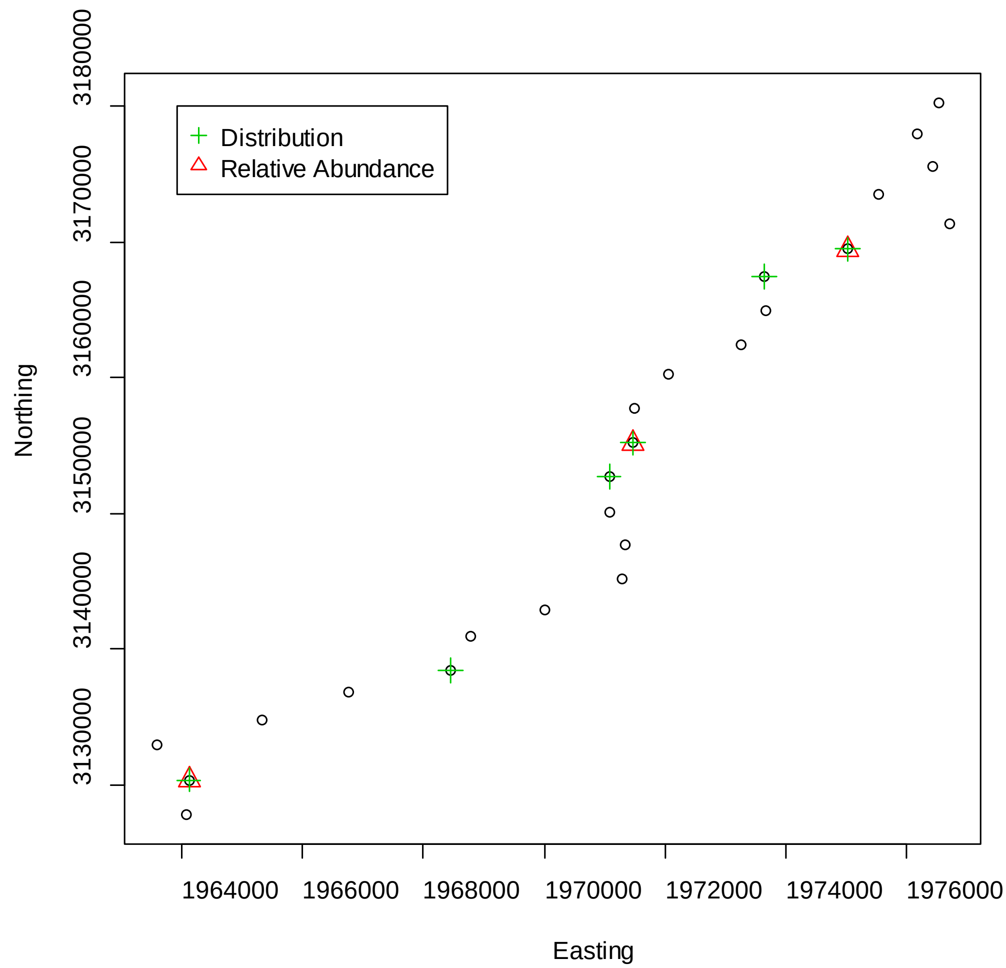

Figure 9.5-5. GRTS sample locations selected for the Kosina River. Each black circle represents the downstream edge of an accessible 800-meter sample unit.

