Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Eulachon Run Timing, Distribution, and Spawning in the Susitna River
Study Plan Section 9.16

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

July 2013

9.16. Eulachon Run Timing, Distribution, and Spawning in the Susitna River

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Section 9.16 of the RSP described the Eulachon Run Timing, Distribution, and Spawning in the Susitna River Study. This section focuses on collecting baseline information regarding eulachon (*Thaleichtys pacificus*), which are an important prey species for the endangered Cook Inlet beluga whale (CIBW; *Delphinapterus leucas*). This study has been designed to support the Cook Inlet Beluga Whale Study (Section 9.17). RSP 9.16 provided goals, objectives, and proposed methods for data collection regarding eulachon in the Susitna River.

On February 1, 2013, FERC staff issued its study plan determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. RSP Section 9.16 was one of the 31 studies approved with no modifications. As such, in developing the Final Study Plan Section 9.16, AEA has made no modifications to to this study from its Revised Study Plan.

9.16.1. General Description of the Proposed Study

The goal of the study is to collect baseline information regarding eulachon run timing, distribution, and habitat use in the Susitna River in 2013 and 2014. Eulachon are an important prey species for the endangered CIBW; therefore, this study has been designed to support the Cook Inlet Beluga Whale Study (Section 9.17). Together with existing information, data collected as part of this study will provide necessary baseline information to address issues identified in the Pre-Application Document (PAD) and assess potential Project effects (AEA 2011).

The objectives of this baseline study are as follows:

1. Determine eulachon run timing and duration in the Susitna River in 2013 and 2014.
2. Identify and map eulachon spawning sites in the Susitna River.
3. Characterize eulachon spawning habitats.
4. Describe population characteristics of eulachon returning in 2013 and 2014.

9.16.2. Existing Information and Need for Additional Information

9.16.2.1. Background Information

Eulachon are relatively small (<250 mm (10 inch) fork length), anadromous forage fish from the family Osmeridae (Scott and Crossman 1973). They occur on the West Coast of North America from the Pribilof Islands and the eastern Bering Sea in Alaska southward to the Klamath River in California (Scott and Crossman 1973). In Alaska, eulachon travel short distances upriver to spawn after ice-out. Lewis et al. (2002) concluded that water velocities greater than 0.4 meters per second (m/s; 1.2 ft/s) may limit upstream eulachon movements.

In most cases, eulachon spawn once, then die; however, Scott and Crossman (1973) found some evidence of repeat spawning. Eulachon generally spawn on silty or sandy substrate in water temperatures ranging from 4°C to 10°C (39°F to 50°F), although exceptions have been documented (Willson et al. 2006). Eggs are not buried, and therefore may drift downstream after spawning. Existing research on eulachon reproduction is limited (Stables et al. 2005).

Eulachon contain as much as 21 percent oil, thus giving them a high energetic content (Payne et al. 1999). This high energetic content, coupled with their abundance at the mouth of the Susitna River, makes eulachon an important prey resource for CIBWs (NMFS 2008). CIBWs are opportunistic feeders and need high prey densities for successful foraging (NMFS 2008). Stomach content analyses from 21 CIBWs from 1995 to 2007 indicated they consumed eulachon during the spring eulachon migration into Upper Cook Inlet (NMFS 2008).

In addition to their importance to CIBWs, a small commercial and personal use fishery for eulachon operated at the mouth of the Susitna River periodically from 1978 to 1999, then continuously since 2005 (Shields and Dupuis 2012). Since 2005, the total commercial fishery for eulachon is not permitted to exceed 100 tons per year, and has averaged 62.4 tons (Shields and Dupuis 2012). Between 2006 and 2011, the Alaska Department of Fish and Game (ADF&G) has sampled approximately 200 eulachon each year from the commercial harvest to collect information on age, length, and sex (Shields and Dupuis 2012). ADF&G found three age classes of eulachon (3, 4, and 5), with age 4 consistently being most numerous. These results differ from data collected during the 1980s Susitna Hydro studies, when age 3 fish dominated (ADF&G 1983a; 1984). It is unclear whether this difference is a true age shift or an artifact of differences in sampling methods.

9.16.2.2. Historic Information

The Susitna River eulachon population was previously studied in 1982 and 1983. At that time, it was determined that the run had an early component (i.e., escapement) of several hundred thousand fish and a later component of several million fish (ADF&G 1984), suggesting they were likely the most abundant fish species in the Susitna River (Vincent-Lang and Queral 1984). The early run entered the river May 16–30 in 1982 and May 10–17 in 1983. The late run entered the river June 1–8 in 1982 and May 19–June 6 in 1983 (ADF&G 1984).

During these studies, ADF&G surveyed by boat-based electrofishing from river mile (RM) 4.5 upstream to RM 60. ADF&G found that the uppermost extent of eulachon spawning was near RM 50 (Little Willow Creek; ADF&G 1983b).

Given their high abundance, eulachon were chosen as an evaluation species for the 1980s project (ADF&G 1983b). Potential Project-related impacts to eulachon that were identified were related to decreased mainstem discharge and increased surface water temperatures during the spawning migration (Vincent-Lang and Queral 1984). During 1982 and 1983, ADF&G initiated studies to identify naturally occurring hydrologic and water temperature relationships with spawning migrations of eulachon (ADF&G 1983a; 1983b). These studies identified eulachon spawning habitats at 20 locations between RM 8.5 and RM 44 (ADF&G 1983b). Water depth, velocity, surface water temperature, water quality parameters, and substrate composition were sampled and summarized (ADF&G 1983a, 1983b; Vincent-Lang and Queral 1984). Spawning depth ranged from 0.3 feet to 4.5 feet, and water velocities ranged from 0.0 to 3.4 feet per second. Spawning usually occurred in riffle habitats or cutbanks along the mainstem, and the most frequently used substrates were loose sand and gravel or silt to silty sand intermixed with gravel and rubble (ADF&G 1984; Vincent-Lang and Queral 1984).

