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

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 lifestage in the Susitna River downstream of the proposed Watana Dam (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 lifestages for the fish species of interest. Not all lifestages 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.

9.6.1.1 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 Pacific lamprey, as well as freshwater rearing lifestages of anadromous salmonids (fry and juveniles) in the middle and lower Susitna River. Specific objectives include the following:

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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, Pacific 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 outmigrant 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 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 lifestages 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 reaches 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 reaches include Bering cisco, threespine stickleback, arctic lamprey, and rainbow trout. Eulachon have been documented only in the Lower Susitna River Reach.

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

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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 reaches (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 outmigrate to the ocean as age 1+ fish, and very few exit the system as fry. Coho salmon typically outmigrate to sea as age 1+ or age 2+ fish. Because chum and pink salmon outmigrate to sea within a few months of emergence, little is known about their dependence on the Susitna River. Most age 0+ sockeye salmon outmigrate 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 Reach.
- 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

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migration of juvenile salmonids from natal habitats to rearing areas and from the Middle Susitna River Reach to the Lower Susitna River Reach 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 Susitna River from river mile (RM) 28 upstream to the proposed Watana Dam site (RM 184) (Figure 9.5-1). RM 28, near the confluence with the Yentna River, approximates the upper extent of tidal influence and is the lower extent of the Habitat Characterization Study (Section 9.9).

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.

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 five levels representing the following: (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 separates the Susitna River into the lower river (RM 2898), middle river (RM 98–RM 184) and upper river (RM 184–233). The mainstem Susitna River and its tributaries upstream of the proposed dam (RM 184) 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 (Section 9.5). In contrast, the mainstem downstream of the Project will be subject to the effects of flow modification and water quality from Project operations, which will diminish below the three rivers' confluence.

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

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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.

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 (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, braided 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 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, the fish sampling scheme also varies between the middle and lower river. Sampling in the lower river will focus on relative abundance. This sampling will only occur at 27 total sites (Figure 9.6–2) comprising three replicates in each of the four categories of mainstem off-channel habitats (12), three replicates within each of the four mainstem channel categories (12), and three replicates for tributary mouths. Sampling within the lower reaches of tributaries in the lower river is not proposed at this time. If 2013 results of the hydrology and geomorphology studies indicate potential effects in lower river tributaries, this decision will be revisited during the Fish and Aquatic Technical Working Group (TWG) process in fall/early winter of 2013.

In the middle river, fish distribution sampling will occur at 96 sites (Figures 9.6–3). The number of replicates per habitat unit varies from three for mesohabitats within main channel, split channel, and braid to six for most other mainstem habitats (side sloughs, upland sloughs, backwater habitats, beaver complexes, and tributary mouths). Due to the number and varied nature of tributaries, sampling in 18 of the 62 middle river tributaries is proposed, and the team will select tributaries across the eight geomorphic reaches that represent multiple stream orders. For relative abundance sampling, sampling of 54 sites in the middle river (Figure 9.6–4) is proposed. Sampling will occur throughout the middle river with the exception of Devils Canyon, where safety concerns prevent access.

Additionally, all “focus areas” will be sampled sites (Figure 9.6–5). Focus areas are sites in which a full complement of cross-disciplinary intensive studies will occur to enhance the richness of the data. Focus area sites are being selected based on a combination of recent and historic data along with the professional judgment of the various technical teams. The first

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selection criterion is to select one or more sites that are considered representative of the stratum or larger river and that contain all habitat types of importance. A suite of criteria includes, but is not limited to geomorphological, riparian/floodplain, fish presence, and habitat characteristics; groundwater, ice, and water quality; and constraints such as safety considerations, raptor nests, land ownership and access. Geospatial data for these individual attributes will be overlain in the Geographic Information System (GIS) to assist in site selection. Approximately 6 to 8 focus areas are anticipated for the middle river as well as at least one study site below the three rivers' confluence in the lower river.

Site selection includes completing the geomorphic reach delineation and habitat mapping tasks first. 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.

