Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Salmon Escapement Study
Study Plan Section 9.7

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

July 2013

9.7. Salmon Escapement Study

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 Salmon Escapement Study, Section 9.7. RSP Section 9.7 focuses on characterizing the current distribution, abundance, habitat use, and migratory behavior of all species of adult anadromous salmon across mainstem river habitats and select tributaries above the Three Rivers Confluence (i.e., confluence of the Susitna, Chulitna, and Talkeetna rivers).

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. RSP Section 9.7 was one of the 13 approved with modifications. In its February 1 SPD, FERC recommended the following:

We recommend the study be modified to require AEA to extend the operation of its Curry Station fishwheels at RM 120 through the entire month of September.

We recommend the study be modified to require AEA to include in the initial study report an evaluation, based on site-specific data obtained during the 2013 study season, of the feasibility of putting in a weir or sonar counting station at or near the dam site during the 2014 study season to provide an accurate count of any resident or anadromous fish that are successfully able to migrate upstream through Devils Canyon into the project area.

On February 21, 2013, the National Marine Fisheries Service (NMFS) filed a notice of study dispute pursuant to section 5.14(a) of the Commission’s regulations. This dispute included four elements of RSP Study 9.7.

On April 3, 2013, a dispute resolution panel held the technical conference, which was attended by representatives from NMFS, AEA, the Commission, and other licensing participants. On April 12, 2013, the panel filed its findings with the Commission, and recommended no additional modifications to RSP Section 9.7. On April 26, 2013, the Commission issued determination requiring no changes in its earlier study plan determination.

In accordance with the February 1 SPD, AEA has adopted the modifications outlined in FERC’s February 1 SPD.

9.7.1. General Description of the Proposed Study

Information from this Salmon Escapement Study will be used in combination with other studies to assess potential effects of the proposed Project on fisheries resources. Construction and operation of the Project will modify the flow, thermal, and sediment regimes of the Susitna River, which may alter the composition and distribution of fish. This study will provide information on the distribution and abundance of adult salmon in the Lower, Middle, and Upper Susitna River. This work will be conducted through collaboration among the Alaska Energy Authority (AEA), the Alaska Department of Fish and Game (ADF&G), and other licensing participants. Information developed in this study may also be used to develop any necessary protection, mitigation, or enhancement measures to address Project impacts to salmonid resources.

9.7.1.1 Study Goals

The primary goal of the study is to characterize the current distribution, abundance, habitat use, and migratory behavior of all species of adult anadromous salmon across mainstem river habitats and select tributaries above the Three Rivers Confluence (i.e., confluence of the Susitna, Chulitna, and Talkeetna rivers). Sufficient information of this nature has been collected for several species elsewhere in the Susitna watershed. However, for Chinook and coho salmon, additional information would aid in assessing the potential impacts of the Project. Therefore, a second goal of this study is to estimate the distribution, abundance, and migratory behavior of adult Chinook throughout the *entire* Susitna River drainage, and the coho salmon distribution and abundance in the Susitna River above the confluence of the Yentna River.

9.7.1.2 Study Objectives

1. Capture, radio-tag, and track adults of five species of Pacific salmon in the Middle and Upper Susitna River in proportion to their abundance. Capture and tag Chinook, coho and pink salmon in the Lower Susitna River.
2. Characterize the migration behavior and spawning locations of radio-tagged fish in the Lower, Middle, and Upper Susitna River.
3. Characterize adult salmon migration behavior and timing within and above Devils Canyon.
4. If shown to be an effective sampling method, and where feasible, use sonar to aid in documenting salmon spawning locations in turbid water in 2013 and 2014.
5. Compare historical and current data on run timing, distribution, relative abundance, and specific locations of spawning and holding salmon.
6. Generate counts of adult Chinook salmon spawning in the Susitna River and its tributaries to estimate the proportions of fish with tags for populations in the watershed.
7. Collect tissue samples to support the Fish Genetic Baseline Study (Section 9.14).
8. Estimate the system-wide Chinook salmon escapement to the entire Susitna River, the coho salmon escapement to the Susitna River above the its confluence with the Yentna River, and the distribution of Chinook, coho, and pink salmon among tributaries of the Susitna River (upstream of Yentna River confluence) in 2013 and 2014.

9.7.2 Existing Information and Need for Additional Information

Existing information includes fish spatial and temporal distribution and relative abundance information from recent and early 1980s studies. The Aquatic Resources Data Gap Analysis (ARDGA; AEA 2011a) and PAD (AEA 2011b) summarized existing information and identified data gaps for adult and rearing salmon. The licensing effort of the 1980s APA Susitna Hydroelectric Project generated a substantial body of literature, some of which will be summarized and used to support the 2013–2014 data collection efforts. The adult salmon habitat use studies conducted by ADF&G during the 1980s are summarized by Woodward-Clyde Consultants and Entrix, Inc. (1985). In recent years, ADF&G has conducted adult salmon (sockeye, coho, and chum) spawning distribution and abundance studies in the Susitna River (e.g., Merizon et al. 2010; Yanusz et al. 2011). In 2012, ADF&G expanded its scope to include Chinook and pink salmon. Existing fish and aquatic resource information appears insufficient to address the issues below that were identified in the PAD (AEA 2011b).

- **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.
- **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.
- **F5:** Potential effect of Project flow regime on anadromous fish migration above Devils Canyon. Devils Canyon is a velocity barrier to most fish movement and changes in flows can result in changes in the potential fish movement through this area (approximately river mile [RM] 150).
- **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 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.

Susitna River Chinook and coho salmon stocks support important commercial, sport, and subsistence fisheries in Northern Cook Inlet (NCI). The Susitna River currently supports the fourth largest run of Chinook salmon in Alaska (Ivey et al. 2009). Chinook salmon escapements in the Susitna drainage are monitored annually by ADF&G with single aerial (helicopter) or foot surveys. These surveys provide an index of escapement rather than a complete census of the escapement. These measurements provide a ranking of escapement magnitudes across years, but alone these measurements provide little information on the total number of fish in the escapement (Fair et al. 2010).

In 1985, ADF&G operated fishwheels at RM 22 and RM 82 in the Susitna River to estimate the escapement of Chinook salmon to the Susitna River drainage. The Chinook salmon escapement at Flathorn was estimated to be 113,931 fish (length greater than 400 millimeters [15.75 inches]) with a standard deviation of 77,931 (Thompson et al. 1986). This is the only drainage-wide Chinook salmon escapement estimate for the Susitna River. A drainage-wide abundance estimate of returning adult Chinook salmon using capture-recapture methods is most likely to yield the most accurate and precise estimate of the abundance of spawning Chinook salmon.

During the 1985 adult salmon investigation study, spawning ground surveys were conducted for Chinook salmon in the Middle and Lower Susitna River. These observational surveys were conducted by surveyors wearing polarized sunglasses looking for visual verification of mating pairs, distinct redds, or the confirmed presence of eggs by intergravel sampling (Thompson et al. 1986). No spawning areas were observed in the sloughs or Middle River mainstem channel in 1985. The 1985 report does not mention if spawning areas were found in the Lower River mainstem channel. This radio telemetry study would attempt to characterize any Chinook salmon spawning in the mainstem Susitna River. ADF&G has successfully used this approach to identify likely spawning areas for sockeye, coho, and chum salmon within the Susitna River drainage (Yanusz et al. 2011; Merizon et al. 2010; Yanusz et al. 2007).

9.7.3 Study Area

The study area encompasses the Susitna River from Cook Inlet upstream to the Oshetna River, or as far upstream as Chinook salmon are detected (Figure 9.7-1), with an emphasis on wherever salmon spawn in mainstem habitats of the Susitna River. The mainstem Susitna River is divided into three generalized reaches for the purposes of this study plan: the Lower River (RM ~30-98), Middle River (RM 98–150), and Upper River (RM 150–234). Devils Canyon extends from approximately RM 150 to RM 164.