During the 1983 study, eulachon were captured with sinking gillnets at RM 2, RM 4, and RM 4.5 during a subset of high tides from May 10 to June 8 (ADF&G 1984). To determine run timing, eulachon were classified by sex and spawning condition (either pre-spawning/spawning or post-spawning). Concurrent with gillnetting at RM 4, 100 eulachon were captured by hand dip nets to characterize sex and condition (ADF&G 1984). Fork length (nearest millimeter) and weight (nearest 0.1 gram) were also collected from the first 10 pre-spawning eulachon per sex. Age analysis (from otoliths) indicated that three-year-old fish were the dominant age class in both peaks. The length/weight analysis indicated that eulachon in the first peak were generally larger and weighed more.

During 1983, the main channel was surveyed daily for eulachon spawning locations between RM 4.5 and RM 60 using a combination of boat electrofishing and hand-operated dip nets (ADF&G 1984). A site was considered a spawning site if the following ADF&G (1983c) criteria were met:

1. Fish captured at the site freely expelled eggs or milt.
2. Fish were in vigorously free-swimming condition.
3. Twenty or more fish were caught in the initial or subsequent site sampling effort, which met criteria 1 through 2 above.

A total of 61 eulachon spawning locations were identified (ADF&G 1984; Figure 9.16-2). The majority of the spawning occurred below the confluence of the Yentna and the Susitna rivers (ADF&G 1984).

Catch per unit effort (CPUE) of eulachon indicated that the June peak of the run included more fish than the May peak. Males outnumbered females, indicating that males mature earlier and spawn over a longer period than females (ADF&G 1984). An analysis of tidal height (feet), temperature (°C), and catch indicated that eulachon were most frequently caught when tides were between 27 and 28 feet and water temperature was between 3.5°C and 10.5°C.

9.16.2.3. Need for Additional Information

Given the importance of eulachon to CIBWs, personal use, and commercial fisheries, the information on eulachon from the 1980s will be updated and expanded to fully evaluate potential post-Project impacts. Information on timing and duration of the eulachon migration, location and number of spawning sites, spawning site characteristics, and population characteristics are needed to characterize the current situation and provide information necessary for future evaluations of the potential impacts of the Project. Changes in run timing and duration could change the availability of eulachon to CIBWs. Project operations could change the number and distribution of spawning sites. Spawning site characterization is needed to allow comparisons of pre- and post-Project habitat availability, which could affect eulachon relative abundance. Biological parameters such as age, fork length, weight, and sex are needed to assess the energetic values eulachon provide to CIBWs. Incidental observations of marine species will assist in documenting other CIBW primary constituent element (PCE) species (i.e. Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), saffron cod (*Eleginus gracilis*), and yellowfin sole (*Limanda aspera*) that may be periodically utilizing the Lower Susitna River.

9.16.3. Study Area

The eulachon study extends from the mouth of the Susitna River to the uppermost extent of spawning, which will be determined by a combination of telemetry and acoustics (see Figure 9.16-1). A split beam sonar device will be positioned at a fixed site near RM 10 to collect information on run timing and duration. This is within the area sampled daily in 1983 (RM 4.5 to RM 60; ADF&G 1984). Few spawning locations were detected below RM 10.

9.16.4. Study Methods

Eulachon studies will be conducted from approximately May 1 (or ice-out) through June 30 (or the end of the eulachon migration onto spawning grounds) in both 2013 and 2014. A combination of acoustic surveys, radio telemetry, and standard fish capture and habitat sampling methods will be used to characterize the eulachon spawning migration. Telemetry and mobile acoustic surveys will be used jointly to identify the full distribution of spawning locations in the study area and to evaluate fish behavior on spawning sites. Acoustic sampling will also be used at a fixed site in the Lower River to assess the timing and duration of the spawning migration, and assess relative abundance of eulachon (measured by CPUE where effort is equal to sampling time). Active capture methods will be used to confirm eulachon spawning concentrations, collect information on eulachon population characteristics, and document incidental observations of marine fish species. Standard methods will be used to characterize physical habitat at confirmed spawning sites.

9.16.4.1. Objective 1: Determine Eulachon Run Timing and Duration in the Susitna River in 2013 and 2014

Tasks to address Objective 1 include the following:

- Use two types of sonar to obtain indices of passage over time for migrating eulachon. Sonar types will be a split beam and a multibeam, which will be either a dual frequency identification sonar (DIDSON) or an adaptive resolution imaging sonar (ARIS).
- Use active fish sampling to confirm presence of eulachon.
- Process multibeam sonar data to provide fish size, counts of fish when the number of fish passing upriver is low, and a relative abundance (as measured by CPUE where effort is equal to sampling time) when fish counts are high. The split beam sonar will provide relative abundance (as measured by CPUE, where effort is equal to time sampled) over time by processing echo integration and scaled by the size of individual eulachon.

9.16.4.1.1. Indices of Passage for Migrating Eulachon

The multibeam and split beam sonars will be positioned at a fixed site in the Lower Susitna River near RM 10 to detect migrating eulachon. The sample site will be selected as low on the river as possible, but will be (1) above the tidally-affected area, (2) on one bank in the major river channel, and (3) at a site with suitable bottom profile for sampling with sonar. A fixed sample site will likely be remote and require a power supply and protection for the equipment. Both sonar systems will be positioned near the bank and aimed horizontally toward mid-channel to sample a range of 5 to 10 meters. A blocking weir will be constructed around the sonars to exclude eulachon from the 70–100 centimeter range in front of the sonar face. Data will be collected continuously over a period from soon after ice-out in early to mid May through the end of the eulachon run in mid to late June. The run will be considered to have ended when, after June 10, no eulachon are detected at the fixed site or during nearby sampling for five consecutive days.