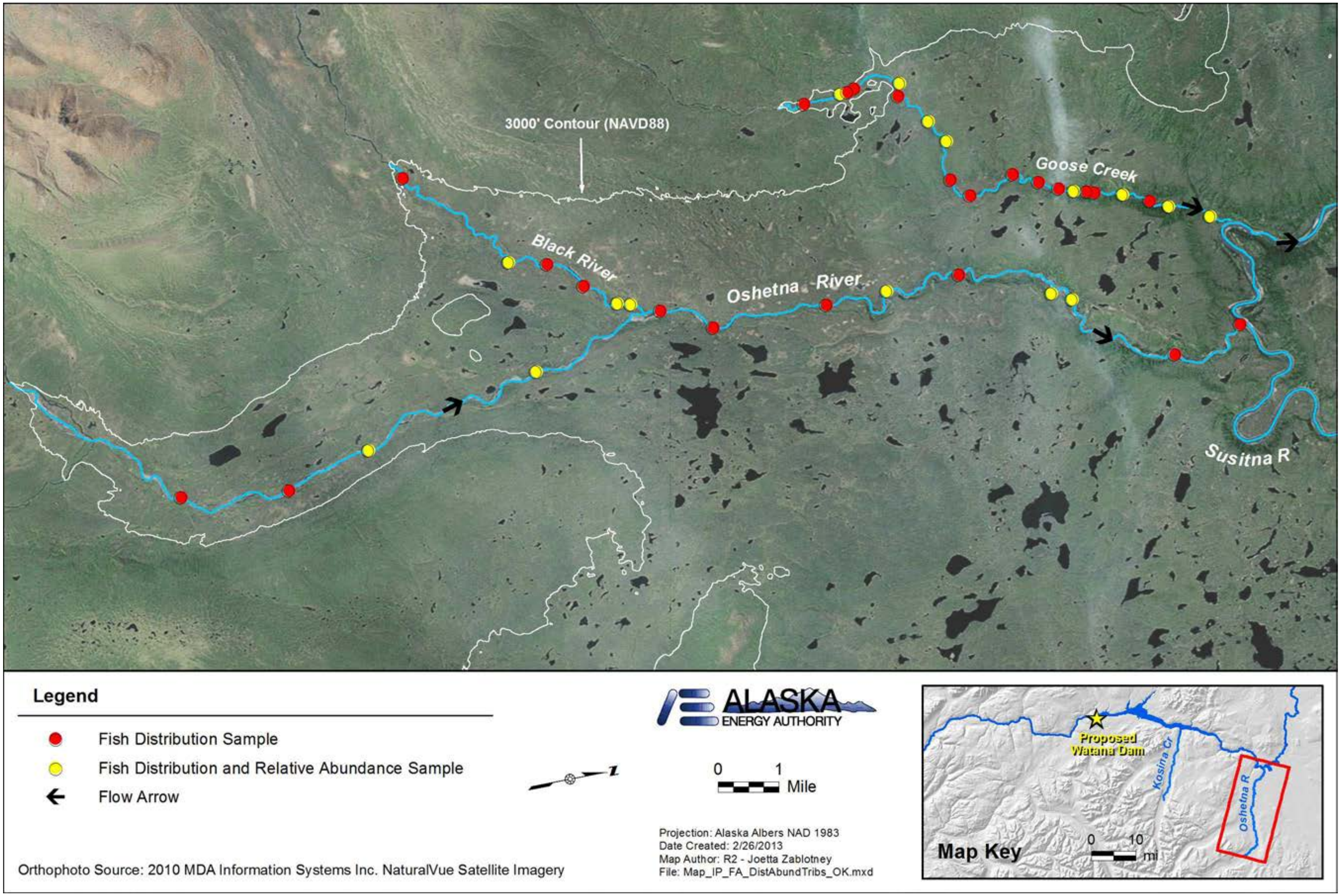

Figure 9.5-6. Map showing sample locations in the Oshetna River, Black River and Goose Creek. Dots represent location of sampled reaches of length 800 meters (Oshetna River), 400 meters (Black River) or 200 meters (Goose Creek).