9.7.4 Study Methods

Descriptions of the study methods are organized below by objective. This is a multi-year study initiated in 2012. The methods below refer to research to be conducted in 2013 and 2014.

9.7.4.1 Objective 1: Capture, radio-tag, and track adults of five species of Pacific salmon in the Middle and Upper Susitna River in proportion to their abundance. Capture and tag Chinook, coho, and pink salmon in the Lower Susitna and Yentna rivers.

Tasks to address Objective 1 include the following:

- Install and operate two fishwheels at approximately RM 30 of the Susitna and two fishwheels on the lower Yentna River from late May through August 2013 and 2014.
- Supplement the fishwheel effort in the Lower River with gillnet/tangle nets to address potential size selectivity of capture and augment catch totals.
- Install and operate two fishwheels at Curry (RM 120) from early June through September in 2013 and 2014 (Figure 9.7-1). Supplement fishing effort for Chinook salmon in the Middle River by operating a fishwheel in Devils Canyon below the impediments from late June through late July in 2013 and 2014.
- Radio-tag a total of 1,400 Chinook salmon (700 in the Yentna River and 700 in the Susitna River at RM 30) and 600 coho and 200 pink salmon in the Susitna River at RM 30 in 2013 and 2014.
- Radio-tag 400 Chinook salmon and 200 each of chum, sockeye, pink, and coho salmon in the Middle River at Curry (RM 120). Apply as many of the 400 radio tags for Chinook salmon in Devils Canyon.

- Assess the degree to which radio-tagged fish are representative of all salmon passing each of the tagging sites (e.g., test for size selectivity, compare mark rates among spawning areas).
- Evaluate the potential for handling-induced changes in fish behavior based on the post-release survival and migration rates of radio-tagged fish.

Meeting the goals of this study will be aided by radio-tagging fish of each species in a manner as representative of each species' "population" in the Lower and Middle River as possible. Tagging particular stocks and/or sizes of fish at different rates than others can often be accommodated during data analysis (Seber 1982; Schwartz and Seber 1999) but could weaken inferences about relative distribution among tributaries and habitat uses of the Middle River such as the relative distribution of spawning fish, migratory behaviors, any fish passage above Devils Canyon, and the river-wide abundance of Chinook and coho salmon. There are multiple ways to assess whether fish passing the tagging sites are equally vulnerable to being radio-tagged. Of greatest importance is to survey spawning areas to determine the size composition of tagged and untagged fish (size distributions) and determine the proportion of fish in different areas that contain a tag (i.e., the mark rate). Statistically significant differences in mark rates among areas would suggest unequal vulnerability; differences in the size distributions of the marked and unmarked fractions of the fish would suggest size-selective capture and tagging.

9.7.4.1.1 Fish Capture

Fishwheels will be used to capture adult salmon for tagging. Two fishwheels will be operated at approximately RM 30 in locations that were fished in 2010–2012. Two fishwheels will be operated on the lower Yentna River during a similar period, and in the same locations as have been operated for three decades. Two fishwheels will also be operated in 2013 and 2014 near Curry (RM 120) from the first week of June through September at the same two locations in 1981–1985 and in 2012. In addition, at least one fishwheel will be operated in the Middle River in lower Devils Canyon at approximately RM 150-151 and below the first of three impediments in Devils Canyon. The Middle River fishwheels consist of aluminum pontoons, three baskets, and two partially submerged live tanks for holding fish in river water. A tower and winch assembly will be used to adjust the height of the baskets and ensure that the baskets are fishing within 20 centimeters (cm) of the river bottom. Net leads will be installed between fishwheels and the adjacent riverbank to direct fish away from the bank and into the path of the fishwheel baskets. Fishwheels will be operated 8–12 hours per day. A two-person crew will staff the fishwheels during operations; when the crew is to be absent from the fishwheel for more than 1 hour, the fishwheel baskets will be raised from the water and stopped. Fishwheels operated in the Lower River will be of similar construction, operated in a similar manner, and will be staffed at all times during operation (Yanusz et al. 2011).

Fishwheel effectiveness, expressed as a fraction of the passing salmon run it captures, often varies within and among seasons. Also known as the catchability coefficient, effectiveness changes with water depth under the fishwheel and water velocity around the fishwheel. The overall abundance of fish in the river at any one time may also affect effectiveness. Variable effectiveness within a season is most problematic for a study of this nature if it varies across the period of the annual run of a particular species and less problematic if it varies across species.

Fish later or earlier within a run of a particular species can represent fish of different sizes, ages, and ultimately, fish bound for different habitats. Therefore, stable effectiveness across time, body size, and spawning destination is ideal, and assumptions will need to be tested by appropriate data collection at the fishwheels and surveys of spawning areas. If sufficiently large numbers of fish can be tagged and later examined, any changes in effectiveness can be compensated for by stratification of results.

9.7.4.1.2 Radio-tagging

ATS pulse-coded, extended-range tags will be applied to a subset of salmon captured in the Lower and Middle river fishwheels. There are 100 unique codes on each available frequency. Model F1835B transmitters will be used for pink salmon (16 grams, 30-centimeter-long antenna, 96-day battery life); Model F1840B tags for sockeye, coho, and chum salmon (22 grams, 30-centimeter antenna, 127-day battery life); and Model F1845B tags for Chinook salmon (26 grams, 41-centimeter antenna, 162-day battery life). All transmitters will be equipped with a mortality sensor that changes the signal pattern to an "inactive" mode for the remainder of the season once the tag becomes stationary for 24 hours. All of the radio tags will be labeled with return contact information. Each tag will be tested immediately prior to deployment to ensure it is functioning properly upon release.

Only uninjured fish that meet or exceed a specific length threshold will be radio-tagged; i.e., Chinook salmon with a mid-eye to fork length (METF) of ≥ 500 millimeters; coho, sockeye, and chum salmon ≥ 400 millimeters; and pink salmon ≥ 325 millimeters. All fish to be tagged will be placed in a water-filled, foam-lined, V-shaped trough. To minimize handling time (i.e., achieve < 1 minute per fish) and tagging-related effects on fish behavior, anesthetic will not be used. Radio tags will be inserted orally into the stomach of the fish using a piece of PVC tubing (1/3-inch diameter and 18 inches long) with the tag antenna left to protrude from the mouth. All radio-tagged salmon will be measured to determine mid-eye-to-fork length (to the nearest centimeter), and sexed based on external morphological characteristics (coloration, body and fin shape, jaw morphology). Radio-tagged fish at Curry will be tagged with a spaghetti tag to assess tag loss, evaluate the effects of spaghetti-tagging on post-handling behavior and final spawning destination, and to provide an external mark for anglers to recognize a fish that has a radio tag. Radio-tagged fish will be sampled for scales (to age) and tissue for genetic baselines (see Section 9.14, Genetic Baseline Study for Selected Fish Species).

To minimize any effects from fish holding, salmon will typically be tagged immediately upon capture. All fish will be released immediately after tagging. All fish captured will be inspected for radio and spaghetti tags.

9.7.4.1.3 Spaghetti-Tagging

Spaghetti-tagging will also augment the ability to test assumptions about the representativeness of fish captured in the fishwheels. The fishwheels may capture more fish of some species than will be needed for radio-tagging alone, and additional marking of fish will provide more information to test assumptions about how representative the captured fish are of the population of fish passing fishwheel sites than the radio tags alone. A portion of these additional fish captured will be spaghetti-tagged, and this portion will vary among species according to availability of fish above radio-tagging goals and the opportunities available for examining fish subsequent to the tagging event.

If similar catches are obtained as in 2012, all of the Chinook salmon captured at Curry that are above the daily radio-tagging goals will be spaghetti-tagged. Tagged Chinook salmon can be subsequently examined in several upstream tributaries to test study assumptions and determine the fraction marked in the different stocks. Based on the 2012 results, we expect few or no coho salmon caught at Curry above the radio-tagging goal of 200 fish.

