2012 Upper Susitna River Fish Distribution and Habitat Study

Introduction

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project). The application will use the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 300-mile long river in the Southcentral region of Alaska. The Project's dam site will be located at River Mile (RM) 184. The results of this study and of other proposed studies will provide the information needed to support the FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

Construction and operation of the Project as described in the Pre-application Document (PAD, AEA 2011a) will modify the flow, thermal, and sediment regimes of the Susitna River, which in turn will alter the composition and distribution of fish habitat. This study plan outlines the goals, objectives, and methods for characterizing fish distribution and habitat in the upper Susitna River in order to provide data relevant to establishing an environmental baseline and potential Project-related effects to fish and their habitats. This study will initiate a multiyear effort that will include data collection activities beginning in 2012. A comprehensive set of fisheries study plans (2013–2014 Fish Study Plans) will be developed during 2012 as part of the Project licensing process. The 2013-2014 Fish Studies will be used to describe the fisheries resources and their habitat within the Project area.

Study Goals and Objectives

Goal 1: Characterize aquatic habitat in the Susitna River and its tributaries/lakes above Devils Canyon upstream to and including the Oshetna River

- Objective 1.1: Develop and implement a habitat mapping approach to characterize the mainstem Susitna River above Devils Canyon upstream to the Oshetna River
- Objective 1.2: Develop and implement a habitat mapping approach to characterize Susitna River tributaries and lakes above Devils Canyon upstream to and including the Oshetna River
- Objective 1.3: Characterize the type and amount of aquatic habitat within the reservoir inundation zone below an elevation of 2,200 feet
- Objective 1.4 Identify the locations of potential fish barriers in tributaries above Devils Canyon (upstream to and including the Oshetna River)

Goal 2: Determine the distribution and relative abundance of adult Chinook salmon in the Susitna River and its tributaries above Devils Canyon upstream to and including the Oshetna River

- Objective 2.1: Determine the distribution and relative abundance of adult Chinook salmon in the mainstem Susitna River and tributaries above Devils Canyon from Cheechako Creek upstream to and including the Oshetna River

Objective 2.2: Support the Alaska Department of Fish and Game (ADF&G) Chinook salmon stock analysis by collecting tissue samples from individual adult salmon for genetic analysis

Objective 2.3: Characterize habitats at adult Chinook salmon spawning sites above Devils Canyon

Goal 3: Determine the distribution and relative abundance of juvenile Chinook salmon and other fish species present in the Susitna River and its tributaries and lakes above Devils Canyon upstream to and including the Oshetna River up to 3,000-foot elevation

Objective 3.1: Determine the distribution and relative abundance of fish species residing in tributary and lake habitats downstream of barriers, up to 3,000-foot elevation.

Objective 3.2: Determine the distribution and relative abundance of fish species residing in accessible mainstem Susitna River habitats within the reservoir inundation zone, including the main channel, side channels, side sloughs, upland sloughs, and tributary mouths

Objective 3.3: Characterize fish habitat for juvenile Chinook salmon where found in the study area

Objective 3.4: Support the ADF&G Chinook salmon genetic stock analysis by collecting tissue samples from individual juvenile salmon

Objective 3.5: Determine whether Dolly Varden and humpback whitefish in the study area have anadromous life histories

Objective 3.6: Determine baseline tissue metal content for fish select species in the study area

STUDY AREA

The study area includes the Susitna River and its tributary streams above Devils Canyon upstream to and including the Oshetna River (Figure 1). The specific areas to be surveyed in 2012 vary with respect to the three main components of this study, which include: 1) aquatic habitat characterization and mapping; 2) adult Chinook salmon spawning distribution; and 3) fish species distribution (juvenile Chinook and other species).

Efforts to document the distribution of Chinook salmon (and other species) will occur in the 16 major tributaries above Devils Canyon (upstream to an elevation of 3,000 feet). Sampling to document fish species composition and distribution will be conducted in 11 lakes in 2012. Fish barriers will be identified throughout the 16 tributaries in the study area up to the 3,000-foot elevation. Habitat characterization will be prioritized in 2012 to focus on 3 of the major tributaries within the inundation zone upstream to an elevation of 3,000 feet. See Figure 1. Additional detail on sampling locations is provided in the methods section.

Figure 1. Study area and sample locations for 2012.

EXISTING INFORMATION

Existing information includes recent and historic aerial photography of the study area, fish spatial and temporal distribution, and relative abundance information from existing recent and early 1980s studies. The Aquatic Resources Data Gap Analysis (AEA 2011b) and PAD (AEA 2011a) summarized existing information and identified data gaps for adult salmon, resident and rearing fish, and aquatic habitats in the Upper Susitna River Reach. The licensing effort of the 1980s Alaska Power Authority (APA) Project generated a substantial body of literature, some of which will be used to support the 2012-to-2014 data collection efforts. Results of ADF&Gs studies in the Upper Susitna River Reach, including resident fish and habitat characterization (ADF&G 1983a, 1984a; Schmidt et al. 1984) and adult salmon habitat utilization studies are summarized in Exhibit E of the 1985 License Application (Harza-Ebasco 1985).

In recent years, ADF&G has conducted sampling in the Upper Susitna River subbasin as part of their Alaska Freshwater Fish Inventory (AFFI) program. In 2003, the ADF&G conducted a reconnaissance inventory in 19 reaches upstream of Devils Canyon. In 2011, ADF&G returned to the Upper Susitna River subbasin and completed a standard AFFI fish inventory, with an emphasis on anadromous fish. During this effort, ADF&G sampled for fish presence using an electrofisher, recorded aquatic and riparian habitat characteristics at each fish sampling site, and conducted surveys to identify locations of spawning Chinook salmon. ADF&G prepared a synopsis of the 2011 fish inventory in November 2011 (Buckwalter 2011). The ADF&G Fishery Data Series (FDS) report that will describe these efforts in detail is currently being prepared (Buckwalter 2011).