9.16.4.1.2. Active Fish Sampling

The team will sample from boats near and downstream from the fixed sonar site to help verify species composition and overall representativeness of sonar results, collect fish for radio telemetry (Objective 2), and describe eulachon population characteristics (Objective 4). When fixed-site sonar has identified concentrations of fish that are likely to be eulachon, the team will use dip nets to collect fish to verify species composition. The team will also conduct standard sampling with dip nets and/or gillnets to assess representativeness of results from the fixed site.

9.16.4.1.3. Acoustic Data Processing

Multibeam sonar data will be processed both during and after the survey season using empty frame removal to remove the time when fish are not passing through the sonar beam. In-season processing is critical for determining run start and end times. Remaining images will be processed either by counting individual eulachon when counts are low, and/or measuring cluster size to estimate relative abundance (as measured by CPUE, where effort is equal to time sampled). Split beam data will be processed using echo integration and scaling the total backscattered energy from fish by the mean size of an individual eulachon. Cross-sectional densities will be made for the sample range and expanded to index fish passage over time using water velocity at the site. Water velocity will be measured weekly.

9.16.4.2. Objective 2: Identify and Map Eulachon Spawning Sites in the Susitna River

Tasks to address Objective 2 include the following:

- Use radio telemetry to locate possible eulachon spawning sites.
- Use multibeam sonar (DIDSON or ARIS) to identify likely eulachon spawning sites.
- Confirm presence of spawning eulachon through active fish sampling methods.
- Map confirmed eulachon sampling sites.

Radio telemetry, acoustics, and active fish sampling methods will be used to identify eulachon spawning sites. Radio telemetry will be used to follow the tagged fish throughout the river until behavior indicates spawning; acoustics will be used at these locations to identify and narrow down the spawning location, verify the presence of other untagged eulachon, verify spawning behavior, and assess the size of the spawning ground. Radio telemetry fieldwork will include tagging and tracking, each performed in conjunction with other Project components. Eulachon will be tagged in the Lower River in the process of sampling fish for Objective 1 of this study. Fish will then be tracked with aerial surveys, using a similar approach to that described in Salmon Escapement Study, Section 9.7. Depending on run timing of the different study species, there may be some overlap in dates/flights needed for the two studies, thereby increasing efficiency. Initial and final distribution of tagged fish will be calculated using the same approach and software as for tagged fish used in the Salmon Escapement Study.

Prospective spawning sites will be confirmed and described using a combination of multibeam sonar (DIDSON or ARIS) and active sampling to capture fish. Multibeam sonar will be used to obtain video-type images of spawning eulachon. Fish sampling (electrofishing, tow nets, etc.) will confirm that detections are eulachon and allow assessment of spawning condition.

9.16.4.2.1. Locate Likely Eulachon Concentrations

Fish capture and tagging, sample sizes

Eulachon will be radio-tagged using a sampling strategy designed to be representative of the entire run migrating into the Susitna River to spawn. This will entail capturing the fish low in the river, from a population representative of the eulachon run in space (e.g., different river corridors) and time (e.g., run timing). Eulachon to be tagged will be captured using dip nets or seine nets, similar to methods described by Spangler et al. (2003). Fish to be tagged will be selected immediately upon capture, and will only be tagged after it is verified that they are vigorous, free of any obvious injuries, and are in pre-spawning condition (Spangler et al. 2003). Tagging below RM 10 may depend on obtaining a permit for sampling in the Cook Inlet beluga whale ESA-designated critical habitat area.

Early in the tagging season, a test group of 15 tagged and 15 untagged fish will be held for approximately 48 hours to test for tag retention and mortality. This test group will be held in a live well in the main river, and thus be subject to ambient river conditions. The results will be used to modify capture and handling methods, to help with inseason interpretation of data, and to draw inferences about any unresolved tag locations at the end of the season.

In 2013, a target sample of 150 eulachon in pre-spawning condition (in addition to the test group described above) will be tagged and tracked in the Lower Susitna River to identify spawning areas. Tags will be placed in proportion to the relative abundance of the run (following a schedule similar to the one used for salmon (see Section 9.7). A given spawning site that contains 2.5 percent of the run will have a 97 percent likelihood of receiving one tag from a release group of 150 tags. For sites with 5 percent of the total run, this likelihood rises to > 99 percent. The team will release 200 tags in the Lower River to conservatively achieve this sample size of 150 viable tags, after which the key to detecting each major spawning area will be ensuring that the total eulachon population is represented, and that final spawning locations are detected. The exact tagging schedule will be developed using as much information as possible from earlier eulachon studies (e.g., ADF&G 1984). All tagged fish will be measured, classified as male or female, and categorized for spawning condition (Spangler et al. 2003). It is important to note that the goal of the spawning ground distribution component using radio tags is primarily to *identify locations of the main spawning areas used in 2013*, which requires fewer tags than precisely determining the *relative importance of different spawning areas* (which is not the issue to be addressed).

Tags will be designed based on literature values of eulachon body sizes from Upper Cook Inlet. The tags will be gastrically implanted, following the methods used by Spangler et al. (2003) on the nearby Twentymile River. Tags will have a minimum battery life of 20 days, and weigh 2.0 grams (2.8 to 3.5 percent of body weight of eulachon, based on the 95 percent range of weights sampled in 1982 and 1983).

Fixed-station tracking

Fixed-receiver stations will be established at the lower and upper bounds of the study area (approximately RM 10 and RM 50), and on the Yentna River near the confluence with the Susitna River (RM 27). A fourth fixed-receiver station may be established at RM 97 to detect fish at the upper end of the anecdotal range. Each fixed-receiver station will include a radio receiver, power supply, and antennas, and will be serviced and downloaded weekly, as described in further detail in the Salmon Escapement Study (Section 9.7).