Sockeye and chum salmon that spawn above Curry will be available for counting and examining for marks in clear-water side channels and sloughs, and the Portage Creek and Indian River tributaries. Given the number of radio tags deployed (200/species), some additional marking of sockeye and chum with spaghetti tags may enable a test for the assumption that capture and marking of fish will be in proportion to stock-specific abundance passing Curry. It is expected that insufficient numbers of pink salmon could be spaghetti-tagged (and later examined) to develop defensible mark-rate estimates in 2013 (an "off-peak" year). In 2014, although a "peak-year", experience in the area in 2012 suggests there are few places to examine significant numbers of pink salmon on the spawning grounds. However, should it become clear during the 2013 field effort that spawning ground surveys could be more successful, spaghetti tags may be applied to pink salmon in 2014.

9.7.4.1.4 Daily Tagging Goals

Recent (2012) and historical (1981–1985) fishwheel catches, effectiveness, and salmon run timing will guide tag application rates over the season. In 2012, Chinook salmon were captured at RM 30 from the last week of May through the first week of July.

Across the five years from 1981 to 1985, Chinook salmon were caught at Curry from as early as June 9 (range June 9–20) to as late as August 20 (range July 29–August 20), with midpoints of the annual runs ranging from June 9–25. During those studies, catches ranged from 201–379 (average 301) for sockeye salmon, 93–350 (average 215) for coho salmon, 861–4,228 (average 2,131) for chum salmon, and 17,394 for the 1984 even-year pink salmon run. Midpoints of the annual migrations at Curry ranged from approximately August 4–5 for sockeye, August 12–13 for coho, August 3–15 for chum, and July 31–August 7 for pink salmon. In 2012, the run timing in the Middle River was within the historical ranges described above. The runs at Curry in 2012 were most similar to those in 1985.

As was done in 2012, the early season tagging rates of fish captured in the fishwheels will be developed prior to the season and will be based on average historical run timing and expected daily fishwheel catches at Curry. These initial radio-tagging rates will be adjusted in-season using run timing information from the fishwheels in the Lower Susitna River (RM 30) and the ratio of current year's daily catch at Curry to the expected daily fishwheel catch based on historical data.

9.7.4.1.5 Numbers and Size of Marked and Unmarked Fish at Selected Locations

To test if Chinook, sockeye, and chum salmon passing fishwheels are equally vulnerable to being captured and radio-tagged, fish will be examined on selected spawning grounds to develop two primary metrics: estimates of the proportion of fish tagged (mark rate) and the size distributions of tagged and untagged fish.

Weirs on tributary streams and aerial and foot surveys will be used to count live and dead fish. Combined with fixed-station and aerial relocating data, these will provide counts of marked and unmarked fish. Lengths of dead fish will be measured to the nearest centimeter and sex and spawning success noted.

9.7.4.1.6 Examining Handling-Induced Changes in Behavior

An assumption of this study is that the behavior of radio-tagged fish is not materially affected by the capture and handling process. By materially affected, we mean that the capture and tagging does not affect the final spawning destination of a fish and/or its migration behavior once it has recovered from the tagging event and resumed its migration. If (and when) sufficient genetic structure can be found among stocks of various species in the Susitna River, genetics could offer a reasonably good test of whether handling may have influenced the final destination of tagged fish. Until then, this assumption cannot be tested directly, but there are several indirect ways to assess its potential magnitude.

The post-release survival and travel time (days) to first detection at upstream fixed-station receivers will provide an indication of the level of handling-induced changes in behavior. Long delays to resume upstream migration and high mortality rates would be indicative of significant changes in behavior; little delay and low mortality rates would be indicative of little effect. Second, we will compare the upstream movement (delays and rates of travel) of tagged fish that were subjected to different holding densities and holding times in the fishwheels. Third, although potentially confounded with different stock-specific vulnerabilities to capture, tag mark rates at spawning locations based on visual observations and telemetry detections (number of tags) can provide an indication of possible handling-induced changes in behavior. Stratification of results by spawning destination based on mark rates can help mitigate any effects of differences that this source of post-release changes in spawning destination might have on our conclusions. Finally, we expect that the fishwheels will recapture some of our radio-tagged fish and the post-release migratory behavior of these already tagged fish will provide additional data on the effects of the fish capture process, including any potential cumulative handling effects.

Note that this is not an issue if the effect is binomial in nature or simply a significant “on” or “off” with any individual fish. The radio-tag study design allows the fish that drop back and do not resume their upstream migration to be censored (removed) from the experiment and subsequent analyses. The issue is more with subtle effects that could go undetected but materially affect conclusions.

9.7.4.1.7 Assessing Any Stock- and Size-selective Capture

Fish will be randomly selected from the fishwheels for tagging. To assess whether these fish are representative of all fish in the in the river, several assumptions need to be tested.

An assumption of equal probability of capture across fish from all spawning destinations can be tested indirectly by examining several sources of information. If there are unequal probabilities of capture among spawning stocks, it will be caused by, and manifest itself, in multiple ways.

Fishwheel effectiveness across time: The main assumption of this study component is that the radio tags are deployed at the fishwheels in proportion to abundance for each species. To help evaluate this assumption at Curry, we will compare the relative effectiveness of each fishwheel, as determined from the ratio of fish caught by a fishwheel and the number of fish observed with DIDSON sonar system operated in close proximity to the fishwheel across multiple time periods, and river discharge. The DIDSON will also be used to qualitatively assess fish approach behavior at the fishwheel relative to discharge and fish abundance. We will also compare the catch per unit effort (CPUE; fish per fishwheel hour) over time and across a range of discharges.

Differences among stocks: To assess whether fish from a particular spawning area were right or left bank-oriented with respect to the capture site, we will compare the proportion of fish migrating into specific areas with the collection bank. Assuming data are suited to statistical analysis, we will also use contingency table analysis to compare mark rates over time and areas at upstream locations (i.e., at weirs and from ground surveys). If tags are deployed in proportion to abundance, then we would expect mark rates to be constant across both temporal and spatial strata in these spawning ground areas. One concern is that mainstem fish could be more vulnerable to the fishwheels because they linger or mill upstream and downstream of capture sites. Recaptures of radio-tagged fish at the tagging site fishwheels will provide a good test of whether milling fish are exposed to greater capture rates. In addition to quantitative and qualitative assessment of subsequent behavior of these recaptured fish, we will compare the final destinations (mainstem/tributary) of recaptured fish to other tagged fish to determine whether fish that spawn in the mainstem are recaptured at a higher rate.

Size-related (and age-related) selectivity will be tested using Kolmogorov-Smirnov (K-S) two-sample tests. For each species, we will compare the cumulative length-frequency distributions of (1) radio-tagged and spaghetti-tagged fish and those fish randomly sampled on the spawning grounds; (2) radio-tagged and spaghetti-tagged fish and all other fish sampled for length at the Curry fishwheels; and (3) radio-tagged and spaghetti-tagged fish captured in individual fishwheels. Using data from similar sources, contingency table analyses and Chi-square tests will be used to compare the sex and age composition of fish radio-tagged by species. Size-related bias can usually be eliminated by size stratification of results.

9.7.4.2 Objective 2: Determine the migration behavior and spawning locations of radio-tagged fish in the Lower, Middle, and Upper Susitna River.

This is a continuation of the multi-year study initiated in 2012. Tasks to meet Objective 2 include the following:

- Track the locations and behavior of radio-tagged fish using an array of fixed-station receivers and mobile-tracking surveys. Aerial surveys will begin in July and end in early October each year.
- Conduct boat- and ground-based surveys to locate holding and spawning salmon to the level of microhabitat use.