Finally, winter sites will be selected based on information gathered from winter 2012–2013 pilot studies at Whisker's Slough and Slough 8A. 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, and trot lines 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. At focus areas, sampling will occur monthly year-round and biweekly 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 lifestage.
- 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 outmigration).
- 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.

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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 lifestage-specific information is desirable, timing of the survey must match the use of the surveyed habitat by that lifestage.

Some details of the sampling scheme have been provided for planning purposes; however, modifications may be appropriate as the results of 2012 data collection are reviewed. A final sampling scheme will be developed by the first quarter of 2013 in coordination with licensing participants. 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.

9.6.4.3.1 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, lifestage, 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 reaches. 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 consultation with state and federal agencies. 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.

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Task B: Relative Abundance

Relative abundance surveys will include monthly 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, lifestage, 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 lifestages 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 outmigrant traps.

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

Historically, outmigrant 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 outmigrate 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 outmigrant 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 by the Fish and Aquatic TWG. Because Chinook salmon are predominantly tributary spawners, outmigrant 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, outmigrant 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 radiotelemetry 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.

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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. 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. Up to 30 radio transmitters will be implanted in selected species including Arctic grayling, Dolly Varden, rainbow trout, burbot, round whitefish, humpback whitefish, Arctic lamprey, in and northern pike.

9.6.4.3.3 Objective 3: Early Life History

Task A: Describe emergence timing of salmonids.

In conjunction with the Intragravel 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 intragravel 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 outmigrant traps (Objective 2, Task A). Biotelemetry cannot be used for this task because juvenile salmonids will be too small to tag at this lifestage.

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 Intragravel Monitoring component of the Instream Flow Study (Section 8.5.4).

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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 lifestages (i.e., fingerlings, smolts, and adults), while also vulnerable, can be protected by less restrictive ramping criteria. Related to this, size (or lifestage) 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 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, gill nets, 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 lifestage 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 lifestage; 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 4, 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

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owing to their effect on salmonids and other species such as stickleback. Rutz (1999) investigated movements of northern pike in the Susitna River using radiotelemetry 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 gill net, electrofishing, angling, trot lines, minnow traps, snorkeling, fishwheels, outmigrant 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 Gill Nets

Variable mesh gill nets (7.5-foot long panels with 1-inch to 2.5-inch stretched mesh) will be deployed. In open water and at sites with high water velocity, gill nets will be deployed as drift nets, while in slow water sloughs, gill nets will be deployed as set (fixed) nets. Depending on conditions, gill nets may be deployed in ice-free areas, and under the ice during winter months. The location of each gill net 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 gill nets 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 gill nets 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

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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. In all cases the electrofishing unit will be operated and configured with settings consistent with guidelines established by ADF&G. The location of each electrofishing transect will be mapped using hand-held GPS units and marked on high-resolution aerial photographs.

Selection of the appropriate electrofishing system will be made as part of site selection, which will include a site reconnaissance and be determined in collaboration with the Fish and Aquatic Technical Workgroup. 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 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 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 burbot. Trot line construction and deployment will follow the techniques used during the 1980s studies as described in ADF&G (1982).

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). During the 1980s, minnow traps were also the primary method used for capturing sculpin, lamprey, and threespine stickleback.

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Minnow traps also captured rainbow trout and Arctic grayling. Minnow traps will be baited with salmon roe, then checked and rebaited after 90 minutes following protocols outlined by Bryant (2000). Between 5 and 10 minnow traps will be deployed, depending upon the size of the sampling site.

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 turbid due to the inability to see the fish (Dolloff et al. 1996; Dolloff et al. 1993). To get relative abundance estimates, a closed population is needed within a single habitat unit, and block nets can be used to prevent fish from leaving the unit (Hillman et al. 1992). If the area to be surveyed is too large for one snorkeler, additional snorkelers can be added to cover the entire channel width. 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).

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 a two-day period. Each fyke net will be configured with two wings to guide the majority of water and fish to the net mouth. 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

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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 suitable in shallow water areas free of large woody debris and snags such as boulders. Seining permits 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, 3/16-inch mesh (net body) with a 1/8-inch net bag; however, the actual length of seine used will depend on the site conditions. The location fished will be mapped using hand-held GPS units and marked on high resolution aerial photographs. The area swept will be noted. To the extent possible, the same area will be fished during each sampling event.