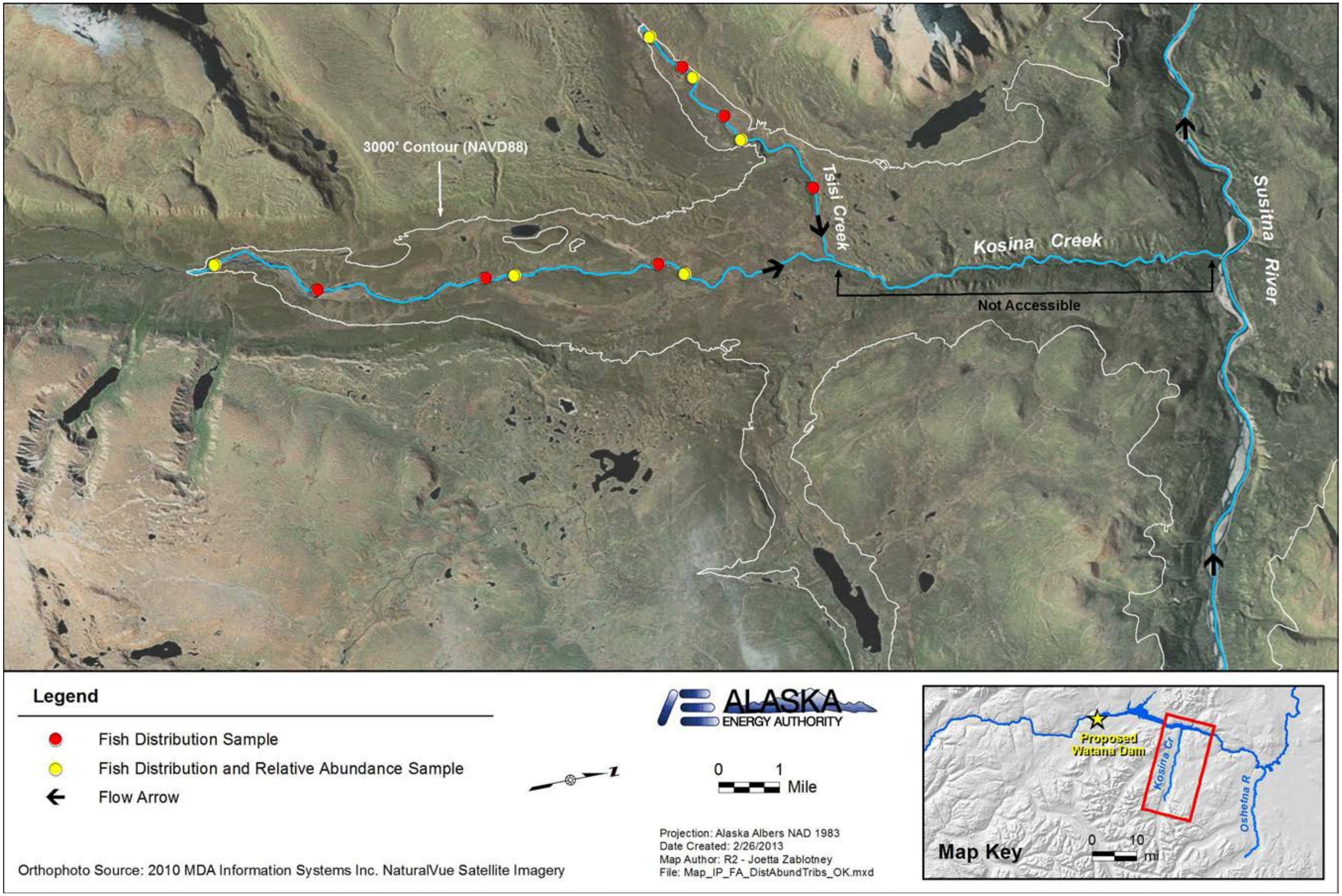

Figure 9.5-7. Map showing sample locations in Kosina and Tsisi creeks. Dots represent locations of 800 meters (Kosina Creek) or 400 meters (Tsisi Creek) sampling units.