In summary, Chinook salmon is the only anadromous species whose presence has been confirmed upstream of Devils Canyon to date[1] (AEA 2011a; Buckwalter 2011). The abundance and distribution of adult and juvenile Chinook salmon in the upper Susitna River has not been extensively studied. In addition to Chinook salmon, previous studies have documented that the 9 fish species listed below were present within stream and lake habitats upstream of Devils Canyon (ADF&G 1983a, Buckwalter 2011, and AEA 2011a).

- Arctic grayling (*Thymallus arcticus*)
- Longnose sucker (*Catostomus catostomus*)
- Round whitefish (*Prosopium cylindraceum*)
- Humpback whitefish (*Coregonus oidschian*)
- Burbot (*Lota lota*)
- Dolly Varden (*Salvelinus malma*)
- Lake trout (*S. namaycush*)
- Rainbow trout (*O. mykiss*)[2]
- Slimy sculpin (*Cottus cognatus*)

A summary of our initial review of information relative to fish distribution above Devils Canyon is presented in Appendix A, along with maps and tables generated from some of the existing studies. Additionally, photographs for some of the major streams in the study area, where available, are provided in Appendix B. This summary information is based on an initial review of a limited portion of the existing information and, as such, is considered a preliminary summary.

[1] In 2011, ADF&G extracted otoliths from whitefish captured above Devils Canyon to determine migration history; results are pending (Buckwalter 2012).
[2] Rainbow trout were documented in High Lake and Little High Lake in the Devils Creek drainage (Schmidt et al. 1984)

Potential Fish Barriers

A literature review of 1980s data and contemporary work (Buckwalter 2011) will be combined with a desk top analysis of topographic data to evaluate locations of potential fish barriers in the Upper Susitna River basin between Devils Canyon and the Oshetna River. This initial desktop work will be followed with helicopter aerial surveys flown in mid to late June. Tributaries will be surveyed from their confluence with the mainstem upstream to the 3,000-foot elevation. Potential barriers will be identified based on physical characteristics. The location of potential barriers will be marked on an aerial photograph, global positioning system (GPS) coordinates will be recorded, and oblique photographs will be taken.

Ground surveys will be conducted to evaluate potential barriers. Using a range finder and portable survey equipment, the ground team will collect measurements to estimate the height, horizontal distance, and slope of the barriers. If a feature can be unequivocally identified from the helicopter as the first barrier, ground verification of this barrier may not be necessary. Ground verification may also not be necessary if the stream gradient beyond the first potential barrier and up to the headwaters simply becomes too steep for Chinook salmon passage or suitable Chinook salmon spawning (DNR 2007).

Locations of the potential barriers will be identified and evaluated using protocol described by Powers and Orsborn (1985) and the Alaska Department of Natural Resources (DNR 2007). Given the discrepancies evident in these protocols one option is to evaluate potential barriers using the most conservative approach. For example, using Powers and Orsborn an adult Chinook salmon cannot pass a barrier height of approximately 8 feet, whereas DNR criteria indicate a height of 11 feet (Figure 3) constitutes a barrier. Using the most conservative approach, we will document the actual height of the obstacle and designate it as complete passage barrier to adult salmon if the height is 11 feet. Barriers surveys will be conducted during summer/fall low flow conditions either by wading, overland, or both. GPS location, photographs, drawings, and dimensions of all potential barriers will be obtained.

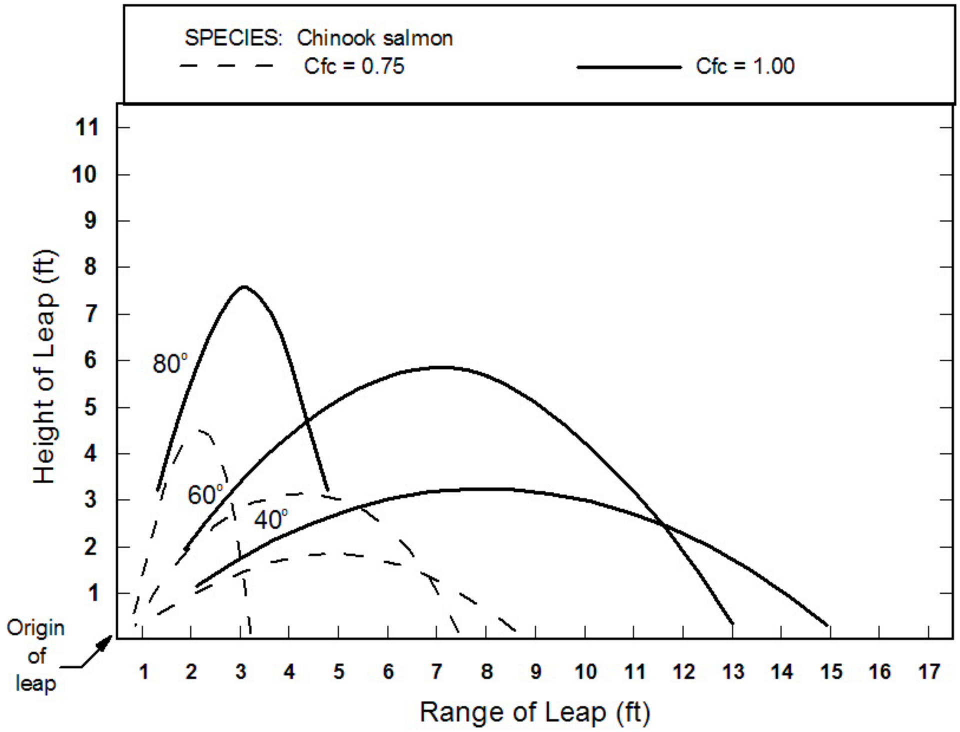

Figure 2. Chinook salmon leaping capabilities based on coefficient of fish condition (Cfc). Cfc = 1 corresponds to a fish in bright condition fresh out of salt water, Cfc = 0.75 corresponds to a fish in the river a short time with spawning colors apparent and still migrating upstream (Powers and Orsborn 1985). ADNR 2007 height of leap criteria is 11 feet.