Three groups of radio-tagged fish will be tracked: (1) adult Chinook, coho, chum, pink, and sockeye salmon will be radio-tagged and released in the Middle River at Curry (RM 120); (2) Chinook, coho, and pink salmon tagged in the Lower Susitna River (RM 30); and (3) Chinook salmon tagged in the lower Yentna River (Figure 9.7-1). The three study components and data analyses will be tightly coordinated. All mobile (aerial, boat, and foot) and fixed-station receiver data will be analyzed together, and analysis products will be characterized in a consistent manner.

The primary function of the telemetry component is to track these tagged fish spatially and temporally with a combination of fixed and mobile receivers. 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)

These data, in conjunction with habitat descriptions, will allow characterization of migratory behavior and final destinations for salmon in mainstem habitats (main channel, slough, side channel) and tributaries. In addition, observed spawning locations will be characterized at a microhabitat level (e.g., depth, velocity, substrate). Spawning or final locations of tagged fish will be used to determine the number and proportion of the tagged fish of each species using mainstem habitats.

9.7.4.2.1 Fixed-Station Monitoring

Stand-alone operating telemetry arrays will be deployed at strategic locations on the Lower, Middle, and Upper River to provide migration checkpoints and develop spawning ground inventories and the fates of individual tagged fish. Each station will include a radio receiver, power supply, antenna switcher, and two or three aerial antennas. Antennas may be mounted in trees or on tripod-mounted poles and orientated to distinguish between upstream and downstream movements of fish (i.e., direction of travel). Receivers will be programmed to scan all frequencies and record coded tags. Initial station installation will include range testing to define the expected detection range (approximately 900 linear feet at 10 feet water depth, configuration dependent) of each antenna. Standard reference or "beacon" tags will be deployed at most fixed stations to provide a continuous record of known signal detections. Fixed stations will be manually downloaded (i.e., by the field crew) on a weekly basis unless a remote communication protocol is established. Raw telemetry files will be archived and then imported into custom database software for processing and summarizing throughout the season, and for post-season reporting.

Figure 9.7-1 shows the locations of the radio telemetry fixed stations in the Lower, Middle, and Upper Rivers. Proposed locations for radio telemetry fixed stations in the Middle and Upper River are also shown in greater spatial resolution in Figure 9.7-2 and are listed below.

1. Lane Creek area (~ RM 113.0)
2. Middle River Gateway - (RM 123.7)
3. Slough 11 (~ RM 135.3)
4. Indian River confluence (RM 138.6)
5. Slough 21 (~ RM 141.1)
6. Portage Creek confluence (RM 148.8)
7. Cheechako Creek confluence (RM 152.4)
8. Chinook Creek confluence (RM 157.0)
9. Devil Creek area (RM 164.0)
10. Kosina Creek confluence (RM 206.8)

The Lower River stations were chosen to represent all significant tributaries that are known to contain or may contain Chinook salmon (Figure 9.7-1). The Middle and Upper River sites were chosen based on the following: (1) the need to provide geographic separation of the Middle River area to describe migration and spawning behaviors, and (2) monitoring at the appropriate resolution through the Upper River area to quantify passage through Devils Canyon. See below for additional details about the telemetric monitoring in Devils Canyon (Objective 3).

9.7.4.2.2 Telemetry Aerial Surveys

Aerial surveys of the mainstem Susitna from RM 22 to Kosina Creek will be conducted by helicopter to allow relatively accurate positioning of tagged fish, to locate spawning areas, and to make visual counts of fish in clear water areas, all with respect to mainstem habitat types. Aerial surveys will begin in July and end in late October (≈16 weeks). Survey timing may be adjusted depending on the observed fishwheel catches in the Lower and Middle River. Surveys will be scheduled at five-day intervals with the intent to ensure a maximum of seven days between surveys with weather contingencies. In the event that fixed stations indicate that no tagged fish have migrated upstream of Devils Canyon, aerial surveys to at least Kosina Creek will be conducted at least three times to confirm these results. If radio-tagged fish are detected moving upstream in the mainstem at the Kosina Creek telemetry station, aerial surveys will be extended to locate those radio-tagged fish and visually survey for untagged fish.

Surveys via helicopter can be conducted at lower elevations and at slower speeds than can be achieved using fixed-wing aircraft, and therefore will allow more time for signal acquisition, higher spatial resolution, and fish/habitat observations. Fixed-wing surveys are most appropriate when the study goal is a spatial resolution of tagged fish locations to be within approximately 800 meters (i.e., to the nearest 0.5 river mile), and some fixed-wing surveys will be conducted about every 10 days. The goal for helicopter-based surveys is to be within approximately 300 meters (1,000 feet), as well as to determine whether the fish is in off-channel or mainstem habitat. Higher precision will be achievable in reaches where conditions are most favorable. Geographic coordinates will be recorded for each detected signal using an integrated communication link between the telemetry receiver and a global positioning system (GPS) unit. The position of the fish will be determined as that position of the aircraft at the time of the highest signal power. Range testing of the mobile aerial setup will be conducted in the Lower River to confirm detection ranges for typical flying heights, receiver gains, and antenna orientation, as well as to work with the helicopter pilot to refine the methods for achieving highest spatial resolution.

The mainstem aerial surveys will need to cover over 200 river miles (RM 22 to RM 230), and multiples of that total when side channels and braids of the Lower River are included. To allocate survey effort efficiently and to the highest priority needs, resolution will be a function of fish behavior. The highest priority and highest resolution needs will be for fish that appear to be holding or spawning. For migrating fish, resolution to the nearest 500 meters (~1,500 feet) of river will generally be sufficient. The proposed frequent surveys will provide a means of focusing a higher-resolution and time-intensive tracking effort on identifying exact locations of spawning and holding fish. To do this, the aerial survey team will have available the most recent observed river locations (to the nearest 1 kilometer [0.62 mile]) of all mainstem fish “at large” (i.e., tagged and not tracked in a tributary). During the survey, the “river km” of all detected fish will be compared to the last seen location from previous surveys to ascertain whether its position has changed by more than 2 kilometers (1.25 miles). When tagged fish are within 2 kilometers of their last seen location, the helicopter will circle at a lower altitude to pinpoint the fish location to mainstem, side channel, or slough habitats.

As well, when aggregations of two or more tagged fish are found “stationary” (i.e., within 2 kilometers [1.25 miles] on one or more surveys) and/or when visual observations of spawning fish are made from the helicopter, ground- and boat-based surveys will pinpoint spawning locations to within 5–10 meters (16–32 feet). This protocol will be particularly important for ensuring coverage of any suspected Lower River habitats with the appropriate level of spatial resolution.

The channel location (mainstem, side channel, slough) and relative water turbidity at the location of the fish will be classified for each tag detected (time stamp, frequency, code, power level) during aerial surveys. If other fish can be seen in the area of the tag position, their relative abundance will be estimated to provide context for the tag observation.

Tag identification, coordinates, and habitat type data will be archived and systematically processed after each survey. A data handling script will be used to extract unique tag records with the highest power level from the receiver files generated during the survey. These records will be imported into a custom database software application (Telemetry Manager) and incorporated into a Geographic Information System (GIS) based mapping database. Geographically and temporally stratified data of radio-tagged fish will be provided to the habitat sampling team and Instream Flow Study to inform their field sampling efforts.

Fixed-wing aerial surveys of tributary systems of the Susitna and Yenta rivers will be conducted from RM 20 to Devils Canyon and the upper Chulitna River at 7- to 10-day intervals from late June through September. These surveys will provide fish locations to the nearest river mile (1.6 km) and will help to fully characterize the fates of fish tagged in the Lower and Middle rivers. Although these will provide less precise spatial resolution of fish locations (and habitat use) than from helicopter surveys, fixed-wing surveys will more effectively cover the very large lineal distances of the Susitna River tributaries than possible by helicopter (and in areas where high spatial resolution is not required).