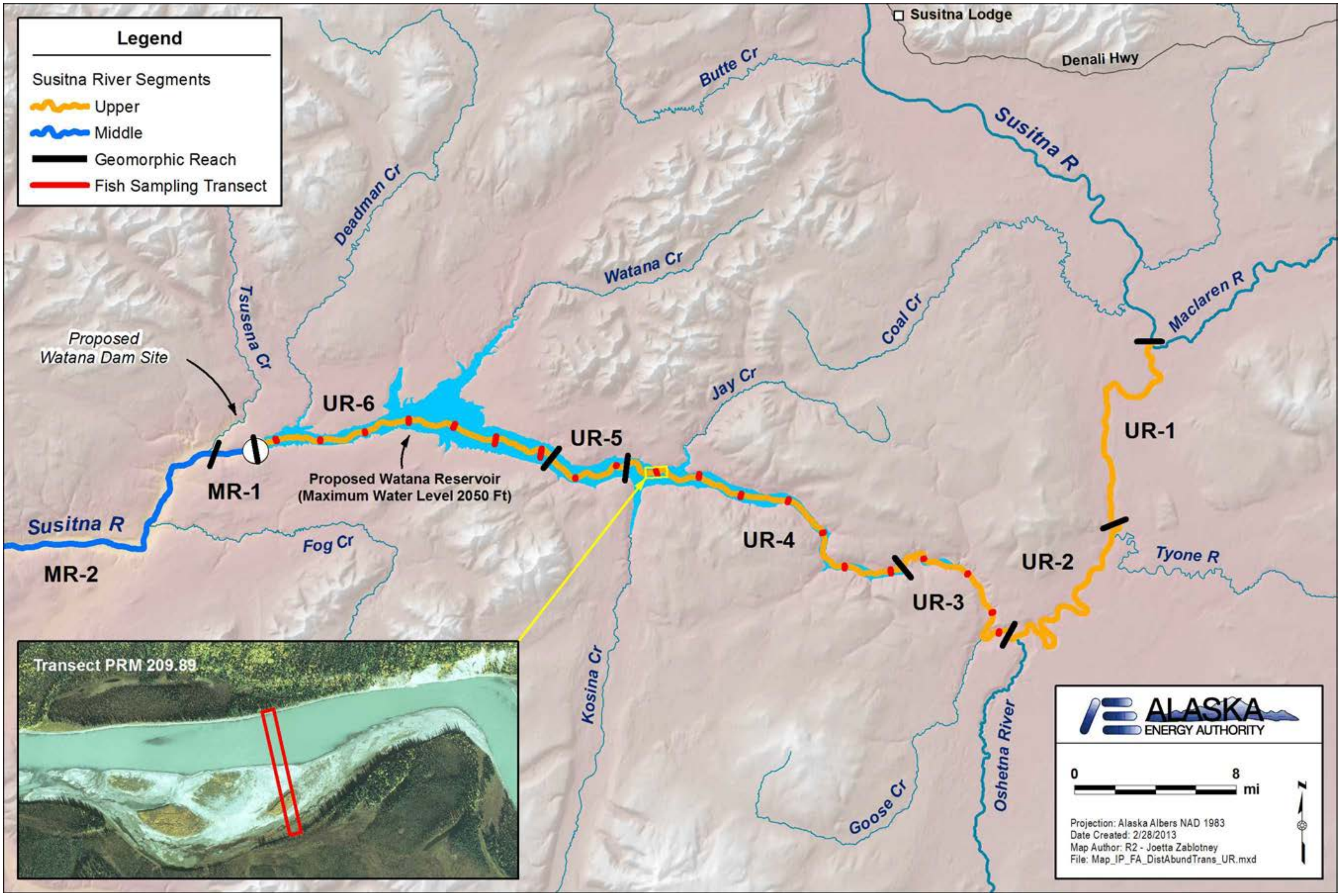

Figure 9.5-8. Fish distribution and abundance sampling transects in the Upper Susitna River.

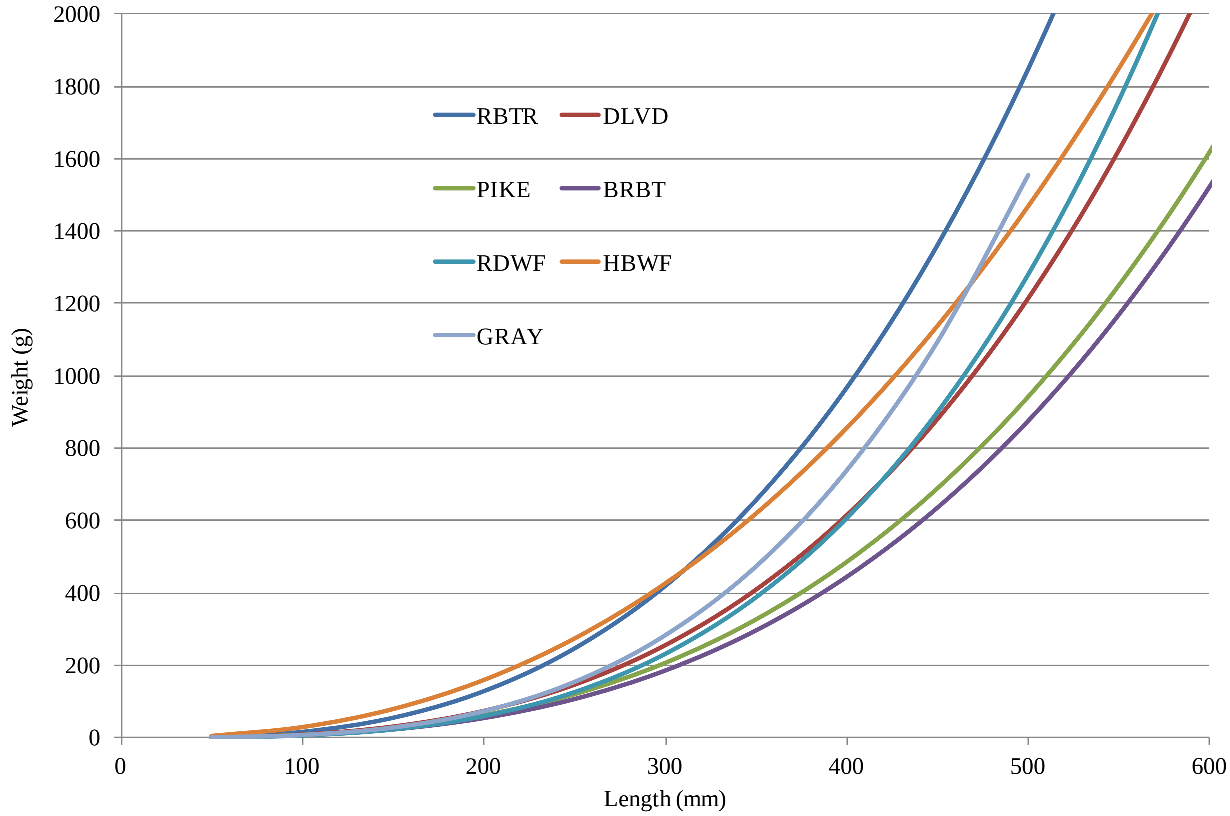

Figure 9.5–9. Existing or derived length–weight relationships for fish species to be radio-tagged.