Aerial surveys will be flown every other day to track the tagged eulachon, using the same procedures described in Section 9.7. It is anticipated that the entire Lower River can be flown in a single day based on experience with the salmon radio-tagging study conducted by AEA in 2012. Tag detections will be stamped for time, location, and mortality status. Location and behavior recorded will be as follows:

- Direction of fish travel
- Fish residence time at specific locations/positions
- Fish travel time between locations/positions
- Identification of fish migratory, holding, and spawning locations/positions
- Fish movement patterns in and between habitats in relation to water conditions (e.g., discharge, temperature, turbidity)

Data analysis

The goal for tag detections from the aerial surveys will be to to classify the most likely locations of fish as mainstem, side channel, or off-channel habitat. Antenna configurations on the helicopter that were developed in 2012 for the adult salmon radio-tagging will be used to geo-reference the tag signal to within the nearest 200 meters. The surveyor will carry a plot of last-seen detections for each tag from prior surveys. During the season, likely spawning locations will be identified based on a combination of duration at a site and groupings of tags; these potential locations will then be followed up adaptively by the boat-based sonar crew that can use underwater imagery to evaluate fish behavior (see below).

Data will be analyzed using custom software that organizes telemetry data, validates records, and allows user-defined criteria for analyses. Output for each tag will include fish entrance to and exit from the study area; all detections from aerial, boat, and fixed-station receivers; movement rate; holdover locations and times; estimated time of death; and residence time.

9.16.4.2.2. Identify Likely Eulachon Spawning Sites

At potential spawning sites as identified by radio telemetry, multibeam sonar from stationary locations will be used to obtain video-type images of spawning eulachon. DIDSON is high-resolution imaging sonar that provides video-type images over a 29-degree field of view. It is well suited for observing dynamic fish behavior, such as spawning, as well as enumerating fish passage. To collect good quality images the platform must be stable, i.e., DIDSON is best suited for sampling from a fixed location. Because of the relatively small size of eulachon, the range over which they can be reliably detected will probably be limited to approximately 15 meters (49 feet). At 15 meters, the beam array will cover an area that is approximately 7 meters (23 feet) wide. Given the shore-oriented migration behavior of eulachon, the team will sample from an anchored boat looking toward shore. DIDSON will normally be deployed for 10 minutes.

All acoustic data will be time-stamped and geo-referenced. Geo-referenced analysis results will be provided in a format that is compatible with ArcGIS.

9.16.4.2.3. Confirm Presence of Spawning Eulachon

When acoustic surveys have identified concentrations of fish that are likely to be spawning eulachon, the team will collect fish by boat electrofishing, dip net, or tow net to confirm species identification and assess spawning condition. Additional sampling with plankton nets or artificial substrates downstream of suspected spawning sites may be conducted to confirm that eggs are being released. This may also facilitate confirmation of spawning in areas not accessible to boats.

The team will use the same criteria as ADF&G (1983c) to confirm spawning sites:

1. Fish captured at the site freely expel eggs or milt.
2. Fish are in vigorously free-swimming condition.
3. Twenty or more fish are caught that meet criteria 1 and 2 above.

As the team collects more data and develops a better sense of how much data are needed to determine presence or absence, the amount of data collected per sample may be modified. The team will provide station ID, location, date, time, eulachon presence/absence, and a description of fish behavior (i.e., moving in continuous band, discrete schools, milling, spawning).

9.16.4.2.4. Map Confirmed Spawning Sites

Acoustics will be synchronized with differential global positioning system (GPS) to map transects and identify acoustic targets. Data including latitude, longitude, time, water depth, and acoustic targets will be uploaded to an Access database to allow for intra-program coordination (i.e., ArcGIS).

Sites that meet spawning criteria will be marked with a GPS. Data summary and analysis will provide bounding coordinates of the areas sampled, eulachon presence/absence, and fish behavior (i.e., migrating, spawning). These sites will be compared to the original 1980s spawning locations to determine changes in spawning locations. Aquatic habitat will be recorded to the mesohabitat level based on the Project mesohabitat classification system.

9.16.4.3. Objective 3: Characterize Eulachon Spawning Habitat

Tasks to address Objective 3 include the following:

- In 2013, determine the feasibility of using acoustics to identify substrate composition at eulachon spawning habitats:
  - Estimate substrate composition using side scan sonar.
  - Verify accuracy using bottom grab samples and visual surveys.
- In 2014, continue to collect substrate composition data:

  - If side scan sonar proves feasible, then collect more data over a wider area of spawning habitats.
  - If it is not feasible to use side scan sonar, then continue using grab samples and visual surveys.
- In both years, describe physical characteristics of spawning habitats, including water quality parameters, depth, and velocity.

9.16.4.3.1. Feasibility of Using Acoustics to Determine Substrate Composition

The team will determine if EdgeTech 4125 1600kHz high-resolution side scan sonar can delineate substrate type (i.e., cobble, gravel, and sand/silt) at eulachon spawning sites. Side scan sonar is well suited for sampling large areas using mobile surveys. The side scan images have a very high across-track resolution of 0.6 centimeters (0.2 inches). The side scan will be run along the shore, looking toward shore. As a rule of thumb, if the transducer is 1 meter (3.3. feet) above the bottom, a swath approximately 10 meter (33 feet) wide along the side of the survey boat can be surveyed. Surveys will occur at a range of 15–20 meters (49-66 feet) from shore and move parallel to the shoreline.

Side scan sonar data will be geo-referenced with a differential GPS and written to file. Data will be processed using HyPack software with the Geocoder module. Geocoder generates bottom classifications using angular response analysis from the side scan sonar to produce substrate classification areas. These area classifications are then matched to known bottom types and the data are output to DXF geo-referenced files.

Preliminary acoustic substrate classifications will be compared to physical grab samples, or where possible, visual surveys. Visual surveys were the primary method used in the 1980s (Vincent-Lang and Queral 1984). The team will use an Ekman Bottom Grab Sampler where visual surveys are not feasible. Overall substrate composition will be recorded based on substrate characterization protocols of the Instream Flow Study (Section 8.5). The percent composition for each substrate size category for each sample will be recorded.

9.16.4.3.2. Continue to Collect Substrate Composition Data

If successful, acoustic substrate classifications will be expanded in 2014. If side scan sonar does not accurately distinguish substrate composition in 2013, then only physical grab samples and visual surveys will be used in 2014. Substrate composition will be compared among spawning sites to describe preferred spawning substrates.