9.7.4.2.3 Lower River Surveys

Helicopter surveys of the Lower River will cover mainstem areas from RM 22 to the confluence of the Chulitna River (RM 98). This reach is highly braided with side channels and sloughs, so complete coverage will require considerable effort and in-flight route tracking. With the survey protocol outlined above and the number of tags anticipated to be at-large on any one survey, this area will require up to two survey days to complete.

9.7.4.2.4 Middle River Surveys

Helicopter surveys of the Middle River will cover mainstem areas from the confluence of the Chulitna River (RM 98) through Devils Canyon (≈ RM 164). This reach (66 miles) will require approximately one day to complete, and as much as two days late in the season when all tags are deployed.

9.7.4.2.5 Upper River Surveys

Helicopter surveys of the Upper River will generally be triggered by detection of fish moving above fixed-stations at the Portage and Devils Canyon stations. Once fish are detected above Devils Canyon, aerial surveys will cover the mainstem areas from Devils Canyon (≈ RM164) to the confluence of the Kosina Creek (RM 206.8). This reach will include approximately 53 relatively confined river miles. This survey will require approximately one survey day; less when done in conjunction with Middle River surveys (i.e., when less conveyance time is involved). Radio-tagged fish above Devils Canyon will be located at a spatial resolution in habitat types similar to the Middle and Lower River surveys.

9.7.4.2.6 Boat and Ground Surveys

Telemetry surveys will also be conducted by boat 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. It is expected that resolution will be within 5–10 meters (16–32 feet) in turbid water and within 2–3 meters (6.5–10 feet) in clear water (dependent on density and highest resolution at low densities). Underwater stripped-coax antennas and judicious use of signal gain control will allow locating tagged fish and recording their geographic position with a GPS. These data will be collected in concert with the field activities and provided to the habitat suitability sampling team to inform their sampling efforts. These surveys will be conducted approximately weekly during the July through September mobile tracking period.

9.7.4.3 Objective 3: Characterize adult salmon migration behavior and timing within and above Devils Canyon.

The tasks to achieve Objective 3 include the following:

- Establish an array of fixed-station receivers at and above Devils Canyon to monitor the behavior of radio-tagged fish from early June to October each year (Figures 9.7-1 and 9.7-2).
- Conduct aerial surveys of the Upper River to locate tagged and other salmon.
- Locate spawning and holding salmon upstream of Devils Canyon.
- Assess the feasibility of operating a fish weir at or near the dam site to provide an accurate count of resident fish passing that location, or anadromous adults that are able to successfully migrate upstream through Devils Canyon into the Project Area.
- Assess the feasibility of operating an acoustic sonar array at or near the dam site to provide an accurate count of resident fish passing that location, or anadromous adults that are able to successfully migrate upstream through Devils Canyon into the Project Area.

A combination of fixed-station receivers below (at the Portage Creek confluence, RM 148.8), within (RM 150 and RM 164), and above Devils Canyon will be used to determine the migration timing and behavior of any radio-tagged salmon that pass into the Upper River area (Figure 9.7-2). Fixed-station receivers will be deployed at locations where they will have the highest probability of detecting radio-tagged salmon. The fixed station deployed at the confluence with Kosina Creek will provide additional information that can be used to assess the detection efficiencies for all mainstem fixed-station receivers downstream from this site. The data from these receivers will also be used to identify the broad reaches of the Upper River to guide the aerial and ground-based survey efforts needed to identify spawning areas.

The mobile survey data will aid in confirming the presence of radio-tagged fish, and locating any fish not detected at downstream fixed-station receiver sites. These additional detections will be combined with the aerial survey data to estimate detection efficiencies for each fixed-station receiver. The timing and proportion of all tagged salmon that pass Devils Canyon will be calculated and compared to the remaining tagged population, and their final spawning locations will be identified.

Based on site-specific data obtained during the 2013 study season, AEA will evaluate the feasibility of placing a weir or sonar counting station at or near the dam site during the 2014 study season. This is aimed at obtaining an accurate count of any resident or anadromous fish passing the site. For anadromous fish, their presence will indicate that they were successfully able to migrate upstream through Devils Canyon into the Project area. Assessment of the feasibility for a fish weir will include a determination as to whether there exists a site with suitable physical characteristics (access, channel configuration, water depth and velocity profile, substrate size, and land above OHW for monitoring facilities). Assessment of the feasibility for a sonar array will include a determination as to whether there exists a site with suitable physical characteristics (access, channel configuration, water depth profile, substrate size, and land above OHW for monitoring facilities). The Initial Study Report (ISR) will report the evaluation of feasibility.

9.7.4.4 Objective 4: Use available technology to document salmon spawning locations in turbid water in 2013 and 2014.

This objective involves using side-scan and/or Dual Frequency Identification Sonar (DIDSON) to characterize any suspected salmon spawning in turbid water of the mainstem habitats of the Susitna River.

Previous studies in the mainstem Susitna River have relied on late-season visual surveys of redds to identify and characterize salmon spawning that occurs in turbid water after temperatures have fallen and the river water has cleared. The efficacy of this technique in the Susitna River mainstem habitats has not been evaluated and it may underestimate the extent of spawning activity in turbid water. Late-season visual surveys of redds may fall below 100 percent detection because detection may vary with discharge, suspended sediment levels, etc.

An AEA-sponsored study in August 2012 set out to examine the feasibility of using sonar to find and characterize spawning activity in turbid water. Technical difficulties in August and flow conditions and fish behavior in September 2012 precluded a rigorous test of this method. The method will be used again in 2013 to examine the feasibility of sampling turbid water to quantify spawning activity. Sonar has the potential to detect redds in turbid water and confirm spawning activity by directly monitoring fish behavior. Radio telemetry provides a powerful tool to identify suspected spawning activity, but subsequent sampling of fish with sonar and/or other methods may be needed to help determine whether spawning has actually occurred. Net sampling may help to determine the degree of sexual maturation and reduce confusion between holding and spawning areas in some instances. If spawning behavior such as the digging of redds is not obvious from the DIDSON imagery, and redds are not clearly visible from the side-scan imagery, additional sampling of the gravel by attempting to pump eggs would be required to confirm spawning. Initial emphasis in 2013 will be placed on any suspected Chinook salmon spawning areas in turbid water identified in the 2012 radio telemetry study.

9.7.4.4.1 Sonar Equipment and Methods

The EdgeTech 4125 600/1600 kHz side-scan sonar can generate high-resolution images with an across-track resolution of 0.6 centimeters (~0.25 inch), independent of the range sampled. The system is well suited for collecting data over large areas. Depending on the water depth, the high frequency side-scan sonar can sample a swath of up to 50 meters (164 feet). As a rule of thumb, if the transducer is 1 meter (3.28 feet) above the bottom, one can “see” an approximately 10-meter (32.8-foot) wide swath on each side of the survey boat (port and starboard). The minimum water depth required for the deployment of the transducer is approximately 0.5 meter (1.64 feet). The survey will be conducted at a boat speed of approximately 1 meter per second (3.28 feet per second), slower in shallow water if there is a danger of hitting obstacles. Where the side-scan sonar encounters aggregations of redds, the survey will periodically be paused to supplement the data with stationary spot checks with a DIDSON.

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, 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 has successfully been used to survey salmon redds in the Columbia River.

If deemed feasible based on results from 2012, acoustic surveys will be made from early August through September to coincide with the times when sockeye, chum, Chinook, and pink salmon are actively spawning.