9.6.4.4.10 Outmigrant Traps

Rotary screw traps and inclined plane traps are useful for determining the timing of emigration by downstream migrating juvenile salmonids and resident fish (Objective 2). In the 1980s, outmigrant 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. Outmigrant traps were also fished at Flathorn Station (RM 22.4) during 1984 and 1985.

Selection of rotary screw traps or inclined plane traps and the location will occur in collaboration with 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 outmigrant traps will be deployed. Flow conditions permitting, traps will be fished on a cycle of 48 hours on, 72 hours off throughout the ice-free period.

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.

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9.6.4.4.12 Remote Fish Telemetry

Remote telemetry techniques will include radiotelemetry and PIT technology. 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 throughout the Susitna River. The target species to radio-tag include Dolly Varden, humpback whitefish, round whitefish, northern pike, Arctic grayling, burbot, and rainbow trout. 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. 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.

Radiotelemetry

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

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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 along with input from the Fish and Aquatic TWG.

The fundamental reason for using radiotelemetry 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, radiotelemetry can provide data on seasonal distribution and movement of the target fish throughout the range of potential habitats. Re-location 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 radiotelemetry 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 9.6–3) were calculated using existing or derived length–weight relationships for Alaska fish (Figure 9.6–6), 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 lifestages 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 radiotelemetry 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 9.6–3). 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 range (Table 9.6–3) based on their 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

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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' radiotelemetry 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 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 based on input from the Fish and Aquatic TWG and after 2012 study results are available (i.e., preliminary fish abundance and distribution). 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 collaboratively with the Fish and Aquatic TWG for deploying PIT tag antenna arrays. Antennas will be tested in the Winter 2012–2013 Pilot Study and deployed shortly after ice-out in 2013. Data loggers will be downloaded every two to four weeks, depending upon the need to replace batteries and reliability of logging systems. Power to the antennas will be supplemented with solar panels.

On an experimental basis, swim-over antennas will be deployed at five sites prior to ice-over and 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 upon the success of these five sites during the winter of 2012–2013, 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.

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 during the winter period. The sloughs

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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).

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.

DIDSON and/or video cameras will be lowered through auger holes drilled through the ice to make 360-degree surveys. 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). However, Mueller et al. (2006) noted that identifying species and observing habitat conditions were more effective with video cameras than with DIDSON cameras. In addition to fish observations, video cameras will also be used to characterize winter habitat attributes such as the presence of anchor ice, hanging dams, and substrate type.

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 100 individuals per species per lifestage per season 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. 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 lifestage, (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, 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 all fish of these species that do not have tags and are approximately 60 mm and larger. Radio transmitters will be surgically implanted in up to 30 fish

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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 in coordination with the Fish and Aquatics TWG and the Subsistence Group for species consumed by humans, and the Wildlife TWG for piscivorous furbearers and birds.

9.6.5. 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

The proposed schedule for the completion of the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River reaches is given below and in Table 9.6-4:

- Selection of study sites – January through March 2013
- Fieldwork – May 2013 through December 2014
- Refined methods for winter sampling 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

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- Initial and Final Study Reports - first quarter 2014 and 215 respectively.
- Supplemental technical memorandum on winter 2014–2015 activities – May 2015

9.6.7. Interdependency with Other 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 AEA studies (Figure 9.6–7). Inputs from the Geomorphology Study (Section 6.0) and the Aquatic Habitat Study (Section 9.9) will aid in site selection. Fish collections will help validate fish periodicity, habitat associations, and selection of target species for reach-specific analyses for the Instream Flow Study (Section 9.5). Additionally, data collected on movement patterns and growth will 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 of 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 adult salmon from the Salmon Escapement Study (Section 9.7). Fish movement, habitat association, and growth data will provide inputs for bioenergetics and trophic analysis modeling, a component of the River Productivity Study (Section 9.8). Further, target species will be sampled for fish stomach contents in support of bioenergetics modeling (Section 9.8). The opportunistic collection of tissue samples will be coordinated with the Fish Genetics Study (Section 9.14). Information gathered on fish distribution and abundance will complement information about harvest rates from the Fish Harvest Study (Section 9.15) 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 aid in the development of fish and habitat associations. 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, gill netting, minnow trapping, angling, trot lines, outmigrant traps, DIDSON, and underwater video depending on stream conditions such as depth, flow, turbidity, target species, and lifestage.