Aquatic Habitat Characterization and Mapping

The previous information collected for the upper Susitna River aquatic habitats is limited. Uncertainties with respect to the total area of habitat that is utilized by Chinook salmon as well as the accessibility and feasibility of conducting standard aquatic surveys in these habitats remain. Because of the uncertainties associate with distance of habitat to be surveyed as well as the ruggedness, and remoteness of the study area, aquatic habitat mapping will be accomplished using aerial videography and photographic imagery coupled ground based surveys of approximately 20 percent (%) of the area to verify the aerial video and extend coverage into areas with poor aerial visibility.

This combination of methods will allow for efficient characterization of river habitats while ensuring safety during ground-based surveys. Sources of remote imagery will include Lidar and aerial photo products from the Matanuska-Susitna Borough Lidar & Imagery Project and low-elevation aerial video of the mainstem and larger tributary corridors. Habitat mapping using video imagery has proven effective in other systems allowing increased coverage of upstream aquatic habitats as compared to foot surveys. Habitat can be easily typed and delineated with quality video imagery. However, both weather and site-specific conditions can affect the quality of the video and the utility of the method. Therefore, the 2012 effort will be limited to selected tributaries to evaluate the effectiveness of this method. Future field efforts will be shifted from aerial video to on-the-ground mapping as appropriate if low-elevation aerial video does not provide the quality coverage that is expected.

While the remote habitat mapping will be applied where feasible, ground-based surveys will be focused on collecting data in wadeable streams and river reaches with closed canopies; i.e., not a good candidate for aerial video.

AEA will collect aerial helicopter videography of aquatic habitats in Kosina Creek, Jay Creek and Watana Creek all located in the reservoir inundation area up to an elevation of 3,000 feet. Video equipment will consist of a high resolution camera with integrated onscreen GPS. Video will be collected by a senior technician who has flown and successfully documented habitats in over 50 stream systems. The video will be shot during a period of low flows and high water clarity, likely in mid to late September 2012. Video will be edited and written to an interactive DVD. A ground-based team will map aquatic habitats in Kosina Creek, Jay Creek and Watana Creek to validate the aerial video results and extend coverage into areas obscured by vegetation. The ground-based mapping will cover approximately 20% of the area completed by the video assessment.

Ground Survey Method

Habitat units will be mapped to the mesohabitat level in accordance with the channel typing and aquatic habitat classification system currently in developed for the Project by the aquatic resources working group. Mesohabitats units will be defined based on a modified U.S. Forest Service (USFS) Tier III stream habitat survey protocol (2001). Habitats will be classified into designated mesohabitat classifications based on characteristics of that unit. Some sections of stream may contain two or more different habitat units. These parallel habitats will be delineated to the mesohabitat level, denoting a primary and secondary unit, and recorded correspondingly.

The habitat survey for each stream will be conducted by a two-person field team walking upstream. A global positioning system (GPS) point will be used to collect the upstream boundary of each mesohabitat unit. Maximum depth and pool crest depth will be recorded in meters and measured with a stadia rod. Wetted and bankfull widths will be recorded in meters and measured with a laser range finder. Dominant substrate type will be estimated by visual identification based on the USFS (2001) classifications.

The amount of large woody debris (LWD) observed will be counted for each habitat unit. For a piece of wood to be considered LWD, it must be at least 0.1 meters (4 inches) in diameter and at least 1.0 meters (39 inches) of the LWD had to be below the water’s surface at bankful flow (USFS 2001).

The amount of undercut bank (UCB) on each side of the stream will be measured to the nearest meter for each habitat unit. A bank will be considered undercut if the undercut is greater than or equal to 0.3 meters (12 inches) incised into the bank and greater than 1.0 meters (39 inches) long. If, at bankful stage, the bank would be considered undercut, then it will be measured even if it is above the current surface of the water (USFS 2001).

Video Method

Video equipment will consist of a high resolution camera with integrated onscreen GPS. All video will be collected by an experienced senior technician. An example of the visual quality of a screen capture from a previous low elevation aerial video is displayed below for reference (Figure 2). Note that this video was shot under ideal conditions. Similar quality may or may not be possible under different climate or topographic conditions. Additionally, the video will provide an important presentational tool to bring outside participants a perspective and view of the system that would otherwise require visiting the stream.

The video will be shot during a period of optimal water clarity during lower flow conditions in September 2012. The video will be shot from the right rear of the helicopter, with its cabin door off to allow for maximum direct viewing. A narrator/navigator will be positioned in the left front next to the pilot. The video elevation will be shot from 75 to 125 feet to allow for safe navigation, but sufficient resolution. The collected video will be post-processed into a navigable DVD that can be played on either an office computer or a home DVD player. The DVD will include a GPS stamp so that the viewer can reference the location on topography maps or with other existing aerial imagery databases. Video stills will be collected to also expand the available aerial imagery and support habitat mapping reporting.

Figure 3. Example of expected image quality from an aerial video still also displaying onscreen GPS and time stamp.