9.16.4.3.3. Describe Physical Characteristics of Spawning Habitats

Water quality will be sampled using a YSI® meter for pH, water temperature, dissolved oxygen, and specific conductance. Turbidity samples will be collected in the field in amber glass vials and analyzed every evening in a Hatch Turbidimeter. Water quality data will be collected once at each spawning location for each survey. Continuous water temperature (°C) will be downloaded from U. S. Geological Survey (USGS) gages and gathered from the Baseline Water Quality Study (Section 5.5).

A grid system for the collection of water depth and water velocity data may be developed similar to the grid used by Vincent-Lang and Queral (1984) for systematic sampling. The length of the grid will be equal to the length of the spawning habitat, and the width of the grid will be equal to the distance from shore in which eulachon are spawning. Size of individual cells within the grid will be determined by total size of the grid. Water depth and water velocity will be sampled in a subset of cells. Water depth at spawning locations will be measured with a metric stadia rod and water velocity will be measured with a velocity flow meter (measured in feet per second). These data will provide the water depth and velocities needed for eulachon spawning and will be averaged across the area sampled and also reported as ranges.

Water quality parameters will be compared among sites to facilitate description of preferred water quality characteristics. Water quality samples recorded for this study will also be compared with the water quality samples collected for the Baseline Water Quality Study (Section 5.5).

Correlation analyses will be used to evaluate the relationship between water temperature and run timing. Similar analyses will evaluate relationships between other water quality and hydrologic parameters and eulachon spawn timing.

All data gathered will be coordinated with the Instream Flow Study (Section 8.5) to help determine the relationship between natural flows and existing habitats. Physical habitat data associated with spawning locations will be collected over a wide range of flows and stages. This will enable (1) characterization of habitat associated with eulachon spawning, and (2) evaluation of the availability of spawning habitat during expected post-Project flows and stages.

9.16.4.4. Objective 4: Describe Population Characteristics of Eulachon Returning in 2013 and 2014

Tasks to address for Objective 4 include the following:

- Determine present baseline population characteristics
- Collect baseline genetic samples
- Document incidental observations of marine fish species

Describing baseline population characteristics was a main focus on 1980s studies; however, subsequent data indicates that population characteristics such as age may have changed since that time (Shields and Dupuis 2012). Additional data will be collected to establish current baseline biological characteristics and archive genetic samples.

9.16.4.4.1. Baseline Population Characteristics

During active fish sampling to confirm presence of eulachon in the Lower Susitna River (Objective 1), the sex and spawning condition of all eulachon collected will be documented. Fork length and weight will be measured, and otoliths will be collectd from a maximum of 30 pre-spawn eulachon of each sex daily. Stomach samples will be collected from a subset of eulachon retained for otolith extraction. Stomachs will initially be evaluated for fullness, and then for diet if feeding is documented.

Biological data such as fork length, weight, and sex will be used to build length and weight frequency distributions by sex and run. Otoliths will be used for age analysis. Age data will be used to assess age-length and age-weight relationships. Sex ratios will be determined for each sampling day.

9.16.4.4.2. Baseline Genetic Samples

In support of the ADF&G's development of genetic baselines for various species, genetic samples from a subset of eulachon (approximately 50 total) will be collected. Genetic samples will be anal fin clips cut from the fish with scissors. Tissue samples will be preserved in ethyl alcohol in a 125–500 milliliter bulk sample bottle for each site. Samples will be delivered to ADF&G's Gene Conservation Laboratory for archiving and potential future analysis.

9.16.4.4.3. Document Incidental Observations of Marine Fish Species

Marine fish species sometimes venture into fresh water for limited periods of time and some prefer shallow coastal water in and around river mouths (Morrow 1980; Cohen et al. 1990). Because walleye pollock, yellowfin sole, saffron cod, and Pacific cod are designated as PCE species for CIBWs, their occurrence in the Susitna River is of special interest to the Project for impact analyses. Marine fish caught while sampling for eulachon as described above and under Objective 1 will be identified, and any fish in question will be photographed and identified later by a marine species expert. All marine fish will be measured (either fork length or total length [tip of the snout to tip of the caudal fin]; nearest millimeter).

Catch per unit effort will be calculated for all fish species. All information regarding marine fish species presence in the Lower Susitna River will be shared with the Fish Distribution and Abuandance in the Middle and Lower River Study (Section 9.6).

9.16.5. Consistency with Generally Accepted Scientific Practice

The methods described in this study plan have been developed in consultation with the agencies and other licensing participants. Radio telemetry was used to study eulachon migration and spawning in Alaska by Spangler et al. (2003). DIDSON has been used by ADF&G for at least five years (Burwen et al. 2007). All data collection efforts will follow State of Alaska guidelines. Acoustical methods will be used to minimize disturbance to eulachon spawning habitat.

9.16.6. Schedule

Table 9.16-1 depicts the study schedule. ADF&G Fish Research Permit applications will be submitted to ADF&G in February of 2013 and 2014. The anticipated field study for both 2013 and 2014 will run from May 1 (or ice-out) through June 30 (or the end of the spawning runs). Most tasks will run concurrently in May and June of 2013 and 2014 (Table 9.16-1). Data processing and analyses will extend through the third quarter of each year, Quality Assurance/Quality Control (QA/QC) on data analyses will be completed by the middle of October each year, and reporting will be completed by the middle of December each year. The Initial Study Report and Updated Study Report will be filed with FERC in February of 2014 and 2015, respectively. Updates on study progress will be provided to the licensing participants during Technical Workgroup meetings to be held quarterly in 2013 and 2014.