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- 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.

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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 reaches (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 Reach.

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Table 9.6-2. Proposed Methods by Objective, Task, Species, and Lifestage.

Obj	Task	Species/ Lifestage	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, gill nets, 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 radiotelemetry 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 • 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, fish wheels, outmigrant 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 meso-habitat type by season.
2A	Timing of downstream movement and catch using outmigrant traps	All species; juveniles	At selected outmigrant trap & PIT tag array sites	• Outmigrant Traps: Maximum of 6. 2-3 Main channel to indicate broad timing of outmigrants 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 lateral habitats downstream of tributaries with fyke nets, seines, and outmigrant traps

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				• 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 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 10 fish of sufficient body size of each species distributed temporally & longitudinally; up to 30 tags inserted in burbot, humpback whitefish, round whitefish, and northern pike. 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 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 lifestages 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
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 lateral habitats • DIDSON, video camera, electrofishing, seines, outmigrant traps and fyke nets. • Monthly measurements of fish size/ growth
4	Winter movements, timing, and location of spawning	burbot, humpback whitefish, and round	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

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		whitefish		methods by Evenson (1993). • To capture whitefish for radio-tagging, use fish wheels 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 lifestage 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.

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Table 9.6-3. Length and weight of fish species to be radio-tagged and respective target radio-tag weights.

Species	All sizes		Most likely to be caught			Tag Weight of Min (3%)	Tag Weight of Max (3%)	Fish length (mm) @ 200 g weight
	Length (mm)	Weight (g)	Fish Length (mm)	Est. Weight Min (g)	Est. Weight Max (g)			
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

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Table 9.6–4. Schedule for implementation of the Fish Distribution and Abundance in the Middle and Lower Susitna River Reaches.

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
Study Site Selection					—								
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)
Δ Initial Study Report
▲ Updated Study Report

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

[PLACEHOLDER; Map will be prepared for RSP]

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Figure 9.6-2 Schematic showing strata by habitat type for relative abundance sampling for the Lower River.