Aerial video mapping will be used to quantify the frequency of mesohabitat types and potentially to map woody debris and riparian vegetation. Video mapping will be used where there is no canopy or topographic cover hiding the channel. However, because tributary habitats may or may not be visible from the aerial video, the tributary assessments may rely more heavily upon ground-based mapping in accessible segments. Tributary junctions should be visible and will be noted during the aerial video fly-over. The results of the remote mapping will be used to develop a mesohabitat unit frequency. This cumulative frequency sampling approach is an extremely efficient way to inventory mesohabitats over long distances. .

Mesohabitats for visible tributaries or tributary sections will be assessed using a time-based frequency method. The video will be stopped at a predetermined time interval and the habitat type that is directly across the channel at the middle of the computer screen will be defined and documented. A line drawn across the video screen determines the dominant habitat at that “point.” The time interval is usually within a range of 3-5 seconds depending on the stream width and mesohabitat length, e.g., sections with short habitat units will use 3-second intervals, while sections with long habitat units will use 5-second intervals. Ground-truth data for every unit that is seen in the video and mapped on the ground will be used to “calibrate the eye” so that features seen in the video have a ground-based reference. Some reaches may use both video and ground-based habitat mapping data to calculate mesohabitat frequency for the entire reach. The video will not be used to measure channel dimensions; ground-based mapping will provide channel characteristics.

The larger tributaries and "open sky" sections of tributaries will be mapped by aerial video. The initial classification will serve to focus effort on accessible and more responsive segments of the tributaries. Effort will be focused on the three tributary streams identified above and downstream of Chinook salmon passage barriers upstream of the inundation zone. Ground-based mapping will be done in stream segments where habitat characteristics are not adequately discernible in the aerial video, are accessible, and generally less than 8% gradient (for safety and channel responsiveness). Poor visibility in the video is usually due to thick overhead vegetation, steep topographic relief, or small channel size. Ground-based mapping will also be conducted in stream segments that are conducive to mapping using aerial video. Ground-based mapping in streams visible in the video is used to "calibrate the eye" by physically measuring and typing specific habitat units observed in the video. Mesohabitat units assessed on the ground can then be "typed" in the remainder of the stream subreach using the video.

The results of the initial effort in 2012 will be reviewed and refined at the end of the study year. The initial findings will help to refine data collection efforts in 2013 and 2014. It is anticipated that this refinement will be coordinated with AEA and regulators to ensure sufficient information is gathered to address all study objectives. Further, it is planned that additional coordination between other study leads may help to refine study methods to benefit or supplement data gathering for other resource areas.

Adult Chinook Salmon Spawning Distribution

Habitat and fish presence studies that rely on direct observation are difficult to accomplish in glacially turbid streams. This study will employ visual observation methods which are restricted to clear-water areas. The 2012 efforts to determine the distribution of adult Chinook salmon will focus on 16 tributaries of the Upper Susitna River starting at Cheechako Creek (RM 152.4) and extending upstream to and including the Oshetna River. Few salmon are known to spawn upstream of Indian River (RM 138.5) and Chinook are the only salmon expected to be upstream of Devils Canyon, though observers will identify all other salmon species observed during the Chinook salmon spawning surveys. These surveys will be used to estimate numbers of Chinook salmon in the survey area.

Aerial surveys will be conducted within target tributaries from their confluence with the Susitna River upstream to the 3,000-foot elevation[3] or to adult salmon passage barriers.[4] If adult salmon are observed in the vicinity of 3,000-foot elevation then surveys will continue upstream until no adult salmon are observed or habitat is no longer suitable.

It is expected that the turbidity in the main stem Susitna River will severely restrict or preclude the ability to visually identify adult salmon. Thus, main channel surveys will focus on clear water areas including plumes at the mouths of tributaries and shallow margins and side channels where spawning fish may be observed.

Aerial spawning surveys will be conducted by a two-person crew from a helicopter. Personnel conducting the counts will be consistent throughout the study to ensure familiarity with the

[3] Most Chinook salmon have been observed downstream of a 3,000-ft elevation; however, a juvenile Chinook salmon was captured above an elevation of 3,000 feet in Fog Creek in July 2011 (Buckwalter 2011).

[4] Chinook salmon passage barriers will be identified prior to the spawning survey period.

streams being surveyed and overall observation consistency. Counts will be made from low altitudes (200 to 400 feet) at an air speed of up to 25 miles per hour (mph). Polarized sunglasses will be used to reduce glare. An experienced survey pilot will be requested to optimize aircraft positioning and minimize the effects of glare off the water. The entire survey route will be tracked with GPS and the survey results mapped in GIS.

Live salmon and carcasses will be counted separately. Counts will be recorded directly on a field data form. If aggregations of adult salmon are encountered an estimated size of the group will be recorded. All fish locations will be marked by GPS. Locations of individual fish and redds will be recorded. In the event of spawning aggregation, the lower and upper extent will be marked. Photographs of fish locations will be taken form the air and fish behavior will be described if possible (e.g., actively spawning, holding, or migrating). Due to the small numbers of fish expected in the Upper River it is anticipated that the survey will pause when fish are identified and an accurate count will be obtained.

As actively spawning salmon are located surveyors will, assuming a suitable helicopter landing zone is available in the vicinity, characterize habitat at active redds. For each identified redd, the following measurements will be made: 1) redd dimensions (length and width [to nearest 0.5 foot] to allow computation of area); 2) water depth to the nearest 0.1 feet at the upstream end of each redd measured using a top setting wading rod; and 3) substrate size (dominant, subdominant, and percent dominant). In addition, representative digital photographs of selected redds will be taken.

The 2012 surveys are planned to correspond with the peak Chinook migration. In 1983, peak Chinook salmon counts for Indian River and Portage Creek (RM 148.9) were obtained on July 25. Recent consultation with ADF&G confirmed that the most likely peak spawn time will be late July (Ivey 2012). Based on this information aerial surveys will commence around July 18 and be repeated approximately every 5 days for a total of four spawning surveys. Surveyors will coordinate closely with the AEA Adult Salmon Distribution and Habitat Utilization Study to obtain temporal and spatial information for radio tagged salmon that have been tracked above Devils Canyon.