9.7.4.4.2 Sonar Data Analysis and Reporting

All sonar data will be collected along with a differential GPS with 10 Hertz (Hz) positioning rate. The GPS coordinates together with heading, pitch, and roll information will allow matching of side-scan and DIDSON data with any visual and telemetry-based ground-truthed data. The side-scan analysis will provide locations of individual redds or redd fields. The DIDSON data analysis will provide the coordinates, coverage, and duration of each station surveyed, together with the mean number of fish observed in the field of view, their size categories (<40 centimeters, 40– 0 centimeters, >70 centimeters [<25 inches, 25–44 inches, >44 inches, respectively]), and a qualitative description of their behavior.

9.7.4.5 Objective 5: Compare historical and current data on run timing, distribution, relative abundance, and specific locations of spawning and holding salmon.

A comparison will be made of this study's results from 2012–2014 to the historical results that characterized the relative abundance, locations of spawning and holding salmon, and use of mainstem, side channel, slough, and tributary habitat types by adult salmon.

Research conducted in the early 1980s provided information relevant to this study. Annual abundance estimates relevant to at least four fishwheel sites along the Susitna River mainstem were developed in each of three years (1983–1985). These abundance estimates were apportioned to mainstem, sloughs, and tributaries, and the results will be useful for assessing the potential impacts of the Project. One weakness of these studies was that they relied heavily on visual observations of fish (and abandoned late-season redds). These methods and results may underestimate the use and relative importance of mainstem habitats, many of which occur in turbid water during a substantial portion of the spawning period. Another concern is that data collected approximately 30 years ago may not characterize the current habitat use in the mainstem Susitna River.

This study will address both of these concerns by deploying a similarly scaled study of the spawning runs to the Susitna River in 2012–2014 and by using radio telemetry and sonar technology not available in the 1980s. We expect both methods to provide a more rigorous characterization of the use of mainstem habitats than methods used in the 1980s. To the extent spawning distribution and habitat use in the current study are similar to earlier studies, it will greatly increase the sample size and confidence in the conclusions from studies in both periods. Therefore, it will be important to explicitly compare and contrast the distribution and habitat use of salmon in the Lower, Middle, and Upper River habitats of the Susitna River.

9.7.4.6 Objective 6: Generate counts of adult Chinook salmon spawning in the Susitna River and its tributaries.

This objective will be addressed by conducting adult salmon spawning surveys (see Objective 1, Section 9.7.4.1.5) and operating weirs on tributaries (see Objective 8) in 2013 and 2014. The purpose of this work will be to attempt to establish survey-area mark rates (proportion of fish tagged in different streams or mainstem habitats) so that inferences can be made about the representativeness of tagging across stocks. In addition, mark rates from these areas can be used to estimate the abundance passing the tagging sites (but not the abundance at the recovery site). If sufficient sampling can be obtained and some assumptions met, some inference can be made about relative abundance among recovery locations using the estimates of mark rates and the number of radio-tagged fish present.

Assumptions will be made and tested regarding the representativeness of tagging and proportion of the run detected visually and by telemetry. A combination of ground-, aerial-, and weir-based counts will be used. Ground-based surveys will be made where high observer efficiency can be achieved (e.g., Portage and Indian Creeks). Weirs will be placed on selected tributaries (see Objective 8). Aerial surveys by helicopter were conducted in July and August 2012. Protocols will be developed based on experience in 2012 and these will be used again in 2013 and 2014 to survey the Portage and Indian tributaries of the Middle River.

Aerial survey data will be used to establish estimates of minimum and likely numbers of fish based on a range of observer efficiencies. These can then be used to establish ranges of possible species-specific mark rates in 2013 and 2014. Multiple aerial surveys will be flown bracketing the peak timing of spawning. Survey aircraft will be equipped with telemetry receivers and GPS to identify positions of tagged and not-tagged Chinook salmon and any other Pacific salmon that may be observed. The aerial surveys will *not* provide a direct estimate of the total salmon abundance in tributaries. Instead, these will provide a minimum count and then help to establish minimum and likely tributary-specific mark rates, as was done for Portage and Indian tributaries in 2012.

9.7.4.7 Objective 7: Collect tissue samples to support the Fish Genetics Study.

The task for this objective is to collect genetic samples from adult anadromous salmon in conjunction with addressing Objectives 1 and 2. Tissue samples will be taken from all radio-tagged salmon and from all untagged spawning fish that are sampled during spawning ground surveys. Sample collections will be coordinated with the Genetic Baseline Study team (see Section 9.14). Similar to 2012, this study will identify the locations of spawning fish and whenever feasible, collect tissue for use with genetics studies by ADF&G and other researchers.

9.7.4.8 Objective 8: Estimate the system-wide Chinook and coho salmon escapement to the Susitna River above Yentna River and the distribution of those fish among tributaries of the Susitna River in 2013 and 2014.

A commonly applied two-event, capture-recapture experiment will be used to estimate the annual abundance of Chinook salmon in the entire Susitna River drainage and the coho salmon abundance in the Susitna River above the Yentna River confluence. Such methods to estimate salmon escapement are ubiquitous in Alaska and along the West Coast of North America. In the Susitna River, the capture event will be provided by fishwheels operating throughout the seasonal salmon migration. Radio tags will be applied to fish as close to proportional of the migrating salmon as possible. Later in the salmon migration, a series of recapture sites on tributaries and mainstem sites will examine salmon to establish the proportion of each species that has a tag (also known as the species-specific and stock-specific mark rate). Using relatively simple algebra and making some testable assumptions, an estimate of the total species-specific abundance that passed the *tagging site* can be estimated; in this case, the abundance and in-river escapement at the fishwheels sites on the Susitna (Chinook and coho salmon) and the Yentna (Chinook salmon) rivers. Length, sex, and genetics information from the tagged and untagged fish can be used to assess the validity of most assumptions. Behavior of radio-tagged fish following tagging also provides information for evaluating two critical assumptions: that you know how many tagged fish have "entered" the experiment, and whether their behavior compromises the experiment.

Fishwheels on the Yentna and Lower Susitna rivers will be used to capture fish for marking. Weirs on tributaries of the Susitna River will be used to recapture fish for estimating the proportion of each species that has a tag. At the weir recapture sites, Chinook salmon will be counted and inspected for tags. Weirs will be operated on the Deshka River (which has been operated by ADF&G for many years), and on Willow Creek and the Middle Chulitna River, as well as Talachulitna River and Lake Creek in the Yentna drainage. These weir sites were chosen based on the numbers of fish using the systems based on a long time series of annual aerial survey data and the ability to weir the sites. Finally, the fishwheels at Curry will also examine a relatively large number of fish of each species and the mark rates (of lower river tags) in the Curry fishwheels. The size characteristics of the tagged and untagged fish at Curry can be used along with weir-based information in estimating escapement and testing assumptions of the mark-recapture experiment each year.

A two-event, capture-recapture experiment will also be used to estimate the abundance of coho salmon in the Susitna River upstream of the confluence with the Yentna River. Coho salmon will be counted and inspected for tags at the weirs on the Deshka River and Willow Creek. In addition, the middle Chulitna River will be evaluated as a possible site once the 2012 coho salmon telemetry analyses provide an indication the relative size of the coho salmon return to the river.

At Willow Creek, a DIDSON unit will likely be used in conjunction with the weir to estimate Chinook and coho salmon abundance. Past studies at Willow Creek found that, early in the season during spring runoff, Chinook salmon migrated past the likely weir site when high, occluded water precluded installation and operation of a weir. The weir will be installed once the water recedes to levels where the weir can be safely installed. In August and September when coho salmon migrate into the creek, the weir may be compromised by high water resulting from rain. During these times, coho salmon abundance will be estimated using DIDSON.

9.7.5 Consistency with Generally Accepted Scientific Practice

The fishwheel capture methods for supplying salmon for biotelemetry studies have been used around Alaska and elsewhere in North America since the early 1980s, including on the Susitna River at the locations proposed here (Cannon 1986). Similarly, radio-tracking of tagged adult salmon by fixed and mobile (aerial and boat) receivers has been established elsewhere, and used extensively in the Lower Susitna River over the last six years (Yanusz et al. 2007; Yanusz et al. 2011; Merizon et al. 2010) and during the AEA-sponsored salmon tagging at Curry in 2012

(Link et al. *in prep*). Two-event, capture-recapture experiments are ubiquitous in North America for assessing salmon abundance.