9.16.7. Relationship with Other Studies

The eulachon study will be coordinated closely with other studies (Baseline Water Quality [Section 5.5]; Water Quality Modeling [Section 5.6]; Geomorphology [Section 6.5]; Fluvial

Geomorphology [Section 6.6]; Ice Processes [Section 7.6]; Fish and Aquatics Instream Flow [Section 8.5]; Salmon Escapement [Section 9.7]; and Cook Inlet Beluga Whale Study [Section 9.17] (see Figure 9.16-3). Continuous water temperature data loggers were deployed during June 2012 in 10 locations between RM 10.1 and RM 97.2 (Baseline Water Quality Study, Section 5.5) to provide current water temperature data in the Susitna River. Because eulachon upstream migration and spawning may be temperature-dependent (Spangler et al. 2003; Willson et al. 2006), any Project-induced changes to water temperature may alter run timing and duration. Seven of the ten continuous surface water temperature monitoring sites will also have monthly in situ water quality parameters measured (i.e., pH, dissolved oxygen [DO], specific conductance, turbidity, etc.; Baseline Water Quality Study, Section 5.5). This information will correspond with the water quality parameters collected at the identified eulachon spawning sites. The baseline water quality information collected during the spawning season will serve two purposes: 1) to help determine if a correlation exists between eulachon presence and water quality, and 2) to aid in eventual analyses of Project effects on baseline conditions. The Water Quality Modeling Study (Section 5.6) will evaluate various models to determine the Project's potential to alter flow, water temperature, and sediment transport downstream of the dam, all of which could impact eulachon. The Geomorphology Study (Section 6.5) will evaluate Project-induced changes to channel formation processes, which in turn could affect spawning habitat. Channel formation modeling will occur under Section 6.6 (Fluvial Geomorphology) and will determine the effects of the dam downstream of the reservoir. The Ice Processes Study (Section 7.6) will determine the baseline ice break-up conditions. It will also model the expected Project-induced changes to break-up. If break-up is altered because of the dam, then spawn timing may also change. Coordination will occur with the Fish and Aquatic Instream Flow Study (Section 8.5) to share spawning habitat characteristics gathered by both teams. Some methods and scheduling may overlap with those of the Salmon Escapement Study (Section 9.7), opening the possibility of increased efficiency through collaboration and sharing. Any potential changes to eulachon relative abundance (as measured by catch per unit effort [CPUE]) will be shared with the Cook Inlet Beluga Whale Study (Section 9.17) because eulachon are a primary prey species for CIBWs.

9.16.8. Level of Effort and Cost

Fieldwork will occur from May 1 or ice-out until June 30 or the end of the eulachon spawning. The Project will consist of two teams of personnel, both based out of a field camp in the Lower River. Team 1 will be responsible for operating the Lower River sonar site (Objective 1), placing radio tags (Objective 2), and sampling eulachon for population characteristics (Objective 4). One individual from Team 1 will also fly the river to track radio tags. Team 2 will conduct mobile sonar surveys for spawning eulachon (Objective 2), and measure and sample spawning ground characteristics (Objective 3).

The approximate cost for the eulachon studies is $635,000 per year for 2013 and 2014. The cost estimate is based on a seven-week eulachon sampling period. If the actual eulachon run is shorter, then the cost will decrease.

9.16.9. Literature Cited

ADF&G (Alaska Department of Fish and Game). 1983a. *Susitna Hydro aquatic studies, phase II basic data report.* Volume 1: Summarization of volumes 2; 3; 4, parts I and II; and 5.

—. 1983b. *Susitna Hydro aquatic studies, phase II basic data report*. Volume 1: Aquatic habitat and instream flow studies, 1982, parts I and II.

—. 1983c. *Subtask 7.10: Aquatic studies procedures manual phase II final draft*. 1982–1983.

—. 1984. Susitna Hydro Aquatic Studies Report No. 1: Adult Anadromous Fish Investigations, May – October 1983.

AEA (Alaska Energy Authority). 2011. *Pre-application document: Susitna-Watana Hydroelectric Project, FERC Project No. 14241*. December 29, 2011.

Burwen, D. L., S. J. Fleischman, and J. D. Miller. 2007. Evaluation of a dual-frequency imaging sonar for estimating fish size in the Kenai River. Alaska Department of Fish and Game, Fishery Data Series No. 07-044, Anchorage.

Cohen, D. M., T. Inada, T. Iwamoto, and N. Scialabba. 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. *FAO FisheriesSynopsis* 10 (125):1-442.

Lewis, A. F. J., M. D. McGurk, and M. G. Galesloot. 2002. *Alcan's Kemano River eulachon (Thaleichthys pacificus) monitoring program 1988-1998*. Consultant's report prepared by Ecofish Research Ltd. for Alcan Primary Metal Ltd., Kitimat, B.C. 136 p.

Morrow, J.E. 1980. *The freshwater fishes of Alaska*. University of British Columbia Animal Resources Ecology Library. 248 p.

National Marine Fisheries Service (NMFS). 2008. *Conservation plan for the Cook Inlet beluga whale (*Delphinapterus leucas*)*. National Marine Fisheries Service, Juneau, Alaska.

Payne, S.A., B.A. Johnson, and R.S. Otto. 1999. Proximate composition of some north-eastern Pacific forage fish species. *Fisheries Oceanography* 8:3, 159-177.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa.

Shields, P. and A. Dupuis. 2012. *Upper Cook Inlet commercial fisheries management report, 2011*. Fisheries Management Report No. 12-25. Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries.

Spangler, E., R. Spangler, and B. Norcross. 2003. *Eulachon subsistence use and ecology investigations of Cook Inlet, 2000–2002.* Fisheries Resource Monitoring Program, Final Rep. 00-041. U.S. Fish and Wildlife Service, Office of Subsistence Management, Anchorage, AK.

Stables, T.B., C.J. Perrin, and M.L. Rosenau. 2005. Acoustic and trawl surveys to locate eulachon aggregations in the lower Fraser River, British Columbia. *North American Journal of Fisheries Management* 25: 675 – 688.

Vincent-Lang, D. and I. Queral. 1984. *Susitna Hydro aquatic studies. Report 3: Aquatic habitat and instream flow*. Chapter 5: Eulachon spawning habitat in the Lower Susitna River.