It is likely that rain events will increase turbidity in some clear water streams, or within particular stream reaches. Surveys will be scheduled to take into account weather, water clarity, and aircraft availability. If weather delays occur the survey schedule will resume as soon as possible.

Visual surveys account for only a portion of the spawning population. At the time of any one survey, some of the salmon may not have reached their spawning destination, some may have already spawned and left the area, and some are present but unseen. This study is challenged by the vast extent of the survey area, large areas of turbid water, the relatively small number of fish that are expected to return above Devils Canyon, and a lack of documented spawning habitat locations. The intent of this study is not to estimate total escapement but only to determine an approximate count and the distribution of Chinook salmon migrating, holding, and spawning in the Upper Susitna River. The actual number of salmon sighted will be considered an indicator of relative abundance comparable to previous ground and aerial surveys and a minimum estimate of the number of fish present. Observer efficiency trials and expansion factors to account for observation error will not be developed for 2012 and may not be appropriate to apply to a system with so few fish.

Quality control will be addressed by employing two observers on each survey and completing a on- time calibration survey on Indian River concurrently with ADF&G. By duplicating the ADF&G Indian River survey on the same day the calibration survey will compare ADF&G results to AEA observer results. Immediately after each aerial survey, or during the survey if survey conditions change rapidly (e.g., weather affects visibility), observers will complete a standardized worksheet that rates an established set of aerial observation criteria including weather conditions, sun angle, overall visibility, overhanging vegetation, and relative fish density. A numerical rating for each survey will be calculated and used to provide an index of the observer's confidence in the estimate.

Adult Chinook Salmon Genetic Samples

To support ADF&G Chinook salmon genetic stock identification program genetic tissue samples will be collected from adult salmon on the spawning grounds in the tributaries above Devils Canyon. Samples will be collected opportunistically from adult Chinook salmon near death following protocols provided by ADF&G.

Distribution of Juvenile Chinook Salmon and Other Fish Species

Approach

The AEA upper river fish study team will conduct surveys to document fish species composition, distribution, and relative abundance with an emphasis on juvenile Chinook salmon rearing habitat in the mainstem Susitna River and selected tributary and lake habitats above Devils Canyon upstream to the Oshetna River (Figure1). The 2012 efforts will focus on conducting sampling for juvenile Chinook salmon and other fish species in habitats located downstream of Chinook salmon passage barriers and up to a 3,000-foot elevation. The team will also document species presence/absence in lakes that fall within the bounds of the expected reservoir inundation zone (Figure 1) or are below a 3,000-foot elevation and have passage to the main stem of the Susitna.

The AEA team will conduct the in-water fish sampling efforts during July and August at which time fish should be well distributed throughout feeding or rearing habitats. It is possible that some sampling efforts may start in late June and extend beyond the month of August, such as those in lake habitats or those associated with migration periods.

Sample site selection within accessible target stream reaches will be systematic and based on methods used during previous baseline fish distribution studies conducted by ADF&G (Buckwalter et al. 2010, 2011). The length sampled at each site will be determined in the field and will be equal to or greater than 40 wetted channel widths based on the mean wetted width at the site (Buckwalter et al. 2010). Mean wetted width will be calculated for a representative habitat transects perpendicular to the direction of flow across a representative non-pool channel unit. A calculation of average wetted width will begin with an initial measurement followed by two additional width measurements (upstream and downstream respectively from the initial one), at distances of five times the width of the initial measurement.

The 2012 sampling effort will target lakes that fall within the reservoir inundation zone as well as those identified in Figure 1. The team will use a combination of gear types to sample for various fish species and size ranges at varying depths, as identified below. A minimum of two transects running in a north/south and east/west pattern will be recorded. If possible, transects will be established so that they intersect at what is believed to be the deepest part of each lake sampled. Sample sites will be flagged in the field and the location recorded on a handheld commercial grade GPS unit.

In stream habitats, the primary methods to document fish species distribution will be electro-fishing, either by boat or backpack method, depending upon stream size, water velocity, water clarity, accessibility, and safety. The bulleted items below provide a generalized basis for selection of sampling method.

- **Boat Electro-fishing** will occur in larger streams (> 15 meters wide) that are accessible by boat and contain either clear or turbid water conditions.
- **Backpack Electro-fishing** will occur in shallow streams (generally < 15 meters wide) can safely be waded and have either clear or turbid water.

Sampling method selection will be variable based on site- specific habitat conditions such as water depth, flow, and wetted width. For example, stream channels containing very high water velocity and/or high turbidity may not be suitable for any of the above sampling methods. For these streams, alternative sampling methods may also be used. In lake habitats, the team will use a combination of gear types (fyke nets, seines, angling, gill nets, and minnow traps) to sample for various fish species and size ranges at varying depths.

Information collected at each sample site will include site identification number (ID), crew members, date and time, weather conditions, surface water temperature, a general description of flow conditions and water clarity, conductivity, and beginning and ending sample locations. Information specific to each gear type will also be recorded, electro-fisher 'time on and time off', etc., so that catch per unit effort can be calculated for each gear type. The team will also record habitat parameters specific to each site or sample reach. Parameters will include: habitat type (using USFS habitat classifications designated for this Project), estimated thalweg depth, estimated average wetted width and bank full width, dominate in-water cover type, and estimated dominate and sub-dominate substrate. To the extent possible, habitat data will be collected using habitat classification parameters consistent with related studies.