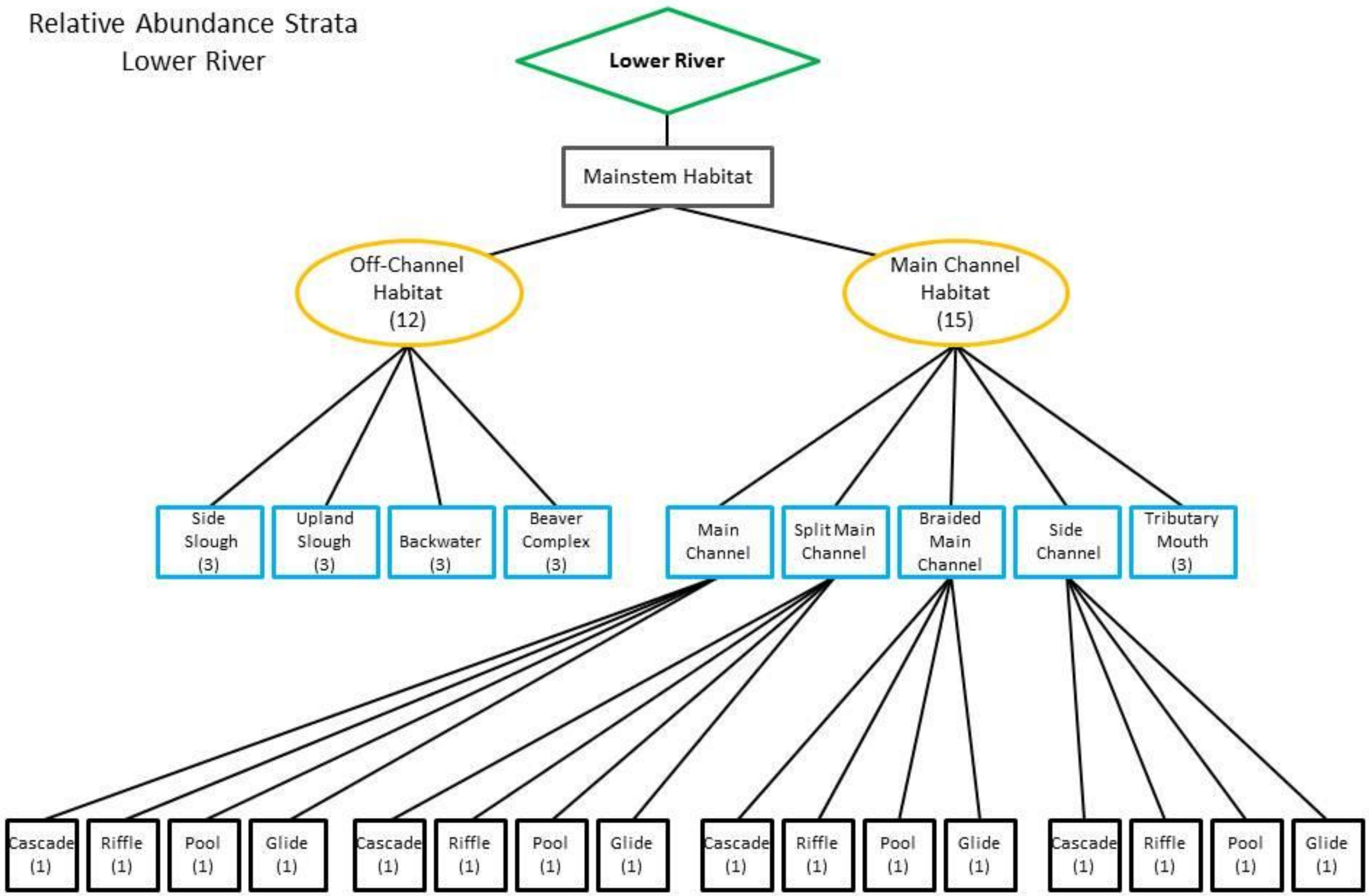


Figure 9.6-3 Schematic showing strata by habitat type for fish distribution sampling for the Middle River.