9.7.6 Schedule

Initial data collection efforts for this multi-year study began in the summer/fall of 2012 and will continue through the 2013 and 2014 adult salmon migration and spawning seasons. The schedule allows for one initial and two complete study seasons. The proposed schedule (Table 9.7-1) for completion of the Salmon Escapement Study is as follows:

- Initial data collection in 2012 will consist of: (1) operation of fishweels in the Susitna near Curry from June through August, (2) radio tagging and tracking of adult salmon (3) steam counts and carcass surveys in Indian River and Portage Creek (4) HSC surveys of mainstem spawning habitat for spawning salmon (5) evaluation of side-scan sonar to identify redds.
- File a supplemental memorandum with the FERC reporting interim 2012 Salmon Escapement results – First quarter 2013
- Install fishwheels and fixed telemetry stations – May and June 2013 and 2014
- Operate fishwheels in the Lower Susitna and Yentna Rivers – May through August, 2013 and 2014.
- Operate fishwheels in the Susitna River near Curry – June through September, 2013 and 2014.
- Conduct aerial surveys in 2013 and 2104 to relocate radio-tagged salmon – mid-June through September in the Lower River and from mid-July through early October in the Middle and Upper River.
- Quality Controlled (QC) Data – December 2013 and 2014.
- QC'd 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)

9.7.7 Relationship with Other Studies

The salmon escapement study is interrelated to several other studies (Figure 9.7-3). Four Project studies will interrelate by providing predecessor information useful to the salmon escapement study. The Upper River Fish Distribution and Abundance Study (Section 9.5) and Middle and Lower River Fish Distribution and Abundance Study (Section 9.6) will each provide salmon distribution information useful for determining travel time, distance and spawning locations (Objective 1); characterizing migration behavior (Objective 2); characterizing movement in and above Devils Canyon (Objective 3); and estimating Chinook and coho escapement and relative distribution among tributaries (Objective 8). The Characterization and Mapping of Aquatic Habitats Study (Section 9.9) will provide habitat characterization information useful for the characterization of migration behavior and spawning locations (Objective 2). The Fish Genetic

Baseline Study (Section 9.14) will provide information on Chinook salmon genetic structure useful for estimation of the relative distribution among tributaries and mainstem spawning habitats (Objective 8). The Salmon Escapement, along with the Upper River Fish Distribution Study (Section 9.5) and Middle and Lower River Fish Distribution Study (Section 9.6), will also interrelate by opportunistically providing genetic tissue samples of Chinook salmon for the Genetic Baseline Study (Section 9.14).

The Salmon Escapement Study will also interrelate with five other Project studies by providing useful output information (Figure 9.7-3). Characterization of travel time and distance, spawning locations (Objective 1), and migration behavior (Objective 2) will provide general information on salmon distribution and access to habitat, which will be used by the Fish Passage Barriers Study (Section 9.12) and the Aquatic Resources Access Study (Section 9.13). Characterization of migration behavior and spawning locations (Objective 2), and fish movement in and above Devils Canyon (Objective 3) will each provide information on salmon presence above the proposed dam site, which will be useful to the Future Reservoir Fish Community (Section 9.10) and the Fish Passage Feasibility Study (Section 9.11). Estimates of Chinook and coho salmon escapement and relative distribution among tributaries (Objective 8) will provide information on distribution and relative abundance of Chinook salmon by major tributary, which can be used in the Analysis of Fish Harvest Study (Section 9.15).

9.7.8 Level of Effort and Cost

The schedule, staffing, and costs will be detailed as the 2013–2014 Study Plan develops. Total study costs are estimated at $10,000,000. Objectives 1 through 7 would be approximately $2,400,000 per year and the estimated costs for work associated with Objective 8 would be $2,600,000 per year.

9.7.9 Literature Cited

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9.7.10 Tables

Table 9.7-1. Schedule for implementation of the Salmon Escapement Study.

Activity	2012				2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Initial studies and Technical Memorandum		—	—	—	●								
Deploy fishwheels and fixed telemetry stations						—				—			
Operate fishwheels and radio tag fish						—	—			—	—		
Conduct aerial telemetry surveys							—	—			—	—	
Aerial and ground escapement visual counts							—				—		
Data entry and geospatial database							—	—			—	—	
In-season progress reporting							—	—			—	—	
Preliminary data Analysis							—	—					
Initial Study Report								—	—Δ				
Final data analysis											—	—	
Updated Study Report												—	—▲

Legend:

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

9.7.11 Figures

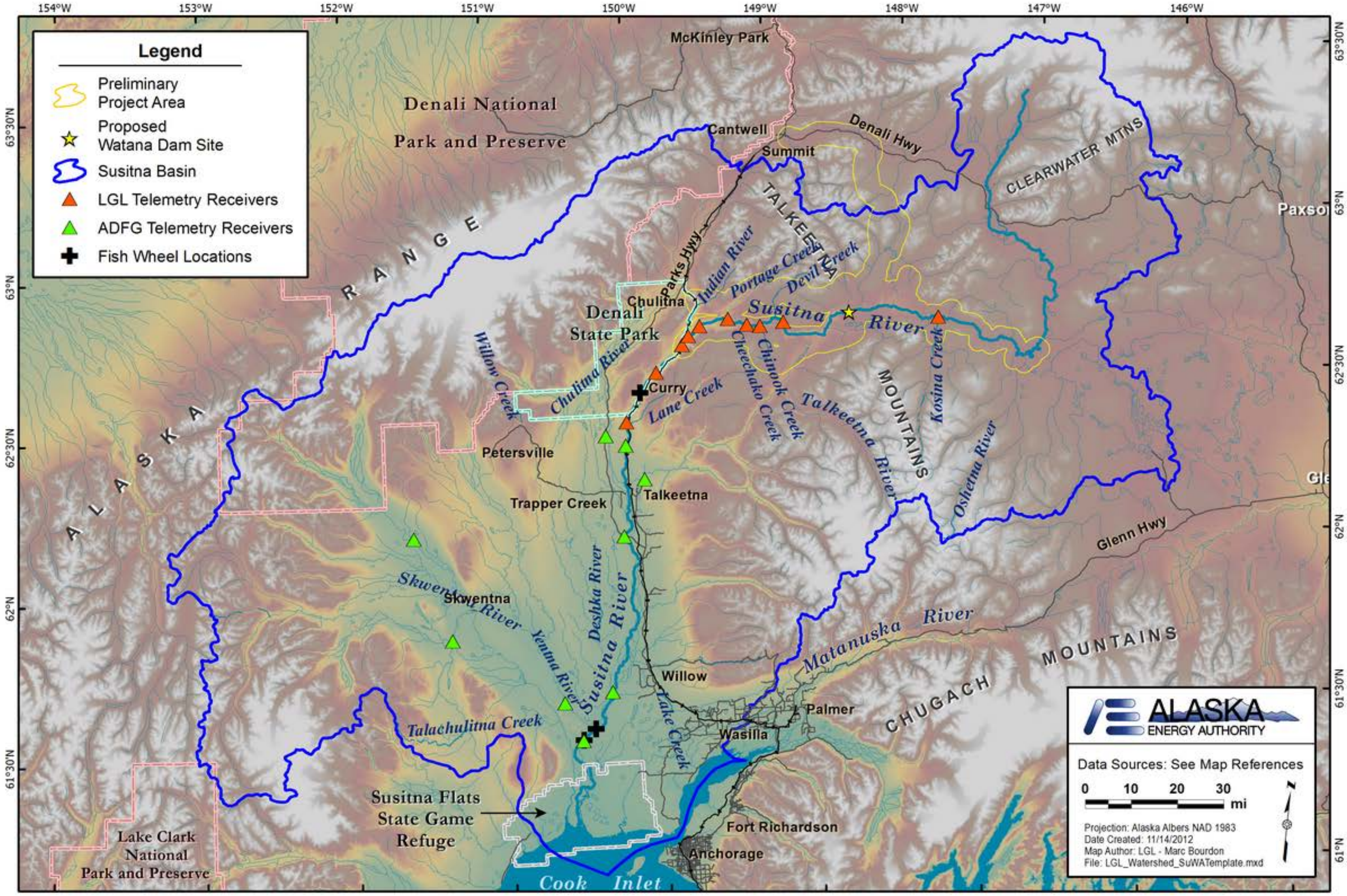

Figure 9.7-1. Susitna watershed showing fish capture sites (fishwheels) and the locations of fixed-station telemetry receivers in the Susitna River.