Willson, M. F, R. H. Armstrong, M. C. Hermans, and K Koski. 2006. Eulachon: a review of biology and an annotated bibliography. AFSC Processed Report2006-12. NMFS, Juneau AK.

9.16.10. Tables

Table 9.16-1. Schedule for implementation of the eulachon study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Objective 1 – Run Timing and Distribution									
Indices of Passage		—				—			
Active Fish Sampling		—				—			
Acoustic Data Processing		—	—	—		—	—	—	
Objective 2 - Identify and Map Spawning Sites									
Locate Likely Spawning Concentrations		—				—			
Identify Likely Spawning Sites		—				—			
Confirm Presence of Spawners		—				—			
Map Confirmed Spawning Sites		—	—	—		—	—	—	
Objective 3 – Characterize Spawning Habitat									
Feasibility of Using Acoustics to Determine Substrate Composition		—							
Continue to Collect Substrate Data		—				—			
Describe Physical Habitat Characteristics		—	—	—		—	—	—	
Objective 4 – Describe Population Characteristics									
Baseline Population Characteristics		—	—	—		—	—	—	
Baseline Genetic Samples		—				—			
Document Marine Species		—	—	—		—	—	—	
Initial Study Report			—	—	Δ				
Updated Study Report							—	—	▲

Legend:

—— Planned Activity
----- Follow up activity (as needed)
Δ Initial Study Report (ILP due date 2-3-2014)
▲ Updated Study Report (ILP due date 2-2-2015)

9.16.11. Figures

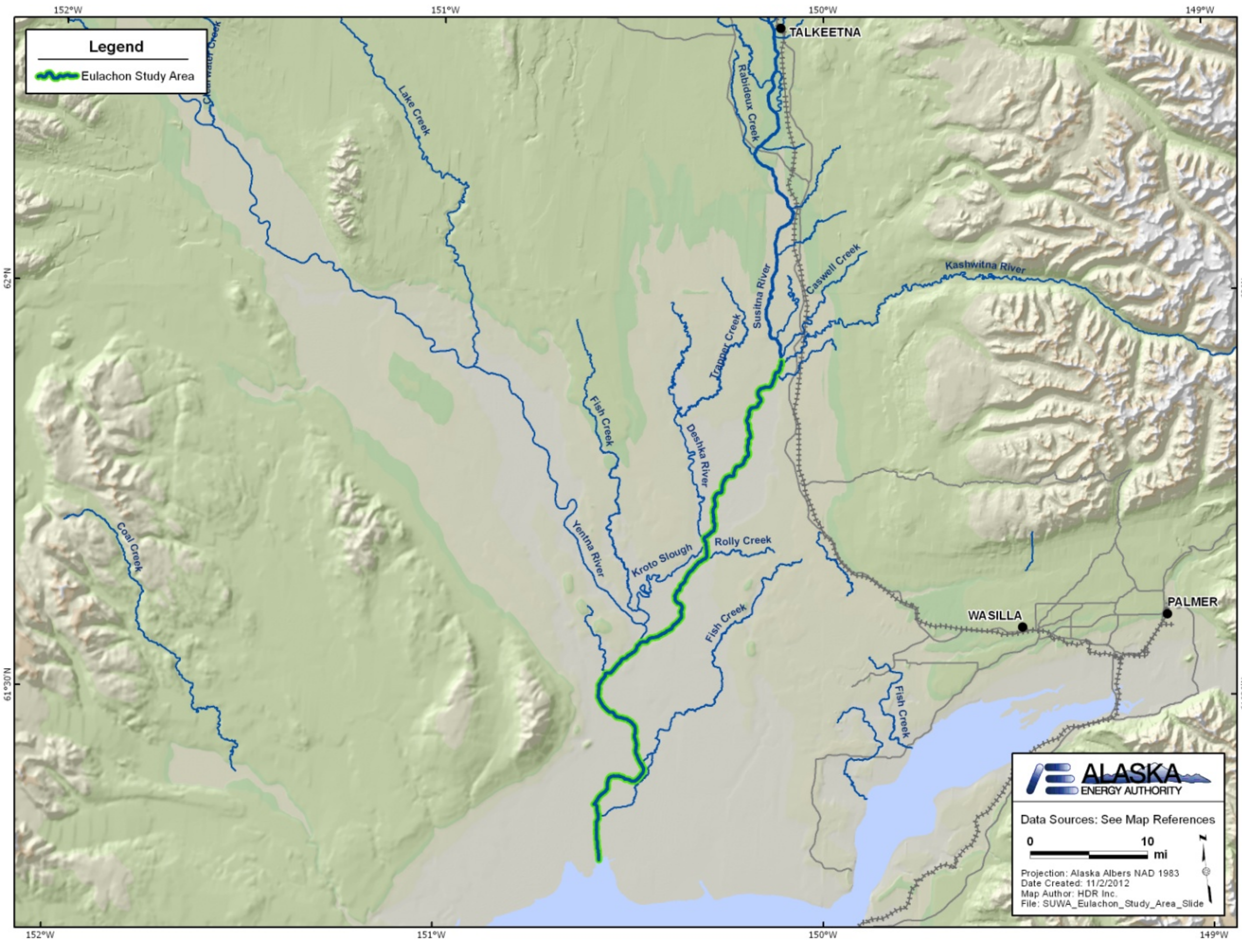

Figure 9.16-1. Eulachon study area.