Electro-Fishing

Single pass open system electro-fishing methods will be used; quantitative methods will not be used during 2012. The team will use a back-pack electro-fisher to sample wadeable streams and a raft-based electrofisher for non-wadeable streams. If adult salmonids or aggregations of large (>300 millimeters) salmonids are encountered, electrofishing activities in the immediate vicinity will cease, except to capture fish for species identification (Buckwalter et al. 2010) or to collect specimens needed for tissue and otoliths samples.

Backpack electro-fishing will be conducted with a Smith-Root LR-24 (or similar) electro-fisher. Electro-fish settings will be determined in the field based upon water quality conditions, professional judgment, and the overall goal of minimizing impacts to fish health. Backpack electrofishing will be conducted by trained staff, using a protocol consistent with Buckwalter (2010) and the following guidelines: Guidelines *for Electro-fishing Waters Containing Salmonids Listed Under the Endangered Species Act* (NMFS 2000); *Fish Exclusion Protocols and Standards* (2006); and *Backpack and Drift Boat Design Considerations and Sampling Protocols* (Temple and Pearsons 2007).

Boat based electro-fishing will be conducted from a 13- to 16-foot long raft or an aluminum hulled jet-boat depending on site and flow conditions. Boats will be outfitted with a Smith-Root electro-fisher (kVA size to be determined) that will include a cathode arrangement across the stern of the boat and two anode arrays positioned off the bow. The size of the sampling crew will consist of two to three people depending on site conditions and safety considerations. One or two netters will be positioned on the bow of the boat. Typically during fish collection, the boat operator will maneuver the boat laterally across the current while moving downstream, while a second crew member will collect fish with a dip net from the bow.

Fish that are captured using electro-fishing methods will be held in buckets and/or live wells until the sampling of each reach is complete. All fish will be identified to species and counted. Up to 100 fish collected at each site will be measured to the nearest millimeter to record fork length; total length will be recorded for species whose caudal fins are not forked. Fish will be released within the sampling reach once electro-fishing has ceased. Fish disposition (e.g., unintended mortality, voucher specimen, injury) will be recorded for each fish handled. All data will be recorded on a standardized datasheet or field computer form.

Lake Sampling Gear

The team will use a combination of gear types to sample for a variety of fish species and life stages throughout representative habitats present. Sampling may include the use of fyke-nets, baited minnow traps, multi-mesh gill nets, seine nets, and angling gear. The gear used at individual sample sites will be a function of habitat conditions encountered. The field team will record GPS locations for each sample site, and document general aquatic habitat characteristics. If fish are present, catch per unit effort will be calculated for each gear type.

Gill nets will be situated perpendicular to shore and fished at varying depths. The team will deploy nets for several hours at a minimum and will check nets periodically to minimize potential fish mortality. To the extent possible, the team will sample multiple locations throughout each lake, including around the inlet and outlet areas. If no fish are captured within several hours, gear will be set overnight. The team will use an inflatable boat and/or drysuits to deploy gear in offshore habitats. Gear type specifications are as follows:

- Minnow traps (also known as basket traps) will be deployed in both streams and lakes. The traps are 436 millimeters long by 229 millimeters in diameter with 6.4 millimeters (¼ inch) or 3.2 millimeters (⅛ inch) mesh size. Traps will be baited with commercially processed roe and secured to vegetation or rock anchors to soak overnight (roughly 24 hours).

- Fyke nets will be used to document fish species presence in both stream and lake habitats. The team will rely primarily on relatively small fyke nets in 2012. The fyke nets are constructed of ¼ inch (44-pound) green treated netting with two metal rectangular entrance frames (27 by 39 inches), a vertical net throat and 4 metal hoops with a single 6-inch diameter throat. The maximum depth fished is approximately 33 inches. The cod end (fish containment) is 8 feet long. Each net will be fished with attached wings and detachable center leads with floats and weighted line. Alternative fyke net sizes and designs may also be used in 2012.

- Beach seines may be used to target fish too small to be captured by traps or species that typically do not recruit well to traps. The team will use a variety of sizes, including a 1.2-meter (4-foot) by 6.1-meter (20-foot) black mesh beach seine with 6.4 millimeters (¼ inch) mesh. The seine should be adequate to sample slow water habitats, such as small pocketwater and backwater sloughs, but will likely not be suitable in areas with swift current. Beach seine sets will be timed and involve a single pass through the sample area.

In addition to biological information, connectivity to other surface-water bodies will be documented. Bathymetry data are available for Lake Sally and Clarence Lake; collection of bathymetry data may be necessary for other lakes identified as providing habitat for fish species. The team will identify lakes where bathymetry data may need to be collected in future study years. To the extent possible, the team will collect depth data at a reconnaissance level using a tag line or electronic depth finder to record depths these lakes.

Genetics Sampling

Tissue samples will be collected from juvenile Chinook salmon captured during the fish distribution studies described above. These samples will support ADF&G's genetic baseline development for Chinook stocks of the Upper Susitna River. Study goals, sampling objectives and protocols will be established by staff at ADF&G's genetics laboratory. Samples will be collected on an opportunistic basis during the 2012 fish distribution surveys. Due to the anticipated low densities of juvenile Chinook in the Upper Susitna River, sample collections over multiple years may be required to meet ADF&G's goals.

Genetic samples will also be taken opportunistically from Arctic grayling, whitefish, burbot, and Dolly Varden for the ADF&G genetics program.

Main Stem Fish Sampling

In 2012, sampling efforts in the main stem Susitna River will primarily target habitats where conditions appear to be suitable for juvenile Chinook salmon (and other species), such as sloughs, in the vicinity of tributary mouths, and throughout side channels. In the 1980s, researchers identified and sampled four major spring-fed sloughs above Devils and identified six other sloughs from color aerial photos (ADF&G 1983a). The team will review available imagery and existing data prior to initiating field sampling, as discussed above. The team will also try to relocate main channel sites that were identified and/or sampled in the 1980s.