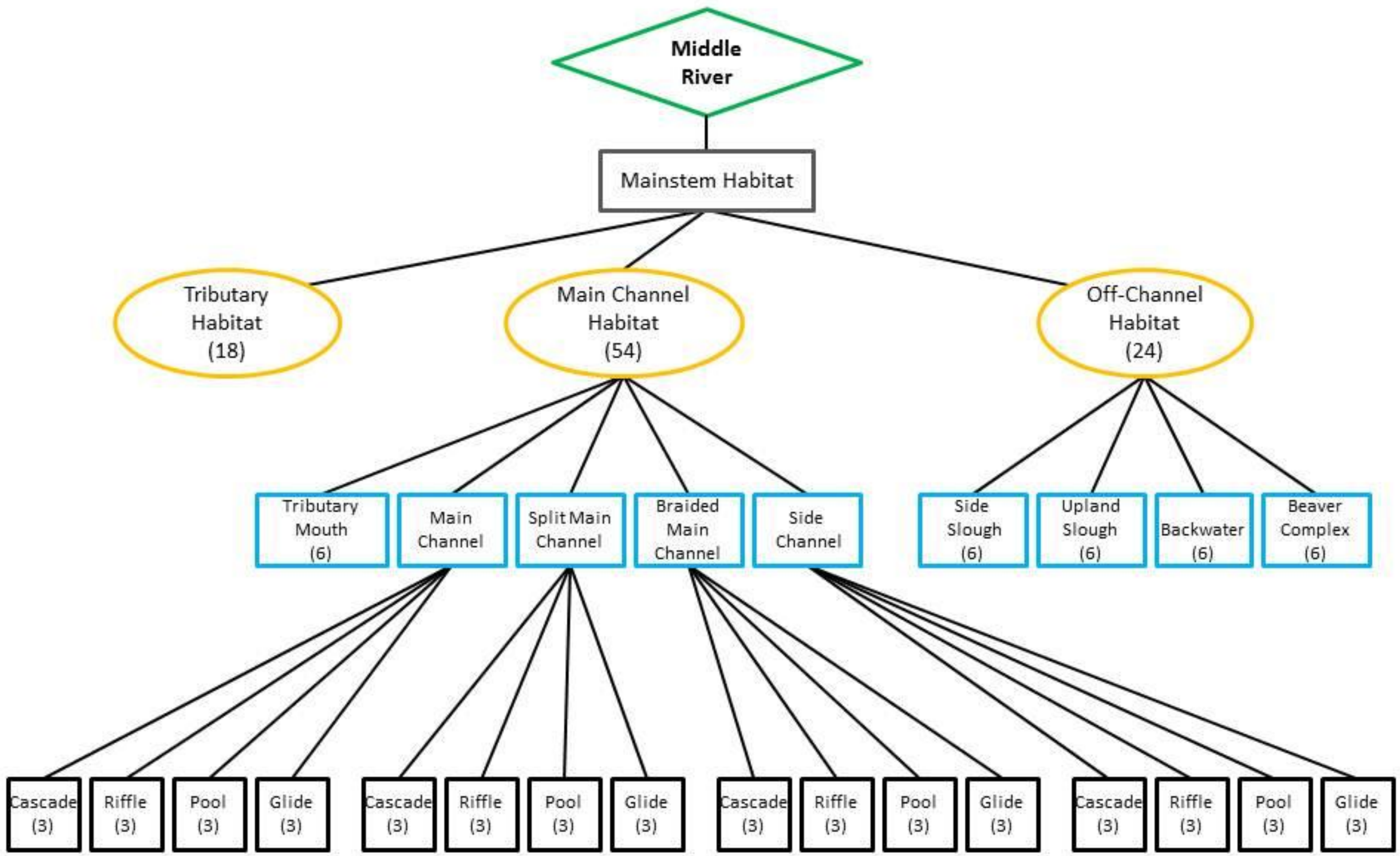


Figure 9.6-4 Schematic showing strata by habitat type for relative abundance sampling for the Middle River.