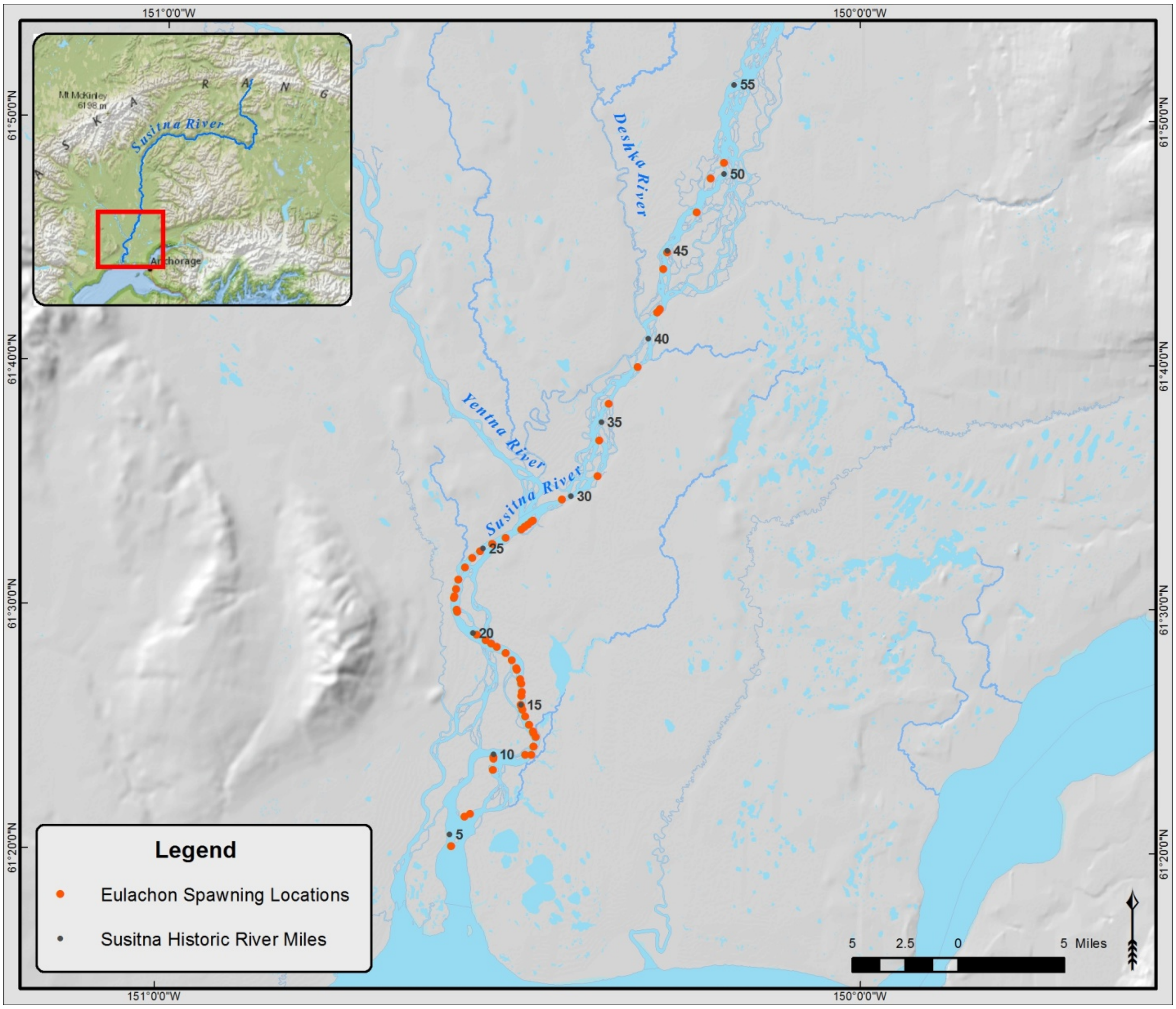

Figure 9.16-2. Historic eulachon spawning locations (ADF&G 1984).

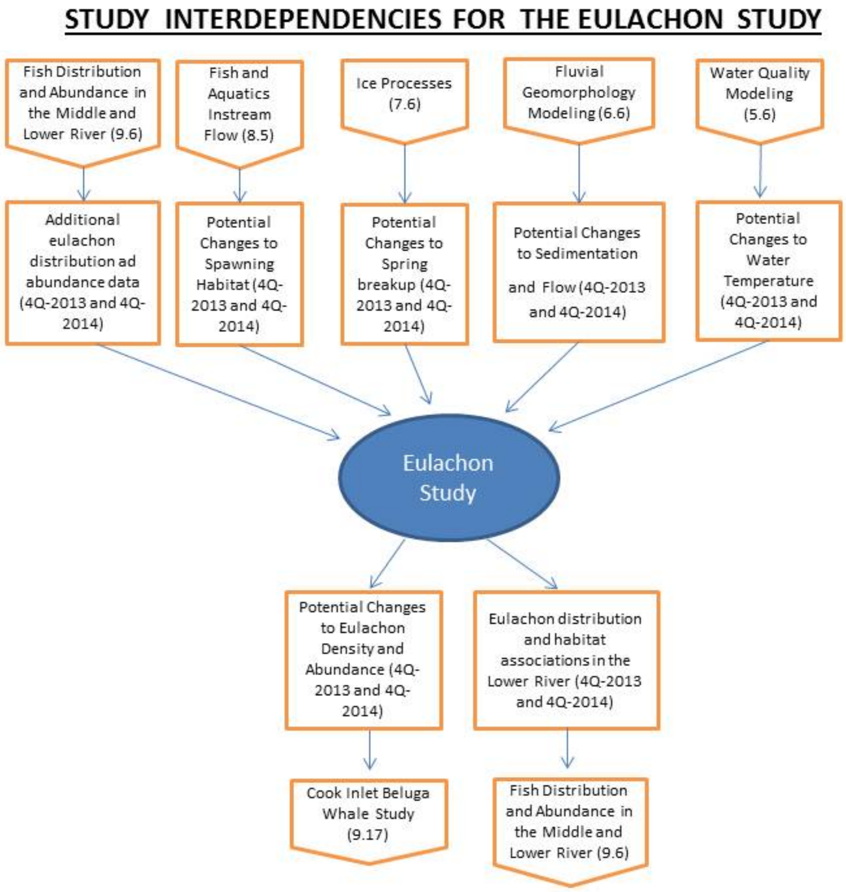

Figure 9.16-3. Eulachon study interdependencies.