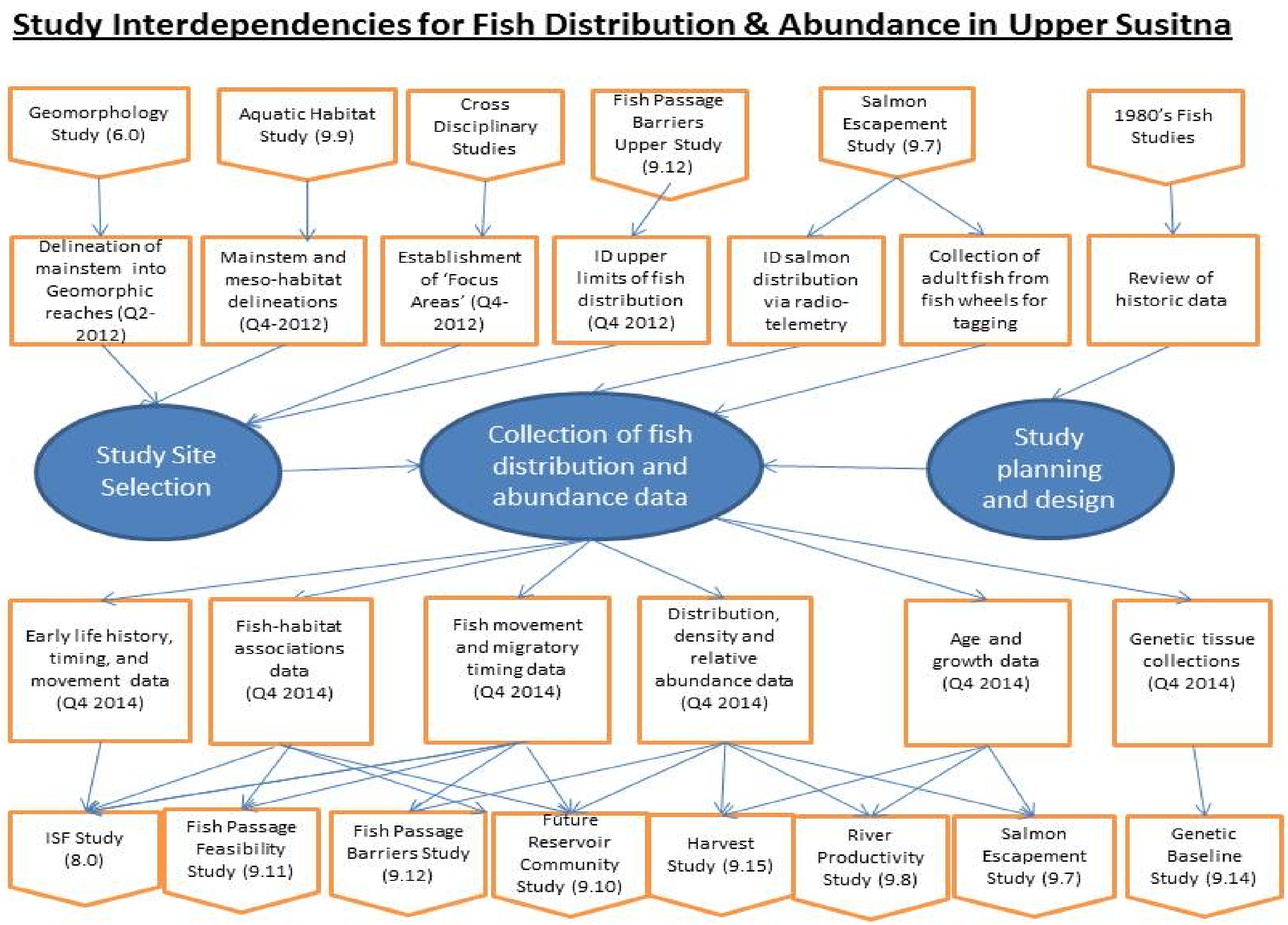

Figure 9.5-10. Flow chart showing study interdependencies for the Fish Distribution and Abundance Study in the Upper River.