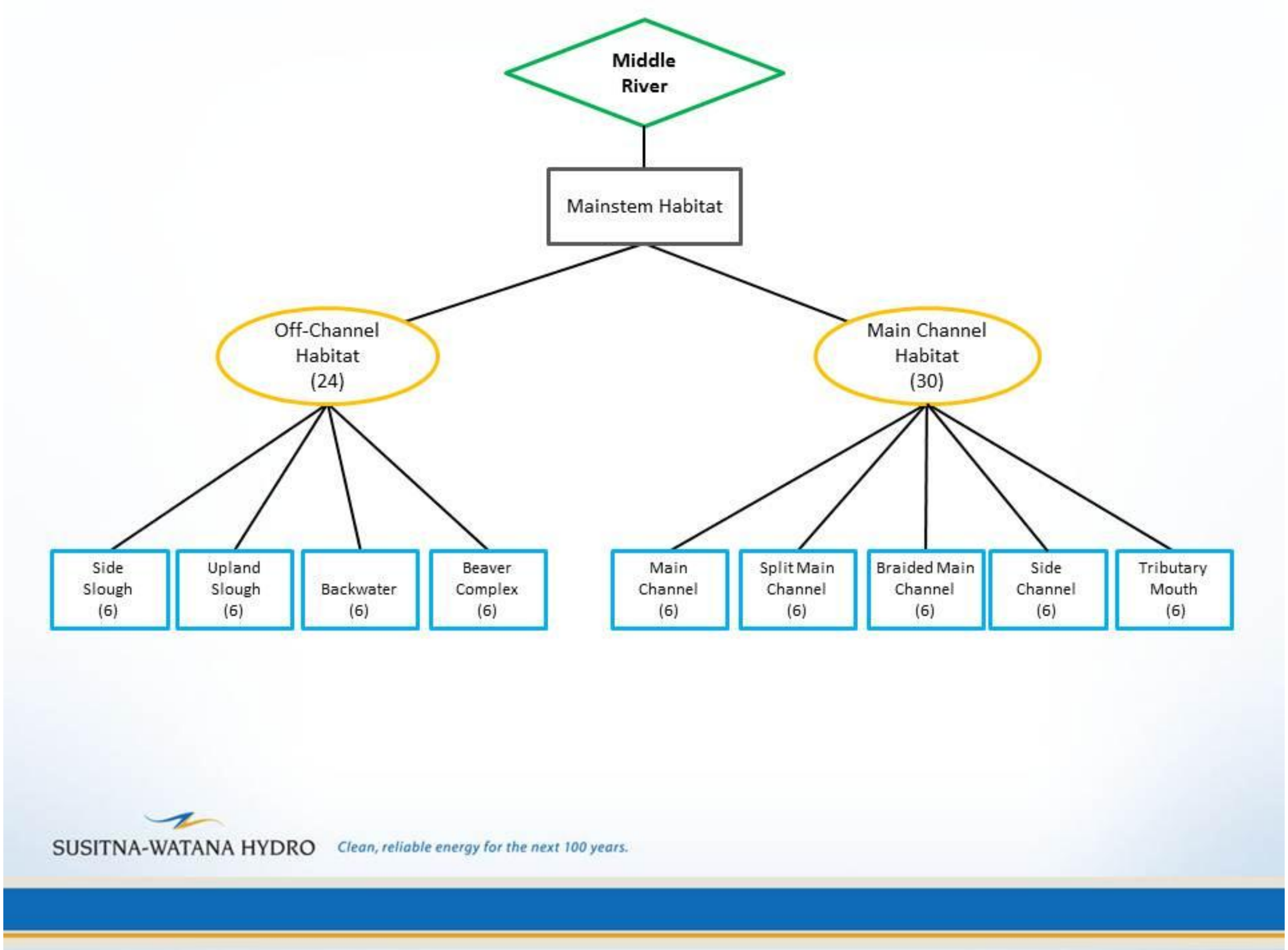
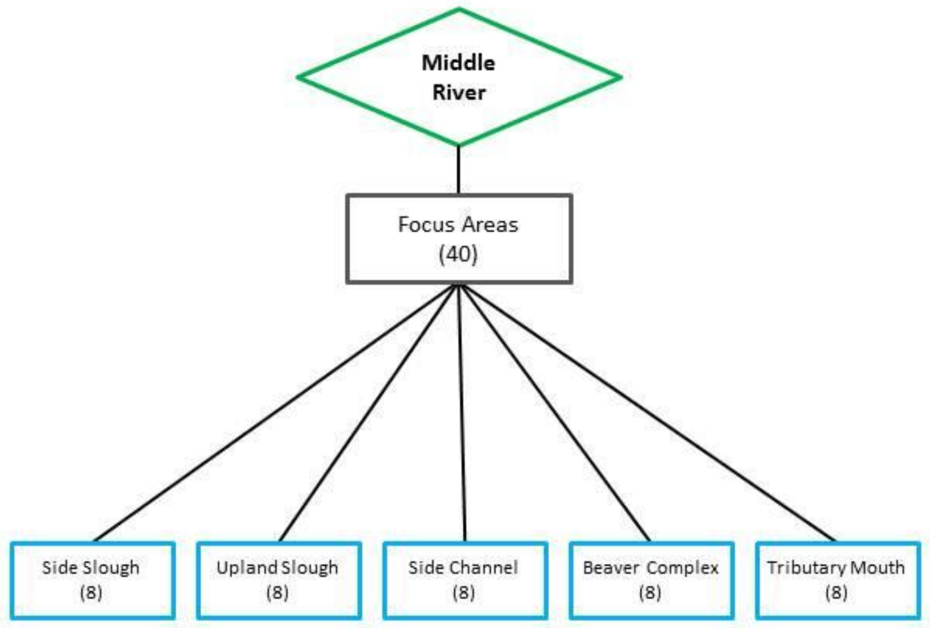