The method used to determine the length of the survey in side channels or sloughs will be similar to that described above for tributaries. If the side channel or slough is relatively homogeneous in nature, wetted width will be determined using five wetted width measurements collected randomly in proximity to the selected sample site; otherwise, the same method for determining channel width described for tributary streams will be used.

It is assumed that boat-based electro-fishing will be used as the primary fish collection method in the main stem Susitna River. However, other sampling methods and gear (e.g., backpack electro-fishing or nets) may also be used in select areas. The field crew leader will select sample sites in the main stem based on the criteria listed below using similar methods developed by ADF&G (Buckwalter et al. 2010):

1. The sample site must be able to be safely floated by raft.
2. Where the crew leader anticipates that anadromous or resident fish could be present, based on observable characteristics including: fish observed from the air, substrate, velocity, aquatic habitat types, stream flow and experience of fish presence in adjacent and similar water bodies previously sampled.

3. Main stem areas located immediately downstream of a major tributary.
4. Where up-welling or down-welling areas have been identified.
5. If applicable, having a safe helicopter landing zone located close enough to the target stream at both the upstream and anticipated downstream ends of the area to be sampled.
6. If applicable, where the landing zones at the put-in and take-out point and the sample site are on lands where previous access approval has been obtained.

Fish sampling planned for the 2012 season includes multiple gear types that will target various fish species and size ranges. The team will use the results of sampling efforts, as described above, to determine fish species composition and relative abundance of fish species within the reservoir inundation zone. Locations of salmon observations will be documented with GPS. Active salmon spawning locations, if present, will be identified and communicated to the salmon spawning ground survey crew.

Otolith Microchemistry

Otoliths will be extracted from Dolly Varden and humpback whitefish to document life histories exhibited by these fish populations in the upper river. Strontium (Sr) distribution within otoliths has been used to describe fish migrations between marine and freshwater environments (Brown et al. 2007). Due to the expected low probability of anadromy above Devils Canyon a large sample size likely will be necessary. A sample size of 10 fish has a 97% probability of selecting one anadromous fish when the actual proportion of anadromous fish in the population is 30% or greater (Brown et al. 2007). The goal during 2012 will be to collect up to 30 adult Dolly Varden and up to 30 adult humpback whitefish.

This analysis determines strontium Sr concentrations across a cross section of the otolith. The laboratory analysis will include otolith Sr or strontium-to-calcium ratios which can be used as a tool to reconstruct the chronology of migration among salinity environments for diadromous salmonids (Zimmerman 2005). Predetermined thresholds from known anadromous and non-anadromous fish standards in published literature will be used as the reference. In whitefish, a Sr concentration above the threshold of 1,700 parts per million indicates exposure to marine conditions during the fish's life history (Brown et al. 2007).

Angling and gill nets will be the primary collection method for this task however; adult Dolly Varden and humpback whitefish captured during sampling as part of other upper river investigations may also be retained for otolith microchemistry analysis. Large fish, which are more likely anadromous, may be most readily caught when they congregate for spawning in the fall however; whitefish spawning typically occurs late in the fall and even after freeze up therefore; in order to obtain the target sample size of 30 adult fish from each species, fish will be collected throughout the open water period in whichever location and riverine habitat they are readily captured. If greater than 30 fish are collected, otoliths from the largest specimens will be analyzed.

Immediately following capture, the collection site will be located with a GPS, the fish will be measured, weighed, photographed, bagged whole in plastic bags, and transported in coolers. Otoliths will be extracted either at a field camp or back at the office. Otoliths will be individually labeled to assure analysis results can be linked back to each specimen's length and weight measurements and shipped to the laboratory for microchemistry analysis. At the time of this study plan a laboratory to perform the analysis has not been contracted.

Tissue Metals Content

Tissue samples also will be collected from Dolly Varden, Arctic grayling, lake trout, burbot and whitefish species to evaluate baseline metal levels in fish that may be used for human consumption. This may also support wildlife investigations of metals in prey for piscivorous furbearers. This effort will be in support of the water quality study. Fish tissue metals content analysis will be conducted on tissues from fish collected during 2012. Up to seven whole-body samples will be collected for each species. Muscle tissue will be analyzed independently for each specimen collected.

Samples will be collected opportunistically in conjunction with the fish distribution studies described above. Angling and gill nets will be the primary collection method for this task however; adult resident fish captured during electrofishing sampling may also be retained for tissue metals content analysis. In order to obtain the sample size of seven fish from each species, fish will be collected throughout the open water period in whichever location and habitat they are readily captured including lakes

Specific protocols for handling fish will be provided by the water quality study lead and the laboratory contracted to process the samples. Chain of custody (COC) seals provided by the laboratory will be placed on each sample bag in the field.

Data Analysis

Catch per unit effort (CPUE) will be determined by dividing the catch (number of fish captured or observed) by the effort (electro fishing time). Data collected using different methods will be normalized so results can be appropriately compared to the extent possible. CPUE will be determined for each species in each stream reach and gear type. CPUE will be compared between reaches to determine the greatest relative abundance for each species.

Due to small sample sizes and the likelihood that the data will not be normally distributed, a nonparametric analysis of variance (ANOVA) will be used to determine if there are statistically significant differences in CPUE between reaches. It is anticipated that the 2012 results will be qualitative in nature and will be used to develop quantitative objectives for the 2013–2014 study seasons.

Relative abundance will be determined by species for each stream reach sampled. Relative abundance values between reaches will also be compared statistically using similar methods as described above. Length frequency distribution graphs will be produced for each species and life stage to determine age classes present in catch.