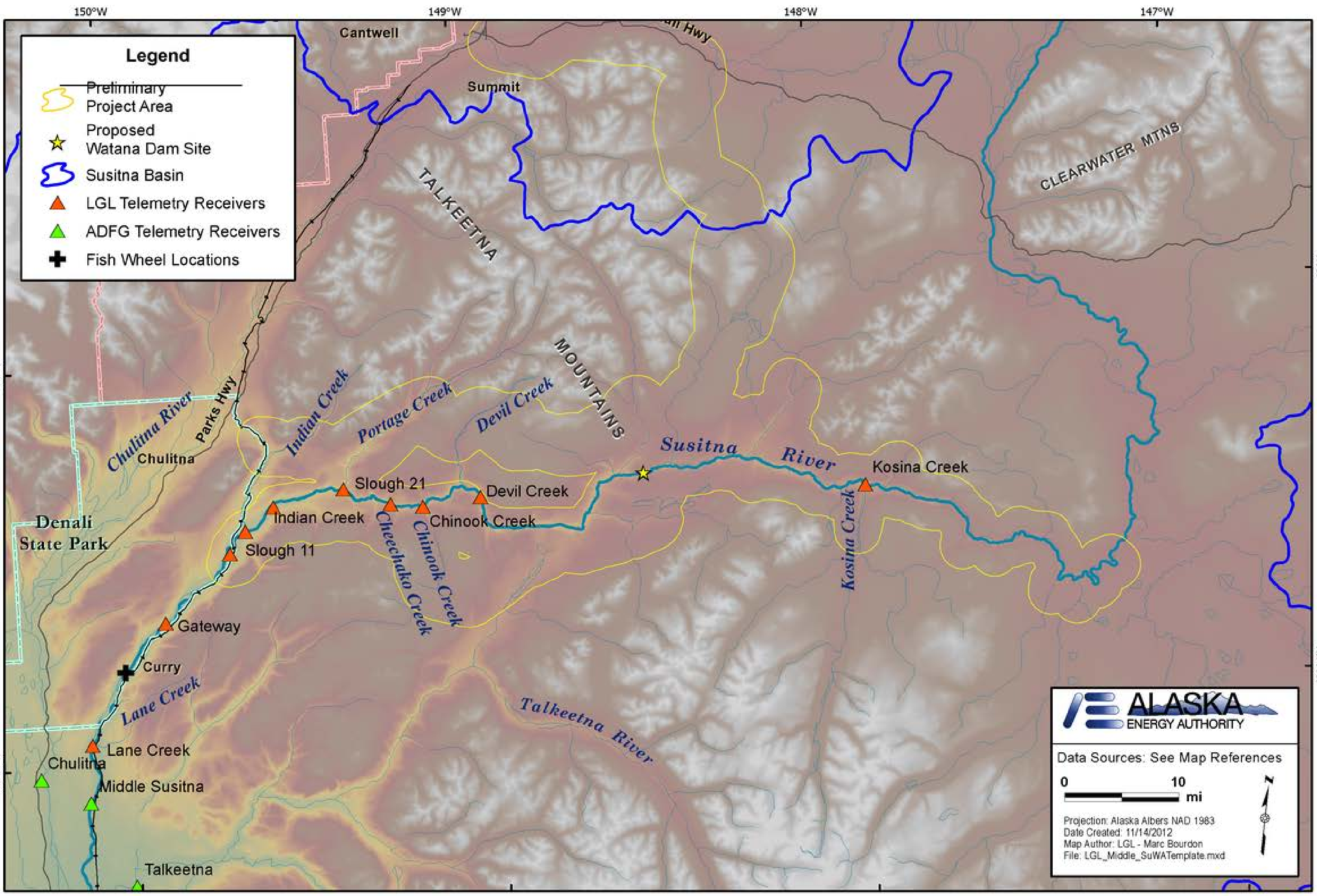

Figure 9.7-2. Fixed-station telemetry receivers in the Middle and Upper Susitna River, 2012–2014.

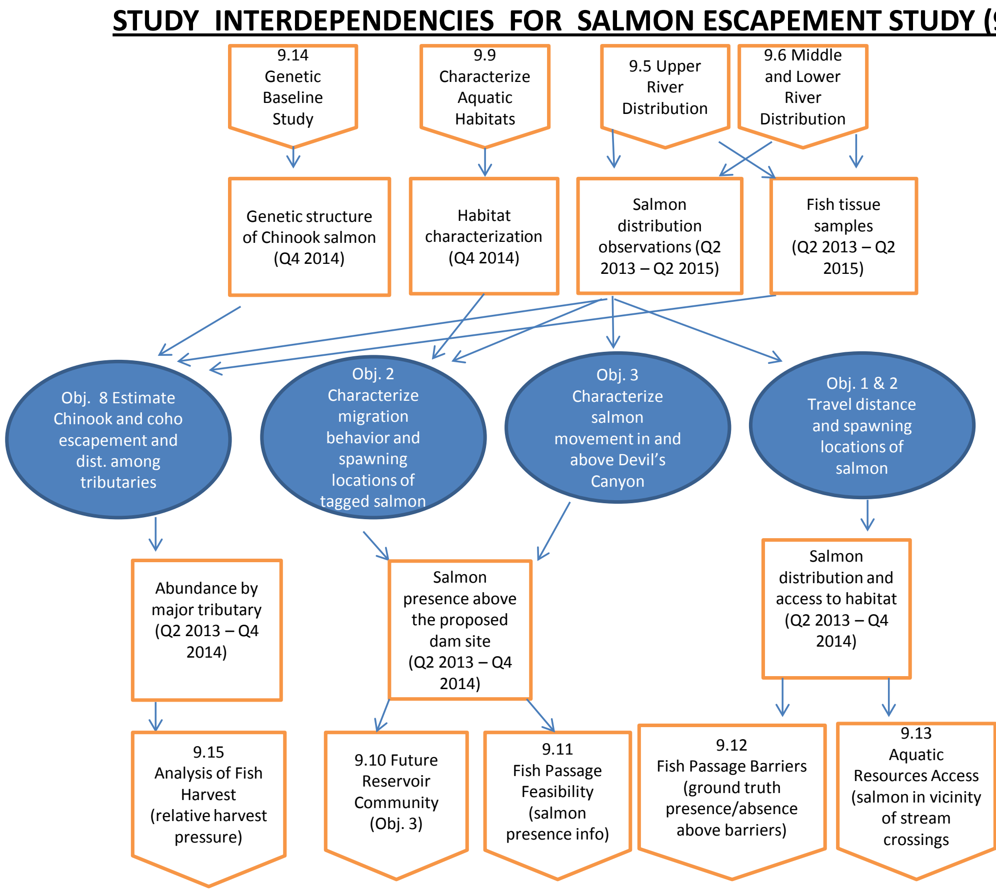

Figure 9.7-3. Study interdependencies for Salmon Escapement Study.