Figure 9.6-5 Schematic showing strata by habitat type for relative abundance sampling in focus areas



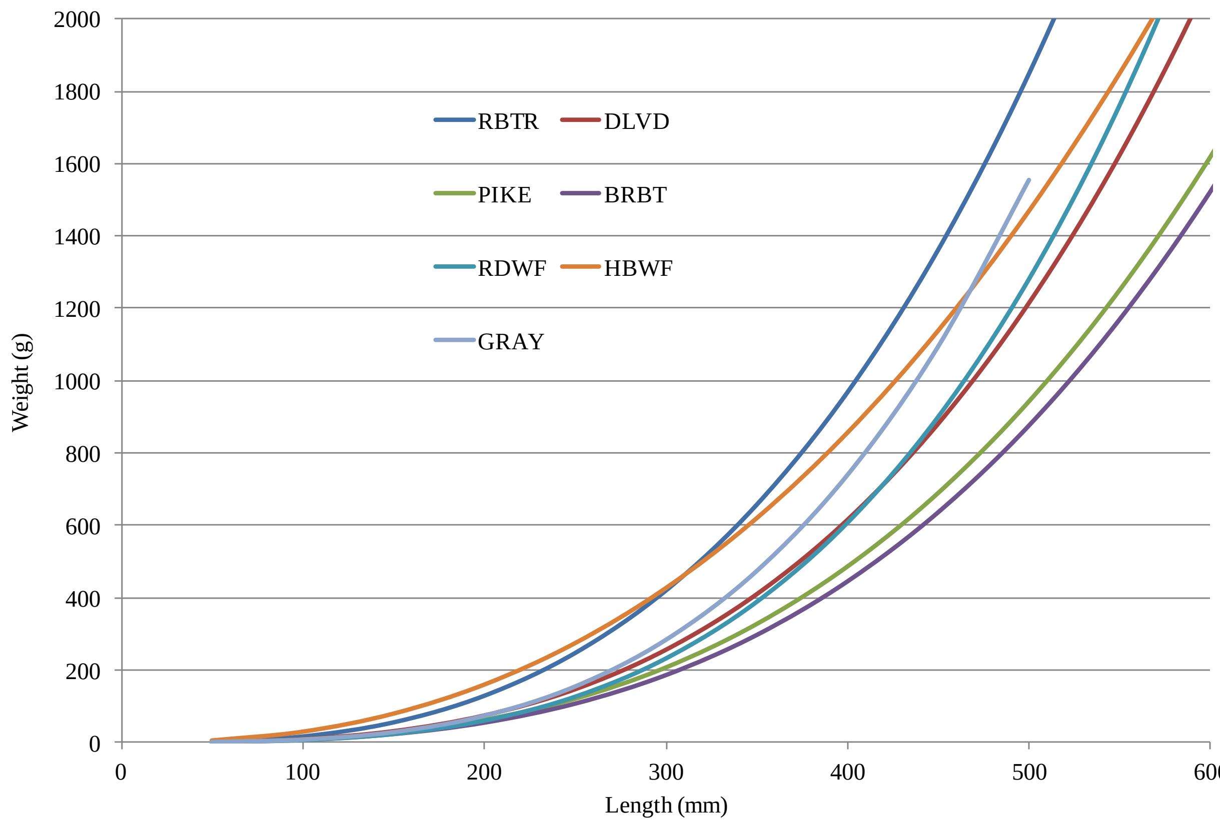


Figure 9.6–6. Existing or derived length-weight relationships for fish species to be radio-tagged.

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Figure 9.6-7 Flow Chart of Study Interdependencies for Fish Distribution and Abundance in the Middle and Lower Susitna River Study Plan.