PROJECT NEXUS

The proposed Project will inundate approximately 39 miles of the Susitna River (~RM 184 to ~RM 223) and operations will modify the flow, thermal, and sediment regimes downstream to and beyond Devils Canyon (~RM 150 to RM 154). Tributaries to the Susitna River within the proposed reservoir will be inundated up to an elevation of approximately 2,100 feet mean sea level (msl) at normal maximum full pool and will be subject to seasonal water level fluctuations between approximate elevations of 2,000 feet and 1,850 feet msl.

In addition, the Project will block fish migration between the upper and lower river at RM 184 and will alter stream flow through Devils Canyon, potentially impacting fish passage conditions through the canyon. Understanding the distribution and relative abundance of Chinook salmon populations above Devils Canyon and the proposed Dam site is essential to assess potential impacts to Chinook salmon, refine Project design, and develop Protection, Mitigation and Enhancement measures (PM&Es).

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

Upper River Fish and Aquatic Issues (Upstream of the Watana Dam Site [RM 184])

- F1: Effect of change from riverine to reservoir lacustrine habitats resulting from Project development on aquatic habitats, fish distribution, composition, and abundance, including primary and secondary production
- 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

Information from this study will also be used to identify study areas or potential survey locations for other studies such as Instream Flow and the 2012 F-S3 Adult Salmon Distribution and Habitat Utilization Study.

DATA MANAGEMENT AND GIS

The AEA field teams will record site coordinates using a handheld GPS. Where appropriate, to increase accuracy and reduce processing involved with migrating data from field to office servers, field computers will be used to collect aquatic habitat and fish capture data,. Data will be directly integrated into the Susitna-Watana Project database and distributed to resource specialists quickly and efficiently. The AEA team will follow the Quality Assurance (QA)/QC protocol establish for the Sustina Fish Program and will submit original data collected in 2012 to the Fish Program Data Resource Manager for post-QC processing and conversion into the geospatially-referenced relational database.

Field Protocols and Data Consistency

Prior to field sampling events, all field staff will meet to review study objectives, sampling protocols, and documentation requirements. Multiple fish identification reviews will also be conducted prior to entering the field. During the first day of the field event, field crews will conduct surveys together to ensure consistency of sampling methods and data documentation, accuracy of species identification, and fish length estimates.

Each field team will carry fish identification reference material to minimize the number of fish relegated to the ‘unknown species’ classification. However, if a fish cannot be positively identified, the fish will be recorded as “unknown”. If a juvenile salmon cannot be identified to species (sometimes juvenile coho and Chinook can be difficult to distinguish from one another- namely at lengths less than 40 mm or greater than 100 mm), the fish will be recorded as “salmon, coho salmon, or Chinook salmon”. Representative specimens of fish unable to be identified in the field will be retained and identified in the lab (e.g., count of gill rakers or fin rays).

Data Entry and Quality Assurance/Control Protocols

Data collected during 2012 will be recorded on field data sheets or on mobile GIS systems. Field data sheets will be available at all time should the electronic system fail to operate properly. A Level I Qualtiy Control (QC) review will occur at the end of each field day. All information on data sheets will be reviewed by the field team leader for accuracy and completeness. Data captured by mobile GIS systems will be reviewed for accuracy and backed up on a lap top or tough book computer. Upon returning to the office all data will be entered or transferred into an electronic database (ARC GIS). All field forms and log notebooks will be scanned and filed in the project filing system. Level II QC review will occur at the office, and will include a line by line verification of data entries. Level II QC review will include the project leader reviewing data for outliers and anomalies.

PRODUCTS

Data

Data will be entered into the relational database described below. All original data collected in the field in 2012 will be QCed and delivered to the Fish Program Data Resource Manager prior to submittal to AEA.

Geospatially-Referenced Relational Database

All data generated during this study will be incorporated into the Susitna Fish Program geospatially-referenced relational database. This database will form the basis for additional data collection in 2013-2014. All new field data will be associated with location information collected using a GPS receiver in unprojected geographic coordinates (latitude/longitude) and the WGS84 datum. Naming conventions of files and data fields, spatial resolution, and metadata descriptions will meet the DNR standards established for the Susitna-Watana Hydroelectric Project.

Spatial Products in ArcGIS Software

The geospatial products will include geospatially referenced relational databases, maps presenting areas sampled, adult Chinook salmon locations by survey, habitat data, and locations of significant features such as barriers and springs. Naming conventions of files, data fields, and metadata descriptions will meet the DNR standards established for the Susitna-Watana Hydroelectric Project. All map and spatial data products will be delivered in the two-dimensional Alaska Albers Conical Equal Area projection, and North American Datum of 1983 (NAD 83) horizontal datum consistent with DNR standards.

Summary of Interim Results

The AEA team will prepare a brief interim report to summarize the study's progress, identify Chinook salmon presence, and identify any issues that have occurred, and provide a basis and allow for further refinement of 2013–2014 Study Plans. The interim report will be delivered to the Fish Program Manager for senior review prior to submittal to AEA.

Technical Memorandum

AEA will complete a technical memorandum that will present data collection and analysis methods and results of field and office-based efforts (including graphic outputs) relevant to this task. This memorandum, which will include spatial data products, will be delivered to the Fish Program Manager for senior review prior to submittal to AEA.

Annual Project Report

An annual report will be prepared to document the methods, field effort, results, conclusions, and recommendations from the 2012 study.

SCHEDULE

This is a multiyear study. The following tentative schedule is for the significant 2012 scope of work deliverables. The schedule for the 2013–2014 components will be developed with AEA, the AEA-selected environmental consultant, during the final 2013–2014 study planning process.

- Final 2012 Study Plan — March 20, 2012
- Original QCed 2012 Data — December 2012
- Summary of Interim Results — September 10, 2012
- Annual Project Report — Decembe 2012

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